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Digital Echoes and Financial Shocks: Analyzing the Impact of Social Media Discourse on Bank Run Dynamics

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INTRODUCTION AND SCOPE OF WORK

A modern economy's ability to maintain financial system stability is essential. However, events like bank runs, which have the power to upend not just specific financial institutions but also larger economic systems, frequently put this stability to the test. Bank runs happen when depositors hurry to take their money out of fear of going bankrupt, which could lead to a liquidity crisis. Although macroeconomic factors and financial instability have long been linked to bank runs, the emergence of digital platforms and social media has introduced a new level of complexity to these incidents.

The advent of digital technology has revolutionized the velocity and scope of information dissemination, rendering social media a crucial element in the dynamics of the financial markets. Millions of individuals may post news, gossip, and opinions in real time on social media sites like Facebook, Twitter, and Reddit. This has made financial information more accessible to the general public, but it has also increased risk because false information or messages meant to incite fear can spread quickly and affect how depositors and investors behave. This "digital echo" has the potential to both increase and generate worries about the soundness of a financial institution. Financial experts and regulators alike must thus comprehend the significance of social media sentiment in financial crises, especially bank runs.

Given the status of the economy today, the significance of this subject cannot be emphasized. Historically, bank runs were thought to be the result of regional rumors or downturns in the economy. But social media's widespread reach has changed the game, allowing rumors and worries to travel the world in a matter of minutes. Financial institutions now have to manage both their operational risks and their internet reputations, which is a big task.

The importance of perception is among the crucial elements of contemporary financial crises. Because investor confidence is frequently brittle, even a tiny hint of doubt might cause out-of-character reactions. This effect is enhanced by social media since posts and comments may be quickly shared, which starts a feedback cycle that heightens anxiety. While traditional media helped to shape public opinion during previous financial crises,

social media is more unpredictable and difficult to govern due to its unregulated and frequently anonymous character. Because of this, it's critical to comprehend how social media sentiment affects bank runs and how financial institutions can mitigate the risk.
In the specific cases of SVB and Credit Suisse, social media played a notable role in shaping the public's perception of these institutions. In the case of SVB, concerns about the bank's liquidity were amplified by social media posts from influential investors and tech entrepreneurs, leading to a rapid increase in withdrawals. Similarly, discussions surrounding Credit Suisse's stability gained traction on platforms like Twitter and Reddit, contributing to heightened uncertainty and market volatility. These case studies offer valuable insights into how social media sentiment can act as both a signal and a catalyst in financial crises.
This thesis' main goal is to examine the connection between bank run dynamics and social media sentiment. I specifically want to respond to the following queries:
In times of financial instability, how do sentiments on social media affect the behavior of investors and depositors?
To what extent does social media contribute to increasing or decreasing the likelihood of bank runs?
In order to stop bank runs in the future, how can regulators and financial institutions keep an eye on and react to opinion influenced by social media?
There are threeprimary chapters in this thesis:

A theoretical foundation for comprehending bank runs and financial intermediation is presented in Chapter 1. It starts out by going over the basic function of banks as financial intermediaries, as well as the dangers they carry and how bank runs can result from them. The historical literature on bank panics and the function of signals and rumors in starting runs is also reviewed in this chapter. Lastly, it examines how social media has emerged as a novel and important player in this process, providing firsthand accounts of how online debates can spread throughout the financial industry.
A case study of the Silicon Valley Bank run is presented in Chapter 2. The first section of the chapter provides a review of the bank's financial performance and business plan, emphasizing the weaknesses that ultimately contributed to its demise. An empirical study of how social media conversations affected the timing and intensity of the bank run comes

after a financial statement examination that includes performance and condition ratios. This chapter assesses how online posts and comments influenced investor and depositor panic using sentiment analysis methodologies.

In Chapter 3, the Credit Suisse case is examined, with particular attention paid to the impact of social media sentiment in the run-up to UBS's takeover of the company. The techniques for gathering and analyzing data that are utilized to obtain sentiment and stock market information are covered in this chapter. I will measure the correlation between mood on social media and Credit Suisse's stock performance using regression analysis to provide some understanding of how digital discourse affects financial markets in uncertain times.

The thesis concludes by summarizing the findings from both case studies and discussing the broader implications for financial institutions and regulators. I'll argue that social media sentiment is not only a reflection of public opinion but also a powerful driver of financial behavior. Therefore, institutions must develop new strategies to monitor and respond to online discourse in real-time. Additionally, the thesis will propose areas for future research, particularly in developing predictive models that can help anticipate social media-driven bank runs.

CHAPTER 1: THE DELICATE WORK OF FINANCIAL INTERMEDIATION

1.1 CREDIT: BRIDGING TIME AND OPPORTUNITY

Credit is one of the most straightforward and most far-reaching concepts in personal finance and the economy at large. It allows a wealth of economic activities by separating time between income and spending or between costs and revenues.

More generally, credit is fundamentally about intertemporal choice—in other words, enabling consumers and businesses to align their spending paths with their income or revenue paths over time.

For consumers, borrowing allows consumption beyond current income levels, while saving facilitates consumption in the future beyond expected income. From a business point of view, credit is an important mechanism to finance the timing gap between expenses and revenues incurred and generated at different periods in time, thus facilitating capital accumulation.

Credit can be categorized based on the period; short to medium-term credit is commonly used to finance circulating capital, while longer-term credits are associated with fixed capital investments. The notion of availability and flow of credit has enormous implications for the economy, as it influences aggregate demand, Gross Domestic product, and employment—such effects usually occur in a procyclical nature, where expansion in credit runs parallel to economic upturns.

Another factor permeates beyond the demand side, acting on aggregate supply but with solid connections to human will and choices: credit-driven investment in infrastructures and innovation. One can approach the relation between finance and economic growth from a cyclical, as much as from a structural point of view, to underline the profound effects that credit operations can have on the workings of an economy.

Commercial banks create the bank money when providing credit to business firms and households, while central banks produce base money when they grant credit to banks.

One needs to understand the logic behind credit operations to form an idea about money supply and demand, as well as monetary policy in general.

Viewed from a bigger perspective, defining elements of the latter would be essentially the following: timing of transactions, identities of the lender and borrower, debt contract, and its maturity and repayment conditions—credit risk.

This logic is perhaps best crystallized by the etymology of "credit," which harks back to the Latin "creditum," meaning a loan or thing entrusted to another. The commercial sense of credit—that is, the acknowledgment of a loan or debt—derives from as far back as the 1520s, with the very word 'credit' coming from Middle French "crédit."

Credit operation begins from the same stage of negotiation and drafting of contracts relating to credit at Time 0 to its maturity and eventual repayment by the debtor at Time 1. Quite clearly, Nicholas Georgescu-Roegen (1971) linked credit with the payment function of money.

It can also dramatically vary in length, starting from overnight loans to the long-term financing arrangements of 30-year mortgage loans, which all relate to and reflect no little diversity of credit within a financial system.

Credit operations are distinguished by their maturity—short-term, a year or less; medium-term, between one and five years; and long-term, over five years—along with the instruments used, like treasury bills, government bonds, and varied forms of loans and deposits. In this respect, each credit instrument could meet certain financial needs and scenarios, from liquidity management to financing long-term investments, which gives an idea about the complexity and multifariousness of credit in both economic and personal finance.

