ESTIMATING DEFAULTS IN ORGANIZED SECURITY LENDING MARKETS: AN EMPIRICAL STUDY ON A DEFAULT INDICATOR

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Thesis Abstract

Latif Cem Ösken, "Estimating Defaults in Organized Security Lending Markets: An Empirical Study on a Default Indicator"

Security lending is a simple financial transaction that leads to credit risk like every other lending transaction. This thesis aims to analyse the dynamics of the security lending process and lending markets in order to identify the variables that can affect the credit risk arising from lending contracts and supplement the internal rating models commonly used for credit risk management with models that incorporate characteristics of the stock borrowed.

Using the data provided by İstanbul Settlement and Custody Bank on the equity lending contracts of Takasbank Securities Lending Market between 2010 and 2012 as well as the data provided by Borsa İstanbul on Equity Market transactions for the same timeframe, this thesis focuses on whether stock price volatility, stock returns and the relative liquidity of lending market and equity market affect the defaults of lending contracts. The results of the thesis illustrate a statistically significant relationship between volatility and the default state of the lending contracts but fail to establish a connection between default states and stock returns or relative liquidity of markets.

Keywords: Security lending, Equity lending, Takasbank, Securities Lending Market, Credit risk management in security lending, Default estimation in security lending

Tez Özeti

Latif Cem Ösken, “Organize Menkul Kıymet Ödünç Piyasalarında Temerrüt Tahmini: Temerrüt İndikatörü Üzerine Ampirik Bir Çalışma”

Menkul kıymet ödüncü, diğer tüm ödünç işlemleri gibi kredi riski doğuran, basit bir finansal işlemdir. Bu tez, menkul kıymet ödüncü sürecinin ve ödünç menkul kıymet piyasalarının dinamiklerini inceleyerek menkul kıymet ödünçlerinden doğan kredi riskini etkileyebilecek değişkenleri tespit etmek ve ödünce konu kıymetlere ilişkin piyasa dinamiklerinden faydalanarak kredi riskini yönetmek amacıyla sıklıkla kullanılan içsel derecelendirme sistemlerini destekleyecek bir model geliştirmeyi amaçlamaktadır.

2010 ve 2012 yılları arasında Ödünç Pay Piyasında gerçekleştirilmiş olan ödünç işlemlerine ilişkin İstanbul Takas ve Saklama Bankası tarafından sağlanan veriler ve aynı dönem için Borsa İstanbul tarafından sağlanan Pay Piyasası işlem verilerini kullanarak; pay fiyatlarının oynaklığı, pay fiyatları ve bahse konu piyasaların göreli likiditeleri ile ödünç sözleşmelerinin temerrütleri arasındaki ilişkiler incelenmiştir. Sonuçlar, oynaklık ile ödünç sözleşmelerinin temerrütleri arasında istatistiksel olarak anlamlı bir ilişkinin varlığını göstermiş fakat likidite ya da pay fiyatları ile temerrütler arasında ilişki kurulmasına imkan vermemiştir.

Anahtar kelimeler: Menkul kıymet ödüncü, pay ödüncü, Takasbank, Ödünç Pay Piyasası, menkul kıymet ödünücünde kredi riski yönetimi, menkul kıymet ödüncünde temerrüt tahmini

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TABLES

ABBREVATIONS

CCP: Central counterparty

CRA: Central Registry Agency (Merkezi Kayıt Kuruluşu)

CMB: Capital Markets Board of Turkey (Sermaye Piyasası Kurulu)

CML: Capital Market Law

IOSCO: The International Organization of Securities Commissions

OPP: Ödünç Pay Piyasası (Takasbank Securities Lending and Borrowing Market)

OTC: Over-the-counter

CONTENTS

CHAPTER 1: INTRODUCTION

The act of temporarily gaining the possession of a security in return for a fee is, in simplest terms, security borrowing. In that context, the previous possessor of the security is called the lender and the act is security lending. Although a fairly simple transaction, the act of lending a security can have various motives and thus the details of the transaction vary accordingly. This market also involves various risks such as credit risk, liquidity risk, market risk, operational risk, legal risk, settlement risk, custody risk, recall risk and manipulation and insider trading risks. While these risks are recognized by The International Organization of Securities Commissions (IOSCO), only some of them are measured such as value-at-risk models used for measuring the exposure to market risks and internal rating models to measure the credibility of borrowers.

Security lending in Turkey can be executed in either Securities Lending and Borrowing Market (referred as OPP hereafter) operated by the İstanbul Settlement and Custody Bank or as over the counter (OTC) transactions via brokerage firms. The brokerage houses that are eligible to operate in Turkey can; on behalf of their customers or themselves, can execute transactions in the OPP. The constraints on the type of securities and the collaterals related to transactions are discussed in detail in “Market Risk” section. Established in 2005, the OPP operates in accordance with the Takasbank Regulation on Directives of OPP (2005, revised 2013). The regulation aims creating an efficient and trusted lending market that is resistant against systemic shocks with enough depth and width to support the growth of the Turkish capital markets (Tuna, 2012). Takasbank acts as the central counterparty (CCP) in every transaction in the market, effectively creating as two transactions for every matched bid and offer by acting as the buyer versus the seller and vice versa. This practice practically eliminates credit risk for the lender while creating credit risk for the CCP. A central counterparty is a financial institution that isolates the parties of a contract from the risk of each other's default by creating two virtual contracts against the original one and acting as the buyer versus the seller and vice versa. Thus, the original parties of the transaction are only exposed to the default risk of the CCP while the CCP accepts the default risks of both parties, usually against collaterals.

Takasbank has, in addition to the market operator and settlement house roles, been acting as the CCP in OPP since 2 September 2013 and thus, each and every transaction in OPP creates a credit exposure to Takasbank, in addition to other risk types. Operating a security lending market, even without the CCP role, creates wide variety of risks for both the market operator and the participants. However, it would be fair to assume that the greatest risk a CCP is exposed to, is the credit risk. As such, Takasbank has an internal rating model to assess the credibility of the market participants to set credit limits and created a dynamic collateral system in which the haircuts of the collaterals provided by the borrowers can change in accordance of price movements. However, this model ignores market-wide factors that can act as incentives for borrowers to default for higher returns. Accordingly, this thesis aims to develop a default indicator in organized security lending markets in Turkey that focuses on market information such as liquidity, return and volatility of the underlying asset.

Organized Security lending in Turkey was established in 2005 and has been growing ever since. There are almost 18000 contracts traded annually on a number of stocks ranging from 250 to 290 with a value of approximately 2.2 billion TRL. While the market is fairly new and the trading volumes are relatively low, the defaults in this market have amounted to more than 10 million TRL in transaction volumes and caused disruptions in the equity transactions for the past decade. Hence, it is important to develop a default estimator.

