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Strategic Behaviors in Financial Markets and Applications of the Market Discipline Mechanism

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ABSTRACT

Strategic Behaviors in Financial Markets and Applications of the Market Discipline

Mechanism

by

Osman Nal

This dissertation provides theoretical and empirical support for the mechanism of market discipline as an alternative channel complementing supervisory efforts of prudential regulation. The model introduced in the first part is based on a novel risk-return technology that summarizes the lending opportunities of the financial intermediaries. The geometric properties and assumptions underlying the risk-return function are also studied. The main result of the model asserts that a banking institution is rewarded by revealing more information about its portfolio structure and penalized by preventing information pertaining to its asset portfolio to generate ambiguity and uncertainty about its condition. Therefore these results encourage bank managers for meaningful disclosure of bank data in a timely fashion. In fact to do so is in the best interest of the bank itself.

The model asserts also that relying solely on capital requirements might be insufficient for establishing safety and soundness of the banking system. Besides, policies like deposit safety nets and “too big to fail” protection severely undermine the effective functioning of market discipline.

The dissertation gathers summary statistics related to subordinated debt issued by the 100 largest U.S. banks from 1984 until 2007. U.S. banks released larger amounts of these types of
securities over the recent years in compliance with greater efforts to enhance market discipline over banks in the U.S.

The second part of the dissertation compares the significance of market discipline in Turkey before and after the 2001 financial crisis. Unlike the literature and past empirical studies about Turkish banking, estimation results from a 3SLS instrumental variable regression is reported. The results support that market discipline is stronger following the crisis. The interaction between deposit insurance and market discipline is also analyzed for the period between the 3rd quarter of 1997 and the first quarter of 2007. Applications of the “too-big-to-fail” protection during and following financial crises are justified from the dataset and regression estimation results. This type of coverage for large banks certainly diminishes the efficiency of the market discipline mechanism in Turkey in the post crisis period.
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1 STRATEGIC BEHAVIORS IN FINANCIAL MARKETS AND THE MECHANISM OF MARKET DISCIPLINE

1.1 INTRODUCTION

Depository institutions (hereafter called as banks) occasionally get involved in excessive risk taking practices due to the structure of their balance sheet and the nature of contractual agreements signed with depositors.\(^1\) At hard times, bank condition may eventually deteriorate and failure becomes inevitable. In this sense, bank runs are equilibrium phenomena (Diamond and Dybvig (1983)) and systemic risk is part of the financial structure of the economy. Needless to say, in such an environment, regulatory agencies are indispensable players that monitor and enforce the safety and soundness of the intermediation process generated by banking institutions in financial markets.\(^2\)

Calomiris and Kahn (1991) argue that demand deposits provide natural and adequate incentives for disciplining bank managers. They claim that demandable debt attracts deposits by letting depositors force the bank to liquidate at any time. Accordingly, depositors can easily punish bank misbehavior by withdrawing their deposits or asking for higher risk premium when realizing the bank they are investing in is taking excessive risks (Flannery (1998)). Consequently, bank managers feel obliged to change the composition of their portfolio in response to such corrective depositor actions. In short, banks are “disciplined” by market forces.

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\(^1\) The author acknowledges that fraud and mismanagement are other (non-random) sources that account for many of the bank failures. However this paper is not interested in this aspect of bank failures and regulation.

\(^2\) Capital requirements, deposit rate regulations, asset portfolio restrictions, etc. are some of the various instruments used by regulators and supervisors to this end. See Freixas and Rochet (1995) for a comprehensive list of types of regulations and restrictions imposed by supervising agencies.
Consider Figure 1 which depicts the active players in the functioning of the mechanism of market discipline. Notice that depositors may impose a control and disciplining mechanism over banks simply by a thread of withdrawing funds.

![Figure 1. Players of the Market Discipline Mechanism.](image)

Considering high costs of monitoring and supervising, regulators seem to be leaned towards adopting policies that would enhance this sort of market control and discipline. This is even more so in the last couple of decades since 1970's because banking institutions become larger than ever and their financial operations and transactions even more complicated to watch over properly. That makes detecting a probable risky position of any given bank virtually impossible.

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3 In a study by the FDIC (1983) in 1983, the need for other regulatory instruments that would relieve the pressure from regulators is supported: "We must seek new ways, in the absence of rigid government controls on competition, to limit destructive competition and excessive risk-taking. There are only two alternatives. We can promulgate countless new regulations governing every aspect of bank behavior and hire thousands of additional examiners to enforce them. This approach would undercut the benefits sought through deregulation, would favor the unregulated at the expense of the regulated, and would ultimately fail. The FDIC much prefers the other alternative: Seeking ways to impose a greater degree of marketplace discipline on the system to replace outmoded government controls."
Some of the policies instituted by bank regulators to provide stability and soundness to the banking system might have adverse effects to the proper functioning of the market discipline mechanism. For example, there is general consensus that deposit safety guarantees in the form of deposit insurance undermine market discipline incentives unambiguously (Furlong and Keeley (1989)). Moreover, “too big to fail” protection, i.e. the anticipation of a total bailout in case of insolvency even for uninsured accounts, leads depositors to monitor less and also encourage banks to gamble.4

There have been numerous empirical studies supporting the existence of market discipline around the world. Most of the studies use U.S. commercial banking data. Among the studies in 1980’s and early 1990’s are Baer and Brewer (1986), Ellis and Flannery (1992) and Flannery and Sorescu (1996).

When it comes to the theoretical side of the discussion, the seminal work is from Calomiris and Kahn (1991). As mentioned above, these authors claim that demandable debt gives the depositors the power to “vote with their feet”. By using a simple model between a banker and a potential depositor this paper proves that depositors find it in their best interest to monitor the bank right because they have the option of early withdrawing of funds. Our paper is similar to Calomiris and Kahn (1991) in that we allow for the depositor to decide its portfolio allocation depending on the risk level chosen by the bank.

Cordella and Yeyati (1998) makes an important theoretical contribution and is the closest in the literature to ours. Depending on whether the bank has control over the risks it is facing, they argue that public disclosure reduces the probability of banking crisis if the bank has complete control over the risks it is facing. Our paper draws a similar conclusion using a

---

4 The implementation of the so-called "too-big-to-fail" policy following the failure of the Continental Illinois Bank in 1983 marks the beginning of such government bailouts (of all accounts irrespective of insured or not) in the U.S. since 1980's following big bank failures.
completely different model by arguing that it is in the best interest of the bank to disclose more information to the depositors.

In an empirical paper, Baumann and Nier (2003) show that banks that disclose more information about their risk profile tend to take less risk. However our paper differs from this study by making the counter claim that releasing more information will give the bank the chance to take a more efficient level of risk which is usually a higher risk. Therefore the bank is in a sense benefited by releasing information.

This first chapter of the dissertation provides a model of indirect lending where funds flow from depositors to borrowers via bank-type institutions. The major players are depositors and banks, whereas firms and bank regulators are exogenously described. The model developed introduces a novel risk return function that summarizes bank lending technology. The assumptions underlying this risk-return function are clearly established in the paper. Using this framework proves to be superior to the traditional variance-return framework when explaining bank response to depositor actions of withdrawal of funds.

The consequences of information disclosure and its effect on market discipline can easily be studied in this new framework. Would releasing of financial information benefit a particular bank? This paper suggests that timely disclosure of bank information is for the own benefit of the bank. That is, a banking institution is rewarded by revealing more information about its portfolio structure and penalized by preventing information pertaining to its asset portfolio to generate ambiguity and uncertainty about its condition.

Another critical question that can be easily handled with this new framework is whether depositors can accurately assess bank condition? This paper provides a simple method that
describes how depositors assess bank condition based on some simple signals they obtain from bank risk choice.

The organization of the rest of the paper will be as follows. The second part investigates the nature of bank failures in the post-Great Depression era within a historical framework. The third part builds the banking model framework. The fourth part solves the problem for homogenous depositors. The fifth part is dedicated to an application of how the distribution of depositor types is crucial for the equilibrium investment strategies of the bank and depositors. The sixth part discusses the role for regulation and interesting policy results are hence gathered. The seventh part explores the relationship between subordinated debt and market discipline. It also gathers interesting summary statistics for subordinated debt for 100 largest U.S. banks from 1984 to 2007. The eighth part concludes the paper by exhibiting how the model would alter when we change the underlying assumptions. At the same time future research directions are also laid down. The appendix motivates the reader to important technical features of the risk-return function $R(q)$ and it also includes the details of the proofs omitted in the main body of the text.

1.2 BANK FAILURES IN THE U.S. AFTER THE 1929-33 GREAT DEPRESSION

The U.S. policymakers have recognized the critical importance of financial markets and institutions to the well being of the overall economy since, at least, the devastation of the Great Depression (1929-33). After those experiences of huge panics and bank runs, the FDIC was established in 1933 to basically restore the public confidence in the financial system, and to prevent another bank panic. Remarkably, the banking industry has performed quite successfully for the first 50 years after FDIC's launch. However a surge of financial instability in the form of bank failures has been observed starting late 70's and early 80's (See Figure 2). This

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5 See, for instance, Mishkin (2004) for a list of laws enacted in the U.S. since early 1900's to improve the functioning of financial markets and institutions.
malfunctioning coincides with liberalization policies implemented all around the world at about the same time. Suspicion among economists aroused whether greater mobility of capital and deregulation has brought more volatility and instability to financial markets. It is not clear how all those changes affected the way individual decision making units behave in financial markets.\footnote{This paper considers to the role played by depositors seriously. Studying the beliefs and actions of depositors under asymmetric information environments might reveal valuable information about the dynamics of the financial markets.}

**Figure 2. The Number of Bank Failures in the U.S. between 1934 and 2005**

It has been argued that deregulation in the banking industry caused a sharp increase in competition among banking firms (Demirguc-Kunt and Detraguiache (1998)). More competition in the marketplace meant fewer profit margins for banks. For example, in the U.S., deposit interest rates have raised substantially after regulation-Q has been abandoned. Banks were able to offer higher interest rates to depositors. Subsequently, these banks have begun to invest increasingly in risky assets in order to meet their payment obligations towards depositors. Another example is that entry restrictions to banking industry have been relaxed significantly;
this further deteriorated the bank balance sheets. With the lack of prudent regulation, the number of bank failures has soared considerably in the U.S. in the early 1980's. Capital requirements regulations have been established against credit and interest rate risk (Keeley and Furlong (1990)) as recommended by the Basle Committee in 1988. It has also been argued that the banks will quit gambling behavior with a minimum risk weighted capital requirement. When banks have more of their own capital at stake, i.e. they have something to loose in case their investment turn out to be a bad one (for more technical discussion, see Hellmann et al. (2000)), they will take less risk.

The Bank for International Settlements (BIS) in Basel, Switzerland, deals with the prudential regulation concerning international banking practices. BIS published the Basel Accord in 1988 and refined it a couple of times over the the course of the following two decades. Eventually, in 2004, the second Basel Accord consultative document (widely known as Basel II) was published and three pillars of effective banking regulation are described in this document.\footnote{A comprehensive version of this document can be downloaded at \url{http://www.bis.org/publ/bcbs128.htm} online.} The first pillar is the minimum capital requirements. A minimum level of capital is formulated for each individual bank. The rationale as discussed in previous section is that when its own resources are at stake, the bank will tend to take less excessive risk. The second pillar is supervisory review process. It underlines the necessity of constant monitoring of bank activities of asset portfolio combination. The third pillar is disclosure requirements to provide more transparency towards the activities of banking institutions. It is believed that the depositors will discipline excessive risk taking of bank managers by withdrawing their funds when necessary, i.e. the market discipline incentive, the subject matter of this paper herein.\footnote{Emerging market countries also have taken enormous steps towards liberalizing and (de)regulating their financial markets and institutions. However, well documented financial trouble in those countries is a reality and these weaknesses may have been caused by incomplete institutional arrangements, lack of prudent regulation and}
Regulators have always been interested in market forces to discipline banking institutions as a supplement to their own devices of control. There have been numerous empirical studies on whether market participants can accurately assess bank risk taking and act upon it. The results were seemingly inconclusive in the beginning. Later on, studies conducted in early 90's with large datasets unambiguously proved the functionality of this disciplining mechanism. Flannery (1998) among others\textsuperscript{9} claims that “regulators could expand their reliance on market discipline, at least for large, publicly owned institutions.” However, market participants’ abilities to assess and control risk in banking institutions is seriously questioned. In the era before the Great Depression, it was mostly the mechanism of market discipline that brought stability to financial markets, especially in the absence of an effective deposit insurance safety net system. However, the creation of deposit safety nets was inevitable following the Great Depression.\textsuperscript{10} Milton Friedman, early on in his career blamed the Federal Reserve Bank for letting fail of good standing banks during depression due to their liquidity needs. He also supported the imposition of deposit insurance as a measure to instate depositor confidence against bank runs and liquidity crises. He later on admitted the price mechanism and market forces can better control bank actions (Friedman and Schwartz (1971)).\textsuperscript{11}

\textsuperscript{9} Flannery and Sorescu (1996) and Goyal (2005) are very good empirical papers on this subject.
\textsuperscript{10} Even though it aggravates the asymmetric information problems by reducing the market discipline of lenders monitoring the borrowers, deposit safety nets provide stability to the financial markets.
\textsuperscript{11} When asked his opinion about the perverse effects of deposit insurance in an interview with the Federal Reserve Bank of Minneapolis in June 1992, Milton Friedman made the following comment: “In my opinion, what destroyed the usefulness of deposit insurance was the inflation of the 1970s for which the Federal Reserve has to bear major responsibility. That inflation had the effect of destroying the net worth of financial enterprises, particularly the savings and loan institutions, which were borrowing short and lending long... Once the net worth of the enterprises was destroyed, deposit insurance did have a very perverse influence. In order for deposit insurance to work, there has to be some private personal incentive for safe banking. That incentive was provided by the net worth of the proprietors of financial institutions. Eliminate that net worth and deposit insurance created a win-win position for proprietors of those enterprises to engage in risky activities.”
The introduction of deposit insurance combined with a widespread belief of "too big to fail" protection has caused some analysts to argue that depositors are basically ignorant about bank condition. Yet, recent research on market discipline has shown that depositors actually punish excessive risk taking by asking higher premium from the financial institutions. On the contrary, financial liberalization combined with weak financial institutions creates a perfect aura for anomalies. The imposition of deposit safety nets in the U.S., it is argued, prevented another bank panic for some long period after 1934 and the number of bank failures was extremely low during this half-a-century period before the late 1970s. Thereafter, this number has soared sharply in 1980s, then gradually declined.\textsuperscript{12} Keeley (1990) claims that making it easier to obtain a bank charter eroded the franchise value of the bank. These charter values, he argued, used to make a counter effect to the moral hazard introduced by the deposit insurance scheme. Afterwards, the banks started to take more risky positions, now that it is less costly for them to earn a new license after losing one. Today, in addition to the deposit insurance system, high regulatory and supervisory measures have been taken in U.S. by the Federal Reserve Bank, the Office of Comptroller’s Currency and other federal agencies to monitor banks and other financial intermediaries.

Before introducing the technical part of the model, it is important to acknowledge the significant players that exercise disciplining in financial markets, at times, in contrasting ways as elaborated in Caprio and Honohan (2004). (Large) depositors, (subordinated) debt holders, (outside) equity holders and information specialists (like rating agencies) are the major players exerting disciplining in the marketplace.

\textsuperscript{12} Figure 2 illustrates quite well the trend of bank failures in the U.S. over the last 70 years.
1.3 THE TECHNICAL FRAMEWORK

What are the characteristics of the interaction between depositors and a unique bank, especially the disciplining mechanism emanating from the incentives of depositors to control bank risk taking actions? Firms and regulators are not in the core of the analysis that follows, but rather they are taken exogenously, given by a specific “risk-return” technology. That assumption greatly simplifies the analysis of the interaction between depositors and banks.\textsuperscript{13} Then a \textit{bank-depositor} game is constructed.\textsuperscript{14} The next part deals with the solution of the game depending on the information structure of the system.

1.3.1 Players, Technologies and Strategy Sets

Consider, first, a unique banking institution facilitating the conventional intermediation process between depositors\textsuperscript{15} and entrepreneurial firms. This representative bank collects deposits with the promise of a future repayment of the initial debt together with some predetermined (real) net interest $r$.\textsuperscript{16} The bank then decides how to invest the gathered deposits among a continuum of (types of) firms, denoted by $q$ along the line segment $[0,1)$. Each $q$ along this line segment in fact represents the probability of default by that particular firm. Put it another way, firms are differentiated and ordered along the line segment $[0,1)$ according to their probability of defaults. The term “default” is used in the sense that the borrower firm is not able to repay the loan back to the bank altogether.\textsuperscript{17}

\textsuperscript{13} The risk-return framework presented here is novel to the best of my knowledge.
\textsuperscript{14} However, later on in the paper, the same model will also be useful to explain and predict the consequences of regulatory actions and policies undertaken by central agencies.
\textsuperscript{15} Depositors are assumed to be identical and homogenous in the next part. Then we’ll relax this assumption and let depositors vary in their type.
\textsuperscript{16} Note that the net interest $r$ is exogenously given and the bank is stuck with it at the beginning of the period.
\textsuperscript{17} In a sense, each borrower has a different \textit{risk} type. That is the reason why I interchangeably use the words “risk” and “probability of default”. When a bank defaults, the loan becomes a non-performing loan for the bank with no return.
The depositors are expected utility (EU) maximizers with identical Bernoulli utilities $u$.\textsuperscript{18} This preference function $u(\cdot)$ is assumed to be strictly concave and increasing for the sake of the argument. The beliefs of depositors about bank condition and probability of failure of a bank are allowed to be different though. In fact, a continuum of types of depositors—differentiated by these beliefs—exists and is characterized by a particular method as will be explained later on. Each depositor has 1 unit of endowment at its disposal. Two different investment technologies are available for each depositor. First, the safe (risk-free) storage technology: 1 unit stored in the beginning of the period yields a certain return of $1 + \rho$ with $\rho > 0$ at the end of the same period.\textsuperscript{19} Second, the “risky” bank deposit account as described briefly above: 1 unit deposited in the bank will yield a gross interest of $1 + r$ if the bank stays in business; however the gross return will be less than 1 if the bank goes into bankruptcy.\textsuperscript{20} Thus, the problem facing the depositor is nothing but that of a typical portfolio choice problem. The depositor will deposit the amount $0 \leq \alpha < 1$ in the bank account and the remainder $(1 - \alpha)$ will be put into the safe storage technology.

The following assumption is a technicality to guarantee that the bank will be able to attract deposits and is not redundant. Otherwise the depositors find it more secure to invest in the market storage technology.

**Assumption 1:** The net interest payment $r$ offered by the bank to depositors is given exogenously and it is always greater than the market net rate of return $\rho$:

\textsuperscript{18} In this sense individuals have the same risk aversion attitude towards risky prospects. What matters is the formation of beliefs (the underlying probabilities) of depositors.

\textsuperscript{19} This can be interpreted as the market net rate of return being $\rho$.

\textsuperscript{20} Thus, some chance of "loss" is associated with the bank deposit investment. Notice that depositing in the bank is risky because the bank is always under the (small) possibility of going into failure due to liquidity problems or excessive risk-taking practices.
At the beginning of the period, a typical depositor chooses the amount \( \alpha \in [0,1] \) to deposit in the bank account and, simultaneously the bank decides what type of investment \( q \in [0,1] \) to make. Notice that the strategies of the players and the resulting outcomes are common knowledge to both parties. At the end of the period the bank returns are realized. The bank pays back the deposited amount plus the interest if it is still in business. In case of failure, bank assets are liquidated (according to the rules prescribed in the next subsection) and the proceeds are shared among depositors fairly.

1.3.2 Risk-Return Function

The bank's return obtained from lending to different type \( q \) borrowers is assumed to be described by a risk-return function, \( R(q) \).\(^{21}\) It basically says that when a bank chooses to invest in type \( q \) firm, the bank will obtain \( R(q) \) with probability \((1 - q)\) and zero otherwise. This indeed has many parallels with the efficiency boundary theme of the optimal portfolio theory introduced by Markowitz (1952).\(^{22}\) However the notion of risk is given a slight flavor and it rather reflects the quality of bank loans extended to entrepreneurs and is deterministic as is put forth in the assumptions that follow.\(^{23}\)

\[ r > \rho \] (1.1)
For the soundness of the results, some assumptions about risk-return function \( R: [0,1) \rightarrow [0, \infty) \) is made.