DIMENSIONS OF CREDIT: TIME, RISK, AND TRUST:

The complex landscape of credit is marked by its temporal, risk, and trust dimensions—each critically playing a role in the dynamics between the lender and the borrower. The time dimension of credit refers to the period from when the agreement was entered into, Time 0, out to the date of actual repayment, Time 1; this goes intrinsically with questions of credit risk and liquidity. The longer the credit, the greater the credit risk—potential loss due to borrower default—and the lesser the liquidity of the asset lent, whether money, financial asset, or good. Therein lies the balancing act that lenders must face in making credit available.

At the core of any credit transaction there is an agreement between a lender, L, and a borrower, B, whereby the former owns valuable assets, and the latter uses precisely

these assets, paying a premium for their usage, usually in the form of interest besides guarantees. Since the terms of the deal have been agreed upon, the valuables are delivered to the borrower, who binds himself into debt repayment through a debt contract under mutually settled terms. This contract is the promise of the borrower and forms the legal backbone of the credit relationship.

The credit landscape is characterized by lending mechanisms that are both diverse and span the spectrum from peer-to-peer lending, where individuals directly lend to one another, to financial intermediation, which involves institutions like banks between the saver and borrower. An essential element in these transactions is trust—the requirement of the lender's belief in the borrower's ability to pay the loan.

It may be based on the borrower's creditworthiness, collateral, or the ability and ease with which debt can readily be securitized and turned into tradeable security in the market.

While trust may be necessary, it cannot alone ensure the smooth working of credit markets. Bonding, legal provisions, bankruptcy laws, social stigma, and exclusion from credit markets are disciplining mechanisms to prevent opportunistic behavior. Therefore, even if somebody does get ostracized by the group due to his undesirable behavior, such a disciplinary mechanism ensures that the sanction gets transmitted to other markets, thus providing the working of the credit market by imposing penalties on people who renege from their commitments to protect the interest of lenders.

The institutional arrangements are essential in ensuring stability in the financial system. Institutions or mechanisms such as a central bank as a lender of last resort and deposit insurance reduce their chances of crises by enhancing confidence in the capacity of the system to stand on its own. Such institutions become very important during times of crisis in any credit system since faith or trust is viewed as being an intangible arrangement where the possibility of a financial crisis is always felt whenever there is a breach of confidence.

The balance of power between the lender and the borrower also comes into play in credit transactions, which can be asymmetric and complex. Again, what shapes these relationships are factors like the urgency of his needs, alternative sources of credit, and market power on both sides. The type of borrower—and here, one may have a person, a

non-financial company, a bank, or even a governmental entity—again complicates things by defining the terms and conditions of the contract.

Credit transactions are complexly determined by time, risk, trust, and power. In the delicate playing balance of these four factors is how credit markets come into existence, and proper functioning is maintained through institutional support, with disciplining mechanisms to keep markets robust and efficient.

The word "obligation" is a deep term, reaching back to about the 1300s from Old French "obligacion," itself meaning duty or responsibility, and further back to Latin "obligationem," meaning an engaging or pledging. It is from this historical understanding of the word that there will be laid bases for such an intricate world of credit and finance, where obligations hold parties together with promises, laws, or duties.

A debt contract formalizes such an obligation and includes some critical elements describing the agreement between a lender and a borrower: who the parties are, what assets are being transferred, how long the loan is for, and under what conditions payment will be made.

Financial practices have evolved significantly over time, adapting to the cultural, religious, and economic contexts of different societies. For instance, in the Middle Ages, the charging of interest on loans, known as usury, was forbidden by the Christian Church. This prohibition was rooted in the moral and ethical teachings of the time, which viewed usury as exploitative and sinful.

Similarly, Islamic finance operates under principles derived from Sharia law, which also prohibits the charging of interest, or riba. Instead, Islamic finance relies on profit-sharing models, such as mudarabah (profit-sharing) and murabaha (cost-plus financing), where the lender and borrower share the risks and profits of the investment. These models ensure that financial transactions are conducted in a manner that promotes fairness, social justice, and ethical behavior, aligning with the religious beliefs of the participants.

Interest, like a return for the risk being taken by the lender and the opportunity cost forgone, has been throughout history in different forms, from being completely abolished to complex structures that can reach zero or even negative rates. How interest will be paid - in one lump sum at the end or several over the course of the loan - reflects both the terms of the agreement and the financial customs current at the time.

This path to repayment is not always cut and dried. Unexpected events can trigger renegotiation, debt forgiveness, or insolvency, a reminder of the risks and uncertainties that are part and parcel not only of the lending and borrowing process itself but also of life in general. Such outcomes bring into sharp relief the need for a unit of account, clear and unambiguous, and a means of payment that everyone agrees upon, as Keynes pointed out years ago in his Treatise on Money, to discharge obligations if financial stability is to be maintained.

The liquidity of a debt contract significantly impacts how easily it can be marketed and resold. High liquidity and ease of selling or transferring marketable debt contracts, such as government and corporate bonds, distinguish them from non-marketable ones like bank loans or consumer credit. Liquidity is a crucial element in the financial system, as it provides added fluidity through the buying and selling of debt contracts, offering security and flexibility to lenders.

In this context, securitization plays a crucial role by transforming non-marketable assets into marketable securities. This enhances the liquidity of financial instruments and reduces reliance on personal guarantees and direct relationships between lenders and borrowers. As a result, the debt market becomes more efficient and less prone to credit risk, contributing to a more stable and dynamic financial landscape. It can be used to absorb credit risk since an exit route is provided to the lenders if they begin to doubt a borrower's creditworthiness.

At the core, it is this medieval conception of obligation that underlines how dynamic the journey of credit has been—through the complex modern financial instruments and markets. It reflects the altered attitude towards debt, the ingenious mechanisms devised to manage financial risk, and the need to create a stable and efficient system that supports economic growth and development.

1.2 BANKS

In the financial ecosystem, Monetary Financial Institutions (MFIs) act as the backbone that enables a myriad of financial services, which are crucial for the smooth functioning of the aggregate economy and individual economic agents. The MFIs are institutions that collect deposits or their substitutes and channel them into credits and investments. They encompass various institutions playing different roles in financial intermediation and stability.

The European Union has classified the MFIs into three broad categories: the ordinary banks that deal directly with consumers and corporations; central banks, which manage and control the monetary system while acting as a banker to both the government and the commercial banks; and the Money Market Investment Funds, which invest in the short-term financial markets and thus have the duty of ensuring liquidity management within the financial markets.

Of these, ordinary banks are further divided into commercial, shadow, and investment banks; each specializes in certain aspects or dimensions of banking and finance.

Commercial banks are essentially involved in activities related to deposit taking and the extension of credit with a central role in delivering liquidity services necessary for day-to-day economic transactions.

They make loans following rigorous screening and monitoring, trade in securities both on behalf of others and for their-own accounts, manage investment funds, participate in foreign exchange markets, and undertake a wide range of off-balance sheet activities.