Managing the credit risk is an issue as old as the concept of credit itself. The classical approach depends on almost exclusively the analysis of the experts by using the character, capital, capacity and the collateral of the potential debtor (Altman & Saunders, 1998). Due to the subjectivity of the experts involved, most financial institutions are now using more objective methods to assess credibility. Methods chosen range from purely statistical models where all the limit decisions are made by the system to expert systems where little data is available on debtors and underwriters use models to guide or drive decisions (Anderson, 2007).

Security lending has, in its essence, differences from bank loans. A borrower who has both the motive and the cash needed to deliver the security borrowed can still default, if he/she cannot acquire the security in time. This leads to an interesting conundrum from the credit risk management perspective; debtors who are both willing and able to pay can still default. The added incentive to voluntarily default a lending contract, arising from the possibility of acquiring the security with a lower cost in times of extreme price drops of the security borrowed, just further complicates the default estimates. Considering the difficulties presented by the unique characteristics of lending markets, we posit that internal rating models, which rely on debtor data, can be supplemented with; liquidity, price and volatility information of the security subject to transaction for better default estimation on a contract basis. It can be argued that default in these markets can be triggered by three main issues: (i) higher stock volatility, (ii) lower liquidity, and (iii) lower stock returns in organized stock exchanges. The results successfully demonstrate that stock volatility carries meaningful information on defaults in security lending transactions but they fail in establishing a meaningful relationship between the liquidity of the stock borrowed relative to the borrowed amount and defaults as well as the price changes of the borrowed stock and defaults.

Chapter 2 presents the literature review on and an overall risk analysis of the security lending markets in order to lay out the theoretical basis of the discriminants proposed for default estimation. Chapter 3 introduces the data and methodology and discusses the empirical results and chapter 4 concludes.

CHAPTER 2: LITERATURE REVIEW

Overview of the Securities Lending Market

The security lending transactions are generally classified into three groups; security lending, repurchase agreements and sell-buyback agreements (IOSCO, 1999). Each of the three main groups shares similar characteristics like usage of margined collaterals, variation margin (with the exception of buy/sell-back transactions) while also having unique features. The economic outcome of sale and repurchase agreements (repo) and buy/sell-back agreements are quite similar to the outcomes of lending transactions however there are some important nuances from legal and accounting perspectives. Repo transactions occur by creating one master agreement that explicitly contains the sale and resale prices and the time of the spot and forward sale transactions. The actual amounts of cash stated in the master agreement are also exchanged in the agreed dates as opposed to lending transactions where collateral plus lending fee and the securities borrowed are usually exchanged. As for buy/sell-back transactions, the main difference arises from the fact that unlike repo transactions, there are two different sales contracts. One contract is for the spot sale transaction of the security while the second contract is a forward buy-back contract that is signed simultaneously with the spot one. Table 1 presents the comparison of security lending transaction types. Security lending transactions vary among seven characteristics that are; method and form of exchange of securities, the types of collaterals used and margining rules, maturity, asset type, motivation and payment. Securities lending can be made with cash collateral or posting other securities as collateral for the borrowing transaction.

Table 1: Comparison of Security Lending Transaction Types

Characteristic	Securities Lending	Repo	Buy/Sell Back
	Cash Collateral / Non-cash Collateral	Specific Securities / General Collateral	
Formal Method of Exchange	Sale with agreement to make subsequent reacquisition of equivalent securities	Sale and repurchase of terms of master agreement	Sale and repurchase
Form of Exchange	Securities vs. cash	Securities vs. cash / Cash vs. securities	Cash vs. securities
Collateral Type	Cash / securities	Cash / General collateral or acceptable collateral as defined by buyer	Typically bonds
Return is paid to the supplier of	Cash collateral / Loan Securities	Cash	Cash
Return payable as	Rebate interest / Fee	Quoted as repo rate, paid as interest on cash collateral	Quoted as repo rate
Initial margin	Yes	Yes	Possible
Variation margin	Yes	Yes	No
Over-collateralization	Yes	No / Possible	Possible

Table 1. Continued

Characteristic	Securities Lending	Repo	Buy/Sell Back
	Cash Collateral / Non-cash Collateral	Specific Securities / General Collateral	
Collateral substitution	Yes (determined by borrower)	No / Yes	No
Dividends and coupons	Manufactured to lender	Paid to original seller	No formal obligation to return income
Legal set off in event of default	Yes	Yes	No
Maturity	Open or term	Open or term	Term only
Typical asset type	Bonds and equities	Mainly bonds, equities possible	Almost definitely bonds
Motivation	Security specific dominant	Security specific / Financing	Financing dominant
Payment	Monthly in arrears	At maturity	At maturity

Source: (Faulkner, 2006, p.30)

While every transaction that involves the temporary transfer of the ownership of a security can be broadly defined as a securities lending market transaction, there are two similar but also distinct facets of this definition: “security-based” and “cash-based” lending markets. Generally, each type of these transaction types are associated with different lending market types although all types of security lending activity, at least in theory, can occur in both of those market classes (Aksoy, 2006).

Security-Based Lending Markets

The security-based market borrowers seek to gain access to certain securities temporarily to overcome settlement failures, deliver short-selling obligations or arbitrage opportunities (IOSCO, 1999). The transfer of the security is usually accompanied with some kind of collateral, usually cash (Geczy, Musto, & Reed, 2002; Ali, 2009), although in some markets this norm may differ. In Canada, for example, approximately 80 percent of the lending agreements executed by custodian banks are against non-cash collateral (Bank of Canada, 2010).

Cash-Based Lending Markets

In cash-based lending markets, investors use securities as collateral to obtain cash financing. The cash lender, generally, does not seek specific securities and allow the cash borrower to select within predefined categories of securities based on cash lenders risk appetite (IOSCO, 1999). Thus, in markets where bilateral lending transactions occur, the securities borrower also becomes the lender for cash.

Mechanics of Lending Markets

The lending transactions can vary from simple, bilateral transactions where the security is exchanged between the lender and the borrower alongside the collateral and the rebate fee to much more complex ones involving intermediaries, custodians and collateral management facilities (Vanguard Corp., 2011). As a rule of thumb, lending fee and terms are freely negotiated between parties with terms ranging from O/N to open -unspecified- terms (Faulkner, 2006). With the exception of simplest of transactions, settlement will usually be through the lender's custodian bank or the organized market operator's settlement agency. The settlement procedures of delivery versus payment, delivery versus delivery and the lack of a settlement agency are discussed in detail in the "Settlement Risk" section.