**Assumption 2:** When the bank invests in a zero-risk type, the same riskless rate of return offered by the market storage technology is obtained:

\[
R(0) = R_o = \rho
\]  

(1.2)

Simply, this assumption says that there are no arbitrage opportunities: When the bank takes no risk, it should gather the same return as the storage technology would have offered.

**Assumption 3:** \( R(q) \) is increasing in \( q \):

\[
R'(q) \geq 0, \forall q
\]  

(1.3)

As the bank is lending to more risky borrowers, the real return increases\(^{24}\). That is, the bank will lend to more risky borrowers only if the expected gain is higher.

**Assumption 4:** The risk-return function \( R(\cdot) \) is assumed to be increasing, first, in a decreasing rate and then after a while it increases in an increasing rate:

\[
R''(q) = \begin{cases} < 0 & \text{if } 0 \leq q < \bar{q} \\ \geq 0 & \text{if } \bar{q} \leq q < 1 \end{cases}
\]  

(1.4)

That means, the risk return function is concave down as \( q < \bar{q} \) and concave up as \( \bar{q} \leq q \).

The next assumption, though, is not critical for the results of the analysis, only a matter of convenience.

**Assumption 5:** The rate of increase of the return is infinite at \( q = 0 \):

\[^{24}\text{It may well be the case that a prudent asset with } R(0)=R_o \text{ has more return than that of a risky asset } R(q)=\gamma \text{ such that } \gamma \geq R_o \geq \gamma(1-q). \text{ This is actually a standard assumption often used in the literature. (See Freixas and Rochet } <\text{cite}>FreixasRochet'95</cite>\text{)} \text{ It basically explains gambling behavior of banks.}\]
\[
\lim_{q \to 0^+} R'(q) = +\infty 
\]

(1.5)

As the bank makes an attempt towards greater profit by taking some small initial risk \( q > 0 \), the marginal expected return is very high (almost infinite!). That means taking the initial risk for the bank would certainly pay off. Due to this last assumption, thus, the bank has an incentive to take risky positions, i.e. \( q > 0 \), which is perfectly natural and in accordance with the bank’s “raison d'être”. As the risk increases even further the increase in the return slows down by Assumption 4, and after reaching some certain level \( \bar{q} \), the expected return increases to become larger and larger. Below, Figure 3 illustrates such a typical risk-return function that satisfies those properties just mentioned above.

![Figure 3 The Risk-Return Function R(q)](image)

To make things work out smoothly in a deterministic manner, the following critical assumption is also imposed before exhibiting the main results.
Assumption 6: There is continuum of infinitesimally small borrowers that the bank may lend to along [0,1]. Moreover, there are infinitely many firms of each risk type \( q \in [0,1) \).

This means that a choice of risk type \( q \) yields certain revenue for the bank as is shown next.\(^{25}\)

**Lemma 1:** By choosing the risk type \( q \in [0,1) \) the bank gets the following certain outcome

\[
Z(q) = (1 - q)(1 + R(q))
\]

(1.6)

**Proof:** Since there is infinitely many firms for each risk type, a law of large numbers argument can be invoked. The bank is able to perfectly diversify out the risk and by choosing a particular risk type \( q \in [0,1] \), the bank is able to obtain a net return \( R(q) \) with certainty. Total outcome would then necessarily follow as in equation (1.6). ■

1.3.3 Bank Liquidity/Solvency and Failure Probability

The bank goes into trouble and might fail when it becomes illiquid, even though it is still solvent. One needs in this respect to clarify the difference between the terms “liquidity” and “solvency” to avoid confusion. Any given bank is said to be insolvent if the discounted present value of its assets fall short of its liabilities. On the other hand the bank is illiquid only if its present ready-to-use assets are not enough to cover instantaneous withdrawals. Thus the bank may become illiquid due to the term structure of the assets and liabilities in the event of a systemic risk where depositors run to the bank to ask for their deposits. In such a case, the long-term bank assets will be liquidated (early) to the degree where the amount requested to be withdrawn is covered.\(^{26}\)

\(^{25}\) We elaborate on the details of this technology in the next section.

\(^{26}\) Early liquidation is very costly for the bank. Remember that long-term assets are not worth a lot when they are liquidated before maturity.
the event where the assets are all liquidated and yet they are not enough to cover the withdrawals
the bank is said to have fallen into bankruptcy even if, in the long-run, it is solvent.

The challenge would be to find a fine measure of bank solvency and liquidity. The cash-
in minus the cash-out at any given time is quite a reliable measure for how solvent and liquid the
bank is.\textsuperscript{27}

The following definition suggests this.

\textbf{Definition 1:} The solvency function $\Delta(\cdot, \cdot)$ is a measure for how solvent/liquid any given bank is
and it is defined by

$$\Delta(\alpha, q) = D(\alpha) \cdot [Z(q) - (1 + r)]$$  \hspace{1cm} (1.7)

where $D(\alpha)$ is the total amount of deposits attracted by the bank\textsuperscript{28} and the term in square
brackets gives per unit net return to the bank.

That is, the return from the loan minus the promised payment to depositors multiplied
with the total amount of deposits gives us a measure for how \textit{solvent} the bank is. Thus the bank
being highly solvent or not is a direct consequence of the risk-return technology faced by this
bank.\textsuperscript{29}

The following assumption reveals the nature of the contractual agreement between
depositors and the bank.

\textbf{Assumption 7:} There is a "standard debt" contractual agreement between depositors and the
monopolist bank.

\textsuperscript{27} It is assumed that the random variable $P(\Delta)$ contains sufficient information about systemic risk and liquidity
concerns.
\textsuperscript{28} For simplicity, $D(\alpha) = N \cdot (\alpha)$ where $N$ is the number of depositors with identical preferences.
\textsuperscript{29} Another important observation is that the bank objective function can equivalently be written as
$\max_{q \in [0,1]} \Delta(\alpha, q) = \alpha \cdot [Z(q) - (1 + r)]$ which delivers the same result.
The Assumption 7 simply says that if the bank fails to pay back its promised obligations of $a \cdot (1 + r)$ to the depositors, then the depositors seize all the cash flow to the bank.$^{30}$

Due to the nature of this debt contract between the bank and the depositor, the payoff that the depositor would get in such a case of bankruptcy will be less than what it would be if the bank did not go bankrupt (in fact, the proceeds are even less than that offered by the riskless technology) as is shown in the following definition.

**Definition 2:** The liquidation rate of a bank investing in $q$, denoted by $V_q$, is the rate of return obtained by the depositor in case of failure of the bank. Notice that $V : [0,1] \rightarrow \mathbb{R}$ such that $V(q) = V_q$. This rate is assumed to be even less than the return of the storage technology irrespective of the risk level choice $q$, i.e.

$$V_q \leq 1 < 1 + \rho \quad (1.8)$$

So far, the model lacks any stochastic component: The bank fails if it is insolvent, i.e. if $\Delta(\cdot,\cdot) < 0$. Hence, the probability of failure is 1 if $\Delta(\cdot,\cdot) < 0$. On the other hand, the same bank stays in business if it is solvent. That is, probability of failure is 0 if $\Delta(\cdot,\cdot) \geq 0$. When (i) there is not any interbank borrowing or lending and (ii) there is no other risk involved, this probability function is discontinuous and jumps at $\Delta = 0$. We keep this lack of borrowing assumption, i.e. item (i) for the rest of the discussion, but drop item (ii) as is shown next.

Why then to worry about failure if it is not even probable that the bank has a risk-return technology that breaks-even? The reason is that there is systemic risk due to liquidity concerns of depositors. This risk may cause the bank to fail even if it is solvent. It summarizes in a sense the

---

$^{30}$ In real life, it is the regulatory agency which confiscate the charter license of the bank and liquidate its assets for the sake of the depositors.
liquidity problem of the economy. It can also be interpreted as a probability of a run to the bank due to systemic risk and contagion factors inherent in the system. That is, the systemic risk component puts into account the possibility of a bank run. Consider the case when given the bank balance sheet, the book value of the bank barely covers all its debt. Following a run into the bank, the assets of the bank are liquidated but of course at a cost. That cost might cause the bank to go into bankruptcy, even if it was solvent at the beginning. The probability of non-failure, \( P(\Delta) \), of the bank is thus an increasing function of the solvency of the bank.\(^{31}\)

**Assumption 8:** The probability of non-failure of the bank, \( P(\Delta) \), is a continuous cumulative distribution function. with the following properties:

\[
P(\Delta) \begin{cases} 
= 0 & \text{if } \Delta \leq 0 \\
> 0 & \text{if } \Delta > 0
\end{cases} 
\]  
(1.9)

\[
P'(\Delta) \leq 0, \forall \Delta
\]  
(1.10)

\[
\lim_{\Delta \to \infty} P(\Delta) = 1
\]  
(1.11)

The equation (1.10) reveals that \( P(\Delta) \) is monotone increasing. Equation (1.11) is a standard property of a cumulative distribution function. Figure 4 below exhibits these properties of the probability of bank solvency \( P(\Delta) \).

In general, these properties establish the possibility of a bank failure (due to, say, liquidity problems) even though this very same bank is yet solvent. Moreover, the function \( P(\cdot) \) simply demonstrates the very intuitive fact that the more solvent and liquid a bank is, the more likely it will not fail.

\(^{31}\) Clearly, the probability of failure of the bank is given by the decumulative distribution function \( 1 - P(\Delta) \).

\(^{32}\) How to come up with a \( P(\cdot) \) from the optimal behavior of depositors and the bank is a challenging task. Is it possible to extract \( P(\cdot) \) from the risk-return function \( R(\cdot) \) or from the optimizing behavior of depositors and banks? This is certainly an important question and the answer depends on the banking industry structure as a whole.
Figure 4 Probability of Bank Solvency with Systemic Risk

Notice that systemic risk of the financial system refers to the overall risk of the banking system, including the correlation between banking assets, cross holdings of assets and other securities. Systemic risk is an important component of the probability of default of a particular bank. That is, the probability of failure of any given bank depends on its own actions and choices as well as the overall interplay between other actors of the financial markets and the overall performance of the economy.

To shed more light on this issue of systemic risk, Allen and Gale (2000) among others emphasizes the role of financial contagion as part of systemic risk in the markets. They argue that the contagion effect is an equilibrium phenomenon and a financial crisis in one region can easily spread to other regions (contagion) via the cross holdings of bank deposits among neighboring regions. That makes perfect sense when you realize that financial liberalization enables increasing mobility of funds throughout the globe. More and more, larger investor portfolios with greater diversification take place. The possibility of a wide-spread financial
contagion through bank cross holdings of assets and other securities is certainly what bothers policymakers the most.\footnote{It is not certain if the total effect will be detrimental or not. Note that cross holdings of assets have a positive effect in terms of diversification and a negative one in terms of contagion. The advantageous effects dominates in general. Nevertheless the extreme cases of adverse market conditions may dominate in times of crises}

1.3.4 Objective Functions of Depositors and the Bank

Based on the structural format defined above, the depositors are expected utility maximizers and the monopolist bank is a profit (expected value) maximizer. Their respective objective functions are laid down next.

1.3.4.1 The Problem of the Bank

The bank solves the following program

\[
\max_{\alpha \in [0,1]} \{ 0, P(\Delta(\alpha, q)) \cdot \Delta(\alpha, q) + [1 - P(\Delta(\alpha, q))] \cdot 0 \}
\]

\[
\Leftrightarrow \max_{\alpha \in [0,1]} \{ 0, P(\Delta(\alpha, q)) \cdot \Delta(\alpha, q) \}
\]

(1.12)

where \(\Delta(\alpha, q) = D(\alpha) \cdot [Z(q) - (1 + r)]\). Notice that the bank shareholders get nothing in case of failure due to the standard (debt) contract; and they get only the remaining of the proceeds after all depositors are paid in full in the case of no bankruptcy. Depending on the shape of the probability function \(P(\Delta)\), this objective functional might reduce to a simpler format.

1.3.4.2 The Problem of Depositors

The depositors choose the optimal amount of deposits to invest in the bank account according to the following program

\[
\max_{\alpha \in [0,1]} P(\Delta(\alpha, q)) \cdot u[(1 + r) \cdot \alpha + (1 + \rho) \cdot (1 - \alpha)] \\
+ [1 - P(\Delta(\alpha, q))] \cdot u[V_q \cdot \alpha + (1 + \rho) \cdot (1 - \alpha)]
\]

(1.13)
where $P(\cdot)$ is the probability of non-failure and $u(\cdot)$ is the Bernoulli utilities of depositors. Thus depositors maximize their expected utility as suggested previously. Apparently there is no cost of acquiring information about the value of $q$.\footnote{However it is possible to add this dimension of complexity into the analysis for a better assessment of informational costs.}

1.4 DEPOSITOR ASSESSMENT OF BANK CONDITION

How would depositors assess bank condition especially when solvency probability $P(\cdot)$ is unknown to them? Which "rule" would be used by depositors to assess bank condition $P(\cdot)$ given they have only truthful information about $q$? The response to such questions would depend on the availability of relevant banking information to depositors. Two cases stand out for further study. First, the benchmark case where there is full information is analyzed.\footnote{The study of this situation is out of theoretical curiosity and the possibility for comparative results. Otherwise, the existence of systemic risk is enough to make the $P(\cdot)$ unknown.} Second, the realistic case where there is incomplete information due to systemic risk is studied.

1.4.1 Full Information: $P(\cdot)$ known

This is a hypothetical case where solvency probability $P(\cdot)$ is assumed to be publicly known.\footnote{This assumption may easily be justified by a regulatory agency correctly monitoring the activities of banking institutions, making the necessary calculations and reporting bank condition to the public in a timely fashion.} It has the benefit of being a benchmark to make comparisons with other cases where there is only "some" information disclosure or no information availability altogether.

Suppose that the risk choice $q$ and bank lending technology $R(q)$ is observable to depositors. Moreover, the probability of solvency $P(\cdot)$ is also known i.e. depositors can assess bank condition accurately. The simple case where systemic risk does not exist is examined first, and then the solution of the general case where systemic risk does in fact exist is given.
1.4.1.1 Deterministic Case

There is no systemic risk in the system. At this case, the probability of non-failure \( P(\Delta) \) is discontinuous and makes a jump at \( \Delta = 0 \):

\[
P(\Delta) = \begin{cases} 1 & \text{if } \Delta(\alpha, q) > 0 \\ 0 & \text{if } \Delta(\alpha, q) \leq 0 \end{cases}
\]  \hspace{1cm} (1.14)

Using the program (1.12), the bank objective function immediately reduces to the following:

\[
\max_{q \in [0,1]} P(\Delta(\alpha, q)) \cdot \Delta(\alpha, q) = \max_{q \in [0,1]} \{0, \Delta(\alpha, q)\}
\]  \hspace{1cm} (1.15)

where \( \Delta(\alpha, q) = D(\alpha) \cdot [Z(q) - (1 + r)] \) and the second line of this reduced form following immediately from equality (1.14).

**Lemma 2.** The bank has a dominant strategy, i.e. the bank decides how much risk to take irrespective of depositors' allocation of deposits.

**Proof:** Solving program (1.15), the bank has a dominant strategy \( q^* \in [0,1] \) satisfying

\[
\frac{\partial \Delta}{\partial q} = \frac{\partial}{\partial q} \{ \alpha \cdot [Z(q) - (1 + r)] \} = Z'(q^*) = 0
\]  \hspace{1cm} (1.16)

as is desired. ■

Therefore this result tells us that what matters for the bank in the case of perfect information and with no stochastic component is the risk-return technology the bank is facing. Quite interestingly, the bank simply cannot care less about depositor action when market conditions are perfectly favorable, in that no systemic component exists, and a clear assessment is possible. In such a market, market discipline cannot exist as a disciplinary tool. Deposit portfolio choices of depositors are irrelevant for banking organizations. In such an environment, what would be the choice of depositors? It comes next.
The depositors choose the optimal amount of deposits to invest in the bank account according to the program (1.13) where

\[
P(\Delta) = \begin{cases} 
1 & \text{if } Z(q) \geq 1 + r \\
0 & \text{if } Z(q) < 1 + r 
\end{cases} \tag{1.17}
\]

since there is no systemic risk.\footnote{37}

Recall that the information structure of this game is common knowledge to both parties.

The depositor will choose the optimal level of investment (portfolio choice) \( \alpha^* \in \{0,1\} \) according to the following result:

**Lemma 3:** When there is no systemic risk, the optimal deposit amount \( \alpha^* \) that is chosen by depositors is given by

\[
\alpha^* = \begin{cases} 
1 & \text{if } Z(q^*) \geq 1 + r \\
0 & \text{if } Z(q^*) < 1 + r 
\end{cases} \tag{1.18}
\]

where \( q^* \) is the optimal risk choice of the bank which satisfies \( Z'(q^*) = 0 \).

**Proof:** The optimal strategy of the bank is given by solving program (1.15) which leads to first order conditions where \( Z'(q^*) = 0 \).

When \( Z(q^*) \geq 1 + r \), the probability of solvency is \( P(\Delta) = 1 \). This implies that the program (1.13) reduces to

\[
\max_{\alpha \in [0,1]} u[(1 + r) \cdot \alpha + (1 + \rho) \cdot (1 - \alpha)] \tag{1.19}
\]

But we know that \( u(\cdot) \) is concave and strictly increasing. Thus, since \( 1 + r > 1 + \rho \), we must have \( \alpha^* = 1 \) when \( Z(q^*) \geq 1 + r \).

In a similar fashion, when \( Z(q^*) < 1 + r \), we have \( \alpha^* = 0 \) as is desired. \( \blacksquare \)

\footnote{37 Notice that depositors know perfectly well that the bank will choose \( q^* \) even though depositors make their choices at the same time with the bank. It is also possible to assume that the representative bank chooses its action first then depositors decide how much to invest. Finally the outcome is realized and the proceeds are shared between depositors and bank shareholders.}
1.4.1.2 Stochastic Case

The probability of solvency of the bank, \( P(\Delta) \), is a continuous monotonically increasing function (random variable) in this scenario since there exists systemic risk.\(^{38}\) The bank then solves the program (1.12) where \( P(\cdot) \) is assumed to be publicly known.

**Lemma 4** The portfolio allocation program (1.12) of the bank reduces to the following form:

\[
\max_{q \in [0,1]} \{0, \Delta(\alpha, q)\}
\]

(1.20)

**Proof:** When \( \Delta(\cdot) \leq 0 \) the value of the objective function (1.12) is simply zero. Thus we are left with the situation where \( \Delta(\cdot) > 0 \). First order conditions of problem (1.12) imply

\[
\frac{\partial \Delta}{\partial q} \left[ \frac{dP(\Delta(\alpha))}{d\Delta} \Delta(\alpha) + P(\Delta(\alpha)) \right] = 0
\]

(1.21)

The first term inside the brackets is equal to zero in this case. This reduces the first order conditions to merely the following equality:

\[
\frac{\partial \Delta}{\partial q} = 0
\]

(1.22)

and \( \Delta(\cdot) > 0 \). Yet, this is the first order condition of (1.20) as well.\( ^{\blacksquare} \)

Let's consider the depositors' problem. A representative depositor continues to solve the program (1.13) in the case where there is systemic risk. The continuity of the probability of non-failure \( P(\Delta) \) of the bank ensures the existence of a solution for the depositor's problem. However the results won't go far since depositors' objective function is not globally concave. One needs to invoke certain regularity conditions\(^{39}\) to ensure concavity and an interior solution to this problem. The following lemma describes this irregularity and is proven later in the Appendix.

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38 This can be interpreted as \( P(\Delta) \) depending on the overall well being of the financial system which includes a stochastic component called "systemic risk".

39 These regularity conditions are explained in the proof of proposition.
**Lemma 5.** The representative depositor's utility function $U(\alpha)$ is increasing for sufficiently large $\alpha$, but not (necessarily) globally concave in $[0,1]$.

The following proposition, whose proof is also in the Appendix, underlines the fact that depositors decide to hold a non-diversified portfolio where they invest all of their endowment in the bank or in the alternative (storage) technology depending on the technology of the bank.