These banks operate in diversified markets through two main channels: wholesale banking, offering other financial institutions and large corporations and investment funds with high-value/low-volume services, and retail banking, with high-volume/low-value services provided to households and small-medium-sized enterprises.

In addition, such particular institutions within the banking landscape will include savings banks, cooperative banks, and mortgage banks.

Savings banks primarily accept deposits at low interest rates and offer basic banking services conservatively. These banks are often mutually owned, meaning they do not have shareholders. Instead, they are owned by their depositors, and any profits made are typically reinvested into the bank or distributed among the depositors in the form of dividends or reduced fees. This mutual ownership structure helps ensure that the bank's operations

focus on serving the best interests of its customers rather than maximizing shareholder profit.

Cooperative banks also have a closely related ethos, although they are typically associated with particular trades or professions, for example, agriculture. They may operate on principles of mutual ownership and benefit.

Mortgage banks are usually entities that specialize in financing transactions in real estate and grant long-term mortgage loans to individuals and businesses.

For instance, in the UK, building societies are very similar to mortgage banks, pooling small savings to finance purchases and construction of homes. It also holds within its fold other particular types of banking institutions, including Girobanks, credit unions, Islamic banks, clearing banks, and public banks. Each one of them engages in a particular financial market niche—from interest-free banking done as an acknowledgment of Islamic laws on usury to payment and settlement or the public sector's projects and initiatives.

This is the diversified array of institutions and services that MFIs perform—the critical mobilization of savings, making and managing payments, mitigating various risks, and providing, in general, the financial infrastructure for supporting economic growth and development. Varied operations run from simple deposit-taking and lending to exceptionally complex business concerning investments and trading, underpinning the multifaceted nature of modern banking today that has become indispensable in the global economy.

BALANCE SHEET

A bank's balance sheet encompasses comprehensive information related to fund allocation and sources of funds. On one broad level, it has assets and liabilities, both of which reflect the intrinsic strategic decisions of the bank toward profitability, liquidity, and risk management.

Assets:

The Utilization of Fund. On the side of the assets, their bank resources are diversified into different categories, whereby each performs some function for the general strategy of the bank.

Examples include cash items and liquid reserves held at the central bank, including required and voluntary reserves. Such highly liquid and very safe assets usually yield no interest but are vital for meeting daily transactional needs and regulatory requirements.

Another significant category is securities, including treasury bills, municipal and corporate bonds, shares, and investment fund shares. These range from quite liquid with relatively low risk to highly illiquid with high risk, exposing the bank to market risk, interest rate risk, and default risks; at the same time, however, they also potentially offer a source of interest or dividend income. Loans, whether they are interbank, consumer, commercial, industrial, or real estate loans, are generally less liquid and riskier compared to other financial instruments, primarily due to credit risks; nonetheless, they bear interest and are, therefore, a sizeable source of bank income.

Derivatives, real assets like gold, art, and real estate further diversify the bank's portfolio. The returns on such assets—interest, dividends, and other revenues—are an important part of a bank's revenue stream; however, they have different degrees of liquidity and risk.

Liabilities:

Sources of Funds. The liability side of the balance sheet outlines the diverse sources of funds utilized by the bank, distinguished by their time dimension and maturity. Short-term liabilities may include funds provided by the central bank's ordinary refinancing operations, while medium-term liabilities may comprise certificates of deposit. An example of long-term liabilities would be bank bonds. The bank also manages non-predetermined liabilities, which are redeemable either on demand or at notice, and non-redeemable liabilities, like shares, which, even though not redeemable, are nevertheless negotiable.

These liabilities are costly for the banks in terms of interest or dividends, which are on the cost side of the income statement and are added to all other costs, including labor costs.

Usually, however, the interest paid on short-term liabilities will be less than on longer-term obligations, again showing the relationship between the interest rate and the liquidity premium.

The manager should aim to strike a balance between assets and liabilities in such a way that he maximizes his profitability with minimal possible risk while ensuring adequate liquidity. Conversely, liquid assets generally yield a low risk, having very minimal impacts on prudential capital needs; nevertheless, they are somewhat less profitable. Liquid liabilities, on the other hand, bring in volatility and an increased threat of liquidity shortages, even though they are vital in ensuring liquidity to any bank or financial enterprise.

In addition to basic banking operations, banks make further revenues associated with issuing letters of credit, bank guarantees, foreign exchange trading, and the provision of overdraft facilities.

The nature of these services—quite often crucial in defining the conduct of international trade—is such that it calls upon credibility founded on the part of the bank to secure some transaction or payment. That brings forth the facilitative role played by the bank in world commerce.

In sum, this balance sheet of a bank essentially reflects the operational strategy, state of risk management practices, and financial health. Careful allocation of assets and prudent liability management were therefore considered essential parts of the banks' role while acting as major financial intermediaries to support economic activity and facilitate financial stability.

INCOME STATEMENT

The bank income statement represents an essential financial statement that itemizes the revenues of a bank against its costs and profits during a specific period. This gives a clear view of the economic health and operational efficiency of the bank regarding how it generates its income and expenditure.

Revenues:

The most apparent source of income for any bank comes from the margin between interest received on loans and that paid on deposits. Such a margin would be considered analogous to the bid-ask spread in security trading and, therefore, constitutes the very foundation of a bank's potential earnings based on its lending operations. Apart from this, banks earn handsome returns on their investments in securities.

All these returns add up to the bank's revenue in totality and supplement the bank's income that it would have earned through its lending operations.

Banks also receive fees from special services they provide and off-balance sheet activities produced. These services include transaction processing and financial advisory services. Fees precipitated from these activities have grown in importance as a bank revenue source. For example, in 2010, off-balance sheet items accounted for 40% of total EU bank income.

Costs:

On the other side of the income statement, there are operational costs that the bank incurs in running its operations. These include salaries due to employees, operation expenses for the daily running of the bank, advertisement costs for marketing services offered by the bank, and maintenance costs for the real estate owned by the bank.

Banks also put aside provisions for losses on loans and investments against any potential risks of default or depreciation of their asset portfolios.

Other costs may include asset depreciation, which gradually decrease in value over time, such as equipment and buildings.

The bank profit formula summarizes several elements that form a bank's revenues and costs. It contains the interest earned on loans (rLL) plus the risk-free rate of return on bank reserves (rFR), plus return on investments in securities, minus interest paid on deposits, minus operational costs, plus fees from off-balance-sheet activities.

This formula shows how multifaceted bank income has become, and effective management is required to be applied along both sides of the balance sheet to ensure profitability.

Interest margins and risk premiums become critical and spot-on in such calculations. Indeed, the expected loan rate is adjusted for the contractual rate probability of default and

recovery rate in case of default, thus showing banks extending a risk-adjusted approach in their lending operations.

Essentially, the bank income statement provides an overview of how banks gain from lending, investments, and fee-based services while at bay keeping an extensive array of operational costs.
It is this delicate act of balancing income against these many expenses that determines overall bank profitability—thereby placing strategy in financial management at the core of banking activities.