Risk Analysis of Security Lending Markets

As an integral part of the capital markets, security-lending transactions are exposed to a number of types of risks while the transactions themselves are also sources of risks. One approach to categorize the types risks associated with security lending activities is to use two main groups of risks: credit risk and transaction risk based on the lender's ability to mitigate them with the lender being able to mitigate the credit risks to a certain degree while having no practical control on transaction risks (Yetim, 1997). Yetim (1997) classifies credit risk into subgroups of; legal risk, collateral risk and default risk while transaction risks are divided into four subgroups consisting of; delivery and settlement risks, internal systems and control risk, custody risk and transaction costs and regulation related risks. While this may be a useful approach to divide risks, it can be argued that the mitigation ability may not be such a clear distinction. A lender can assess the credibility of a borrower by using corporate governance data to mitigate for borrowers with weak internal control environments while the legal scope of the contracts may not be negotiable in a given market. Also, assessing the risks from the perspective of a single transaction will likely miss the systemic shocks that can arise from a market. Another approach to identify risks for lending activities is using 7 subgroups consisting of; credit risk, liquidity risk, market risk, legal risk, operational risk, settlement risk and custody risk (IOSCO, 1999). While this approach does not use arbitrary categories for separation between different risk sources, the scope still leaves out the manipulation and insider trading related risks. In our study, we will use the 7 risk groups used by IOSCO plus the recall risk (D'Avolio, 2002) for identifying possible default discriminants. This thesis particularly focuses on credit risk, liquidity risk and market risk. The remaining risks such as legal and operational risks are out of the scope.

Credit Risk

Credit risks are risks that arise when a counterpart defaults on its obligations in a securities lending transaction or the borrower does not return the loaned securities and there is insufficient collateral to buy in the securities (Bianconi, Collot, & Knepper, 2010). In securities lending transactions credit risk can be classified into two main groups, the risk of loss of full value of securities that a non-defaulting party has transferred to a defaulting party is classified as principal risk. The other subgroup, called the replacement risk, consist of the risks that arise from lending transactions are initially fully collateralized and where a delivery versus payment/delivery settlement mechanism exists. After a default, the non-defaulting party may or may not cover the replacement costs of the borrowed security with the defaulting party’s collaterals and thus incur replacement costs (IOSCO, 1999).

In OPP, the borrowers are required to set up collaterals with an initial margin of 120 percent of the transaction value and the maintenance requirement is a margin of 105 percent of the market value of the borrowed securities.

Takasbank functions as CCP in OPP and guarantee the elimination of the default risk of the actual borrower so that the actual lender has practically no exposure to credit risk. However this model obviously does not eliminate the credit risk, just transfer it to Takasbank. In order to manage this credit risk, Takasbank has identified relevant financial ratios and other moral discriminants pertaining to the credibility of the brokerage houses operating in OPP. Studies have shown that using several key financial ratios alone to predict the possibility of defaults without at least a statistical model to weight them is not a prudential approach (Altman, 1968). The quality and consistency of management, market position and other non-financial factors are known to yield information on the possibility of corporate defaults (Grunert, Norden, & Weber, 2005). As such, Takasbank has developed an internal rating system that accommodates financial and non-financial discriminants to assess a brokerage house's credibility to assign transaction limits in OPP.

Liquidity Risk

Liquidity risk can arise from a number of sources, all of which result in one party's not being able to fulfil an obligation temporarily. The mismatch of the maturity and the timing of funds or securities or the inability to acquire securities due to inadequate depth of markets are the main culprits (Aksoy, 2006). Another source of liquidity, although it may be argued that this is just a function of the market risk, is the increasing amount of collaterals required for borrowed securities while collaterals decrease in value relative to the security (IOSCO, 1999). A typical example for the last category of liquidity risks is the downward spiral generated by the attempts to liquidate collaterals of parties that could not maintain their collateral margins during the 2008 Global Financial Crisis. This increase in stock supply during an already illiquid market phase led to a self-feeding downward spiral (Bank of Canada, 2010).

Currently, Takasbank mitigates liquidity risk by establishing a hard cap on the ratio of lending volume for every stock to the stocks' free floating volume; with the hard cap set at 20%. However, at any given time, the liquidity for a stock can be lower than the free-floating volume and such an imbalance can cause the inability of borrower's acquisition of the stock. Also, trade volume is but one of the many measures of market liquidity. Quoted spread, effective spread, quoted depth and turnover are all measures of liquidity used for equity markets (Butler, Grullon, & Weston, 2005). Liquidity is known to affect and also to be affected by volatility too by creating liquidity spirals (Brunnermeier & Pedersen, 2009). We have already posited that during periods of sharp drop in stock prices borrowers may be incentivized to default on current contracts.

Therefore it can be posited that by monitoring the relative liquidity of the Borsa İstanbul Equity Market and OPP, risk can be more effectively mitigated to a sufficient degree. Due to the relatively low number of quotes and transactions in OPP, trade volume was chosen as a proxy for market liquidity in both markets. Thus, the first hypothesis is constructed as:

H_1: Decrease of transaction volume in the Borsa İstanbul Equity Market with respect to OPP transaction volumes increases the probability of defaults in OPP by creating an upward pressure in stock price.

Of course it can be argued that lending volumes and thus short-selling activities tend to change with the trade volume so such an indicator may not provide information. However, the relationship between trade volumes and short-selling volumes for stocks may not be correlated (Shapiro & Pham, 2009). Also, the borrower may have motives other than short selling like re-lending for arbitrage or fulfilling settlement obligations for another transaction.

Market Risk

The possibility of the decrease in security prices due to market fluctuations is generally defined as market risk (Uysal, 2001). Within the context of lending transactions, a revision for this definition becomes necessary. The mechanics of market risk for the borrower are quite different from the lenders. During the life of a lending transaction, the price of the borrowed security may decrease relative to the collateral's value and cause no risk for the borrower or the market in general. Assuming that the collateral's loss of value in a downward market is negligible, price drops cause no risk for the borrower. In fact, they are necessary to create profit from the transaction. Thus, the real risk for the overall market function would arise from the increasing value of the borrowed security relative to the collaterals value. Such a change, may lead to increased collateral obligations, or as discussed in previous sections, in a defaulting borrower scenario, will lead to a loss due to replacement costs.

However, market risk dynamics are more complicated from lender's perspective. First of all, price drops create a problem due to the very fact that the security owned but not possessed currently loses value. Even if the lender is aware of the probable range of decrease in the security and intends to hold the security in her portfolio despite the value decrease, there are other facets of the market risk. Price drops can become a trend during the lifetime of the lending contract, creating an incentive for the borrower to absorb the default penalties – if any – and default the contract with the hope of replacing it from a much lower price. Also, in a bear market, collaterals can lose value relative to the borrowed security and the credit risk may not be covered as it was initially planned. That is why an improper margining or collateral valuation process can also augment the market risks. One final source of market risk arises from the use of cash as collateral. The lender will reinvest the collateral to ensure loan performance and any mismatch on maturities of the loan rebates and collateral reinvestment will expose the lender to market risk.

This thesis aims to measure market risk with two main constructs of market risk; stock price and volatility. Stock price is proxied by stock returns calculated logarithmically. The return variable is used in two alternate forms; average daily return for the duration of the borrowing contract and total volatility for the duration of the borrowing contract. The volatility construct is proxied by truerange (Wilder, 1978).

A positive (negative) association between volatility (stock returns) and defaults is expected. Especially for high volatility periods of sustained stock price decreases –proxied by the interaction terms of volatility and return measures- a strong negative association between the proxy and defaults is expected. So the remaining two hypotheses are constructed as:

H_2: Increased volatility of stock prices in the Borsa İstanbul Equity Market increases the possibility of defaults in OPP by creating an expectancy of lower replacement costs in the near future.