**Proposition 1.** Consider the bank-depositor game with many depositors and a (unique) bank.\(^{40}\) Assume that the risk taking choice $q$ as well as the bank condition\(^ {41}\) is observable to the depositors. The Nash equilibrium strategies consist of the bank taking risk $q^*$ that satisfies $Z'(q^*) = 0$ as a dominant strategy and the depositors choosing to invest $\alpha^* \in \{0,1\}$ as long as $Z(q^*) \geq 1 + r$. Otherwise, when $Z(q^*) < 1 + r$, the optimal deposit amount will be $\alpha^* = 0$ for certain.

Some comments are in order. The functioning of the “market discipline” mechanism is obscured by two facts. First, banks have a dominant risk-taking strategy that they hold onto. Banks value deposits as it has a multiplier effect on their profits, however they simply do not care about that in their risk-taking decision process.

Second, depositors choose "in the corners", i.e. $\alpha^* = 0$ or $1$. This result suggests that in perfect information conditions instability and lack of robustness prevails. This is so because as soon a large enough negative shock hits the financial markets the depositors will end up switching from investing all to investing almost nothing. As such, it would be very hard to justify

\(^{40}\) The word "monopolist" can be replaced for the word "unique". Notice that the banking industry is free-entry and exit. The reason that banks end up making positive profits is that they suffer charter license fees (which can be considered as rent). Adding these fees into the analysis would make the banking industry quite competitive; or monopolistically competitive one can say. This paper do not account for the banking industry structure due to varying license fees.

\(^{41}\) The term 'bank condition' is synonymous to the probability of solvency/failure $P(\Delta)$. 
market discipline as a "coherent" and reliable mechanism that would supplement conventional regulatory devices implemented by regulators. But also this unstable equilibrium result shows us that regulators certainly do not want to release too much information!

1.4.2 Incomplete Information of Bank Condition

The probability of solvency $P(\cdot)$ is not known publicly this time.\footnote{This is certainly a more realistic case.} Suppose, though, the risk choice $q$ taken by the bank continues to be observable to depositors. Now the markets are structured in a way that bank risk choice $q$ may help depositors assess bank condition $P(\Delta)$. Notice that depositors do not have effective means for evaluating bank probability of default $P(\cdot)$. Instead, what they do is to use bank risk taking signal $q$ which is common knowledge as a measure for assessing the quality of bank loans, and eventually to come up with the probability of solvency of the bank (or bank probability of failure). The depositors' assessment of bank condition is based on a "threshold method" which is defined next:

**Definition 3.** According to the threshold method, depositor $i$ considers the bank to be safe if bank risk taking strategy $q$ is below a permissible level $q_i$, for that particular depositor $i$. If the bank is safe, that is, if $q < q_i$, then the depositor $i$ predicts the probability of solvency of the bank to be of high value $P_H$. Instead, if the bank is taking a risky strategy, i.e. if $q \geq q_i$, then from the view point of the depositor the probability of solvency of the bank falls to a low value $P_L$, where $P_L < P_H$.

The following assumption illustrates the fact that depositors have distinct threshold levels.
**Assumption 9.** There is a continuum of depositor types along $[0,1]$ with varying thresholds $q_i$ for each depositor $i$. Denote this distribution by $f(\cdot)$ and notice that

$$\int_0^1 f(q) dq = 1$$  \hspace{1cm} (1.23)

The following assumption is necessary for technical purposes:

**Assumption 10.** Given that the function $f(\cdot)$ is the distribution of these depositor types, $f(\cdot)$ is a continuous function.

Figure 5 illustrates a situation where the depositor considers and flags the bank as safe. He/she assigns a high probability of solvency $P_H$ consequently. The threshold level of $q$ is lower for cautious depositors than it is for patient depositors. The challenging question is whether the bank will revise its risk-taking strategy $q^*$ given this structure of depositor behavior? Is risk level $q$ chosen by the bank lower now compared to the case where no such information was available?

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43 This assumption certainly simplifies the proofs of the propositions that follow. It is a natural assumption to me.
Each and every depositor in the economy is endowed with 1 unit of a consumption good and the depositors choose \( \alpha \in [0,1] \) according to their portfolio selection program given by (1.13) with the slight difference that the true \( P(\cdot) \) is replaced by an estimate \( \tilde{P}(\cdot) \)

\[
\max_{\alpha \in [0,1]} \tilde{P}(q) \cdot u[(1 + r) \cdot \alpha + (1 + \rho) \cdot (1 - \alpha)] \\
+ [1 - \tilde{P}(q)] \cdot u[V_q \cdot \alpha + (1 + \rho) \cdot (1 - \alpha)]
\]

(1.24)

where

\[
\tilde{p} = \begin{cases} 
    P_h & \text{if } q^{**} \leq \bar{q}_i \\
    P_L & \text{if } q^{**} > \bar{q}_i
\end{cases}
\]

(1.25)

and given \( q^{**} \) is the revised risk taking level by the bank when depositors have heterogeneous beliefs.

Assume that the solution to the depositors’ problem (1.24) is given by

\[
\alpha^{**} = \begin{cases} 
    \alpha_H^* & \text{if } q^{**} \leq \bar{q}_i \\
    \alpha_L^* & \text{if } q^{**} > \bar{q}_i
\end{cases}
\]

(1.26)

Without loss of generality we assume that \( P_L = 0 \), this ensures that \( \alpha_L^{(*)} = 0 \).

\( F(q^{**}) \) determines the proportion of depositor types that would consider the bank risky given \( q^{**} \) is the decision of the bank to the constrained optimization problem and \( F(\cdot) \) is the cumulative distribution function. Therefore these depositors will not deposit in the bank. The risk choice \( q^{**} \) of the bank is now a solution to the following program \(^{44}\)

\[
\max_{q \in [0,1]} D(\alpha, q) \cdot [(1 - q)(1 + R(q)) - (1 + r)]
\]

(1.27)

Notice that

\[
D(\alpha, q) = \alpha \cdot [1 - F(q)] = \alpha \left[ 1 - \int_{-\infty}^{q} f(s)ds \right]
\]

(1.28)

\(^{44}\) The objective function of the bank is only of the following form \( \max_q \Delta(\alpha, q) \) such that the threshold condition is satisfied. The analysis in the previous section has well established that these two problems are equivalent when there is no constraint. Moreover the bank has no interest in evaluating the number \( P(\Delta) \) since this may be prohibitively too costly.
where \( \alpha^* \) is optimal allocation of the depositors who have chosen to deposit in the bank. Observe that \( \frac{\partial p}{\partial q} < 0 \) and

\[
\frac{\partial}{\partial q} [(1 - q)(1 + R(q)) - (1 + r)] > 0
\]

(1.29)

for \( q < q^* \) where \( q^* \) satisfies \( Z'(q^*) = 0 \). Therefore the higher \( q \) gets, the higher the net return per deposit, however, the lower \( \alpha \) become as well. There is a tradeoff where the risk choice \( q \) of the bank will eventually be based upon some marginality constraint prescribed by first order conditions. The following is a critical step for the proposition that follows:

**Proposition 2.** Let \( f(q) \) be a probability distribution function with positive support on \([0,1]\).

Assume that \( q^* \) is a solution to the following unconstrained problem with known \( P(\cdot) \)

\[
\max_q [Z(q) - (1 + r)]
\]

(1.30)

Also, let \( q^{**} \) be the solution to the following constrained problem

\[
\max_q [1 - F(q)][Z(q) - (1 + r)]
\]

(1.31)

Then

\[
q^{**} \leq q^*
\]

(1.32)

The proof of Proposition 2 is available in the Appendix. The main implication of this proposition, though, is that bank risk taking will be hampered from the first best allocation to an inferior position. Even though it is more fruitful to take risk \( q^* \), the bank will end up choosing \( q^{**} \) which is inferior. Yet, this might be interpreted as a market disciplinary revision indeed. The bank is prevented from taking a higher risk.

This result may also be interpreted as follows: the banking institution is rewarded by revealing more information about its portfolio structure and penalized by preventing information
pertaining to its asset portfolio to generate ambiguity and uncertainty about its condition. Therefore these results encourage bank managers for meaningful disclosure of bank data in a timely fashion. In fact to do so is in the best interest of the bank itself.

Finally, consider of what might happen when financial markets lack the capacity to provide relevant financial information pertaining to bank condition altogether. If there is no public disclosure the term “disciplining” ceases to exist in the financial markets. To prove this, one can consider the situation where there is no way to ascertain the condition of the bank by simply looking at the quality of loan type $q$. The depositors all incur the same costs and have the same vague assessment regarding bank condition. Assume the counterstatement is correct, that, there is market discipline and depositors assign meaningful probabilities, though independent of risk choice $q$, to a given bank.

Consider, now, an outside shock that hits depositor expectations about the bank probability of solvency. Depositor beliefs will naturally change since each depositor knows that he has the same lack of information like others. Some of depositors’ withdrawing may ignite a full bank run, seriously damaging bank condition. That means an outside exogenous shock may disrupt bank activity abruptly. As such there is no way a banking system might be stable

1.5 EQUILIBRIUM WITH HETEROGENOUS DEPOSITORS

The results of the previous section suggest that the choice of the risk level by a bank in any given economy depends on the risk tolerance of depositors, that is, the distribution of depositor types. Notice that this may explain why financial institutions with the same fundamentals but operating in different markets perform differently. Some apparently perform better than others.

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45 It is quite interesting to see that the case where market discipline does not exist or is weak leads to more instability. A later section will be devoted to these considerations.
Grossman and Hart (1983) first suggested the use of the monotone likelihood ratio property in asymmetric information problems.

**Definition 4.** Let $f_1$ and $f_2$ be two probability distribution functions defined on $[0,1]$. These distributions satisfy monotone likelihood ratio property (MLRP) if $\frac{f_1(q)}{f_2(q)}$ decreases (or increases) monotonically in $q$.\(^{46}\)

MLRP is an assumption which forces relative concavity/convexity of distribution functions.

**Assumption 11.** Let $\{f_i\}_{i \in I}$ be a sequence of probability distribution functions defined on $[0,1]$. This set of distribution functions satisfies the monotone likelihood ratio property if any two of its elements satisfy the monotone likelihood ratio property.

Observe that the MLRP is stronger than first order stochastic dominance (FOSD). As a demonstration, consider the following distribution functions $f_1$ and $f_2$ in two different markets. Let

$$f_1(q) = 1 \quad (1.33)$$

and $f_2(\cdot)$ be a monotonically increasing distribution function. The depositors in the first market are evenly distributed in terms of types whereas the depositors in the second market are more patient.

The cumulative distribution function of $f_1$ is given by

$$G_1(q) = 1 - F_1(q) = 1 - q \quad (1.34)$$

\(^{46}\) An alternative definition for MLRP suggests to look at whether the ratio $\frac{f(q)}{1-F(q)}$ decreases or increases monotonically in $q$.\)
Notice that

\[ G_2(q) \geq G_1(q) \text{ for all } q \]  

(1.35)

This means \( F_1 \) first order stochastically dominates \( F_2 \).

![Figure 6 Concave shape of \( G_2 \)](image)

The monotone likelihood ratio property (MLRP) implies the slope of \( G_2(\cdot) \) to be increasing in absolute terms compared to that of \( G_1(\cdot) \) as is shown in Figure 6. This observation has some implications in terms of convexity/concavity. This is due to the fact that the slope of \( G_2(\cdot) \) at a particular \( q \) is the negative of the probability distribution function \( f_2 \) at that point of interest \( q \).\(^{47}\)

**Proposition 3.** Let \( f_1 \) and \( f_2 \) be two distributions that can be ordered according to the monotone likelihood ratio property, such that \( \frac{f_1(q)}{f_2(q)} \) decreases in \( q \). Also further assume that the

\(^{47}\) The proposition 3 imposes concavity to deal with technical complexities that may arise without loss of generality.
decumulative distribution functions $G_1(\cdot)$ and $G_2(\cdot)$ associated with $f_1(\cdot)$ and $f_2(\cdot)$, respectively, are concave functions.

Then the solution (described as $q_1^{**}$) to the corresponding constrained optima for these two distributions will be ranked as follows:

$$q_1^{**} < q_2^{**}$$  \hfill (1.36)

See the Appendix for the complete proof of Proposition 3 which have far reaching implications in terms of financial market efficiency and stability across different financial arrangements. This may explain why the same financial institutions work well in some countries but may perform very poorly in some others. For example, a country like Argentina which consists of historically more cautious type depositors (Maria-Perez and Schmukler (2001) may need different financial framework than in Germany.

The result of the analysis regarding the ordering of MLRP can be justified and interpreted on several grounds. It suggests that bank depositors’ expectations and beliefs are crucial for the safety and soundness of the overall economy. Moreover the distribution of depositors’ beliefs can be changed through the enforcement of disclosure requirements policies.

Basel II principles of the Basel Committee on Banking Supervision at the BIS provide state-of-the-art policy objectives for central bankers. Basel II consists of three essential pillars. The first one is the minimum capital that banking institutions are required to hold. The second pillar is related to supervisory review process. Finally, the third pillar suggests the transparency of bank risk-taking activities. This third pillar is relevant for the purposes of this paper. It forces banks to disclose relevant financial data in a timely fashion. More transparency will supposedly bolster market discipline in those countries. That is, liberalization policies and more transparency
for emerging market countries is certainly good and necessary since it initiates motives for market disciplinary forces to function properly to complement prudential regulatory policies.

The analysis proposed in this paper has many other policy implications. For example consider the case where bank regulators and supervisors evaluate bank condition based on bank financial statements and on-site visits. They rate each and every single bank based on what is called "CAMELS ratings". The outcome is a grade from 1 (strong) to 5 (weak) and it is delivered to the bank owners and top managers. The banks with bad grades are supposed to pay some premium since they have a higher probability of default. The question of whether it would be useful to release this information seems to have a clear answer in our analysis. Making CAMELS ratings publicly available may cause a bank run since it contains too much speculative information.

Compare the results of this section with that of Cordella and Yeyati [14]. They argue that if the risk component is governed by nature and is beyond the control and management of the banking institution, then disclosure alone would not be enough for effective regulation and market discipline. They also acknowledge the problematic feature of distinguishing between exogenous and what is bank’s excessive discretion. Finally they conclude that information disclosure in such an environment has the potential of becoming misleading, parallel with what this present paper demonstrates.

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48 CAMELS stands for capital adequacy (C), asset quality (A), management (M), earnings (E), liquidity (L) and sensitivity (S).

49 It would be “heroic”, as the authors put it, to claim to perfectly quantify the risks that a bank is exposed to.
1.6 PRUDENTIAL REGULATION

The rationale for strict regulation of the banking industry stems from the balance sheet composition of the banking institution. Depositors, being first claimants over bank assets want less risk and ask for safety of their deposits, whereas equity holders (owners) of the bank want to engage in more risky activities for a higher return on equity. When shareholders are not satisfied with the job handling of the bank manager, they can simply replace him/her with a new manager that would pursue their interests. Thus, contradicting objectives of bank liability holders explain why the banking industry is so much regulated. This also perfectly demonstrates the power of leverage.

1.6.1 Financial Stability

Notice that when the probability of solvency $P(\cdot)$ is perfectly known to depositors, the equilibrium happens to be unstable. Optimal investment of a representative depositor changes between the extremes, i.e. $\alpha^* = 0$ or 1 depending on parameters like interest rate $r$ and $R(q)$. That result by itself suffices to establish the regulatory common sense of not disclosing too much information.

On the other hand, the stability conditions of the new equilibrium where $P(\cdot)$ is unknown is of special interest. That equilibrium is in fact inherently stable when market discipline exists. Otherwise it continues to be a source of instability. Apparently when too much information is disclosed, this might ignite a run to the bank in case the bank probability of failure is relatively high. For example, releasing CAMELS ratings to the public may have such effects. On the other

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50 A quick look at the balance sheet of a typical bank would be enough to respond to that question. Recall that depositors and equity (share) holders are liability holders of the bank. Assume depositors put a total of $90 in the bank, whereas the equity capital hold is only at $10. Notice that a 1% return on assets (ROA) is equal to a 10% return on equity (ROE)!

51 Some economists argued more leverage as a danger for systemic risk whereas some others oppose this idea. Their claim is that more leverage is indeed necessary for growth of the overall economy.
hand, lack of information release is also not good since there is no room for market discipline in this situation. Finally, disclosing the relevant financial data in a timely fashion will enable depositors to assess bank condition in a meaningful context.

Therefore, the challenging question shall be as follows: “What is a meaningful context to release bank financial data to the public?” The response to how often to release the meaningful data seems to be quarterly. At least this is the common practice in the U.S. and most of the developed countries and the E.U. countries.

Here is also a game theoretical interpretation of the stability dimension of market discipline. Notice that depositors and banks are in a sense playing a trust game. Recall that the Nash equilibrium can also be defined as an allocation where no party has an incentive to deviate. This has some stability consequences obviously.51

Consider the first notion of stability where no agent has an incentive to deviate from the equilibrium allocation. That equilibrium refers to the bank choosing a risk level and depositors deciding how much to invest in the bank. Notice that when adverse conditions hit the bank and depositor expectations change in an adverse manner, some of the depositors may decide to withdraw. When there is sufficient information release enabling market discipline, some depositors’ withdrawal will not cause others to withdraw as well. Instead those who are relatively more patient will contemplate that it is those at the margin who withdrew and there is nothing serious to be worried about. On the contrary, if the market discipline mechanism was not in place, after some depositors’ withdrawal, others might feel like withdrawing too. That would cause an unstable equilibrium.
1.6.2 The Ineffectiveness of Minimum Capital Requirements

Regulators require bank owners (shareholders) to put a minimum amount of capital (equity) into the bank. Two rationale is given to explain why this should be the practice. First, it is argued that this capital will serve as a cushion for possible future market shocks. It is secondly argued that having something of their own at stake, the bank shareholders are expected to be involved in less excessive risk-taking activities. The first rationale is reasonable however the second one is indeed misleading according to the implications of the model used in this paper.

For this consider a bank with the following simplified balance sheet. It starts business with only $5 of capital and collects $95 of deposit. The leverage ratio is thus very high (1-to-20). Assets consist of $100 loans to entrepreneurs. Assume that a negative macroeconomic shock deteriorates the balance sheet of the bank and its loans are now devalued from $100 to $92. The bank will not be able to pay its debt to depositors under this scenario. Thus, a minimum capital requirement is necessary to guarantee that the bank keeps solvent. More capital also reinforces depositor confidence to the banking institutions.

Concerning the other rationale, namely, the use of capital requirements as an instrument to curb excessive bank risk-taking, the results do not follow as simple. One should ask: How would these ownership structure considerations affect the formulation of the problem? To deal with this question, one needs to accommodate the minimum capital requirement into the objective function of the bank.

Consider the bank objective function with no regulation or whatsoever:

\[
\max_{\Delta \in [0,1]} P(\Delta) \cdot \Delta + (1 - P(\Delta)) \cdot \Delta
\]

(1.37)

Now it is not difficult to notice that this is a situation where the bank has no risk of losing anything! Only a probability \( P \) of a win when \( \Delta > 0 \) or a probability of not win. This needs to be
changed. When shareholders' equity \((K_0)\) is also included into the objective function, it would become

\[
\max_{q \in [0,1]} P(\Delta) \cdot \Delta + (1 - P(\Delta)) \cdot (SV(\Delta) - K_0)
\]  

(1.38)

where \(0 \leq SV(\Delta) \leq K_0\) is the liquidation value of the bank (in case of takeover by the regulator) after all first claimant liability holders are paid off. Obviously the second term in equation (1.38) is no longer equal to zero but a negative quantity reflecting a possible loss from the point of view of the bank. How would this change the results of our analysis?

The following assumption is a regularity-type condition about the rate of change of the liquidation value of the bank.

**Assumption 12.** The rate of change of the salvage value of the bank in terms of the solvency rate, i.e. \(\frac{dSV}{d\Delta}\) satisfy the following

\[
0 \leq \frac{dSV}{d\Delta} \leq 1
\]  

(1.39)

**Corollary 1.** When Assumption 8 holds, risk taking incentives of the bank do not change and remain the same. In this sense minimum capital requirements are irrelevant.