1.2.1 RISKS IN FINANCIAL INTERMEDIATION

In banking, risk management is essential not only to the individual institutions but also to the stability of the entire financial system. There are numerous forms of risk facing banks in their day-to-day operations in activities such as lending, investing, and trading. It is based on this understanding of the risks that banking professionals and stakeholders anchor their practice to ensure prudent management of resources toward long-term viability. Among many core types of risk encountered in banking activities, the essay looks into five: credit risk, liquidity risk, interest rate risk, market risk, and solvency risk.

a. Credit Risk:
Probably one of the most widespread risks in banking is credit risk, occurring when a borrower fails successfully to service their debt obligation. This could be based on primal factors such as financial stress, change in the credit standing of the borrower, or deterioration in economic conditions. The effects of credit risk are immense, for they directly influence the quality and profitability of the banks' assets.
Managing credit risk requires much attention to possible creditworthiness assessment before extending credit and periodic monitoring of the performance of the loan. Of all the risks operational in a bank's complex landscape of operations, credit risk is a core concern, mainly due to its potential significant impacts on a bank's financial health. If anything, it would be that kind of risk intrinsically linked with uncertainty regarding lending—whether or not borrowers will pay out their debt.

The challenge in credit risk assessment is further complicated by the difficulty of classifying high-risk and low-risk borrowers. This task can be easily muddled due to asymmetric information between the borrowers and the lenders. Credit risk management thus requires that its constituent elements be delineated similarly: expected loss and unexpected loss, with a specific quantifying formula each, and the establishment of comprehensive strategies mitigating this risk.

There are two elements of credit risk: Expected Loss and Unexpected Loss.

Expected Loss is represented by the formula: EL = PD * LGD * EAD under the Basel II framework.

This encapsulates within it the probability of default, a statistical measure of the likelihood that a debtor will default over a year or any specified period, usually one, computed from history for each class of risk.

LGD is the share of exposure that a lender can expect to lose if a counterparty defaults, while EAD measures the absolute value at risk at default.

Unexpected Loss, however, represents the variance (and covariance) around the expected loss, capturing the potential for losses in excess of what is expected.

Banks have many ways of controlling credit risk, emphasizing initial assessment before lending and risk management throughout the life of the loan. Before lending, banks do the screening, where all information about the client is gathered in detail to prevent adverse selection. Such information may include statements about income, assets, and existing loans, and hence, it is a way for the bank to deduce the creditworthiness of their clients.

Monitoring follows the extension of credit, and through this process, banks discourage borrowers from actions that will heighten their chance of default.

This they do by including restrictive covenants in the loan agreement, all of which will limit risky behaviors by the borrower.

Further, there can be demands for collateral or compensating balances, which implies that the borrower must maintain a minimum deposit or balance with the bank that will be partly commensurating with the rationale of securing the loan, and in case of any loss, it will interoperate building and maintaining long-term customer relationships will substitute rigorous screening thereby motivating customers to enjoy good credit status for better loan terms later.

Moreover, credit portfolio diversification acts as a general safeguard against risks if different risks are not correlated to one another.
This would be complemented further by a preference for shortening maturity and favoring commercial loans over industrial loans to manage risk exposure.
Concentrating on prime clients could also further mitigate risk exposure, even after considering the higher interest rates that the sub-prime clients may offer.
Loan Commitments, as an off-balance sheet activity, ensures a lesser hit to the prudential capital requirements compared with loans booked on their balance sheet. The Large Exposures are kept at a minimum and disclosed, thereby combating concentration risk. Finally, another risk mitigation strategy is Credit Rationing, either by exogenously limiting the quantity of credit available or through endogenous pricing policies that reflect default risk.
In summary, credit risk management needs an integrated and business-like strategy that embodies cook-like careful assessment of the borrowers, their continuous monitoring, and strategic portfolio management.
It is through the proper use of formulas on the quantification of risks, coupled with the execution of a coterie of strategies for mitigating them, that banks will be better placed to avoid modern losses and ultimately be part of the upkeep aimed at bringing back stability and reliability to the financial system.

b. Liquidity Risk:
Liquidity risk is the potential inability of a bank to meet both its onshore and offshore commitments promptly without incurring substantial costs and penalties associated with emergency borrowing.
Intrinsic to banking, this risk is already implicitly involved in the generally mismatched maturity profiles of assets and liabilities—a plethora of illiquid assets, such as long-term loans, with liquid liabilities, like demand deposits, may easily lead to situations wherein it would be tough for the bank to service its withdrawal requests. Effective liquidity management in banks refers to maintaining genuinely sufficient reserves and funding market accessibility to meet short-term obligations.

Out of their business model, one such challenge is managing their liquidity risk. Generally, any bank's business model involves some sort of maturity transformation. That essentially means that banks take short-term deposits from customers and later use them to make long-term loans and investments. This action or, rather equivalently, this practice empowers these banks to execute their specific assignment to society--to provide long-term financing that will set off an economic growth rebound.

However, it also introduces liquidity risk, which occurs when a bank's outgoing cash flows are more significant than the incoming ones, thus being potentially disruptive to operations and depositors and, in harsh cases, causes insolvency.

These different methods are in place within banks to protect against liquidity shortages.

One essential investment tool would be maintaining liquid reserves at the central bank. While this view is essential for immediately available liquidity, it will entail forgone interest as these reserves usually yield lower returns than other investments. However, the security and accessibility yielded by these reserves make them an essential prima facie element of a bank's general liquidity management framework.

Other ways in which banks manage their liquidity risks include investing in the most liquid and secure securities, like government bonds. This way, they can maintain a balance between liquidity and yield and enjoy comparatively easy access to funds with portions of current accounts without having to bear heavy losses on their principal.

However, lessons learned from the recent Euro area sovereign debt crisis revealed that even these seemingly riskless assets were made or could be rendered illiquid under those particular circumstances of the market—a fact that further complicated the intricacies of liquidity risk.

Banks are also biased towards short-term lending, which turns over rapidly to enable a more regular flow of repayments and increase the functioning liquidity position of the institution. This approach contributes positively towards liquidity but, as this book repeats continually, must be kept in the official balance against the other prime possibilities of a bank's long-term financing function for the optimal development of an economy.

It is in this regard that banks charge liquidity premiums on loans to manage the risk of their liquidity. Banks can protect their interests by requiring higher interest rates to compensate for the risk of running short of liquidity.

This could suffer from adverse selection and moral hazard since it could amount to significant lending to those willing to pay higher rates, increasing the bank's risk exposure. Add to these internal measures those by a central bank, which is most relevant in stature as a lender of last resort. Central banks make liquidity available to the banking system if and when required through ordinary refinancing operations, marginal lending facilities, and other mechanisms that ensure stability within the financial system.

c. Interest Rate Risk:

Interest rate risk is the risk begun by changes in interest rates on a bank's overall financial condition. Interest rates alter interest margins on outstanding loans and capital values of marketable assets the bank holds. For example, if interest rates rise, then fixed-income securities in the bank's portfolio would decline. Interest risk is managed within a bank by adopting strategies aimed at balancing fixed and variable rate instruments with hedging techniques to protect against adverse movements in interest rates.

In greater detail, changes in the interest rate environment represent interest-rate risk since it will directly impact a change in the market value of securities for a bank and the interest margin between loans and deposits.

Interest rate changes bring about a mismatch between the interest income accruable from loans and the interest payable on deposits. Such a change not only affects the revenues and costs banks realize but also impacts the value of the banks' financial assets.