H_3: Decrease of stock prices for the duration of the lending contract in the Borsa İstanbul Equity Market increases the probability of defaults in OPP by creating an expectancy of lower replacement costs in the near future.

Legal Risk

Every financial transaction carry, to some degree, legal risks and the lending transactions are not exceptions. The inability to enforce a contractual obligation for various legal reasons and the possibility of incurring losses due to such events is called legal risk (IOSCO, 1999). The use of well-reviewed and generally accepted contracts specifically prepared for certain regulations and markets are the easiest method to mitigate this risk. The Global Master Securities Lending Agreement (GMSLA) and the Global Master Repurchase Agreement (GMRA) are the main standard agreements that govern lending transactions (Bianconi, Collot, & Knepper, 2010).

Unlike many regulators that do not directly regulate lending activities (Secondary Market Advisory Committee of Securities and Exchange Board of India, 2006), Capital Market Board (CMB) of Turkey has created a strict regulatory frame for lending and short-selling activities. However, CMB has not set an oversight function for lending activities neither within itself or Takasbank. The existence of an oversight function with enough regulatory authority and monitoring capabilities is crucial for the safety and the efficiency of a market (Georgakis, 2005).

Operational Risk

Operational risks, in a broad sense, can be defined as the risk that arises from the deficiencies in the systems, procedures or internal controls of one or more parties to a transaction resulting in loss.

Operational risk is inherent in each and every financial transaction but it is of particular interest in the case of securities lending. Timely and accurate information is critical to the management of counterparty credit risks and market risks associated with securities lending transactions. Securities lending transactions entail settlements at two instances and internal controls need to be in place to ensure effective and timely settlements. Between settlements, sound and robust systems and procedures are required to monitor daily income, counterparty credit limits, collateral values and securities lending internal accounts relative to general ledger balances (IOSCO, 1999).

Lenders of securities also have to closely monitor the trading activity of their portfolio managers to ensure that securities lending activities do not negatively impact the rest of the firm's investment activities while borrowers have to actively monitor price movements to be able to supply additional collateral if needed. A security lending market should have an infrastructure that can fulfil all those operational needs, creating a granular operational risk map.

Advances in technology and operational efficiency have made it possible to separate the administration of securities lending from the provision of basic custody services, and a number of specialist third party agency lenders have established themselves as an alternative to custodian banks, creating a defence-in-depth structure for operational and segregation-of-duties perspectives (Faulkner, 2006).

Settlement Risk

According to IOSCO (1999), "Settlement risk refers to the risk that the completion or settlement of individual transactions will not take place as expected". Two major sources of settlement risk are (a) a time-lag between the execution of the transaction and its final completion and (b) a time-lag between the completion of the two legs of the transaction (i.e. any lag between payment leg and delivery leg) (IOSCO, 1999). The first kind of settlement risk is, from Takasbank's perspective a function of the operational risk as Takasbank functions as the clearing and settlement house and the central counter party for all transactions in OPP on a delivery versus payment basis.

Securities registration procedures can also adversely affect the settlement of securities lending transactions. When registration is a prerequisite for settlement, there are typically two different sources of delay that can result in settlement lags. Registration delays may be a factor in markets where securities have been dematerialized, as is the case in Turkey. The central securities depository of Turkey, Central Registry Agency (CRA) keeps the records for the equities traded in Borsa İstanbul and thus lending transactions have to be registered with MKK in order to be completed. However, the almost instantaneous registration of transactions makes this additional risk negligible.

Custody Risk

Securities belonging to investors are, as a common practice, held with a custodian. Custody risk is the loss of securities due to custodians' insolvency, negligence or fraud (IOSCO, 1999). All common stocks traded in ISE Stock Market are dematerialized and accounted for by the CRA in accordance with Turkish Capital Market Law (1981 – revised on 1999) provisions while Takasbank performs custody functions on brokerage house level but cannot access investor portfolio data of CRA. This dual structure provides a good example of segregation of duties and greatly mitigates custody fraud risk.

Recall Risk

In a continuous timeframe, the borrower is concerned not only with the initial transaction fee, but also with the variance of fees with respect to time. The reason for this concern is the general regulations and established practices that allow the lender to terminate the transaction and recall the loan at any time before the maturity (D'Avolio, 2002). This can increase the cost of covering the short position by forcing the borrower to buy the stock or re-borrow at unfavourable rates.

OPP directives state that, with the exception of an announcement of general shareholders meeting between the transaction date and the maturity date, a loaned cannot be recalled. To compensate for the possible loss from early termination, Takasbank charges back half of the accrued lending fee from the lender to the borrower.

Manipulation and Insider Trading

The New Capital Market Law (CML) of Turkey (2012) includes the following provision: "Those who; buy, sell, give orders, change or cancel given orders or make any transactions on capital market instruments in order to artificially affect their demand and supply, to give the impression of existence of active market, to hold the prices at the same level, to increase or decrease the prices." providing a definition for manipulation in capital markets. Due to the complicated and obscure nature of the manipulation activities, "those acting together" expression contains legal ambiguity and may pose problems for the penal prosecution of manipulation cases (Baysal, 2011). Manipulatory actions are generally studied under three categories: trade-based, information-based and action-based manipulation (Tezcanlı, 1996). CML also "give and disseminate misleading, false, deceiving information and news" and "do not disclose information he/she should disclose" provisions respectively. The literature on stock manipulation is wide and extensive but due to the unregulated and OTC dominated nature of security lending activities, studies on manipulation activity in stock lending and corresponding effects of stock manipulation in lending markets are scarce. Short sale data has been used for stock price movement forecasts and manipulation discovery extensively (Duffie, GArleanu, & Pedersen, 2002; Finnerty, 2005). Although security lending rates are expected to provide clues for future price movements at least as reliably as short sale volumes, studies have not always supported this hypothesis (Galper, 2007). It can be posited that analysis of;

- Lending fees that are significantly different from the market rates (IOSCO, 2000) by accepting the interest rate range for market rates as Central Bank of Turkey TL borrowing and lending rates for the transaction day and the daily nominal fee lower and upper range limits as 10 and 100 TL respectively (Keser, 2011) ,
- Lending transactions that result in loss for the lender after the settlement fees are calculated

would yield a comprehensive coverage of unexpected and abnormal transaction patterns in OPP due to the fact that the transaction fee is negotiated before the lending, the settlement fees are known by all parties and no rational lender should execute a transaction that results in an immediate loss without foreseeable gains.

Information is a vital asset in capital markets. Investors act based on the information that is available to them. As such, any unfair information asymmetry will lead to investors' loss. The information that is not available to the public yet, but pertaining to a firm's future plans or current situation is insider information (Karasioğlu, 1998). Tezcanlı (1996) defines insider information in broader terms: "Information directly or indirectly related to securities or their issuers and when announced; affects investment decisions of capital market investors, affects prices of the securities" and insider trading as: "trading on securities with such information where the trader or tipper breaches a fiduciary duty or a duty based on a relationship of trust and confidence.