**Proof.** The maximization problem (1.38) can be written as

\[
\max_{q \in [0,1]} P(\Delta) \cdot [\Delta - SV(\Delta) + K_0] + SV(\Delta)
\]  

(1.40)

Assuming an interior solution without loss of generality, the first order conditions imply

\[
0 = \frac{dP(\Delta)}{d\Delta} \frac{\partial \Delta(\alpha, q)}{\partial q} [\Delta(\alpha, q) - SV(\Delta) + K_0] + \frac{dSV(\Delta)}{d\Delta} \frac{\partial \Delta(\alpha, q)}{\partial q}
\]

\[
+ \left[ \frac{\partial \Delta(\alpha, q)}{\partial q} - \frac{dSV(\Delta)}{d\Delta} \frac{\partial \Delta(\alpha, q)}{\partial q} \right] \cdot P(\Delta)
\]  

(1.41)

The equality reduces to the following
\[
\frac{\partial \Delta}{\partial q} \cdot \left\{ \frac{dP}{d\Delta} \cdot [\Delta(\alpha, q) - SV(\Delta) + K_q] + \frac{\partial SV}{\partial \Delta} + \left( 1 - \frac{\partial SV(\Delta)}{\partial \Delta} \right) \cdot P \right\} = 0
\]  
(1.42)

There are only two possible cases: Either \( \frac{\partial \Delta}{\partial q} = 0 \) which implies \( Z'(q) = 0 \) at the maximum. Or else, the second term equals to zero. This is only possible if \( \Delta \leq 0 \) (or equivalently \( P = 0 \)). This holds at the minimum.

Therefore the value of program (1.38) is the same as the one for the following program where

\[
\max_q P(\Delta) \cdot \Delta(q)
\]  
(1.43)

which in turn is equal to \( \max_q \Delta(q) \). This means that risk-taking incentives of the bank remain the same even though the bank has its own capital at stake that it can lose. \( \blacksquare \)

The fact that when Assumption 12 is dropped a minimum capital requirement by itself may even harm the well being of the bank is given next.

**Corollary 2.** If Assumption 12 fails to hold, then minimum capital requirements may even lead the bank to take further excessive risk.

**Proof.** Consider Equation (1.42). When \( \frac{\partial SV}{\partial \Delta} \geq 1 \), the term inside parenthesis may become zero and even negative. That implies that minimum capital requirements may lead to even more risk taking by the bank. \( \blacksquare \)

This striking result is consistent with Kahane (1977) and Kim and Santomero (1988). The implication is clear: The minimum capital requirement in such a scenario (assuming the regularity condition holds) is not enough to take care of asymmetric information problems. Put it another way, solvency requirements have nothing to offer in terms of reducing excessive risk taking. On the other hand, Hellman et al. (2000) argue that there are two opposing effects related
to capital requirements: gambling incentives fall due to the equity at stake, but also, they rise due to the perverse effect of harming banks’ franchise values. Only adding deposit rate controls to the situation, they argue, can yield efficient allocations.

1.6.3 The Impact of Deposit Safety Nets

This new framework has also interesting implications regarding the use of deposit safety nets as is common in many countries today. Insured bank deposits lead depositors to be more patient and less worried. That significantly reduces the probability of a bank run emanating from the concerns of the depositors. However the drawback of this instrument is that it deteriorates market discipline almost altogether. For this reason effective safety net design has always been a big concern for regulators.

Consider a continuum of depositor types with the probability distribution \( f(\cdot) \) on \([0,1]\).

The next assumption argues that deposit safety nets will discourage depositors to monitor bank actions and the probability distribution function with support again on \([0; 1]\) will have more weight towards the right now. This interpretation can be stated in terms of first order stochastic dominance as follows.

**Assumption 13.** Let \( F(\cdot) \) denote the distribution of depositors when their demand deposits are uninsured. Similarly, \( \bar{F}(\cdot) \) is assumed to be the distribution when the deposits are insured. Then \( \bar{F} \) first order stochastically dominates \( F \), i.e. \( \bar{F} \) FOSD \( F \).

That would immediately imply that the optimal risk choice \( q_\cdot \) of the bank will increase when deposit safety nets are in effect.

**Corollary 3** When deposits are insured, the level of risk taking by the bank increases unambiguously.
Proof. Consider again the program of the bank

\[ \max_q [1 - F(q)] \cdot [Z(q) - (1 + r)] \tag{1.44} \]

where \( F(\cdot) \) is the cumulative distribution function of depositor types. When \( \bar{F} \) first order

stochastically dominates \( F \) this implies a decrease in \( F \) to \( \bar{F} \). That obviously leads the optimal

risk level to shift to the right by the same argument used in the proof of Proposition 2. ■

This corollary exhibits the negative impact of deposit guarantees and safety nets on the

financial markets. To support this result, consider the empirical evidence provided by Demirguc-

Kunt and Detraguiache (1998) on a sample where banks offer different deposit accounts where

some are insured against bank failure by the government, some are not.\(^{52}\) Accordingly, the

depositors in developed countries, where financial institutions are well established, tend to ignore

the threat of losing funds from their uninsured accounts. They are very optimistic that failing

banks will be bailed out and they will recover their losses as in the insured accounts.\(^{53}\) That has

been certainly the case, for example, in Australia where deposit safety guarantees on all sorts of

accounts have been removed. No financial crisis happened in Australia since then.\(^{54}\) On the

contrary, in Latin American economies, people don’t even trust in full faith the bailing of their

government guaranteed insured accounts. That is, they are not confident that they will be paid

back at all for their insured accounts or that it will not compensate for all the losses in case of a

bank failure.

Also, notice that the deposit rate \( r \) is assumed to be exogenously given throughout the

paper. That has been the main rationale for restricting the analysis to a single bank. However

\(^{52}\) Those that are not insured are riskier and thus have a higher return.

\(^{53}\) The FDIC is trying to get rid of this perception since mid 1980’s.

\(^{54}\) The East Asian crisis in 1998 has certainly made an impact on the Australian economy, but to a lesser degree than

many South East Asian economies.
when allowing for more than one bank, the deposit rate $r_i$ offered by bank $i$ has a critical role of determining which bank is going to get how much deposits. Banks, competing for more deposits and more of the market share, will tend to increase the deposit rates they offer as high as they can. Any sort of competition in the banking industry will certainly change the regulatory effects of different policies. For example, earlier, it is concluded that minimum capital requirements have no risk-taking effect on the bank behavior. That may not be the case now. Controlling for deposit rate may give an advantage for the regulators. Hellman, et al. (2000) investigate the effect of minimum capital requirement combined with deposit rate regulation. They conclude that deposit rate controls are necessary to make minimum capital requirements an effective instrument for curbing excessive risk taking practices of the bank.

1.6.4 Too Big To Fail Protection

The regulatory agencies’ reluctance to let “big” banks fail is known as too big to fail (TBTF) protection. Following the Continental Illinois Bank becoming insolvent in 1984, the Federal Reserve Bank and the FDIC prepared a rescue package to bail out the bank depositors and shareholders. In congressional testimony, the then Comptroller of the Currency C.T. Conover admitted that regulatory agencies would not let the largest 11 banks of that time fail. Consequently, the deposit insurance fund would also cover uninsured deposits and bondholders as well. This meant there is differential treatment towards large banks and that created lots of criticism among academics. Arguably, letting some of these large banks fail and only cover the loss of those accounts that are insured could send the right message to investors: Monitor your investment; otherwise we will not take the responsibility for any losses that may materialize in your uninsured accounts. Yet the regulatory agencies seem hesitant to let the market itself handle the troubled institutions.
The aftermath of this bail out had severe consequences. The most important one being the fact in which depositors’ beliefs have changed all together in favor of big banks. Also the stock prices of large banks have risen by the amount of the premium introduced through implicit government guarantees. Notice that the key aspect in the TBTF policy is the fear of regulators that the financial markets will be hit through contagion since the danger of a systemic risk has devastating potential.

The Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991 passed to eliminate the implicit protection offered by TBTF policy. For example, it gave the regulators the power to pursue the least costly way to handle an insolvent bank. Many economists including Gary Stern, the Chairman of Fed-Minneapolis criticized the FDICIA as not addressing the problem completely. That is, the Act is being far from eliminating a differential treatment policy. This claim has been proven true when the Fed and the FDIC took responsibility to rescue the Long-Term Capital Management (LTCM), a hedge fund, in 1998. The rescue seemed to have been unnecessary since the LTCM would not have failed anyway.

The problem with such policies is clear. It changes the expectations and beliefs of depositors as well as banks. Depositors feel less obliged to monitor bank risk taking activities and bank managers take more risk which certainly pays off when there is high leverage.

1.7 SUBORDINATED DEBT AND MARKET DISCIPLINE

Subordinated notes and debentures (subordinated debt) is a junior debt which ranks behind senior debt (that is, deposits) should a company fall into bankruptcy and have to be liquidated. It is only superior to claims by bank shareholders. It is argued that subordinated debt might be used to provide additional control against excessive bank risk taking since it is a very risk sensitive
security. It assumes all the downside risk like equity (and unlike deposits) but lacks upside improvements like deposits (and unlike equity).  

1.7.1 Proposals of Mandatory Issuance of Subordinated Debt

The Gramm-Leach-Bliley Act of 1999 (a.k.a. the Financial Services Modernization Act) recommended the Board of Governors of the Federal Reserve Bank to further study and report the implications of mandatory issuance of subordinated debt. The report subsequently submitted by the Federal Reserve System December 2000 studied the feasibility and desirability of a mandatory subordinated debt policy for systemically important banking institutions. The report made findings and conclusions regarding using subordinated debt to increase market discipline at depository institutions and to protect the deposit insurance funds.

Current subordinated debt proposals aim to achieve the following objectives: (1) improve direct market discipline by increasing funding costs if the intermediary increases the risk of its portfolio; (2) improve indirect market discipline, by augmenting the information available to other investors and to regulators, if debt prices in secondary markets respond to the solvency risk of the institution; (3) improve transparency and disclosure, which are needed to price risk accurately; (4) protect the deposit insurance fund because subordinated debt holders have claims subordinated to the deposit insurer; and (5) reduce regulatory forbearance, encouraging regulators to take prompt corrective actions.

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55 A hypothetical bank would issue three types of claims to finance its assets worth A in market value: deposits with promised payment D, subordinate debt with promised payment B, and a residual equity claim receiving $A - D - B$ if the bank is solvent at the end of the period. The following table by Levonian (2001) nicely summarizes the payoffs of liability holders contingent on bank solvency status at the end of period:

<table>
<thead>
<tr>
<th></th>
<th>$D + B &lt; A$</th>
<th>$D &lt; A &lt; D + B$</th>
<th>$A &lt; D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits</td>
<td>D</td>
<td>D</td>
<td>A</td>
</tr>
<tr>
<td>Subordinated Debt</td>
<td>B</td>
<td>$A - D$</td>
<td>0</td>
</tr>
<tr>
<td>Equity</td>
<td>$A - D - B$</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Gonzalez-Rivera and Nickerson (2001) claim that the practical value of using subordinated debt yields to discipline bank is at best questionable. First, they state that secondary markets for subordinated corporate debt are decentralized, being formed by independent dealers. Consequently, pricing data is both difficult to access and likely to reflect a variety of influences in addition to default risk. The authors propose a novel model of a multivariate dynamic signal, combining fluctuations in equity prices, subordinated debt and senior debt yields, which could be a valuable and practical instrument for regulators and investors to monitor and assess in real time the risk profile of the issuing institution.

1.7.2 U.S. Data of Subordinated Debt

The objective of the section is to analyze the change in the volume of subordinated debt and the change in interest expense on subordinated debt over time. It also compares this information with other variables, and look at correlations with other variables.

The first step in the process was to collect data from the IBIS call report database. The request was for a selection of the top 100 FDIC Insured Commercial Banks by total asset size in first quarter of 2007. A program was also created to look at these 100 banks back in time. Quarterly data from the first quarter of 1984 to till the first quarter of 2007 was collected in the dataset. The dataset also takes care of mergers by adding financial information from any institutions that merged with them. See the appendix to see the details of the method.

The data is requested from IBIS, Integrated Bank Information System, an automated examination support system, which gives examiners and analysts access to data on banks, bank customers, and the competitive and economic environment in which banks operate. The variables
requested from IBIS include bank certificate number, bank name, highest and direct holding company name and ID, interest expense on subordinated debt, etc.\textsuperscript{56}

Figure 7 below shows the volume of aggregate subordinated debt issued by the largest 100 U.S. banks. It is clear that the increase in the size of subordinated debt is steeper than that of the total assets.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Aggregate Subordinated Debt Compared to Bank Asset Size for Top 100 U.S. Banks}
\end{figure}

Figure 8 below shows the average interest rate on subordinated debt issued by top 100 banks in the U.S. and it also more or less elaborates the fact that the cost of subordinated debt has been very stable and in fact even gradually declining over the last two decades.

\textsuperscript{56} For a full list of variables requested from IBIS see the Appendix.
Figure 8 Average Interest Rates on Subordinated Debt Issued by Top 100 Banks in the U.S.

Figure 9 below is also interesting in that it provides a comparative analysis of the share of subordinated debt interest expenses in total interest expenses paid by the top 100 U.S. banks. There is an upward sloping trend which signifies the bigger share of interest expenses since the last 20 years.

Figure 9 Share of Subordinated Debt Interest Expenses
The Figure 10 below confirms that interest expenses paid for subordinated debt holders steadily increasing in volume which is consistent with what we obtained in the previous Figure 9 Share of Subordinated Debt Interest Expenses.

![Graph of Subordinated Debt Interest Expenses](image)

**Figure 10 Subordinated Debt Interest Expenses**

### 1.8 CONCLUSION

This paper provides theoretical support to the mechanism of market discipline. The dynamics of this mechanism depends on the equilibrium bank risk-taking allocations and depositor investment decisions. It turns out that banks have dominant strategies given their risk-return technology and homogenous depositors cannot influence the risk-taking behavior of banks. However heterogeneity in depositor beliefs may cause inefficiencies for the overall economy. That is, the distribution of depositor types and beliefs is fundamental (coupled with bank technologies) in determining the optimal level of investment in an economy. The immediate
implication is that markets with relatively more patient-type depositors would generate second best outcomes that are closer to first best efficient outcomes than markets with relatively more cautious depositors. Therefore, the distribution of depositor beliefs about a particular bank's condition in an economy summarizes the market assessment for that bank and the aggregate market information obtained as such contains valuable information for bank managers as well as regulators.

The main result of the model asserts that a banking institution is rewarded by revealing more information about its portfolio structure and penalized by preventing information pertaining to its asset portfolio to generate ambiguity and uncertainty about its condition. Therefore these results encourage bank managers for meaningful disclosure of bank data in a timely fashion. In fact to do so is in the best interest of the bank itself.

This paper also provides important insight into various ongoing debate regarding prudential regulation. It acknowledges the interaction between market control mechanisms and prudential regulatory systems. It also highlights the negative effects of full deposit insurance scheme.

Market based solutions to moral hazard problems in financial markets seems to be the most relevant. Yet, policymakers have a long way to finalize the new policy proposals to change the regulatory structure. One obvious reason being the fact that policymakers are usually reluctant to make changes as long as the problem does not materialize. In this respect the author of this paper believes subordinated debt is a critical instrument that the regulators might use. This paper provides summary statistics about the growing volume of subordinated debt. It is based on the IBIS.
Our study can be extended into many different directions. Here are a couple of suggestions for further research.

1. *Adding the decision of whether to monitor or not.* Consider the example where the depositors choose the pair \((\alpha, \beta) \in [0,1]^2\), that is, the amount of deposits \(\alpha\) and a parameter \(\beta\) on whether to monitor the bank \((\beta = 1)\) or not \((\beta = 0)\). Note that when the depositors decide not to monitor the bank since it is too costly probably, then they get to know less about the failure probabilities of the bank. That uncertainty triggers the depositors’ attitudes to exhibit pessimism or optimism depending on the general state of the economy as a whole.

2. *On the industry and organization of financial markets.* One may expect many banking firms in the marketplace, and yet the high profitability of these institutions is a sign of oligopolistic competition. This provides a natural way to extend the results of this study from one bank to a few banks and afterwards to many banks.

3. *Shareholder incentives can be integrated into the model.* Recall shareholders are last claimants over the assets of the bank. They hence have a tendency to take excessive risk. The contradicting objectives of depositors and shareholders can be put together in the new framework presented in this paper.
1.9 APPENDIX

1.9.1 Properties of the Risk-Return Function

Recall that the net return function $R(q)$ has the following property: $R'(q)$ decreases at first and then starts increasing after a certain risk level is attained:

$$R''(q) < 0 \text{ if } q < \bar{q}, \text{ and } R''(q) > 0 \text{ if } q \geq \bar{q}$$

(1.45)

where $\bar{q}$ is an inflection point, i.e. $R''(\bar{q}) = 0$.

Also recall that the optimum always happens at levels of risk less than 1, i.e. $q^* < 1$. To justify this claim, we have assumed that $R(q)$ is approximately equal to $\frac{q}{1-q}$ as $q$ approaches to 1.

To prove the desired result, consider, for a moment, $R(q) = \frac{q}{1-q}$. Then

$$Z(q) = (1 - q)(1 + R(q))$$

$$= (1 - q)\left(1 + \frac{q}{1-q}\right)$$

$$= (1 - q)\left(\frac{1}{1-q}\right)$$

(1.46)

Thus irrespective of the choice of risk, the certain return $Z(q)$ is equal to 1. Therefore a distortion to the shape of $\frac{q}{1-q}$ such as the concavity of the typical net return function $R(q)$ for lower levels of risk $q$ (as shown in Figure 11) implies that the optimal risk-net return choice will be in that distorted region.
Notice that this risk-return framework cannot explain the diversification effects of a portfolio to the mean-variance analysis and the mutual fund theorem given above.

1.9.1.1 Example

We’ll convey this initially-concave-and-then-convex shape net return function $R(q)$ next.

Consider the mean-variance analysis where the efficient frontier is given by $\mu(\sigma) = 1 + \sqrt{1 - \sigma}$ where $\mu$ is the mean and $\sigma$ is the standard deviation of the portfolio. With a change of variable $q = 1 - \frac{1}{\sigma}$, where $q \in [0,1)$ one can obtain a similar net return function which increases at a smaller rate and then at higher and higher rates for sufficiently large risks, $q$. Notice that for

$$\mu(q) = 1 + \sqrt{\frac{q}{1-q}},$$

it has a reflection point at $\bar{q} = \frac{1}{4}$.\(^{57}\) (See Figure 12)

\(^{57}\) This can easily be proven by solving the following equation
1.9.1.2 The Geometry of the risk-return framework

Use Figure 13 to visualize the geometric location of $q^*$. Notice that $|x| = |y| = 1 - q^*$. Also the slope of the tangent to $R(q)$ at $q^*$ is equal to $\frac{1+R(q^*)}{1-q^*}$. This geometric argument is necessary to better understand the functioning of the model. Also, this turns out to be crucial for understanding the comparative statics related to this model.

\[
\frac{d^2\mu}{dq^2} = -\frac{1-4q}{4u^{3/2}(1-q)^{3/2}} = 0
\]
1.9.2 Proofs

1.9.2.1 Proof of Lemma 5

One can easily derive the following first and second order conditions respectively. For this observe that

\[
\frac{dU}{da} = \frac{dQ}{da} \cdot [u[G(\alpha)] - u[B(\alpha)]] + Q(\alpha) \cdot (r - \rho)u'[G(\alpha)] \\
+ [1 - Q(\alpha)][V_q - (1 + \rho)]u'[B(\alpha)]
\]  

(1.47)
Here, $G(\alpha) = (1 + r)\alpha + (1 + \rho)(1 - \alpha)$ and $B(\alpha) = V_q\alpha + (1 + \rho)(1 - \alpha)$ and also $Q(\alpha) = (P \circ \Delta)(\alpha)$. Also recall that $V_q < 1 + \rho < 1 + r$. For small values of $\alpha$ the expression in equation (1.47) might be negative, however as $\alpha$ becomes sufficiently large $\frac{du}{d\alpha}$ becomes positive.