For interest rate increases, the present value of any future cash flows from the capitalization of fixed-income securities decreases, which accordingly drops in value. While changes in interest rates form one of the bases for reinvestment risk, returns on the reinvested amount could be less than expected because the interest rate environment has changed.

Banks manages these through matching or asset-liability matching, hedging with interest rate derivatives, and diversification in asset and liability maturity profiles.

d. Market Risk: Market risk may be the loss in trading portfolio value resulting from adverse movements in financial market prices. Bank risks that fall into this category include equity risk, commodity risk, and foreign exchange risk, relating to potential loss within distinct market segments.

Banks involved in trading thus have proper risk management systems that will aid in monitoring the volatility of the markets and provide a way of damping their effect on their portfolio.

Market risk is loss incurred in the adverse movement of securities, currency, and commodities.

This broad risk category is further divisible into sub-components, such as currency and country risks. Market movements can easily alter the middleware value of the trading portfolio of banks dramatically, thus affecting their financial stability.

Hedging through derivatives, diversification of portfolios to take away concentration in one particular class of assets, and investing in short-term securities that are less volatile to markets reduce market risks.

Moreover, there exists settlement risk, which comes as a result of one of the parties failing to perform in respect of contract terms at the time of settlement, leading to loss.

e. Solvency Risk:

Solvency risk means that a bank has the necessary capital to meet its liabilities. The said risk thus emanates from some adverse alterations in the values of the bank's assets or significant losses that would reduce its capital base. Solvency is essential in maintaining depositor confidence and for the continued operation of banks.

Regulatory frameworks, like Basel III, thereby create capital requirements and supervisory practices intended to ensure security against solvency risk and promote stability in the banking sector. Solvency risk, an essential bank' concern, is simply the possibility that the value of banks' assets may drop below their liabilities, resulting in a company's a negative net worth.

This risk often cumulates from a number of other risks, such as liquidity risk, market risk, and credit risk, which can bring about bankruptcy if not appropriately controlled.

The history of bankruptcy, as far back as the 1560s, when the term referred to the Italian "banca rotta," or "a broken bench," indicates that the consequences for solvency are very serious. The banks fight solvency risk through careful asset management, proper and adequate capital levels, and respect for capital regulatory requirements.

Prudential regulation and supervision are among the significant ways to impede solvency at both micro and macro levels. The former ensures the safety and soundness of individual institutions, while the latter tries to contain systemic risk and prevent financial contagion.

1.2.2 THE ROLE OF BANKS IN FINANCIAL INTERMEDIATION

In the intricate web of the financial system, banks play a crucial role as intermediaries, expertly navigating the divide between those with surplus funds and those in need of capital.

This intermediary function is not just about channeling funds from savers to borrowers; it encapsulates a range of activities and services that significantly enhance the efficiency, accessibility, and stability of finance. Understanding the essence of financial intermediation and its pivotal benefits sheds light on why banks are indispensable to both economic growth and individual prosperity.

At its core, the process of financial intermediation involves banks taking deposits from individuals and institutions with excess funds and lending these funds to those in need of capital for various purposes, be it for purchasing a home, expanding a business, or funding government projects.

This mechanism of pooling and allocating resources is fundamental to economic development, enabling investments that individual savers could not finance alone due to their limited resources.

One of the key advantages of banking intermediation lies in the economies of scale banks achieve in monitoring and evaluating investment projects. By engaging in "delegated monitoring," banks take on the responsibility of assessing the creditworthiness of borrowers and overseeing the progress of funded projects. This specialization allows banks to monitor investments more efficiently and at a lower cost than individual lenders could manage on their own. The benefit of this expertise and oversight is twofold: it reduces the risk of investment failure and ensures a more effective allocation of financial resources across the economy.

The funding capacity limitations of individual savers are addressed through the intermediary role of banks. Many investment projects, particularly those of a large scale, require substantial amounts of capital that far exceed the capabilities of single investors.

Banks ease this challenge by aggregating small and large deposits from numerous savers, creating a pool of funds large enough to finance significant investments. This aggregation process is crucial for enabling economic ventures that drive innovation, create jobs, and stimulate growth.

Additionally, the costs associated with monitoring and managing investments are substantially reduced when conducted through banks.

By centralizing these activities, banks minimize the expenses related to due diligence, contract enforcement, and ongoing supervision of borrowers. This efficiency not only benefits the ultimate lenders and borrowers by lowering the overall cost of capital but also contributes to the financial system's resilience by ensuring that investments are subject to rigorous evaluation and oversight.

Those who emphasize the assets, rather than the liabilities of banking intermediaries, recognize a critical importance in the functions of evaluation and selection of entrepreneurial projects to be financed, and in the monitoring functions of the investment results carried out by banks.

It is indeed natural to assume that those who need funds for financing a given project normally have a greater volume of information, and of superior quality, compared to the potential financier.

The activity of evaluating documents presented by the applicant for funds is a specific activity that can be performed by various subjects, but banks are particularly well-suited to carry it forward for a series of reasons.

These range from the simple accumulation of this type of know-how due to purely historical reasons, having been the first intermediaries to perform this function, to the possibility of using a very large informative set (direct or indirect) founded on the credit history of many operators.

Once the investment projects have been evaluated and those to be financed selected, it is also necessary to monitor that the borrower does not use the financing for purposes other than those contracted, for example, to undertake a riskier project than the one for which the funds had been granted or making strategic use of bankruptcy.

In a work that has become a classic, Diamond (1984) demonstrated how it is optimal, in the presence of moral hazard due to costly state verification in the sense of Townsend (1979), that the financing of investment projects occurs through the activity of an intermediary rather than on the direct market.
Furthermore, the optimal financing contract is a standard debt contract, which provides for the payment by the borrower of a fixed sum (principal plus agreed interest) regardless of the actual realization of the investment project, at least as long as the latter allows repayment to the financier. The essential aspects can be captured using the following simplified exposition of Diamond's (1984) model.

MODELLO DI DIAMOND:

Douglas W. Diamond's model on the role of banks in resolving the cost of monitoring is a cornerstone of financial intermediation theory, elucidating why banks are pivotal in the financial system, especially in addressing issues of *moral hazard* in an environment of information asymmetry between borrowers and lenders.
Introduced in his 1984 paper, "Financial Intermediation and Delegated Monitoring," Diamond's model fundamentally posits that banks serve as efficient mechanisms to mitigate the inefficiencies inherent in direct lending by individual investors to borrowers. This is primarily due to the asymmetric information problem, where borrowers inherently have more and better information regarding their investment projects than lenders. The crux of Diamond's contribution lies in presenting banks as "*delegated monitors*," which implies that instead of every lender incurring the costs of monitoring their borrowers, these tasks are centralized within banks. This delegation of monitoring to a single intermediary, like a bank, allows for a more efficient allocation of resources for several reasons.
Firstly, banks can leverage economies of scale in monitoring activities. Since banks specialize in these tasks, they can conduct them more efficiently and at a lower cost per loan than individual lenders. This specialization not only includes the evaluation of borrowers' creditworthiness before issuing loans but also encompasses ongoing monitoring to ensure borrowers use the funds as agreed and are likely to repay. In the model's context, the