The Old CML Article 47 defines insider information as: "non-public information which will be able to affect the values of capital market instruments" while limiting insider trading activity to: "The chairman and members of the Board of Directors, directors, internal auditors and other staff of the issuers within the scope of Article 11, capital market institutions or of the subsidiary or dominant establishment, and apart from these the persons who are in a position to be have information while carrying out their professions or duties, and the persons who are in a position to have information because of their direct or indirect relations with these" thus limiting the insider trading crime with those that have fiduciary duties.

Unfortunately, identifying and investigating insider information cases are even harder than manipulation cases for the seemingly normal natures of the transactions. An encompassing database for managers, auditors and their relatives can be maintained at the CRA and sudden increases in lending volumes of stocks and fiduciaries as well as borrowers that accept higher than normal fees can be flagged for further analysis. While using knowledge discovery in databases (KDD) models for anomaly and fraud detection is a widely accepted trend (Han & Kamber, 2006), as of June 2012 CMB has declined a petition about granting access to their investigation case data for such an analysis within the scope of this thesis.

CHAPTER 3: DATA AND PROPOSED MODEL

Two main data sources were used for the analysis in the thesis; (i) lending transactions secondary data, acquired from Takasbank and (ii) Borsa İstanbul trade volume and stock prices data, acquired from Borsa İstanbul.

The OPP was established in 28th November 2005. The average number of transactions increased steadily due to a base effect from 36 per day in 2006 to 100 in 2010. The upward trend is also visible in the daily transaction volumes; from 3,075,847 USD per day to 7,826,108 USD in 2010. Due to the low number of transaction in the early years and the fact that those years happen to coincide with the global financial crisis, inclusion of transactions from this time period would bias default estimations. So, the data used for the study encompasses a period of three years ranging beginning with 2010. Daily transaction data from the Lending Market of Takasbank and the Equity Market of Borsa İstanbul are used for analysis and risk indicator for our studies.

A specific stock with a total of 541 lending transactions was chosen for the study due to its relatively high percentage of defaults in the data. Per the agreement with our data provider, Takasbank, the name of the stock chosen for the study cannot be disclosed. Of the 68,951 transactions that have occurred in the market encompassing the aforementioned timeframe, only 96 (<.1%) resulted in defaults whereas the chosen stock resulted in 14 defaults out of 541 transactions (<2.6%). The stocks with second and third highest number of defaults (12 and 11 in the chosen timeframe) had all of their defaults clustered in one year, creating a possible bias from an unidentifiable specific risk.

The lending transactions data consists of all the borrowing contracts created in OPP between 2010 and 2012 for the stock (actual transaction dates of 19/03/2010 and 27/12/2012) with a total of 541 transactions.

Table 2: Number of lending contracts per month

Year	Month	No. Of Contracts
2010	3	1
	5	1
	6	5
	7	1
	9	1
	10	1
	11	3
	12	191
	Annual Total	204
2011	2	1
	3	3
	4	218
	5	30
	6	1
	8	2
	10	22
	11	3
	12	28
	Annual Total	308
2012	3	1
	4	1
	5	1
	7	7
	8	3
	9	2
	10	8
	11	1
	12	5
	Annual Total	29
Grand Total		541

The transaction data is dominated by 1-day lending contracts as seen in Table-3.

Table 3: Number of lending contracts per maturity

Number of Business	Number of Contracts	Percentage of Total
1	494	91,3
2	45	8,3
3	1	0,2
4	1	0,2

As the clearing and settlement processes of Borsa İstanbul Equity Markets take 2 days to complete, the actual change of possession of stocks traded at T-day occur at T+2. Due to this business rule, a 4-business-day borrowing position has to be either closed on the first two days in the BIAS market or should be rolled in OPP. For this reason the effective days to maturity for contracts were calculated as 2 days less than the actual amounts for contracts with 3 or 4 days to maturity. Let "t" be the number of business days to maturity in the original contract and $t_e$be the effective maturity used in our analysis, then effective maturity is calculated as follows:$\begin{cases} t > 2, t_e = (t-2) \\ t < 3,\ \ t_e = \ \ t \end{cases}$

Comparing the trade volumes of Borsa İstanbul Equity Market and OPP proves to be another challenge. A borrowing contract in OPP has a defined lifespan and therefore the short position associated with the borrowing transaction can be closed at any time until the effective maturity date.

Let's give an example: A contract with an effective maturity of 10 business days on 100 shares of stock A is agreed upon on March 3, 2014. The borrower has to acquire the 100 shares he has borrowed in OPP from Borsa İstanbul Equity Market until March 14. He can choose to do so in any combination of stock purchases in any of the business days in between so an extremely low volume of trading on March 5 and 6, for example need not necessarily impede his strategy. He can choose not to purchase the stock on those days for more favourable market conditions. But a low liquidity for the whole duration of the contract will be another matter.

In order to be able to identify the relationship between the liquidity present in those two markets we have developed an effective trade volume for OPP. Let t_e denote the effective maturity, v denote the original borrowing volume and $v_e t_i$ denote the effective volume of the borrowing contract for the business day t_i, from t_1 to t_e. This way, the borrowed volume can be spread amongst the business days in the effective maturity so that we can calculate a likely amount of shares that will be bought on day t_i from Borsa İstanbul Equity Market because of the borrowing transaction.

For each contract, $v_e \ for\ t_i = \frac{v \times t_i}{\sum_1^i t}$ is calculated. As clearly seen, a linearly increasing weight is used to distribute the borrowed volume amongst the business days so that the nearer contract maturity gets the more weight is given. This is due to the expectation that investors choose the maturity of the borrowing contracts according to certain expectations and strategies and thus generally do not expect to close their positions earlier.

After the effective volume of every contract is calculated for every business day, aggregate trading volumes are calculated for each and every business day. Let v_a denote the aggregate borrowing volume for the n number of contracts on a given business day. Then $v_a = \sum_1^n v_e$.

Such a distribution of borrowing volume throughout the contract life involves assumptions like the one stated above about the investor behaviour or about the pattern of weight distributions. Because of that, three other ways are also used to calculate the v_a, a distribution of borrowing volumes evenly, an exponentially weighted distribution with a λ of .94 and an exponentially weighted distribution with a λ of .75. This enables us to use trading volumes of both markets as proxies without binding our model with unnecessary assumptions. To illustrate, v_e with a λ of .94 is calculated for each contract as: $v_e \ for \ t_i = v \times 0.94^i$ and thus v_a is still $v_a = \sum_1^n v_e$. For linearly weighted v_a and obviously no-weight distribution of v_a it is obvious that $v = v_a$ due to the fact that $v_a = \sum_1^n v_e = \frac{v \times \sum_1^n t}{\sum_1^n t}$. However, as for exponentially weighted v_a, for any given contract with an t_e of greater than 1, v_a is greater than v. This is because $v_a = \sum_1^i (v \times 0.94)^i$. This method, while distorting the transaction volume, makes it possible to give greater weights to days closer to contract maturity while distributing the borrowed volume.