For the second derivative we get

$$\frac{d^2 U}{d\alpha^2} = \frac{d^2 Q}{d\alpha^2} \cdot \{u[G(\alpha)] - u[B(\alpha)]\} + 2 \frac{dQ}{d\alpha} \cdot \{(r - \rho)u'[G(\alpha)] - [V_q(1 + \rho)]u'[B(\alpha)]\} + (r - \rho)^2 Q(\alpha)u''[G(\alpha)] + [V_q(1 + \rho)]^2 [1 - Q(\alpha)]u''[B(\alpha)]$$

(1.48)

which consists of four terms in the right hand side. The sign of the first term depends on the value of $\alpha$. For small values of $\alpha$ this expression is positive whereas for large values of $\alpha$, it becomes negative.

The second expression is greater than or equal to zero since $\frac{dQ}{d\alpha} \geq 0$ and everything inside brackets is also nonnegative.\(^{58}\) The third and fourth terms are also clearly non-positive. In fact it is not very difficult to come up with values of $\alpha$ that would make $\frac{d^2 U}{d\alpha^2}$ positive and also some other values that would make it negative.

This indeed implies that the function is not necessarily globally concave (or convex). \(\blacksquare\)

1.9.2.2 Proof of Proposition 1

First order conditions of the bank's problem is

$$\frac{\partial \Delta}{\partial \alpha} \left( \frac{dP(\Delta(\alpha))}{d\Delta} \Delta(\alpha) + P(\Delta(\alpha)) \right) = 0$$

(1.49)

\(^{58}\) Recall $u'(\cdot) \geq 0$ but $u''(\cdot) \leq 0$. Also notice that $G(\alpha) \geq B(\alpha)$ and $V_q \leq 1 + \rho \leq 1 + r$. 
Since the term inside the brackets is greater than zero, the fraction $\frac{\partial \Delta}{\partial \alpha}$ has to be equal to zero. Clearly, the bank has a dominant strategy $q^*$ satisfying $Z'(q^*) = 0$.

Regarding the depositor's optimal strategy, we rewrite the program of the depositor as

$$\max_{\alpha \in [0,1]} U = Q(\alpha) \cdot \{u[G(\alpha)] - u[B(\alpha)]\} + u[B(\alpha)] \quad (1.50)$$

Notice first that when $Z(q^*) < 1 + r$, the solvency probability of the bank is zero, and thus the depositor's optimal deposit choice $\alpha^*$ equals zero. So let us assume that $Z(q^*) \geq 1 + r$.

Weierstrass theorem\(^{59}\) implies the existence of a maximum since the probability of solvency $P(\Delta)$ is a continuous function defined on the real line. Furthermore, the first order conditions\(^{60}\) describe the exact location of the optimum $\alpha^*$. For this, the Lagrangian associated with the objective function in equation (1.50) is as follows

$$L = Q(\alpha) \cdot \{u[G(\alpha)] - u[B(\alpha)]\} + u[B(\alpha)] + \lambda \cdot \alpha + \mu \cdot (1 - \alpha) \quad (1.51)$$

where $\lambda$ and $\mu$ are non-negative numbers. The first order conditions imply

$$\frac{dL}{d\alpha} = 0 = \frac{dQ}{d\alpha} \cdot \{u[G(\alpha)] - u[B(\alpha)]\} + Q(\alpha) \cdot (r - \rho)u'[G(\alpha)]$$

$$+ [1 - Q(\alpha)] [V_q - (1 + \rho)] u'[B(\alpha)] + \mu - \lambda \quad (1.52)$$

Notice that $0 \leq Q(\cdot) \leq 1$ and $\frac{dQ}{d\alpha} \geq 0$. Also, recall $r > \rho$ and $1 + \rho \geq V_q$. That implies $G(\alpha) > B(\alpha)$ and thus the first term above in equation Error! Reference source not found. is strictly greater than zero. The second term is also strictly greater than zero since $u' > 0$. For the third term, it is less than zero since, $1 - P(\Delta) > 0$ and $u'(\Delta) > 0$. Finally $V_q - (1 + \rho) < 0$ by definition.

Now when the first three terms add up to a positive number, then $\lambda - \mu \leq 0$, i.e. $\lambda \leq \mu$. Then one of the following holds:

---

\(^{59}\) This crucial theorem states that any continuous function defined on a closed and bounded interval will attain its maximum and/or minimum.

\(^{60}\) That means we do not have to worry about the complementary slackness conditions.
1. \( \mu = 0 \) (i.e. \( \alpha < 1 \)) necessarily implies \( \lambda = 0 \) (i.e. \( \alpha > 0 \)) since Lagrange multipliers are by definition non-negative.

2. \( \mu > 0 \) (i.e. \( \alpha = 1 \)) then \( \lambda \geq 0 \).

For an interior solution we need (i) the objective function to be concave and (ii) \( \frac{du}{d\alpha} > 0 \) for \( \alpha < \alpha^* \) and \( \frac{du}{d\alpha} < 0 \) for \( \alpha > \alpha^* \). That means \( \alpha \in (0,1) \) will be chosen in the margin where the utility contribution of depositing the money in the bank is equal to investing in the alternative technology. However as long as \( u(\cdot) \) is strictly increasing and concave, this is a standard portfolio diversification result.\(^{61} \)

### 1.9.2.3 Proof of Proposition 2

Let \( G(q) = 1 - F(q) \) and \( W(q) = Z(q) - (1 + r) \). We can rephrase the program of the bank as follows:

\[
\max_q G(q) \cdot U(q)
\]  

(1.53)

Obviously there is a trade-off when increasing \( q \) between increasing \( U(\cdot) \) versus decreasing \( G(\cdot) \).

The first order necessary conditions imply

\[
\frac{dG(q)}{dq} \cdot U(q) + G(q) \cdot \frac{dU(q)}{dq} = 0
\]  

(1.54)

Since \( 0 \leq G(q) \leq 1 \) and \( \frac{dG(q)}{dq} \leq 0 \), we have only two cases possible:

(i) Either \( U(q) \geq 0 \) which implies \( U'(q) \geq 0 \). That means \( q^{**} < q^* \) at the maximal point. Or:

(ii) \( U(q) \leq 0 \) which implies \( U'(q) \leq 0 \). This gives us a minimal value rather than a maximum.

\(^{61}\text{It is impossible to find a closed form result without loss of generality. However it is not difficult to design numeric algorithms to tackle this hardship.}\)
This proves that the solution $q^*$ to problem (1.30) is less than or equal to the solution $q^{**}$ to problem (1.31). \(^\text{62}\) ■

![Graph of $G(q)U(q)$](image)

**Figure 14.** The graph of $G(q)U(q)$

### 1.9.2.4 Proof of Proposition 3

For simplicity and without loss of generality, let us assume that $f_1(q) = 1$ and $f_2(\cdot)$ is increasing. The depositors in the first market are evenly distributed in terms of types whereas the depositors in the second market are more patient and optimist.

The cumulative distribution function of $f_1$ is $G_1(q) = 1 - F_1(q) = 1 - q$. For $G_2$, notice that $G_2(q) \succeq G_1(q)$ for all $q$. That means the second distribution first order stochastically dominates the first distribution of types of depositors.

\(^\text{62}\) Consider the Figure 14 where $q^{**} < q^*$ for an illustration of this result.
The monotone likelihood ratio property (MLRP) implies the slope of $G_2(\cdot)$ to be increasing in absolute terms compared to that of $G_1(\cdot)$ as is shown in Figure 15 as well. That has some implications in terms of convexity/concavity. This is due to the fact that the slope of $G_2(\cdot)$ at a particular $q$ is the negative of the probability distribution function $f_2$ at that point of interest $q$.

Now going back to the first order conditions (1.54), for $i = 1, 2$ we have the following. Let

$$K_i(q_i) = K_{1i}(q_i) + K_{2i}(q_i) = 0$$ (1.55)

where $K_{1i}(q_i) = G_i'(q_i)U(q_i)$ and $K_{2i}(q_i) = G_i(q_i)U'(q_i)$. Recall $G_i(q) = f_i(q)$.

![Figure 15. Proof of Proposition 3](image)

Since $K_i(q_i)$ consists of two terms, the magnitude of the shift will depend on (i) the slope of the decumulative function at the point of interest i.e. $G_i'(q) = f_i(q)$, and (ii) the actual value
of the decumulative distribution function i.e. $G_i(q)$. For our illustration above, where $f_1(q) = 1, \forall q$, and $f_2(q)$ is as described above, we compare these two terms as follows. Notice that due to the MLRP for $q \leq q_i$, we have $G_2'(q) \leq G_1'(q)$ i.e. $f_2(q) \leq f_1(q)$ as is shown in Figure 15. This implies that the first term $K_{1i}(q_i)$ is negative for $i = 1,2$. Moreover $|K_{12}(q)| \leq |K_{11}(q)|$.

On the other hand, consider the second term $K_{2i}(q_i)$. It depends on the height of $G_i(q)$. For this we'll construct a new problem

$$\max_q [G(q) + a] U(q). \ a > 0$$ (1.56)

The first order conditions imply that at the optimum $q^{***}$.

$$G'(q) U(q) + G(q) U'(q) + aU'(q) = 0$$ (1.57)

Here let $I(q) = G'(q) U(q) + G(q) U'(q)$ and $J(q) = aU'(q)$. Notice that $I(q)$ is a decreasing function of $q$ whereas $J(q)$ also decreases in $q$. However $I(q)$ has a zero at $q^{**}$ whereas $J(q)$ is zero at $q^*$. That implies that $I(q) + J(q)$ has a zero at $q^{***} \in [q^{**}, q^*]$.

That completes the proof of the claim. ■

1.9.3 Collecting the U.S. Subordinated Debt Data

1.9.3.1 Mergers

This section will elaborate on the methodology of handling the data when bank mergers happen.

Consider the following example:

<table>
<thead>
<tr>
<th>Year</th>
<th>1984</th>
<th>1985</th>
<th>1986</th>
<th>...</th>
<th>1990</th>
<th>1991</th>
<th>...</th>
<th>2007</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank A</td>
<td>50</td>
<td>70</td>
<td>80</td>
<td>...</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td>Bank A merges with Bank B in 1991</td>
</tr>
<tr>
<td>Bank B</td>
<td>...</td>
<td>60</td>
<td>285</td>
<td>...</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
<td>Bank B opens in 1990</td>
</tr>
</tbody>
</table>

**Final Results for Bank B**

| Bank B | 50    | 70    | 80   | ... | 260   | 285  | ... | 400 | Bank A's data is used for history of Bank B |

Bank A merges with Bank B in 1991

Bank B opens in 1990

Bank A's data is used for history of Bank B
Mergers cause a bank’s financial data to jump in the merger year. For example, when looking at subordinated debt, it may appear that the bank issued more debt when in fact they are just taking on the debt of the merged bank.

Here is another example:

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FirstUSA</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BankOne</td>
<td>120</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>Chase</td>
<td>100</td>
<td>125</td>
<td>420</td>
</tr>
<tr>
<td>What we want to see from Chase</td>
<td>370</td>
<td>405</td>
<td>420</td>
</tr>
</tbody>
</table>

The table depicts the result expected from the data arrangement. First USA and Bank One would not be in the final dataset but their financial data would be included in Chase’s numbers. The code was created to account for mergers at the cert. level but in the end aggregate to the direct holder level. At this time accounting changes were ignored.

1.9.3.2 List of Variables requested from IBIS

Below you can find the full list of variables requested from IBIS (Integrated Bank Information System) together with their abbreviation.

1. Cert: Bank certificate number
2. Name: Bank name
3. Rssdhcr: Highest holding company ID
4. Nameehcr: Highest holding company name
5. Rssdhccd: Direct holding company ID
6. Nameehed: Direct holding company name
7. Asset: Direct holding company name
8. Sub_debt_int_exp: Interest Expense on subordinated debt (Esubndq)
9. Sub_debt: Subordinated Debt (Subnd)
10. Total_chargeoffs: Total Chargeoffs (Drlnlsq)
11. Total_recoveries: Total Recoveries (Crlnlsq)
12. Int_exp: Interest Expense (Einlxq)
13. Tot_int_inc: Total Interest Income (Intinq)
14. Tot_nonint_inc: Total Noninterest Income (Noniiq)
15. Nonixq: Total Noninterest Expense
16. Eothninq: Other NonInterest Expense
17. Trading_revenue: Trading Revenue (Igltrdq)
18. Net_int_inc: Net Interest Income (Nimq)
19. Non_perf_realest: Non performing real estate (Ncore)
20. Non_perf_asset: Non performing assets (Nperf)
2 MARKET DISCIPLINE IN TURKEY BEFORE AND AFTER THE 2001 FINANCIAL CRISIS

2.1 INTRODUCTION

Financial markets all around the world opened up their borders for more competition and global capital movements in the 1980's. Like most of the other emerging market countries, Turkey also liberalized its economy lifting restrictions against capital, money and goods movements.\(^{63}\) This period of financial liberalization has been accompanied in part by deregulation of these financial markets and institution. Many charter licenses have been issued for new banks. In fact, Demirguc-Kunt & Detragiache (1998) claim that deregulation in the banking industry in emerging markets caused a sharp increase in competition among banking firms. Increased competition is encouraged directly by policymakers of those markets in the hope for more efficient and better functioning markets.\(^{64}\)

The policy of "more liberalization and less regulation" caused an unhealthy financial structure for at least 2 decades in Turkey, being responsible for 1994 and 2001 financial crises. The weak and unstable financial institutions especially those related to regulation and supervision began to get its toll on banking institutions whose condition gradually deteriorated causing failures. The financial crises in 1980s and 90s in Latin America, East Asia and Russia affected and put pressure on Turkish economy through global connectedness and contagion. The valuable lesson taken following these harmful events has been the necessity of having liberalization practices accompanied by tight regulatory oversight and supervision.

---

\(^{63}\) The limits over the entrance and exit of foreign currencies have been lifted in early 1980's for example. This allowed U.S. dollars, Deutsche marks, and French francs to move in and out of the country without restriction.

\(^{64}\) Though the authors admit and acknowledge that increasing competition in banking through the entrance of foreign banks has led banks to take more risks and, as it happens usually, this weakened the capital structure of the inefficient banks.
The first serious financial crisis experienced in Turkey after liberalization was in 1994. The Turkish Lira devalued and lost half of its value in weeks. In April 5, 1994 the government approved to implement a full-coverage deposit insurance package to reinstate the investor trust towards the financial markets and banking system. In fact this has been a practical application during times of crises all around the world. Once the negative effects of the crises are over, it is advised that the full-coverage protection for deposits of all kind is gradually shifted towards a limited-coverage insurance or even a co-insurance system. However this certainly has not been the case in Turkey and full coverage insurance was kept up until November 2000 when a new banking crisis hit the financial markets. The overall burden to the economy and taxpayers has been immense with an overall of $40 billion dollars of cost. The regulators and policymakers realized that the unlimited deposit insurance coverage is causing serious moral hazard problems and shall be reduced gradually over time as the public trust to the financial markets builds back.

One reason that policymakers in Turkey could not pass enough resolutions to provide a safe and sound financial system is the lack of a strong government will from 1992 until 2002. Many standby agreements have been signed with the IMF and agreed upon however none proved to be executed properly by government officials at that time. This rightly reduced the credibility of the government.

The general outlook of the Turkish economy is shaky for the 1994-2001 period. High levels of inflation accompanied by high levels of structural and frictional unemployment are macroeconomic problems that policymakers simply could not find a way out. The bureaucratic impediments for foreigners to open a new business in Turkey were huge. That was probably the major reason for lack of foreign capital in the Turkish markets. Thus foreign direct investment (FDI) has been low throughout this period.
The early 2001 financial crisis was a wake-up call for investors and bankers alike in Turkey. The public voted for one ruling party after decades of political coalitions. Policymakers seem to have learned from the previous experience and acted promptly to revise banking laws. From 2001 to 2003, the number of banks reduced from a figure over 80 banks to somewhere at 50 banks following bank failures and consolidations. The remaining banks in Turkey today are more efficient compared to the period before 2001 according to capital ratios and asset quality of these banks. It looks like inefficient banks are taken out of the industry and the remaining ones are more closely watched. The overall Turkish banking system is much stronger today after the turbulence of the 2001 financial crisis. The economy has been growing constantly in high rates since 2002 without interruption. Foreign debt is reduced considerably as a ratio to the GDP. The GDP per capita is above $5,000 dollars in line with the growth performance.\textsuperscript{65} Following these prosperous years of growth and good policymaking, the foreign banks increased their operations in Turkey. As of summer 2007, 71\% of the stocks traded in Istanbul Stock Exchange is under foreign ownership and control. 42\% of the Turkish banking system is owned by foreign companies as well. Not only conventional banking but also the “Islamic Banks” have also benefited from the safe and sound financial environment. The law governing these institutions has been changed so that Islamic banks are today regulated by the same governmental agencies supervising mainstream banks.\textsuperscript{66}

Basel accord standards in banking are devised by the Bank for International Settlements (BIS) in Switzerland as guidelines for member countries towards better regulation and supervision of especially large international banking organizations. The requirement of a

\textsuperscript{65} The ruling AK Party officials in Turkey made it clear to the public that their objective is to bring the GDP per capita to $10,000 level as a primary objective. As of 2006, the IMF Annual Report suggests that the GDP per capita in Turkey is over $9,000.

\textsuperscript{66} The share of Islamic banks overall is also in rise some considering the natural level of Islamic financial instruments would dominate 10\% of the market in a couple of decades.
minimum regulatory capital in a banking institution was the critical first step suggested in 1988. Later on, a new capital accord, Basel II, has been implemented to improve the Basel Accord and its weaknesses. It proposes two more instruments for a sound banking system besides minimum capital requirements a bank shall hold. These are, namely, supervisory review and market discipline for greater stability in the financial markets. In fact this paper analyzes this third pillar, namely the market discipline aspect of regulation. Considering high costs of monitoring and supervising, regulators seem to be leaned towards adopting policies that would enhance market control and discipline. This is so because banking institutions become bigger and their financial operations become more and more complicated. That makes detecting a probable risky position of any given bank virtually impossible.

We empirically test the hypothesis of the impact of market disciplinary forces in Turkey and its interaction with the existing deposit insurance scheme. One thing that stands out in terms of good quality regulation in Turkey is that the policymakers have been more vigilant towards the implementation of Basel II rules and procedures after the 2001 crisis. This has proven to be a step forward with strong bank capital structure.

Besides, the following results are also established in this paper. First, the interaction between deposit insurance and market discipline is also analyzed for the period between 1997 and 2007. Mispriced deposit insurance seems to be one of the key factors towards financial instability in Turkey before 2001. Second, applications of the "too-big-to-fail" and "unlimited warranty" during and following financial crises seem to send wrong signals to depositors and diminish the efficiency of the market discipline mechanism.

The organization of the paper is as follows. The second part discusses the literature of market discipline for emerging markets. The third part describes the data set and the
methodology used in the paper. The fourth part shows the equations estimated and the results are also revealed. The fifth part steps back and discuss the applicability of the overall notion of market discipline for Turkey and the impediments. Finally we conclude in part six with future research directions.

2.2 LITERATURE REVIEW FOR MARKET DISCIPLINE IN EMERGING MARKETS

The market discipline literature starts in the early 1990's. In a seminal paper, Calomiris & Kahn (1991) argue that demand deposits, in theory, provide natural and adequate incentives for disciplining bank owners and managers against excessive risk taking. According to these authors, demandable debt attracts funds by giving depositors an option to force liquidation. As they put it, depositors "vote with their feet"; withdrawal of funds is a vote of no confidence in the activities of the banker.

Flannery (1998) proposes that depositors discipline bank managers by (1) monitoring and (2) influencing bank activities. Monitoring and withdrawing of depositors is not enough for us to call it "disciplining" unless the bank revisits its portfolio composition of risky assets it holds. Flannery argues depositors can simply withdraw their funds or ask for higher deposit interest rates when realizing excessive bank risk taking. Flannery further suggests that regulators could expand their reliance on market discipline, at least for large, publicly owned institutions.

The U.S. banking industry has received considerable attention and whether the market discipline mechanism is significant (or even if it really existed) was put into test numerous times for the U.S. banks. The results seem to be mixed with early studies not finding significant evidence in support of market disciplinary forces. Market participants' abilities to assess and control risk in banking institutions is seriously questioned following these early studies. Later
studies in late 1990's though unanimously supported the fact that market discipline exists and is significant.

Flannery & Sorescu (1996) conclude that indeed market disciplinary forces are significant for risk sensitive financial instruments by using subordinated debenture spreads. Accordingly, they find that firm-specific measures of risk are correlated with spreads. They also find out that the correlation increased over time as implied TBTF guarantees weakened in by early 1990s.