bank's role is to mitigate the risk that borrowers might engage in projects with higher risk than agreed upon without the lenders' consent, an action termed "moral hazard."
Secondly, Diamond's analysis underlines the importance of banks in diversifying risk. By holding a diversified portfolio of loans, banks can spread out the risk of default, which is critical given the uncertain outcome of investment projects. This diversification reduces the impact of any single borrower's default on the bank's overall financial health, thereby safeguarding depositors' interests indirectly.
A crucial aspect of Diamond's model is its elucidation of the contractual relationship between banks and borrowers through the lens of "costly state verification" (Townsend, 1979). The model assumes that verifying the actual return from an investment project is costly and that these costs do not need to be incurred unless there is suspicion of default. Consequently, debt becomes the optimal contract type in this setting, characterized by fixed repayments from the borrower to the bank. This structure simplifies monitoring as the bank only needs to investigate the borrower's state if these fixed repayments are not made, essentially reducing the overall cost of monitoring across the financial system.
Diamond's model also implies significant policy and regulatory implications, particularly highlighting the need for bank regulation. While banks mitigate the monitoring costs and contribute to financial system efficiency, they also introduce another layer of asymmetric information—this time between the bank itself and its depositors. To address this, regulatory measures are essential to ensure that banks maintain adequate liquidity and adhere to risk management principles that prevent them from taking excessive risks.
In mathematical terms, though Diamond's model is rich in conceptual insights, it is built on a framework where the benefits of delegated monitoring (B) outweigh the costs (C), implying that $B > C$ for the system to function efficiently. The model can be further detailed through equations representing the cost of monitoring (C) as a function of the number of lenders (n) and the fixed cost of monitoring (F), where $C = F/n$, highlighting how banks, by centralizing monitoring, reduce the per-lender cost of this essential activity.

The concept of information asymmetry, is deeply intertwined with the phenomenon of bank run, underscoring the fragility inherent in the banking sector.
In Diamond's seminal model, the emphasis is placed on the credit intermediation function performed by banking intermediaries.

Stemming from the foundational work of Diamond and Dybvig (1983), a significant strand of research on the theoretical underpinnings of banking intermediation concentrates on the monetary function of banks, particularly the liquidity characteristics of bank deposits.

From their work is possible to derive that in a context of uncertainty, where individuals are unsure about the timing of their future funding needs for consumption, bank deposits offer an insurance mechanism against the risk of illiquidity. This service is not equally provided by other intermediaries whose liabilities do not have a guaranteed nominal value, as their worth depends on market conditions.

Moreover, the credit function of banks, by allowing a portion of deposits to be invested in longer-term, higher-yield assets, enables banks to offer interest on deposits while maintaining profit margins. However, this also exposes banks to the risk of liquidity crises if withdrawal demands exceed the bank's readily liquidable assets.

Then, the potential for widespread bank runs and the severe consequences for financial system stability and possible collapse then justify the need for public intervention in the banking sector. Yet, such intervention need not go beyond simple deposit insurance, potentially even on a private basis, or the central bank's commitment to act as a lender of last resort, providing necessary liquidity to meet unexpected excessive withdrawal demands.

The Diamond and Dybvig model itself invites further exploration to deepen our understanding of these dynamics. The distinction between direct and indirect lending further illustrates the value of banks as financial intermediaries. Direct lending, where investors lend directly to borrowers, often faces challenges such as uncertainty about cash flow, higher costs, and a lack of insurance against default. Indirect lending, facilitated by banks, addresses these issues by providing a buffer against uncertainties and spreading the risk of default across a broader portfolio of investments.

Banks as financial intermediaries perform a critical function in the economy, transforming individual savings into productive investments while managing the risks and costs associated with lending. Their ability to monitor, evaluate, and finance projects on a scale unattainable by individual lenders underscores their importance in fostering economic development and financial stability. Through their intermediary services, banks not only

facilitate capital flow but also contribute to the broader goal of sustainable economic progress.

1.3 THE RISE OF BANK RUNS

The term banking panic is used quite ambiguously and, in many manners, synonymously, with events like bank failure, recession, or financial market turmoil like stock market crashes.

Historically, bank debt has been composed mainly of liabilities that circulate as a medium of exchange, such as bank notes and demand deposits. The contract defining this debt allowed the debt holder the right to redeem the debt (into hard currency) on demand at par. We define a banking panic as follows: A banking panic occurs when the bank debt holders at all or many banks in the banking system suddenly demand that the banks convert their debt claims into cash, on par, to such an extent that the banks suspend convertibility of debt into money, or, in the case of the United States, collaborate to avoid suspension by issuing clearinghouse loan certificates. Several elements of this definition bear discussion.

First, the definition requires that a significant number of banks be involved. If bank debt holders of a single bank demand redemption, this is not a banking panic, though such events are often called "bank runs." The term banking panic is so frequently used synonymously with "bank run" that there is no point in distinguishing between the two terms.

What is usually termed a "bank run" or a "bank panic" is an event involving a large number of banks and is, therefore, to be distinguished from a "run" involving only a single bank. Usually, all banks in a single geographical location are "run" simultaneously, and "runs" subsequently occur in other places. The definition requires that depositors suddenly wish to redeem bank debt for cash. Thus, protracted withdrawals are ruled out, though sometimes the measured currency-deposit ratio rises for some period before the date taken to be the panic date.

Panics did not occur at different locations simultaneously; nevertheless, at each location, the panic occurred suddenly.

A panic requires that the volume of desired debt redemptions into cash be large enough that the banks either suspend convertibility or collaborate to avoid suspension. There are, presumably, various events in which depositors might wish to make large withdrawals.

Maybe a single bank, or group of banks at a single location, could honor large withdrawals, even more significant than those demanded during a panic if, at the same time, other

banks were not faced with such demands. If the banking system cannot honor demands for redemption at the agreed-upon exchange rate of one dollar of debt for one dollar of cash, then suspension occurs. Suspension signals that the banking system can no longer honor the redemption option. Note that a banking panic cannot be defined concerning the currency-deposit ratio.

Since banks suspend the convertibility of deposits into currency, the measured currency-deposit ratio will not show a sharp increase at, or after, the panic date. The measured number may be below the desired currency-deposit ratio, but that is not observable. Also, the arrangements and suspension of clearinghouses allowed banks to continue loans that might otherwise have been called.

In fact, in some episodes, lending increased.

Thus, there is no immediate or obvious way to identify a banking panic using interest rate movements related to credit reductions.

The critical question, however, is: What causes banking panics? That has been a tough question to answer.

1.3.1 HISTORICAL OVERVIEW

Even if agreement could be reached on a definition of a banking panic, it is still not clear, practically speaking, which historical events constitute panics.

Many historical events do not entirely fit the definition. Thus, there is some delicacy in determining which historical events in American history should be labelled panics.

Consider, first, the pre–Civil War period of American history. We find that bank debt liabilities are mostly comprised of circulating bank notes during this period.

We classify six events as panics during this period: the suspensions of 1814, 1819, 1837, 1839, 1857, and 1861.