Empirical Model

As stated before, it is posited that stock market related discriminants, which affect the lending market as a whole, do affect defaults and must be considered in managing credit risk. The variables used in the thesis are explained in detail in Table-4.

The default state of each contract is proxied with two variables a dummy one and a continuous variable. The liquidity risk is proxied by four alternatives of one variable; the market risk is proxied by two alternate variables for return and volatility as well as their interaction terms.

Table 4: Variables Used

Variable	Description and Calculation	Expected sign
Tem	Dummy variable that shows whether the contract defaulted or not. $\begin{cases} Defaulted\ contract, Tem = 1 \\ Non-defaulted\ contract, \quad Tem = 0 \end{cases}$	
Temratio	An alternative dependent variable used for robustness test. If the contract has defaulted: The ratio of the v_a of defaulted contracts to the v_a of all the contracts for the day. If the contract has not defaulted: 0	
Contractmean	Proxy for the stock price movements and thus market risk, calculated as the logarithmic return of the chosen stock for the duration of the contract.	(-)
Truerange	Proxy for the volatility and thus market risk of a stock. For each contract that lives through day 1 to day *i*, *Truerange* is calculated as: $\sum_{1}^{i}\left(\text{Max}\left(\ln\left(\frac{pmax_i}{pmin_i}\right), \ln\left(\frac{pclose_{i-1}}{pmin_i}\right), \ln\left(\frac{pmax_i}{pclose_{i-1}}\right)\right)\right)$ Where $pmax_i$ ($pmin_i$) is the maximum (minimum) trade price attained for the stock in Borsa İstanbul Equity market for day *i* and $pclose_{i-1}$ is the closing price of the previous day.	+
Riskadj1	Interaction term of *Contractmean* and *Truerange* calculated as (*Contractmean/truerange*). A proxy for total return of stock price throughout the borrowing contract per unit risk.	(-)
Riskadj2	Interaction term of *Dailyret* and *Truerange* calculated as (*Dailyret/truerange*). A proxy for daily return per unit risk.	(-)
Dailyret	Average daily return for the stock for the actual duration of the contract. A proxy for daily return per unit risk.	(-)
TAO_75	A ratio of the v_a and BIAS Equity Market total trade volume for any day used as a proxy for possible liquidity pressure created because of large volumes of lending contracts due to be closed. For each contract that lives through t_1 to t_i *TAO_75* is calculated as: $\frac{\sum_1^i((v_{ai}\ with\ \lambda\ .75)\times 0.75^i)}{\text{BIAS Equity Market volume}})$	(-)
TAO_94	A ratio of the v_a and BIAS Equity Market total trade volume for any day used as a proxy for possible liquidity pressure created because of large volumes of lending contracts due to be closed. For each contract that lives through t_1 to t_i *TAO_94* is calculated as: $\frac{\sum_1^i((v_{ai}\ with\ \lambda\ .94)\times 0.94^i)}{\text{BIAS Equity Market volume}})$	(-)

Table 4. Continued

Variable	Description and Calculation	Expected sign
TAO_lin	A ratio of the v_a and BIAS Equity Market total trade volume for any day used as a proxy for possible liquidity pressure created because of large volumes of lending contracts due to be closed. For each contract that lives through t_1 to t_i *TAO_lin* is calculated as: $\frac{\sum_1^i((v_{ai}\ with\ \text{lineer weights})\times\frac{i}{\sum_1^i i})}{\text{BIAS Equity Market volume}})$	(-)
TAO_nw	A ratio of the v_a and BIAS Equity Market total trade volume for any day used as a proxy for possible liquidity pressure created because of large volumes of lending contracts due to be closed. For each contract that lives through t_1 to t_i *TAO_nw* is calculated as: $\frac{\sum_1^i(v_{ai}\ without\ weights)}{\text{BIAS Equity Market volume}}$	(-)

The following models are estimated respectively with logistic regression. The research strategy employed begins with investigating the individual impact of right-hand side variables on default risk by adding them one-by-one (models 1-5) and then continues with estimating multivariate models, where interaction terms are also incorporated (models 6-9).

$$(1)\ Tem_t = \alpha + \beta_1 TAO + \epsilon_t$$

$$(2)\ Tem_t = \alpha + \beta_1 Truerange + \epsilon_t$$

$$(3)\ Tem_t = \alpha + \beta_1 Contractreturn + \epsilon_t$$

$$(4)\ Tem_t = \alpha + \beta_1 Dailyret + \epsilon_t$$

$$(5)\ Tem_t = \alpha + \beta_1 Riskadj + \epsilon_t$$

$$(6)\ Tem_t = \alpha + \beta_1 Truerange + \beta_2 Contractmean + \epsilon_t$$

$$(7)\ Tem_t = \alpha + \beta_1 Truerange + \beta_2 Riskadj1 + \epsilon_t$$

$$(8)\ Tem_t = \alpha + \beta_1 Truerange + \beta_2 Riskadj1 + \ \beta_3 Contractmean + \epsilon_t$$

$$(9)\ Tem_t = \alpha + \beta_1 TAO + \beta_2 Truerange + \beta_3 Riskadj1 + \beta_4 Contractmean + \epsilon_t$$

Logistic regression is used to analyse whether independent variables carried information about the default state of the contract with Tem as the dependent variable. However, logistic regression is known to underestimate the probability of rare events (Calabrese & Osmetti, 2013) and with such a low number of defaults in the data, this method cannot be solely relied upon. In order to overcome this drawback, a continuous variable that measures the effect of market wide discriminants on defaults, the *Temratio* was constructed. For example, on a given day, if more than 80% of v_a defaults, than this can imply that a systemic event has caused a market wide increase in defaults. Also, with a continuous dependent variable, it is possible to cross check the logistic regression results with linear regression. Also, as stated earlier, in every analysis involving liquidity proxies, each of the four liquidity variables was used to see if the results varied significantly.

In models (1) and (9) the independent variable *TAO* is used to represent respectively our four liquidity proxies: *TAO_75*, *TAO_94*, *TAO_lin and TAO_nw*. All of the models were estimated respectively with each of the liquidity measures for robustness. Similarly, the return per unit risk proxies were likewise used alternatively for model (5). Another robustness measure used is the construction of a continuous variable, *Temratio*. In order to do that, all of the aforementioned models were replicated with linear regressions using *Temratio* as the dependent variable.

The preliminary analysis demonstrate that none of our variables with the exception of *Dailyret* are normally distributed as seen from the Jarque-Bera test results in Table 5. The corresponding p-values for 541 observations lead to accepting the null-hypothesis that those variables do not fit to normal distribution. The daily return maximum of the stock for the chosen timeframe was almost 15% and the daily return minimum was almost -16% (corresponding to 0.14 and -0.17 when calculated logarithmically). The maximum and minimum cumulative stock returns during the life of a lending contract were about 38% and -38% respectively. During the chosen 3 year timeframe the underlying stock was subject to wide fluctuations with a relatively stable price in the long term as seen from the -1% mean daily return (-0.01 mean of the *Dailyret* variable) and 0.7 standard deviation of the same variable as well as the maximum 38%, minimum -38% returns and a mean return of -2% throughout the lives lending contracts (*Contractmean* variable). The volatility proxy (*Truerange*) also confirms those preliminary findings with a mean of 0.23 and a maximum of 0.55. The details of the descriptive statistics of the variables are presented in Table 5.