Demirguc-Kunt & Detragiache (1998) suggest that as financial systems are liberalized and rely more and more on market forces, they also become more vulnerable and subject to more instability. This is probably the most significant disadvantage of deregulation.

Using cross-country evidence, Demirguc-Kunt & Huizinga (2004) suggests that explicit deposit insurance reduces required deposit interest rates, while at the same time it lowers market discipline on bank risk taking. This result supports the fact that explicit deposit insurance evaporates market disciplinary forces.

In an interesting paper, Martinez-Peria & Schmukler (2001) also confirms the negative effects of deposit insurance by claiming that limits on the maximum amount that depositors might lose in case of liquidation causes significant moral hazard in bank behavior. However the authors further propose that if the deposit guarantee is not credible or if there are costs associated with the recovery of deposits following a bank failure, insured depositors are compelled to monitor banks. Something very important suggested by these authors which we also apply in our
analysis here in this paper for banks in Turkey is that depositors in Chile in the 1980s are de
facto protected even though there is limited insurance in place.67

Barajas & Steiner (2000) go along the same line by asking the following questions:
Which specific return or risk factors are the most important in explaining a bank's deposit
growth? How well do depositors discriminate between well and poorly managed banks? Besides
that Barajas & Steiner (2000) also points out the necessity to involve a second test besides
whether depositors signal their preferences when measuring market discipline. It involves a test
in which it is determined whether banks effectively respond to signals provided by depositors.
They go on to argue that even though deposits are explicitly insured depositors behave as if they
were not insured, refusing to trust the deposit guarantee fully. That means depositors in emerging
markets do not think deposit insurance is credible or at least that it has some costs in the form of
late repayment and missing the interest during liquidation period.

The only study about the significance of market discipline in Turkey to the best of my
knowledge is Ungan and Caner (2003). They argue that contrary to the international evidence,
market participants’ monitoring is relaxed after the 2001 crisis implying more dependence on the
governmental supervisory and regulatory experiences. They consider that the presence of state's
blanket guarantee prevents market forces to monitor and control bank risks after 2001 financial
crisis. They also claim their results provide evidence that the responsibility to monitor Turkish
banking system has shifted to governmental supervision and regulation authorities especially
after the 2001 crisis. This paper challenges the findings of Ungan and Caner (2003) in two
respects. First, state's blanket guarantee was instituted before 2001 and covered almost all
deposits. The changes in banking law limited the coverage to only 50,000 NTL (New Turkish

67 Notice that after the financial crises is long over in July 2003 the Turkish government imposed a full guarantee of
deposits for a full year until July 2004 in order to establish the safety of the markets. Something hard to swallow
considering the will of the administration to gradually reduce the protection!
Lira). Second, Ungan and Caner do not consider seasonality effects and endogeneity issues in the data.

2.3 EMPIRICAL METHODOLOGY

Efficient market discipline of banking sector necessitates two mutually inclusive occurrences: first half of the market discipline requires market reaction to banking performance; depositors should be able to monitor and analyze the performance of (commercial) banks and should decide based on the risk and profit realizations. Market indicators should reflect the risk characteristics of individual bank and banks in general. Other half of the market discipline necessitates banking reactions to market indicators; banks in a disciplining market, should change their behaviors according to the changes in the financial indicators pertaining to their actions. Absence of either of these happenings will break down the market discipline mechanism. The majority of the empirical literature on banking discipline use deposit growth rates to measure market reaction to the banking performance. Depositors whether withdraw their deposit or are reluctant to deposit to the poor performing banks. The inflation-adjusted implicit interest rates, on the other hand, are used to proxy the extend of the power of the market discipline on banks: in a well-functioning market discipline, poor performing banks will face a decline on their deposit growth rate and they will be forced to pay a higher interest on their deposit unless they improve their financial positions. Both approaches are based on the idea that there is a market-based punishment mechanism for the greater risk-taking banks by demanding higher yields on the liabilities of those banks. This incentive sometime may be in the form of decreasing the quantity of deposits or increasing the required yield on their deposits.

For the first half of the market discipline, the following regression model is used:
\[ \Delta Deposits_{i,t} = \alpha_i + D \cdot \alpha_i + \beta' \text{BankRisks}_{i,t-1} + \hat{\beta} D \cdot \text{BankRisks}_{i,t-1} + \gamma X_{i,t} + \theta_1 \text{ImplicitRate}_{i,t} + \epsilon_{i,t} \] (1.58)

where the dependent variable, \( \Delta Deposits \), is the growth rate of deposits which is the percentage change in the outstanding deposits from one quarter to the corresponding quarter in the following year. BankRisks refers to the vector of several measures of bank and market risks such as liquidity risk, credit risk, market risks, etc. In an environment with efficient banking discipline, depositors' decision won't be independent of the bank's risk fundamentals as risky behaviors are being punished in terms of a reduction in the growth rate of deposits. This is another way of saying that there is depositor discipline in the market as depositors decrease the availability of the funds to the bank with high risk performance. Depositors are in one sense a creditor and they discipline the bad-performing banks by not selecting them as their deposit institutions. In this equation, DI refers to a dummy variable. Particularly, it is equal to 0 before the crisis and 1 after the crisis. On the other hand, the control variables included in the columns of matrix \( X \) have an effect on the evolution of the growth rate of deposits other than that of market discipline. The deposit growth rate will be affected by some macroeconomic conditions in the national economy such as the real GDP growth rate, market real interest rate. Finally \( r_{i,t} \) refers to inflation adjusted implicit interest rate measured by the ratio of interest payments on outstanding deposits as a fraction of total deposits minus the inflation rate. The banks that offer higher inflation adjusted return on deposits will attract more deposits from the market.

Contemporaneous values of all bank risk variables might show some correlation with both deposit growth and implicit interest rates as the current values of deposit growth and implicit interest rate will influence the contemporaneous occurrences of the bank risk variables. Therefore, to reduce any possible simultaneity bias and multi-collinearity, all risk variables are evaluated at their first lag.
One problem in regression equation (1.58) is the interpretation of the coefficient on the inflation-adjusted implicit interest rates. Were the deposit growth rates significantly influenced by the implicit interest rate, it can be concluded that market mechanism price the excessive-risk taking of the banks. Higher inflation-adjusted implicit interest rate signals the increase in the required yield on bank deposits as a result of excessive risk taking by the banks. Therefore, depositors decrease their deposits. Were the second half of the banking discipline works perfectly, there will be a false conclusion of absence of banking discipline if the coefficient estimates of implicit interest rate will be significantly zero. If banks are taking market signals seriously, they might change their behavior in an attempt to avoid having the depositors' imposed cost through increased yields on their deposits. Thus, estimation results should be jointly tested with the banks' responses when regression equation (1.58) gives no evidence of market discipline against risk-taking banks.

Notice that regression equation (1.58) can be interpreted as a demand equation. Given the implicit interest rate (functioning like a reciprocal price) the depositor decides how much to demand the bank depository service in terms of total deposits put into the banking account. The higher the interest rate the higher the demand.

The second half of the bank discipline refers to the reaction of the banks to the signals sent by the depositors. From this perspective the following regression equation is estimated:

\[
ImplicitRate_{i,t} = \phi_i + D \cdot \phi_i + \delta' BankRisks_{i,t-1} + \delta' D \cdot BankRisks_{i,t-1} + \gamma W_{i,t} + \theta_2 \Delta Deposits_{i,t} + \nu_{i,t}
\]

Here, the dependent variable, ImplicitRate, is the inflation-adjusted implicit interest rates on deposits, BankRisks variables are the same as in the regression equation (1.58). DI is the dummy variable introduced in equation (1.58), i.e. it takes a value of 0 before the crisis and 1 after it. W refers to vector of some control variables and the last variable, deposit growth rate,
characterizes the market discipline variable. It functions as a quantity signal to the banks. Bad performing banks are priced in the market with lower deposit growth rate, and in a well-functioning market, bad-performing banks with lower deposit growth rates are forced to pay higher interest rates on their outstanding deposits. Therefore a statistically significantly negative coefficient on the deposit growth rate will imply a well-functioning market disciplining of the firms.

Interestingly equation (1.59) can also be interpreted as a supply equation where the bank decides how much funds to attract given the implicit interest rate (functioning as a reciprocal price). Equations (1.58) and (1.59) together can be solved simultaneously to give the equilibrium conditions.

Equations (1.58) and (1.59) create an endogeneity problem. When banks are faced with higher risk premia due to the increase in their riskiness, they may switch to alternative source of funds. Therefore an instrumental variable three stages least square (3SLS) procedure is applied to get rid of endogeneity problem. Even though 3SLS is asymptotically equivalent to 2SLS, for system estimations, 3SLS is generally consistent and more efficient than 2SLS asymptotically. In the first stage, deposit growth rate and inflation-adjusted implicit interest rates have been regressed on the list of instruments, and then in the second stage, residuals from a 2SLS estimation of each structural equation will be used to obtain a consistent estimate for the covariance matrix of the equation disturbances. In the third stage, right hand side endogenous variables will be replaced by the instrumented values and a GLS-type estimation will be performed by using the covariance matrix obtained from the second stage. The list of instruments are the bank fundamentals such as liquidity ratio, credit-asset ratio, non-performing loans to total asset ratio, capital-asset ratio, market share, real GDP growth rate, cash to reserve ratio, reserves
to M2 ratio, interest rate differentials and bank ownership dummies. In fact many of the bank-level variables can be considered as endogenous over longer horizons, but in the short run they can be considered as exogenous as it is very unlikely that banks can change those bank fundamentals in a very short time horizon.

Depositors, creditors in one dimension, evaluate banks in terms of their credit risk, asset risk, and liquidity risk before giving their deposit decision. By being consistent with the literature, in the econometric estimation, the following 5 banks’ risk measurements are used to measure bank risk fundamentals; for liquidity risk, the ratio of liquid assets to total assets is used. Banks with large liquid assets are perceived to be safer, since these assets would allow a bank to meet unexpected withdrawals. So, it is expected that banks with higher liquidity ratio will have a higher deposit growth. Another banks' risk measurement is the bank profitability which is measured by the ratio of operational profits to total assets. It is expected that profitability variable has a positive influence on deposit growth. When realizing that the bank they are investing in is making higher profits, the depositors would allow more funds injected into the bank. The ratio of own capital to total asset is used to measure asset risk: The higher the ratio is the lower the bank risk. Mentioned thoroughly in the first part of this dissertation, depositors perceive more capital as a sign of trust by shareholders. Since bank owners have more at stake to lose in case of trouble, it makes depositors more confident about their investment. There are two measures used in this paper to capture credit risk: Total credit-to-total asset ratio and non-performing loans-to-total asset ratio. As bank start making loans out to firms needing funds the depositors theoretically perceive the bank to be doing its intermediation function. However as more and more funds are given out to entrepreneurs, this makes the bank more vulnerable to bank runs as rightly perceived by depositors. Non-performing loans are bad for any type of
banking institution. It signifies that the bank will not realize some of its expected returns. That clearly gives adverse signals to depositors as the amount of outstanding nonperforming loans increase in volume.

Several specifications are applied to control the effects of non-bank factors on both deposit growth rate and inflation-adjusted implicit interest rates. GDP growth rate is used to control the economy-wide factors. Bank size and bank ownership are used to control for bank-specific factors. Banks are classified into three categories: state owned commercial banks, private domestic commercial banks and foreign-owned commercial banks. In general, it is believed that state-owned banks are more likely to get bailed out, and foreign-owned banks have advantages in terms of reputation over their domestic counterparts. Bank size is proxied by two different variables: one is the natural logarithm of total assets of the banks and the other is the time varying market share of a bank which is calculated as the fraction of each bank's asset in total industry size in each quarter. Bank size variable is included to the regression equations to test whether depositors respond to a “too-big-too-fail” effect. If larger banks are being perceived more solid, size variable will positively affect the deposit growth rates. In regression (1.58), another control variable, cash outside banks to total deposits in the banking industry, is used to control for the behavior of the overall banking sector.68 This variable reflects depositors' preferences towards currency and bank deposits. If depositors perceive a market risk independent of the individual bank risk, they will switch from bank deposits to cash outside the banking sector regardless of what the bank fundamentals are. Another control variable used in the literature is the central bank reserves as a ratio of M2 and stock market index.

The econometric testing of the market disciplining in banking is based on time-series regressions (within banks) which utilize cross-time variation of bank risk measurements across

68 From Martinez-Peria and Schmukler (2001).
banks to explain deposit growth rates and inflation-adjusted implicit interest rate. As this paper aims to look at the role of deposit insurance and banking crisis on the banking discipline in Turkish economy, time dummies are used as mentioned above to differentiate banking discipline before and after the banking crisis.

2.4 PRELIMINARY DATA ANALYSIS

Banking data is provided from the Banks Association of Turkey. The data is at the quarterly frequency from 3rd quarter of 1997 to 1st quarter of 2007. As for the dependent variables, deposit growth rate and inflation-adjusted implicit interest rates have been used. In the measurement of growth rate, the percentage increase from the corresponding quarter of the previous year has been used to overcome seasonality effect. Inflation-adjusted implicit interest rate is measured by dividing total interests paid on deposits by deposits outstanding minus the quarterly inflation rate.

In Table 1 the descriptive statistics for the dependent variables, bank fundamentals and control variables are shown at the quarterly frequency. The quarterly data for the deposit growth rate shows a volatile behavior with huge swings. While on average the deposit growth rate is positive at rate of 8%, the standard deviation is very high and there are banks that have almost doubled their deposits from one quarter to another. During the time period, there occurred several outliers in the deposit growth rate variable as the banking sector exercised several banking merges which creates a one time massive increase in the deposit growth rates. Therefore, any deposit growth rate more than 100% is excluded from the analysis. Inflation-adjusted implicit interest rates, on the other hand shows a negative return on average with high fluctuations across the banks. Almost all banks in the sample period paid negative inflation adjusted interests on their deposits during the banking crises period.
Across the bank risk variables, the liquidity risk shows the highest volatility throughout the time period. On average banks hold 43% of their total assets in the liquid assets while the ratio shows big fluctuations across banks. Credit-asset ratio is the second most volatile risk variable at an average ratio of 31% of total asset with a standard deviation of 0.174. It is followed by the capital-asset ratio with 12% mean ratio and standard deviation of 0.156. Banks' profitability variable implies an almost zero bank profit on average. Non-performing loans, on the other hand, seems to be an important risk parameter. Real GDP shows a sample average annualized quarterly growth rate of 3.7% with high fluctuations. There was a period where the economy grows 13.4% as well as a period with a decrease in the real GDP by 10.9% at the quarterly frequency. One other control variable is the market share variable which shows the average size of each bank in the banking industry. Within the sample banks, even though the average bank's market share is 3.5%, the banking system in Turkey shows a high level of concentration as a few of large-scale deposit banks constitute majority of the banking sector.

2.5 EMPIRICAL RESULTS

Turkish economy was hit by a major banking crisis in 2001. The economy just before the banking crises was experiencing some major macroeconomic problems: the higher chronic inflation rates were around 70%, the nominal interest rate was around 100%, while real interest rate was about 30%. Exchange rate was very volatile and the government was running high budget deficit. On the other hand, the banking system was in trouble. There were a lot of insolvent banks in the system with high non-performing loans and poor capital structure. After the crisis, some major banking reforms have been taken into action. A new banking law was adopted after the crisis which brought an independent banking regulation and supervision entity. Banking standards were upgraded to the EU standards and deposit insurance system has been re-
established. Given all these happenings, in the empirical testing of the market discipline in
banking sector, it is believed that the re-constructions in the banking sector might have some
significant affect on the banking discipline mechanism. Therefore, the effect of unlimited deposit
insurance on the banking discipline is estimated by means of creating dummy variables to
differentiate between the pre and post crises period.

2.5.1 3SLS Regression

In testing the depositor reactions to greater risk-taking banks, the following regression equation
is estimated by using instrumental variable (3SLS) regression:

\[ \Delta \text{Deposits}_{i,t} = \alpha_i + \text{PostCrisis} \cdot \alpha_i \\
+ \beta_1 \text{Liquidity}_{i,t-1} + \beta_1 \text{PostCrisis} \cdot \text{Liquidity}_{i,t-1} \\
+ \beta_2 \text{Profit}_{i,t-1} + \beta_2 \text{PostCrisis} \cdot \text{Profit}_{i,t-1} \\
+ \beta_3 \text{Capital}_{i,t-1} + \beta_3 \text{PostCrisis} \cdot \text{Capital}_{i,t-1} \\
+ \beta_4 \text{Credit}_{i,t-1} + \beta_4 \text{PostCrisis} \cdot \text{Credit}_{i,t-1} \\
+ \beta_5 \text{NPLoans}_{i,t-1} + \beta_5 \text{PostCrisis} \cdot \text{NPLoans}_{i,t-1} \\
+ \gamma_1 \text{MarketShare}_{i,t} + \gamma_2 \text{realGDP}_{i,t-1} \\
+ \gamma_3 \text{CashtoDeposits}_{i,t-1} + \gamma_4 \text{ReservestoM2}_{i,t-1} \\
+ \gamma_5 \text{Foreign}_{i} + \gamma_6 \text{State}_{i} + \theta_1 \text{ImplicitRate}_{i,t} + \epsilon_{i,t} \](1.60)

\[ \text{ImplicitRate}_{i,t} = \phi_i + \text{PostCrisis} \cdot \phi_i \\
+ \delta_1 \text{Liquidity}_{i,t-1} + \delta_1 \text{PostCrisis} \cdot \text{Liquidity}_{i,t-1} \\
+ \delta_2 \text{Profit}_{i,t-1} + \delta_2 \text{PostCrisis} \cdot \text{Profit}_{i,t-1} \\
+ \delta_3 \text{Capital}_{i,t-1} + \delta_3 \text{PostCrisis} \cdot \text{Capital}_{i,t-1} \\
+ \delta_4 \text{Credit}_{i,t-1} + \delta_4 \text{PostCrisis} \cdot \text{Credit}_{i,t-1} \\
+ \delta_5 \text{NPLoans}_{i,t-1} + \delta_5 \text{PostCrisis} \cdot \text{NPLoans}_{i,t-1} \\
+ \gamma_1 \text{MarketShare}_{i,t} + \gamma_2 \text{realGDP}_{i,t-1} + \gamma_3 \text{DiffInterest} \\
+ \gamma_4 \text{Foreign}_{i} + \gamma_5 \text{State}_{i} + \theta_2 \text{Deposits}_{i,t} + v_{i,t} \](1.61)

In regression equations (1.60) and (1.61), The constants \( \alpha_i \) is used to control for the
affects on the deposit growth rates of bank-specific factors that may not be captured by single
bank-specific variables. The constants \( \phi_i \), on the other hand, characterize the bank-specific fixed
effects on the inflation-adjusted implicit interest rates. As for the bank risk fundamentals, these
variables are as described above. In short, *Liquidity* refers to the liquidity risk and is measured
as the ratio of liquid asset to total asset, *Profit* corresponds to the banks’ profitability measured
as the fraction of net profit in total asset, *Capital* is the ratio of own asset to total asset, *Credit*
refers to total credit to total asset ratio, and *NPloans* refers to the ratio of non-performing loans
to the total asset. All bank risk measurements are treated in one lag as those variables will be
available to public after one lag. *MarketShare* is measured as the each bank’s total asset at a
point in time as a fraction of the total asset in the market. *ΔrealGDP* is the real GDP growth rate
at the quarterly frequency. *DiffInterest* denotes the interest rate differential between the
average deposit interest rate on the 3 months’ time deposits and the interbank money market rate
in the economy. *CashtoDeposit* variable is the ratio of cash outside the banking sector to total
deposits in the banking sector. *ReservestoM2* is the ratio of central bank reserves to M2.
*Foreign* and *State* variables are dummy variables indicating whether a bank is a foreign owned
or state-owned bank.

Regression equations (1.60) and (1.61) constitute a system of structural equations where
each equation contains endogenous variable among the explanatory variables. A 3SLS estimation
strategy is applied as the endogenous variables are the dependent variables from the other
equation in the system. It is assumed that both deposit growth rate and inflation-adjusted implicit
interest rates are correlated with the disturbance term in each of the structural equations. On the
other hand, all other explanatory variables are taken as exogenous. Even though the
contemporaneous bank risk fundamentals might be endogenous to the system, it is believed that
taking the lag values of bank risk variables will eliminate this possibility. Due to the
simultaneity, error terms among the structural equations will be correlated, therefore, 3SLS will
use an instrumental variable approach to produce consistent estimate and generalized least squares (GLS) to account for the correlation structure in the disturbances across the equations.