Data limitations prevent a detailed empirical analysis of the earliest panics. Also, some of these seem to have been conditioned by "special" historical circumstances, and this argues against their relevance to the general question of the sources of banking instability.

Both the Panics of 1814 and 1861 followed precipitous exogenous declines in the value

of government securities during wartime, related to adverse news regarding the probability of government repayment.

Mitchell (1903) shows that the bad financial news in December 1861 occurred when the banks in the principal financial centers were holding large quantities of government bonds; also see Dewey (1903).

During the National Banking Era, there were four general suspensions of convertibility 1873, 1893, 1907, and 1914 and six episodes where clearinghouse loan certificates were issued 1873, 1884, 1890, 1893, 1907, and 1914. In October 1896, the New York Clearing House Association authorized issuing loan certificates, but none were issued.

Thus, one could rank panics in order of the severity of the coordination problem faced by banks into three sets: suspensions (1873, 1893, 1907, 1914); coordination to forestall suspensions (1884, 1890); and a perceived need for coordination (1896). We leave it an open question whether to view 1896 as a panic since our results do not depend on its inclusion or exclusion.

The panics during the Great Depression appear to be different than earlier panics. Unlike the panics of the National Banking Era, these events did not occur near the peak of the business cycle.

They did result in widespread failures and significant losses to depositors.

The worst loss per deposit dollar during a panic, expressed from panic beginning to business cycle trough, was 2.1 cents per dollar of deposits in the National Banking Era. The worst case concerning the numbers of banks failing during a panic was 1.28 percent in the Panic of 1893.

Of course, the panics during the Great Depression were far worse regarding the rate of loss or failure.

During the Depression, a range of estimates for failures comes to 26 percent to 16 percent of the national banks, depending on how it is sliced, with losses on deposits of nearly 5 percent.

See Gorton (1988). Many authors have argued that the panics during the 1930s were special events explicable mainly by the pernicious role of the Federal Reserve, or at least by the absence of superior preexisting institutional arrangements or standard policy responses that would have limited the persistence or severity of the banking collapse.

From the standpoint of this literature, the Great Depression tells one less about the intrinsic instability of the banking system than about the extent to which foolish government policies can destroy banks. Most panics during the National Banking Era, just like the Panic of 1857, have their evidence found very near or at business cycle peaks. The last issue is that panics and the aftermath did not generally end with enormous bank failures or losses on deposits.

Separate explanations of panics must also be such that they are compatible with, if not incorporate, the rich evidence suggesting that differences in branch-banking laws and interbank arrangements were critical in determining the likelihood and severity of panics.

The point has often been driven home in international comparisons. Within the United States, the counterpart observation is that branch banking states' systems exhibited low failure rates and losses or where there were private or state-sponsored cooperative arrangements, like clearing houses or state insurance funds. Insofar as there now appears to be widespread agreement on the validity of these conclusions, theories of banking panics must be consistent with this evidence.

These were institutional arrangements of three types that mattered.

First, there were more or less informal cooperative, sometimes spontaneous, arrangements among banks for dealing with panics. Preeminently these were particularly prevalent in states that allowed branch banking.

Some states sponsored formal insurance arrangements among banks. And finally, starting in the 1850s in New York City, there were formal agreements originated privately by clearing houses.

It is possible to review evidence concerning the importance of these institutional arrangements in explaining cross-country and intra-U.S. differences in the propensity of panics and their severity. During the nine-tenth century, starting in New York City in 1853, clearing houses evolved into highly formal institutions. Not only did these institutions transparent interbank liabilities, but in response to banking panics, they acted as lenders of last resort, issuing private money and providing deposit insurance. Accompanying the process for performing these functions was regulating the member banks through auditing member risk-taking activities, setting capital requirements, and penalizing members for violating clearinghouse rules. It was during banking panics that clearing houses created a ready market for the illiquid assets held by member banks. In this regard, the clearing

house accepted such assets as collateral in turning out clearinghouse loan certificates, which were liabilities of the association of banks. Member banks then exchanged loan certificates for depositors' demand deposits.

Clearing-house loan certificates were printed in small denominations and functioned as a hand-to-hand currency. Since these securities were the liability of the association of banks and not of any individual bank, the depositors were insured against the failure of their particular bank.

At first, clearinghouse loan certificates sold at a discount against gold. This discount presumably reflected the chance that the clearing house would not be able to honor the certificates at par.

When this discount dropped to zero, the suspension was lifted. Because of branching restrictions, bank clearing houses and their cooperative benefits were limited to city-wide arrangements in the United States. The sharing of risk inherent in these cooperative arrangements necessitated effective monitoring and enforcement of self-imposed regulations. Effective monitoring and enforcement were only possible if banks were geographically coincident. Moreover, the larger a self-policing coalition of banks is, the weaker the incentives to monitor effectively will be since monitoring costs are individually borne and all members reap benefits. The varied institutional arrangements described above generated different tendencies to experience panics and generated different capacities to respond at those limited times when panics did occur.

Abroad, not all countries experienced panics, even when their banking contracts appear similar to those in the United States. For that of the United States, as reviewed above, there is direct proof that these institutional arrangements resulted in different loss and failure experiences.

The Free Banking Era, 1837-1863, in the United States was characterized by the absence of a central regulatory authority, with banks being chartered and regulated by individual states. Banks issued their own currency, known as bank notes, which were traded in markets and varied in value based on the perceived solvency of the issuing banks. This period saw significant financial instability and frequent bank failures due to inconsistent regulation and speculative practices. The era highlighted the importance of effective banking regulation and led to the establishment of the National Banking System in 1863, creating a more uniform and stable financial framework.

For example, as Gorton, (1989;1990) has previously shown, note prices differed according to the existence or nonexistence of arrangements like insurance, clearing houses and so on. The evidence on the importance of market and institutional structure strongly suggests the importance of asymmetric information in banking. If complete information for all agents characterized these markets, then institutional differences would not matter. If this is the case, this evidence can be interpreted to imply a set of stylized facts with which any theory of banking panics must be consistent.
A theory should explain why an institutional structure of this kind matters and how it has originated from the structures of the responses to panic.

1.3.2 THEORETICAL LITERATURE

Theoretical models of banking panics are inextricably linked with explanations for the existence of banks and, mainly, of bank debt contracts that finance "illiquid" assets while containing American put options, giving debt holders the right to redeem debt on demand at par. The difficulty has been in explaining the optimality of this debt contract and the put option while at the same time presenting the possibility of the suboptimal event of a banking panic. Partly, the reason it is difficult is that posing the problem this way identifies banks and banking panics too closely.
In the last decade, sweeping simultaneous explanations of banks and banking panics foundered on the inconvenient historical fact that not all countries have experienced banking panics, even though their banking systems offered the same debt contract.
The empirical research in this period has sharpened this insight with a focus on how structure in the banking market and institutional differences affect the likelihood of panic. That is, the observed variation in historical experience, which can be attributed to differences in the structure of banking systems, constitutes compelling evidence that neither the nature of debt contracts nor the presence of exogenous shocks which reduce the value of bank asset portfolios provides "sufficient conditions" for banking panics.