Table 5: Descriptive Statistics of Variables

	Tem	Temratio	Contractmean	Truerange	Riskadj1	Riskadj2	Dailyret	Riskadjret2	Tao_94	Tao_75	Tao_lin	Tao_nw
Mean	0.03	0.08	-0.02	0.23	-0.06	-0.06	-	-0.06	55.08	40.58	99.57	32.19
Median	0.00	0.00	-0.02	0.22	-0.20	-0.20	-	-0.20	38.55	25.17	60.41	16.71
Maximum	1.00	0.83	0.32	0.55	0.82	0.82	0.14	0.82	234.02	156.18	563.27	130.21
Minimum	0.00	0.00	-0.48	0.03	-0.90	-0.90	-	-0.90	0.00	0.00	0.00	0.00
Std. Dev.	0.16	0.23	0.16	0.12	0.48	0.46	0.07	0.46	58.45	43.72	109.01	37.89
Skewness	5.97	2.71	-0.38	0.50	0.35	0.39	-	0.39	1.43	1.45	1.58	1.75
Kurtosis	36.67	8.61	3.64	2.74	2.29	2.47	3.26	2.47	3.82	3.82	4.41	4.93
Jarque-Bera	28770.10	1371.36	22.17	24.11	22.47	20.03	7.03	20.03	198.96	204.91	268.60	360.53

Table 6: Correlations between Variables

	Tem	Temratio	Contractmean	Truerange	Riskadj1	Riskadj2	Dailyret	Tao_75	Tao_94	Tao_lin	Tao_nw
Tem	1,00	0,99	0,93	0,90	-	-0,15	-0,13	-0,09	-0,03	-0,05	-0,22
Temratio	0,99	1,00	0,95	0,93	-	-0,16	-0,14	-0,12	-0,04	-0,06	-0,19
Contractmean	0,93	0,96	1,00	0,99	-	-0,24	-0,22	-0,20	-0,02	-0,05	-0,03
Truerange	0,90	0,93	0,99	1,00	-	-0,25	-0,23	-0,21	-0,03	-0,05	-0,01
Riskadj1	-	-	-	-	1,00	1,00	0,99	0,94	-0,04	-0,05	-0,23
Riskadj2	-	-	-	-	1,00	1,00	0,98	0,92	-0,04	-0,05	-0,23
Dailyret	-	-	-	-	0,99	0,98	1,00	0,96	-0,04	-0,05	-0,19
Tao_75	-	-	-	-	0,94	0,92	0,96	1,00	-0,02	-0,02	-0,20
Tao_94	-	-	-	-	-	-0,04	-0,04	-0,02	1,00	0,89	0,10
Tao_lin	-	-	-	-	-	-0,05	-0,05	-0,02	0,89	1,00	0,10
Tao_nw	-	-	-	-	-	-0,23	-0,19	-0,20	0,10	0,10	1,00

The correlations between the variables illustrated in Table 6 present some interesting inferences. First of all, it can be seen that stock return and the return per unit risk constructs are strongly correlated as expected but the correlation between the volatility proxy and return per unit risk constructs are quit low, indicating that the interaction terms is dominated by the stock return variables. The strong correlation between the stock return (*Contractmean* and *dailyret*) and return per unit risk (*riskadj1* and *riskadj2*) constructs pose problems for models (6) and (9) but the strongly correlated independent variables do not have a statistically significant relationship with the dependent variable in Table 9. Another interesting outcome of the correlations demonstrated in Table 6 is the low level of correlation between *TAO_94* and the other 3 alternatives of the liquidity proxy. While the other 3 alternatives are very strongly correlated with each other, the use of 0.94 as λ seems to significantly distort the real contract volumes with respect to lower λ. However, the regression results for each and every one of the liquidity proxy alternatives are statistically insignificant so debating whether the distortion of volume is beneficial is irrelevant.

Results

The results of the univariate models (1 – 5), presented in Table 7, show that the only variable that has a statistically significant relationship with the default state is the volatility proxy, *Truerange*. None of the liquidity proxies have an explanatory power on the default dummy and neither the return proxies do. The presence of the explanatory power of volatility on the default state of lending contracts is consistent with our hypothesis that higher volatility is associated with higher default. However, the results can be attributed to axioms and the pitfalls of the logistic regression model so we check the results with our linear regression models.

Table 7: Logistic Regression Results for Models 1 to 5

	Truerange	Contractmean	Dailyret	Riskadj1	Riskadj2	Tao_75	Tao_94	Tao_lin	Tao_Nw
TEM	4.4599** (2.0620)								
		-1.1272 (1.6902)							
			-2.2113 (1.908)						
				-0.32275 (0.58)					
					-0,512 (0,6213)				
						-0.0078 (0.0081)			
							-0.0059 (0.006)		
								-0.0033 (0.0033)	
									-0.0038 (0.0081)
Number of obsv	541	541	541	541	541	541	541	541	541
McFadden R-squared	0.0364	0.0033	0.0101	0.0024	0.0054	0.0086	0.0088	0.0094	0.0018
Akaike info criterion	0.2389	0.2468	0.2611	0.247	0.2463	0.2455	0.2455	0.2454	0.2472
Prob(LR stat)	0.0297	0.5096	0.252	0.5737	0.4011	0.2894	0.2848	0.2694	0.6289

** Significant at 0.05

The results of the linear regression analysis for univariate models are consistent with the logistic regression results with the exception that *Riskdaj1*, the return per unit risk proxy also has a significant relationship with defaults. Thus, in linear regression tests of the univariate models, *Truerange* and *Riskdaj1* are the only variables that have a statistically significant relationship with constructed dependent variable, albeit at a worse degree of significance compared to logistic regression results. It is again demonstrated that the volatility proxy has explanatory power over the defaulted contract volume proxy. However the results again fail to illustrate a significant relationship for liquidity or return variables.

The Mc-Fadden R-squared results shown in Table 7 and R-squared results shown in Table 8 both indicate that only a small portion of the variance in defaults can be explained by volatility and stock returns. This is consistent with the initial assumption that those variables alone cannot predict defaults in security lending markets but can be used in conjunction with internal rating models to get a better understanding of credit risk exposure.