Table 2 shows the 3SLS regression results on the system of structural regression equations (1.60) and (1.61). It shows the reaction of both deposit growth rates and inflation-adjusted implicit interest rates to change in several bank risk variables after controlling for some macro or bank-specific variables and controlling for the simultaneous determination of each of the dependent variable in the system. The third and the fourth columns show the extent of market discipline by looking at the price response of depositors to the change in the bank risk fundamentals after controlling for the effect of change in bank risk variables on the deposit growth rate. We expect to find a positive association between a higher bank risk variable and interest rates charged on the banks' deposits. As the riskiness of the bank increases, depositors will require a higher return on their deposits. Estimation results show that banks with higher liquidity ratio are facing a decline on their inflation-adjusted implicit interest rates. Any 1% increase in liquidity ratio decreases the inflation-adjusted implicit interest rates by almost 0.09%. The coefficient estimate is statistically significant at the 1% level. The results show that banks with a higher profit are tented to pay lower interest rates on their deposits: Any 1% increases in the bank's profitability decreases the inflation-adjusted implicit interest rates by almost 0.07%. On the other hand, the coefficient estimate of effect of capital-asset ratio on implicit interest rate has an incorrect and statistically significant sign. Banks with higher capital-asset ratio are suffered from a higher interest rates paid on their holdings of deposits (0.085%) and the effect is statistically significant at 1% level. As for the credit-asset ratio the sign of the coefficient estimate is correct: Any 1% increases in credit-asset ratio increases the inflation-adjusted implicit interest rates by almost 0.045% and the effect is statistically significant at the 10% level. The
remaining variable, non-performing loan to asset ratio, has no sign of statistically significant
effect on the implicit interest rates at any traditional significance levels. Amongst the control
variables, the market share variable seems to have an unexpected positive effect on the interest
rates paid on deposits.\textsuperscript{69} It is expected that larger banks will be perceived as less risky than the
smaller ones, thus they will have to pay less on their deposits though the effect is positive and
statistically significant at the 1\% level. The coefficient estimates on the state-owned banks and
foreign-owned banks have the expected negative signs that show that both types of banks are
allowed to pay lower interest on their deposits. State-owned banks have less probability of
default due to the government bailout, thus are paying 0.077\% less on their deposits and foreign-
owned banks with their reputation in the market are able to take advantage of this and pay
0.082\% less interest on their deposit holdings.

The extent of market discipline in the form of quantity restriction imposed by the
depositors to the bad performing banks is estimated in the first and the second columns of Table
2. The 3SLS estimation results show the depositors' reaction to the several bank risk
fundamentals after controlling for the effect of several macro bank-specific variables as well as
the effect of inflation-adjusted implicit interest rates. Banks with higher liquid assets are facing
an increase in their deposits while the effect is not statistically significant at any conventional
level. Credit-asset ratio has the incorrect sign but it is statistically insignificant. On the other
hand, though not statistically significant, banks with higher non-performing loan ratios are
punished by the depositors with a decline in the bank's deposit growth rates. Any 1\% increases
in non-performing loans to asset ratio decreases the deposit growth rates by almost 0.39\% and
the effect is statistically significant at 13\% level. The other bank risk variable with incorrect

\textsuperscript{69} The results are basically same when natural logarithm of bank's total assets is used as a proxy for the size of a
bank.
signs in deposit growth rate regression is the capital-asset ratio. Bank's profit to asset ratio has the correct sign but it is not statistically significant at any conventional levels. Amongst the control variables, the only statistically significant factors that contribute to the change in deposit growth rate in the banking industry are cash to deposit ratio and the ratio of central bank deposits to M2. The former reflects depositors' preferences towards currency and bank deposits. Any increase in the cash to deposit ratio means that depositors perceive a market risk in the economy and independent of the bank risk fundamentals, they switch from bank deposits to cash. Interestingly this ratio is statistically positively significant which shows that as depositors' preferences towards non-deposit items increases, deposit growth rate increases. Maybe, this ratio is capturing some trending behavior in the deposit to growth rate which is not captured by the regression equation. One explanation would be that deposits in the entire banking system grow at a slower rate than the cash outside the banking system. \textit{ReservetoM2} ratio is statistically significant and negative which shows that the government lost reserves even though banking system did not.

The overall result regarding the market discipline in banking industry may lead to conflicting conclusion if individual bank risk variables are treated separately. Therefore F-tests which jointly test the effectiveness of all bank risk variables is applied to check the existence of market discipline in the economy. The F-test results does not seem to reject the null hypothesis that all bank variables are jointly have no role in effecting either of the dependent variable.

One important issue regarding the market discipline in Turkish banking industry is to check if the aftermath of the banking crisis in 2001 has any influence on the degree of market disciplining. After the crisis, the government did some major revisions in the banking law, number of banks have declined significantly in the industry while the remaining ones are
monitored constantly. Therefore, post-crisis period should be controlled in understanding the disciplining mechanism in the market. For this reason a PostCrisis dummy variable have been created which takes the value of 1 beginning from the first quarter of 2002. Then, this dummy variable has been interacted with all bank risk fundamentals and results are shown in the second and the fourth columns of Table 2. If the aftermath of the crisis will have an influential effect on the banking discipline, we would expect significantly non-zero coefficients on the interacted variables. The estimation results show that the only statistically significant interaction variable for the deposit growth rate regression is the capital asset ratio. The results show that, relative to the pre-crisis period, in the aftermath of 2001 banking crisis, banks see a decline in their deposits after an increase in their capital asset ratio. The sign of the coefficient on the interacted capital-asset ratio is wrong along with the other interacted bank risk variables. It can be due to some other non-bank factors that lead the growth rate of deposit to decline with the increase in the capital-asset ratio.

As for the variation in the inflation-adjusted implicit interest rate, only the capital-asset ratio and credit-asset ratio variables that are interacted with the PostCrisis dummy variable have a statistically significant coefficient estimates shown in the last column of Table 2. While the overall results before controlling for the post-crisis period does show a significantly lower interest rates charged on deposits after an increase in liquidity, after the interaction of PostCrisis dummy, the relationship becomes statistically insignificant but still negative. Consistent with the banking discipline hypothesis, Profit variable shows that, relative to the pre-crisis period, post-crisis banks with higher profits are being charged less for their deposits. After a 1% increase in profits, banks in the post-crisis period face 0.045% lower interest rate charged on their deposits, but the effect is not statistically significant at any conventional level.
The result on the interacted *Credit* variable also shows a bank disciplinary effect in the aftermath of the crisis. During that period, banks that have increased their credit-asset ratio by 1% have seen an increase in interest rates charged on their deposits by 0.257% higher than the pre-crisis period. Therefore, it can be concluded that depositors become more cautious after the crisis and the market functions well in terms of punishing the bad performing banks. This piece of evidence shows the change in the banking discipline after the crisis. Before the crisis period, banks were paid less on their deposits after an increase in their credit asset ratio, but this undisciplining negative association changes its since after the crisis in accordance with the market disciplining hypothesis.

As for the capital-asset ratio, the introduction of *PostCrisis* dummy corrects the sign of the coefficient estimates from positive to negative. Banks with higher capital-asset ratio faced less interest charged on their deposits. One noteworthy examination is that in the aftermath of the banking crises, in contrast with the prediction of an efficient banking discipline, banks with higher capital asset ratio faced higher interest on their deposits. One explanation can be that markets are too cautious with the banks with higher capital-asset, thus require more interest from these banks. The coefficient estimate on the non-performing loan to deposit ratio has the correct sign after the interaction effect. Though is not statistically significant, banks with higher non-performing loans to deposit ratio are forced to pay high on their deposits. F-test is applied to test if all interacted bank risk variables are jointly equal to zero. The result show that we can reject the hypothesis that post-crisis period has not change the banking discipline at the 5% significance level.

In Table 3, the estimated bank-specific fixed effects from the 3SLS instrumental variable regressions are documented separately to see if there is any significant change in these
characteristics after the banking crisis. Columns (1) and (3) show the estimated constant variables for each bank without controlling for the banking crises. All but one bank-specific fixed effect estimates are statistically insignificant for the deposit growth rate. As for the implicit interest rate regression, shown in the third column, constant variable estimates are statistically significant for the 17 banks, while for the 8 banks, the estimated fixed bank characteristics are statistically insignificant. In the second and the fourth columns, we are testing how strong our assumption of bank-specific fixed effects by interacting each bank dummy with the PostCrisis dummy and to see if any of the interacted variable is significant. In columns (2) and (4) of Table 3, only the coefficient estimates of the interacted variable are shown. For the regression for deposit growth rate, there are 2 banks with a statistically significant interacted variable, and for the regression for the inflation-adjusted implicit interest rate, there are also only two banks with a statistically significant interaction variable. Therefore, the unobserved bank specific characteristics seem to be constant throughout the sample period. F-test statistics in Table 3 shows the Chi-2 statistics that jointly tests all bank fixed effects are zero. We strongly reject this hypothesis for the bank dummy variables while fail to reject for the interacted variables.

2.5.2 2SLS Regression

Instead of using a simultaneous system equation, a single equation instrumental variable regression is applied to estimate the structural equations (1.60) and (1.61) in a two-stage settings. In the first stage the following regressions are estimated by using the lag values of endogenous variable as the instruments along with other bank-specific and macro variables:
\[ \Delta \text{Deposits}_{i,t} = \alpha_i + \beta_1 \text{Liquidity}_{i,t-1} + \tilde{\beta}_1 \text{PostCrisis} \cdot \text{Liquidity}_{i,t-1} + \beta_2 \text{Profit}_{i,t-1} + \tilde{\beta}_2 \text{PostCrisis} \cdot \text{Profit}_{i,t-1} + \beta_3 \text{Capital}_{i,t-1} + \tilde{\beta}_3 \text{PostCrisis} \cdot \text{Capital}_{i,t-1} + \beta_4 \text{Credit}_{i,t-1} + \tilde{\beta}_4 \text{PostCrisis} \cdot \text{Credit}_{i,t-1} + \beta_5 \text{NPLoans}_{i,t-1} + \tilde{\beta}_5 \text{PostCrisis} \cdot \text{NPLoans}_{i,t-1} + \gamma_1 \text{MarketShare}_{i,t} + \gamma_2 \Delta \text{realGDP}_{i,t-1} + \gamma_3 \text{CashstoDeposit}_{i,t-1} + \gamma_4 \text{ReservestoM2}_{i,t-1} + \gamma_5 \text{Foreign}_i + \gamma_6 \text{State}_i + \theta_1 \text{ImplicitRate}_{i,t} + \epsilon_{i,t} \] 

\[ \text{ImplicitRate}_{i,t} = \phi_i + \delta_1 \text{Liquidity}_{i,t-1} + \delta_1 \text{PostCrisis} \cdot \text{Liquidity}_{i,t-1} + \delta_2 \text{Profit}_{i,t-1} + \delta_2 \text{PostCrisis} \cdot \text{Profit}_{i,t-1} + \delta_3 \text{Capital}_{i,t-1} + \delta_3 \text{PostCrisis} \cdot \text{Capital}_{i,t-1} + \delta_4 \text{Credit}_{i,t-1} + \delta_4 \text{PostCrisis} \cdot \text{Credit}_{i,t-1} + \delta_5 \text{NPLoans}_{i,t-1} + \delta_5 \text{PostCrisis} \cdot \text{NPLoans}_{i,t-1} + \gamma_1 \text{MarketShare}_{i,t} + \gamma_2 \Delta \text{realGDP}_{i,t-1} + \gamma_3 \text{DiffInterest} + \gamma_4 \text{Foreign}_i + \gamma_5 \text{State}_i + \theta_2 \Delta \text{Deposits}_{i,t} + \upsilon_{i,t} \] 

In the second stage, predicted values of deposit growth rates and implicit interest rates are used to replace the endogenous variables in regression equations (3) and (4) by using the robust standard errors. The results are shown in Tables (4) and (5). 2SLS bank-fixed effect IV regression results show that deposit growth rates are only responsive to the credit-asset ratio. Improvement in the credit-asset ratio increases the banks' deposit growth rate. On the other hand, even though it is not statistically significant at the conventional levels, there is a negative association between deposit growth rates and inflation-adjusted implicit interest rates. Banks that are facing higher interest charged to their deposits are experiencing a statistically significant decrease in their deposit rates. This result is in accordance with the market discipline hypothesis where depositors are monitoring the banks and punishing the bad performing banks that are facing higher implicit interest rates by decreasing their deposit holdings. As for the implicit interest rate variable, shown in the second column of Table (4), coefficient estimates of both bank profitability and credit-asset ratio are statistically significantly showing a disciplining market system. Banks that face a 1% increase in their profits are being charged 0.089% less on
their deposits. On the other hand, banks that have an increase of their credit-asset ratio by 1%, are punished by the market with an increase on the interest rates charged on to their deposits by an additional 0.099%. The coefficient estimates are all statistically significant at the 1% significance level. One important finding in the fixed effect regression is that the coefficient estimate of deposit growth rate on the implicit interest rate regression is statistically significantly negative. Banks that face a 1% increase in their deposit growth rate are experiencing a 0.097% decrease in the interest rates charged to their deposits. It is a sign that the less-risky banks that face an increase in their deposit growth rates are being priced in the market by a reduction in the implicit interest rate. When PostCrisis dummy variables have been interacted with those bank risk measurements, as shown in the third and fourth columns of Table (4), there is not much any effect of the post-crisis period on the behavior of depositors to the bank performance. None of the interaction variables are statistically significant for the deposit growth regression. As for the implicit interest rate regression, 3 of the 5 risk variables interacted with the post-crisis dummy variable are statistically significant. Thus, the depositors' respond to the bank risk measurements significantly changed after the bank crisis in 2001. Comparing to the pre-crisis period, banks with an additional 1% increase in their credit-asset ratio are being charged 0.2% more on their deposits after the post-crisis period. On the other hand, estimates on the effect of non-performing loans and capital-asset ratio have the wrong sign. As shown in Table (5), the story doesn't change much as in the fixed effect regression results. There is a significant change in the depositors behavior against the bad performing loans after the post-crisis period, but deposit growth regressions does not provide any strong evidence of it.
2.6 REMARKS

This paper closely follows other publications of the same subject done for Latin American economies. Probably the most striking among the results is the fact that the presence of market discipline still exists despite the fact that there is de facto full coverage insurance. This can be explained as in Martinez-Peria and Schmukler (2001) by the lack of credibility of the deposit insurance scheme. Especially for the case of Turkey depositors seem to be worried about the opportunity cost of their loans waiting to be refunded due to the delays in repayment.

Another important result that should be discussed is why market discipline is effective in the after-crisis period. One explanation is that there is full coverage before the crisis and only a limited one after the crisis. However we think that cannot be the main reason considering the fact that the government insured the deposits in full coverage in the after-crisis period from July 2003 until July 2004. Recall that during and right before the crisis period it is the systemic components—rather than bank fundamentals—that determine deposit amounts and interest rates which are very much correlated across banks. However what we propose as the main agent of market discipline after the crisis is the fresh memory of the crisis imprinted in the minds of depositors and the reduced trust to the banking institutions. These psychological effects cause depositors to be extra cautious about the condition of the bank.\footnote{As Martinez-Peria and Schmukler (2001) put it rightly, "... crises seem to be wake up calls for depositors."} As long as there is an uncertainty component about the availability of their funds in the future, the depositors continue to keep a watchful eye on the actions of the bank managers.

There is strong evidence from recent experience following the 2001 crisis that the “too-big-to-fail” policy is implemented in Turkey. Especially following the financial trouble of “Yapi ve Kredi Bankasi” (YKB), the government policymakers decided to bail this bank out. At the
time of its bailout this bank was the 6th largest bank in Turkey in terms of its capitalization. Its bank holding company was employing 42,000 people. The policymakers feared that YKB failing will have drastic repercussions for the whole economy through systemic risk and contagion effects. Instead of leaving the bank to fail the Central Bank and the Treasury came up with a rescue package where $500 million U.S. dollars was injected into the troubled bank. After holding the bank for 2 years and assuming all its debt, the Banking Regulatory Agency in Turkey successfully marketed the bank to another group. Of course, this bailout sent mixed signals to depositors and investors in Turkey. Especially the belief that policymakers will not let a large banking organization to fail apparently is a negative effect on market discipline.

Today there is limited deposit insurance in Turkey since 2004. The coverage has an upper cap at 50,000 new Turkish lira and the government is seriously considering to cut it even further. Yet due to the strong presence of too-big-to-fail support this might not be a credible policy to impose. Apparently after each financial crisis in Turkey several banks failed and insured together with uninsured accounts have been bailed out. These policies have put huge burden on taxpayers in Turkey. To this day, the design of the deposit insurance scheme is a hotly debated issue.

One striking development in Turkish financial markets is the entrance of big foreign players. HSBC, Deutsche Bank, JP Morgan Chase and Citibank are among these banks operating in Turkey. These banks accept deposits and make loans effectively. Regression results show that investors and depositors impose less market discipline over these banks and trust them more than they do towards Turkish banks. Recently some discussions broke out in the Turkish parliament whether the presence of foreign owned banks is healthy for the overall economy. It looks like, at least, these banks operate very efficiently and the level of competition is higher in the banking industry.
2.7 CONCLUSION

This paper estimated the effectiveness of depositors in monitoring and disciplining bank activities before and after the 2001 financial crisis. Market disciplinary forces are effective in the Turkish financial markets following the 2001 crisis period. This can be explained on several grounds. First, the crisis in 2001 acted as a “wake up call” in the financial markets. Investors learned that government regulation and supervision might be insufficient and deposit insurance compensation does not cover the real extent of losses. Second a natural selection in banking industry occurred. That is, inefficient banks failed during and right after the crisis and left the playing field to efficient banks. Third, political stability and determination of policymakers to instate new banking laws organizing financial institutions proved effective so far.

Full deposit insurance before 2001 as well as implicit guarantees after the crisis to this day is a challenge in front of policymakers. Some too-big-to-fail practices even after the crisis apparently sent mixed signals to depositors. Depositors got the impression and revised their beliefs that they will be repaid of their losses if a bank fails. Interestingly, the partial deposit insurance also generates mixed signals. For deposits that are under government guarantee of limited coverage, the possibility of delays in repayment makes the depositors feel cautious.

As a first step we tested the correlation between bank riskiness and deposit growth rates. We find evidence that the interaction is stronger after 2001 indicating some type of learning in part of depositors. Then for the regression in the second step we estimated the interest rate changes to see how fast banks response to a deposit growth rate change signal. In addition to bank specific risk variables, we control the size, ownership type, deposit insurance scheme, 2001 financial crisis and the macroeconomic environment.
The results provide evidence that the disciplining mechanism is in effect in Turkey even for insured deposits before and after the financial crisis in both periods, but more so after the financial crisis. The important determinants of depositor discipline are the ratio of total loans to total assets, loans to other banks to total assets, cash, reserves and bonds to total assets and capitalization. Additionally size and especially foreign ownership of the banks are important in the determination of the interest paid to deposits.
2.8 Appendix

2.8.1 Figures

Figure 16. Capital Adequacy

Figure 17. Liquidity
Figure 18. Asset Quality-1

Figure 19. Asset Quality-2
Figure 20. Profitability

Figure 21. Share of Total Deposits
2.8.2 Tables

<table>
<thead>
<tr>
<th>Table 1. Descriptive Statistics: Yearly data (1990-2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variables</td>
</tr>
<tr>
<td>Deposit Growth Rate</td>
</tr>
<tr>
<td>Adjusted Implicit Interest Rate</td>
</tr>
<tr>
<td>Bank Fundamentals</td>
</tr>
<tr>
<td>Liquidity Risk</td>
</tr>
<tr>
<td>Banks' Profitability</td>
</tr>
<tr>
<td>Capital-Asset Ratio</td>
</tr>
<tr>
<td>Credit-Asset Ratio</td>
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<tr>
<td>Non-Performing Loans</td>
</tr>
<tr>
<td>Control Variables</td>
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<tr>
<td>Market Share</td>
</tr>
<tr>
<td>GDP Growth Rate</td>
</tr>
<tr>
<td>Cash to Deposits</td>
</tr>
<tr>
<td>Reserves to M2</td>
</tr>
<tr>
<td>Diff. Interest</td>
</tr>
</tbody>
</table>

There are 25 banks of which 9 are foreign-owned commercial banks, 3 are state-owned commercial banks, and the remaining 13 are private domestic commercial banks. Deposit and GDP growth rates are measured as the percentage change from one quarter to the corresponding quarter in the following year. Adjusted implicit interest rate is measured as the ratio of interest payments on deposits to deposits adjusted from quarterly inflation rate. Market share variable is measured as each bank's total asset at a point in time as a fraction of the total asset in the market. Liquidity risk is measured by the ratio of liquidate asset to the total asset. Banks' profitability is measured as a ratio of total bank profit to total asset. Capital-asset ratio stands for the ratio of total capital to total asset, credit-asset ratio is the fraction of total liabilities to the total asset, and lastly, Non-performing loans stands for the bank's non-performing loans as a fraction of their total asset.

Data Source: Banks Association of Turkey
Table 2. 3SLS Instrumental Variable Regression: Quarterly Data (1997Q3-2007Q1)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>ΔDeposits_{it}, t-1</th>
<th>ImplicitRate_{it}, t-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquidity_{it}, t-1</strong></td>
<td>0.064</td>
<td>-0.090***</td>
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<tr>
<td></td>
<td>(0.219)</td>
<td>(0.004)</td>
</tr>
<tr>
<td><strong>Profit_{it}, t-1</strong></td>
<td>0.004</td>
<td>-0.066*</td>
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<tr>
<td></td>
<td>(0.965)</td>
<td>(0.042)</td>
</tr>
<tr>
<td><strong>Capital_{it}, t-1</strong></td>
<td>-0.043</td>
<td>0.085***</td>
</tr>
<tr>
<td></td>
<td>(0.452)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>Credit_{it}, t-1</strong></td>
<td>0.096</td>
<td>0.045*</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(0.038)</td>
</tr>
<tr>
<td><strong>NPLoans_{it}, t-1</strong></td>
<td>-0.389</td>
<td>-0.064</td>
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<tr>
<td></td>
<td>(0.128)</td>
<td>(0.439)</td>
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<tr>
<td><strong>PostCrisis * Liquidity_{it}, t-1</strong></td>
<td>0.018</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(0.849)</td>
<td>(0.243)</td>
</tr>
<tr>
<td><strong>PostCrisis * Profit_{it}, t-1</strong></td>
<td>-0.021</td>
<td>-0.045</td>
</tr>
<tr>
<td></td>
<td>(0.930)</td>
<td>(0.501)</td>
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<tr>
<td><strong>PostCrisis * Capital_{it}, t-1</strong></td>
<td>-0.349*</td>
<td>0.173***</td>
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<td>(0.029)</td>
<td>(0.000)</td>
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<tr>
<td><strong>PostCrisis * Credit_{it}, t-1</strong></td>
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<td>0.257***</td>
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<td>(0.354)</td>
<td>(0.000)</td>
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<tr>
<td><strong>PostCrisis * NPLoans_{it}, t-1</strong></td>
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<td>-0.491</td>
</tr>
<tr>
<td></td>
<td>(0.327)</td>
<td>(0.270)</td>
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<tr>
<td><strong>MarketShare</strong></td>
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<td>0.752**</td>
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<td></td>
<td>(0.223)</td>
<td>(0.002)</td>
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<td><strong>ΔrealGDP_{it}, t-1</strong></td>
<td>-0.164</td>
<td>0.395***</td>
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<td>(0.244)</td>
<td>(0.000)</td>
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<td><strong>Cash to Deposits_{it}, t-1</strong></td>
<td>0.012*</td>
<td>0.014*</td>
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<td>(0.033)</td>
<td>(0.025)</td>
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<tr>
<td><strong>ReservestoM2_{it}, t-1</strong></td>
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<td>-0.294*</td>
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<td>(0.000)</td>
<td>(0.019)</td>
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<td><strong>Foreign</strong></td>
<td>0</td>
<td>-0.082***</td>
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<tr>
<td></td>
<td>(0.998)</td>
<td>(0.000)</td>
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<tr>
<td><strong>State</strong></td>
<td>-0.021</td>
<td>-0.077**</td>
</tr>
<tr>
<td></td>
<td>(0.814)</td>
<td>(0.005)</td>
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<tr>
<td><strong>Diff Interest_{it}, t-1</strong></td>
<td>-0.02</td>
<td>-0.047***</td>
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<tr>
<td></td>
<td>(0.177)</td>
<td>(0.000)</td>
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</table>

F-test on **BankRisks**  | 6.72               | 11.87*                 |
|                          | (0.243)             | (0.037)                |

F-test on **PostCrisis * BankRisks**  | 11.87*              |
|                                      | (0.037)              |

There are 957 observations from 25 banks of which 9 are foreign-owned commercial banks, 3 are state-owned commercial banks, and the remaining 13 are private domestic commercial banks. Endogenous variables are the deposit growth rate and inflation-adjusted implicit interest rates. All other variables as well as both the bank dummy and bank dummy variable interacted with the PostCrisis dummy are used as an instrument in estimating the dependent variables. GLS-type estimation has been performed to simultaneous system of structural equations in (1.60) and (1.61). PostCrisis is a dummy variable that takes the value of 1 after the Banking crises end in the first quarter of 2002. F-test shows the Chi-2 test statistic with a degrees of freedom of 10 and it tests the joint significance of bank risk variables. The numbers in parenthesis are the p-values. ***, ** and * denote significance at 1%, 5% and 10%, respectively.
Table 3. Constant Estimates from the 3SLS Instrumental Variable Regression: Quarterly Data (1997Q3-2007Q1)

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<tr>
<th>Dependent Variable</th>
<th>ΔDeposits_{it}</th>
<th>ImplicitRate_{it}</th>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<td>Akbank</td>
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<td>-0.147***</td>
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<tr>
<td></td>
<td>(0.622)</td>
<td>(0.168)</td>
<td>(0.000)</td>
<td>(0.795)</td>
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<td></td>
</tr>
<tr>
<td>Alternatif Bank</td>
<td>0.032</td>
<td>0.063</td>
<td>-0.066***</td>
<td>-0.015</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.571)</td>
<td>(0.446)</td>
<td>(0.000)</td>
<td>(0.612)</td>
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</tr>
<tr>
<td>Anadoluank</td>
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<td>0.243**</td>
<td>-0.068***</td>
<td>-0.006</td>
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<tr>
<td></td>
<td>(0.060)</td>
<td>(0.003)</td>
<td>(0.000)</td>
<td>(0.851)</td>
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<tr>
<td>Banca di Roma S.P.A.</td>
<td>-0.046</td>
<td>-0.04</td>
<td>0.02</td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.504)</td>
<td>(0.746)</td>
<td>(0.292)</td>
<td>(0.295)</td>
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<td>0.105</td>
<td>0.032</td>
<td>-0.01</td>
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<td></td>
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<td>(0.210)</td>
<td>(0.063)</td>
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<td></td>
<td>(0.681)</td>
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<td></td>
<td>(0.241)</td>
<td>(0.103)</td>
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<td></td>
<td>(0.601)</td>
<td>(0.519)</td>
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<td></td>
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<td></td>
<td>(0.065)</td>
<td>(0.083)</td>
<td>(0.003)</td>
<td>(0.897)</td>
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<tr>
<td>Oyak Bank</td>
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<td>0.032</td>
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<tr>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<td>Turk Ekonomi Bankasi</td>
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<td>(0.525)</td>
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<td>T.C. Ziraat Bankasi</td>
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<td></td>
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<td>Turkiye Garanti Bankasi</td>
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<td>Turkiye Halk Bankasi</td>
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<td>Turkiye Is Bankasi</td>
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<td>0.111***</td>
<td>0.016</td>
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<td>(0.007)</td>
<td>(0.314)</td>
<td>(0.000)</td>
<td>(0.642)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yapi ve Kredi Bankasi</td>
<td>-0.025</td>
<td>-0.201</td>
<td>-0.141***</td>
<td>-0.012</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.766)</td>
<td>(0.165)</td>
<td>0.000</td>
<td>(0.716)</td>
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</table>

<table>
<thead>
<tr>
<th>F-test on Bank Dummy</th>
<th>47.57</th>
<th>47.57</th>
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<tbody>
<tr>
<td>F-test on Post Crisis*Bank Dummy</td>
<td>31.6</td>
<td>31.6</td>
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<tr>
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<td>(0.004)</td>
<td>(0.004)</td>
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<tr>
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<td>(0.250)</td>
<td>(0.250)</td>
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Columns (1) and (3) show the constant estimates for bank-specific fixed effects from the 3SLS instrumental variable regression shown in Table 2. Columns (2) and (4) show the estimates of the bank-specific fixed effects interacted with the PostCrisis dummy variable that takes the value of 1 after the banking crises end in the first quarter of 2002. The numbers in parenthesis are the p-values. *** and ** denote significance at 1%, 5% and 10%, respectively. F-test shows the Chi-2 test statistic with a degrees of freedom of 27 and it tests the joint significance of bank fixed effects and bank fixed effects interacted with the PostCrisis dummy variable.
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>( \Delta Deposits_{it} )</th>
<th>ImplicitRate_{it}</th>
<th>( \Delta Deposits_{it} )</th>
<th>ImplicitRate_{it}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquidity_{it-1}</strong></td>
<td>0.103</td>
<td>-0.019</td>
<td>0.094</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.161)</td>
<td>(0.418)</td>
<td>(0.244)</td>
<td>(0.399)</td>
</tr>
<tr>
<td><strong>Profit_{it-1}</strong></td>
<td>-0.067</td>
<td>-0.089***</td>
<td>-0.132</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.519)</td>
<td>(0.007)</td>
<td>(0.489)</td>
<td>(0.521)</td>
</tr>
<tr>
<td><strong>Capital_{it-1}</strong></td>
<td>0.024</td>
<td>0.104***</td>
<td>0.108</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(0.714)</td>
<td>(0.000)</td>
<td>(0.303)</td>
<td>(0.622)</td>
</tr>
<tr>
<td><strong>Credit_{it-1}</strong></td>
<td>0.165**</td>
<td>0.099***</td>
<td>0.251***</td>
<td>-0.058**</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.000)</td>
<td>(0.009)</td>
<td>(0.053)</td>
</tr>
<tr>
<td><strong>NPloans_{it-1}</strong></td>
<td>-0.372</td>
<td>-0.019</td>
<td>-1.645</td>
<td>0.485</td>
</tr>
<tr>
<td></td>
<td>(0.161)</td>
<td>(0.823)</td>
<td>(0.179)</td>
<td>(0.191)</td>
</tr>
<tr>
<td><strong>PostCrisis * Liquidity_{it-1}</strong></td>
<td>-0.031</td>
<td>-0.007</td>
<td>-0.001</td>
<td>-0.072</td>
</tr>
<tr>
<td></td>
<td>(0.568)</td>
<td>(0.648)</td>
<td>(0.997)</td>
<td>(0.287)</td>
</tr>
<tr>
<td><strong>PostCrisis * Profit_{it-1}</strong></td>
<td>-0.16</td>
<td>0.148***</td>
<td>-0.125</td>
<td>0.201***</td>
</tr>
<tr>
<td></td>
<td>(0.212)</td>
<td>(0.000)</td>
<td>(0.154)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>PostCrisis * Capital_{it-1}</strong></td>
<td>1.534</td>
<td>-0.637*</td>
<td>0.584</td>
<td>0.315</td>
</tr>
<tr>
<td></td>
<td>(0.217)</td>
<td>(0.090)</td>
<td>(0.161)</td>
<td>(0.090)</td>
</tr>
<tr>
<td><strong>MarketShare</strong></td>
<td>1.046</td>
<td>0.805***</td>
<td>1.278*</td>
<td>0.332</td>
</tr>
<tr>
<td></td>
<td>(0.165)</td>
<td>(0.001)</td>
<td>(0.097)</td>
<td>(0.161)</td>
</tr>
<tr>
<td><strong>( \Delta realGDP_{it} )</strong></td>
<td>0.023</td>
<td>0.352***</td>
<td>0.02</td>
<td>0.187***</td>
</tr>
<tr>
<td></td>
<td>(0.879)</td>
<td>(0.000)</td>
<td>(0.897)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>Cash to Deposits_{it-1}</strong></td>
<td>0.023***</td>
<td>0.018**</td>
<td>-0.449***</td>
<td>-0.383***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.026)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td><strong>Reserve to M2_{it-1}</strong></td>
<td>-0.449***</td>
<td>-0.383***</td>
<td>-0.027*</td>
<td>-0.058***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.008)</td>
<td>(0.067)</td>
<td>(0.000)</td>
</tr>
<tr>
<td><strong>Diff Interest_{it-1}</strong></td>
<td>-0.227</td>
<td>0.036</td>
<td>-0.097**</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.271)</td>
<td>(0.896)</td>
<td>(0.005)</td>
<td>(0.813)</td>
</tr>
<tr>
<td><strong>( \Delta Deposit_{it-1} )</strong></td>
<td>8.78</td>
<td>55.21</td>
<td>8.16</td>
<td>143.43</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>0.000</td>
<td>(0.148)</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

There are 957 observations from 25 banks of which 9 are foreign-owned commercial banks, 3 are state-owned commercial banks, and the remaining 13 are private domestic commercial banks. Endogenous variables are the deposit growth rate and inflation-adjusted implicit interest rates. Bank fixed effect instrumental variable estimation is performed in a 2SLS form to estimate the structural equations in (3) and (4). PostCrisis is a dummy variable that takes the value of 1 after the Banking crises end in the first quarter of 2002. F-test shows the Chi-2 test statistic with a degrees of freedom of 10 and it tests the joint significance of bank risk variables. Robust standard errors are used. The numbers in parenthesis are the p-values. ***, ** and * denote significance at 1%, 5% and 10%, respectively.
<table>
<thead>
<tr>
<th></th>
<th>$\Delta Deposits_{t,t-1}$</th>
<th>$\text{ImplicitRate}_{t,t-1}$</th>
<th>$\Delta Deposits_{t,t-1}$</th>
<th>$\text{ImplicitRate}_{t,t-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Liquidity}_{t,t-1}$</td>
<td>0.038</td>
<td>-0.011</td>
<td>0.054</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.512)</td>
<td>(0.625)</td>
<td>(0.398)</td>
<td>(0.855)</td>
</tr>
<tr>
<td>$\text{Profit}_{t,t-1}$</td>
<td>-0.066</td>
<td>-0.085***</td>
<td>-0.064</td>
<td>0.089</td>
</tr>
<tr>
<td></td>
<td>(0.495)</td>
<td>(0.010)</td>
<td>(0.729)</td>
<td>(0.154)</td>
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<tr>
<td>$\text{Capital}_{t,t-1}$</td>
<td>0.007</td>
<td>0.096***</td>
<td>0.087</td>
<td>-0.05</td>
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<tr>
<td></td>
<td>(0.896)</td>
<td>(0.000)</td>
<td>(0.347)</td>
<td>(0.132)</td>
</tr>
<tr>
<td>$\text{Credit}_{t,t-1}$</td>
<td>0.144**</td>
<td>0.082***</td>
<td>0.168**</td>
<td>-0.104***</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.001)</td>
<td>(0.043)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>$\text{NPloans}_{t,t-1}$</td>
<td>-0.381</td>
<td>-0.035</td>
<td>-0.529</td>
<td>0.591</td>
</tr>
<tr>
<td></td>
<td>(0.135)</td>
<td>(0.681)</td>
<td>(0.634)</td>
<td>(0.127)</td>
</tr>
<tr>
<td>$\text{PostCrisis} \times \text{Liquidity}_{t,t-1}$</td>
<td>-0.045</td>
<td></td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.375)</td>
<td></td>
<td>(0.899)</td>
<td></td>
</tr>
<tr>
<td>$\text{PostCrisis} \times \text{Profit}_{t,t-1}$</td>
<td>-0.081</td>
<td></td>
<td>-0.113</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.710)</td>
<td></td>
<td>(0.125)</td>
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</tr>
<tr>
<td>$\text{PostCrisis} \times \text{Capital}_{t,t-1}$</td>
<td>-0.122</td>
<td></td>
<td>0.177***</td>
<td></td>
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<tr>
<td></td>
<td>(0.298)</td>
<td></td>
<td>(0.000)</td>
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</tr>
<tr>
<td>$\text{PostCrisis} \times \text{Credit}_{t,t-1}$</td>
<td>-0.031</td>
<td></td>
<td>0.200***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.675)</td>
<td></td>
<td>(0.000)</td>
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<tr>
<td>$\text{PostCrisis} \times \text{NPloans}_{t,t-1}$</td>
<td>0.317</td>
<td></td>
<td>-0.807**</td>
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</tr>
<tr>
<td></td>
<td>(0.779)</td>
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<td>(0.040)</td>
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<tr>
<td>$\text{MarketShare}$</td>
<td>0.239</td>
<td>0.219</td>
<td>0.226</td>
<td>0.017</td>
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<tr>
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<td>(0.300)</td>
<td>(0.127)</td>
<td>(0.304)</td>
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<tr>
<td>$\text{AreaGDP}_{t,t-1}$</td>
<td>0.061</td>
<td>0.362***</td>
<td>0.101</td>
<td>0.193***</td>
</tr>
<tr>
<td></td>
<td>(0.679)</td>
<td>(0.000)</td>
<td>(0.500)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>$\text{Cash to Deposit}_{t,t-1}$</td>
<td>0.022***</td>
<td></td>
<td>0.018***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
<td>(0.019)</td>
<td></td>
</tr>
<tr>
<td>$\text{Reserve to M2}_{t,t-1}$</td>
<td>-0.449***</td>
<td></td>
<td>-0.381***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td></td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>$\text{Foreign}$</td>
<td>-0.019</td>
<td>0.039***</td>
<td>-0.020</td>
<td>0.028***</td>
</tr>
<tr>
<td></td>
<td>(0.363)</td>
<td>(0.009)</td>
<td>(0.310)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>$\text{State}$</td>
<td>0.006</td>
<td>0.026</td>
<td>0.003</td>
<td>0.045***</td>
</tr>
<tr>
<td></td>
<td>(0.876)</td>
<td>(0.308)</td>
<td>(0.940)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>$\text{Diff Interest}_{t,t-1}$</td>
<td>-0.025*</td>
<td></td>
<td>-0.056***</td>
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</tr>
<tr>
<td></td>
<td>(0.095)</td>
<td></td>
<td>(0.000)</td>
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<tr>
<td>$\text{ImplicitRate}_{t,t-1}$</td>
<td>-0.310**</td>
<td></td>
<td>-0.202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td></td>
<td>(0.232)</td>
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<tr>
<td>$\Delta Deposits_{t,t-1}$</td>
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<td>0.037</td>
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<td>$\text{F-test on Bank Risks}$</td>
<td>9.7</td>
<td>41.63</td>
<td></td>
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<td></td>
<td>(0.080)</td>
<td>(0.000)</td>
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<tr>
<td>$\text{F-test on Post Crisis} \times \text{Bank Risks}$</td>
<td>5.37</td>
<td></td>
<td>137.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.370)</td>
<td></td>
<td>(0.000)</td>
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</tr>
</tbody>
</table>

There are 957 observations from 25 banks of which 9 are foreign-owned commercial banks, 3 are state-owned commercial banks, and the remaining 13 are private domestic commercial banks. Endogenous variables are the deposit growth rate and inflation-adjusted implicit interest rates. Random effect instrumental variable estimation is performed in a 2SLS form to estimate the structural equations in (3) and (4). PostCrisis is a dummy variable that takes the value of 1 after the Banking crises end in the first quarter of 2002. F-test shows the Chi-2 test statistic with a degrees of freedom of 10 and it tests the joint significance of bank risk variables. Robust standard errors are used. The numbers in parenthesis are the p-values. ***, ** and * denote significance at 1%, 5% and 10%, respectively. Data Source: Banks Association of Turkey.
3 BIBLIOGRAPHY


Markowitz, H. "Portfolio Selection." *Cowles Foundation Monograph,* no. 16 (1952).