Table 8 Linear Regression Results for Models 1 to 5

	Truerange	Contractmean	Dailyret	Riskadj1	Riskadj2	Tao_75	Tao_94	Tao_lin	Tao_nw
Temratio	0.1473* (0.0806)								
		0,0911 (0,0634)							
			0,0369 (0,0718)						
				0,0382* (0,0204)					
					0,0277 (0,0214)				
						-0,0003 (0,0002)			
							-0,0002 (0,0001)		
								-0,0001 (0)	
									-0,0002 (0,0002)
Number of obsv.	541	541	541	541	541	541	541	541	541
R-squared	0.0062	0.0038	0.0005	0.0065	0.0031	0.003	0.003	0.0034	0.0018
Adj R-square	0.0043	0.002	-0.0014	0.0046	0.0012	0.0011	0.0011	0.0015	0
F-stat	3.3375	2.0652	0.2646	3.5051	1.6737	1.6047	1.6043	1.8278	0.9671
Prob(F-stat)	0.0682	0.1513	0.6072	0.0617	0.1963	0.2058	0.2058	0.177	0.3258

* Significant at 0.1

Table 9 presents the multivariate estimates. The multivariate regression analysis pertaining models (6), (7), (8) and (9) yield similar findings to the univariate models. For ease of comprehension, the results for both logistic and linear regression of models of (6), (7), (8) and (9) are aggregated in Table 9.

The most impressive result of the multivariate models is that, the volatility proxy is statistically significant in all models. From this bit of information it can be inferred that the second hypothesis that higher volatility is associated with higher default cannot be rejected for this dataset. While *Riskadj1* yielded significant positive association with default in Table 6, the logistic regression results for univariate models and both the logistic and linear regression results for multivariate models fail to confirm this relationship. Linear regression results for model 6 in Table 9 demonstrate that a combination of *Truerange* and *Riskadj1* yield a higher adjusted R-square than each of them separately, albeit for a very small increase. The logistic regression results for stock return proxies do not yield statistically significant results and robustness test do not present a clear picture so it may be considered safe to infer that return data is not related to defaults and it will be prudential to reject the third hypothesis. The liquidity proxy alternatives have no explanatory power on the default state of contracts in neither logistic nor linear regression tests of all 9 models. Thus the null hypotheses for the first and third hypotheses regarding the relationships between the defaults and relative market liquidity and stock price returns respectively (H_1 and H_3) cannot be rejected.

The logistic and linear regressions are run for every 2, 3 and 4 variable combinations, but only the most meaningful of them are shown in Table 9. Suffice to say, volatility was significant in each and every one of them, at small levels of adjusted r-squares though. It can be inferred that, in the data set, volatility was a probable discriminant for default prediction.

Table 9: Logistic and Linear Regression Results for Models 6 to 9

	Model 6		Model 7		Model 8		Model 9***	
	TEM	TEMRATIO	TEM	TEMRATIO	TEM	TEMRATIO	TEM	TEMRATIO
Truerange	4.6022* (0.7081)	0,1815** (0,0824)	4.4379* (2.1005)	0,0069* (0,056)	5.7323* (2.4036)	0,1613* (0,09329	5.3724** (0.8576)	0.1545* (0.094)
Contractmean	0.0949 (1.4379)	0,1224* (0,0648)			4.9629 (4.9032)	0,037 (0,1949)	5.4795 (4.8763)	0.0522 (0.1966)
Riskadj1			-0.1229 (0.5225)	-0.0068 (0.142)	-1.8377 (1.7989)	0,0285 (0,0612)	-2.0813 (1.7808)	0.021 (0.0625)
Tao_lin							-0.0028 0.0035	0 0
Number of obsv	541	541	541	541	541	541	541	541
R-squared/McFadden r-square	0.0364	0.0127	0.036805	0.00982	0.0446	0.0131	0.05	0.0138
Adj R-square		0.009		0.006139		0.0076		0.0064
Akaike info criterion	0.2426	-0.1155	0.242465	-0.841482	0.2442	-0.1122	0.2467	-0.1092
Schwarz criterion	0.2664		0.266273	-0.817673				
F-stat/LR-stat	4.7314	3.4642	4.783003	0.00982	5.7907	2.3782	6.494	1.8754
Prob	0.0934	0.032	0.091492	0.006139	0.1222	0.069	0.1652	0.1133

* Significant at 0.1

** Significant at 0.05

*** Results for *Tao_lin* are shown, however other liquidity proxies (*TAO_94, TAO_75 and TAO_nw)* performed no better or affected the significance of other variables.

CHAPTER 4: CONCLUSION

Securities lending, as with any other financial transaction, exposes the involved parties to a number of risks. As with most transactions involving credit, credit risk is one of the biggest, if not the greatest, risk related to security lending transactions. The usual approach to mitigate credit risk is to correctly assess the credibility of the debtor, but securities lending contracts have some quirks that make it possible to increase the odds of identifying risky contracts by using discriminants unrelated to the debtor. It is posited that liquidity, volatility and the returns of the stock borrowed can affect whether a contract resulted in a default or not.

For hypothesis testing the lending contracts of a chosen stock for a time period of three years in OPP were analysed. The scope was limited to one particular stock's contracts due to a two reasons; low number of defaults in the market and costly data processing needs of the variables. Also, the timeframe of transactions studied were limited with 3 years due to the relatively recent establishment of the market resulting in a base effect of growth for the first 3 years until 2009 and to eliminate the effects of the global financial crisis. Out of a total of 541 transactions made between the years 2010 and 2012, 14 of them had resulted in defaults.

Data related to lending transactions were acquired from Takasbank and data about Borsa İstanbul trade volume and stock prices were acquired from Borsa İstanbul. Truerange, a well-known volatility measure was used as a volatility proxy, logarithmic returns of the stock –both daily and throughout the life of the lending contract – were used for stock return and a liquidity measure was developed from trade volumes of both OPP and Borsa İstanbul Equity Market daily trade volumes to compare the relative liquidity changes. A dummy variable was used for identifying the default states of the contracts and this dependent variable was swapped with a continuous variable that represented the ratio of defaulting contracts' total volume to the daily trade volume in OPP for defaulting contracts as a robustness test. The constructed liquidity measure was also reconstructed in three alternative ways and used in models in all its alternate values for robustness test.

Volatility, as proxied by truerange is shown to have a statistically significant relationship with the defaults, albeit with a small portion of the variance of defaults being explained by volatility. However, this is in accordance with the expectations that those variables can provide complimentary information on defaults but cannot replace internal rating models that rely on debtor data. The liquidity proxies' and the return variables' hypotheses are not confirmed by the data. No significant relationship between default state of contracts and the liquidity measure or the stock return was found. However, the study encompasses a small portion of the available data in OPP and repeating the study with a greater number of stocks and for a bigger timeframe can yield more enlightening results. Also, constructing other liquidity measures to compare the liquidity of lending market and stock market can establish a relationship. Finally, using other volatility measures for historical volatility and adding forward volatility predictions can enhance the information derived on the volatility.

Although the results are limited in some ways due to the restrictions aforementioned, it is shown that credit risk management in security lending transactions can and do differ from traditional credit risk techniques. With its unique market dynamics, the defaults in lending transactions can be hard to predict with traditional internal rating models and stock market related variables must be taken into account in order to successfully monitor and manage the credit risk of a securities lending market.

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