Empirical research has shown that institutional structures, like branch bank laws as developed by Calomiris and Gorton(1991) or Kroszner and Raghuram (1997), bank cooperation arrangements described by Allen and Douglas (2000), and formal clearing houses in managing systemic risk studied by Mitchener and Richardson (2019), are essential for the probability of panic and crisis resolution. It's possible to state that banking panics are thus not inherent in banking contracts—institutional structure matters.

That observation has now been built into new generations of theoretical models. But while theoretical models have sharpened our understanding of how banking panics might have occurred, few of these models have emphasized testable implications. Moreover, empirical work that seeks to isolate precisely which factors caused panics historically has been hampered both by the lack of the requisite historical data and by the fact that there were only a relatively small number of panics. Given, however, the complexity of these issues, a consensus view on either the origins of banking panics or the appropriate regulatory response to their threat is unlikely to have emerged in as yet a relatively short history of research into the subject.

In the paper "The Origins of Banking Panics: Models, Facts, and Bank Regulation" by Calomiris and Gorton (1991) is traced the evolution of two competing views about the origins of banking panics. In the first view, labeled the "*random withdrawal*" *theory*, these panics were caused historically by unexpected withdrawals by bank depositors associated primarily with natural location-specific economic shocks (ex., seasonal demands for currency due to agricultural payment procedures favoring cash).

The mechanism that causes the panic in this theory suggests that the availability of reserves, say through central bank open market operations, would eliminate panics.

The second view, which we label the "*asymmetric information" theory,* sees panics as being caused by depositor revisions in the perceived risk of bank debt when they are uninformed about bank asset portfolio values and receive adverse news about the macro economy.

Their view assumes that depositors try to withdraw huge sums from banks when they have a reason to believe that banks are likely to fail. Since they don't know which of them are going to fail, they bear upon all banks. Availability of reserves through central bank action would not, in this view, prevent panic.

The theoretical literature on bank runs has pointed at many different possible causes of depositor runs, all of which may be usefully grouped into two broad classes.

The first class of models, attributes bank runs to coordination problems among depositors. These models argue that runs occur because of the self-fulfilling nature of depositors' expectations about what other depositors will do. If depositors expect others to withdraw, they rush to withdraw theirs to not be the last in line, thus putting themselves in a position that potentially triggers a bank run.

Seminal contributions to this literature were provided by Bryant, who in 1980 introduced the notion of coordination failures among depositors, and by Diamond and Dybvig, who in 1983 constructed the seminal model of how the liquidity-transformation role of banks renders them vulnerable to runs driven by depositor panic. Further work by Postlewaite and Vives (1987), Goldstein and Pauzner (2005), and Rochet and Vives (2005) developed this idea further to study the strategic behavior of depositors and the conditions under which depositors' expectations can lead to stability or a run.

The second class of models, attributes bank runs to asymmetric information among depositors regarding the bank's fundamentals. Models in this category underscore that the beliefs of depositors about a bank's solvency play an essential role in withdrawal decisions. If depositors do develop private information about a bank's financial health—especially negative information—an individual with such information may trigger a run by withdrawing her deposits, which will trigger others to do likewise. Significant contributions to this literature come from Chari and Jagannathan, who introduced a model that generated bank runs as a result of asymmetric information about the bank's quality of assets, and Jacklin and Bhattacharya, who showed how information asymmetries at the root of runs may arise without problems of solvency. Further elaborations by Chen and Calomiris, and Kahn, building on the models of asymmetric information and heterogeneous depositor beliefs, add dynamics to the bank-run setting.

The literature thus provides a rich understanding of the mechanisms in bank runs. It underscores the role of depositor expectations and informational asymmetry as determinants of banking stability by examining these two classes.

As many theoretical models and much empirical evidence suggest, even fundamentally sound banks can experience runs because depositors run in anticipation of a run. One key

question in this regard is how such contagion effects of bank runs spread and which factors mitigate them. Understanding the cost of a bank run, even if it survives, is important from several perspectives—those of the bank itself, its customers, and regulators.

Ó Gráda and White (2003) provide a meticulous microeconomic analysis of two New York banking panics in the work "The Panics of 1854 and 1857: A View from the Emigrant Industrial Savings Bank."

In their paper, the authors provide a distinct contribution against the backdrop of the traditional theoretical models of banking panics because these were natural experiments - the panics were due to quite different shocks. While the panic in 1854 was local and genuinely based upon tidings of the insolvency of a bank, the panic in 1857 was caused by a change affecting the whole community. These two types of panics reflect the two theoretical explanations for panics.

According to models based on the seminal paper by Douglas Diamond and Philip Dybvig, bank runs are ignited by random events that cause depositors to run to avoid being left behind and suffer costly liquidation. In this view, panic is driven by sequential service of depositors and runs spread from one bank to another.

Alternatively, asymmetric information-based models postulate that runs occur when some depositors get adverse information about bank assets and withdraw. Other depositors who cannot differentiate participate, leading to widespread runs.

During the 1854 panic, the run on EISB was composed mainly of less wealthy, less experienced, and less sophisticated "uninformed" depositors. Runs were inflamed by the failure of another savings bank when no insolvency evidence existed about EISB.

Previous research by Kelly and Ó Gráda finds this run followed through networks within the Irish community, thus displaying social contagion as described by Diamond and Dybvig.

Yet the banks were not overwhelmed; by calmly continuing to pay their customers, the panic was subdued.

In contrast, the 1857 panic began with withdrawals of wealthier, experienced, and sophisticated "informed" depositors who recognized the declining value of many bank portfolios. Having noticed that other depositors followed these informed depositors, thereby

making the 1857 crisis an asymmetric informational price-driven event. The banking system became rapidly overwhelmed with a general suspension of payments, avoiding complete collapse.

This analysis places depositor behavior and informational asymmetry at the heart of banking crises.

In contrast to this general depiction of panic among depositors and instant withdrawal, Ó Gráda and White find that systemic banking crises in the United States, in particular those of 1854 and 1857, were not distinguished at all by massive runs on the banks to withdraw deposits. Account closures, even in the 1857 severe crisis, constituted only a modest fraction of total accounts. Many depositors hedged their bets, withdrawing part of their funds while keeping their accounts open.

The researchers also find significant time dimensions to these panics: in particular, the empirical findings show that account withdrawals bounce high in a short period, move during daily jumps, and are distinct; often, their origin is news-based.

This heterogeneous depositor behavior indicates elements of contagion and responses to dramatic news events.

In the 1854 panic, contagion seemed to be operating, though it was not strong enough to drive the crisis to a systemic shutdown. Matters were different in the 1857 panic. It was driven by the most informed business leaders and banking sophisticates, followed by informed depositors, indicating that the run was primarily warranted due to genuine informational shocks and asymmetric information about the banks' financial conditions.

While uninformed contagion might have been present, this record indicates that the actions the depositors took in the panic of 1857 were information-justified; even then, a rational response to perceived risks associated with bank portfolios is reflected. It gives a nuanced dimension of how banking panics unfold and the role of information in affecting depositor behavior.

RANDOM WITHDRAWALS BANK PANIC

In the Diamond and Dybvig (1983) model, bank runs are explained through the lens of coordination problems among depositors, where the fear of being last in line to withdraw funds can lead to a self-fulfilling prophecy.

Even banks with healthy assets can fail if depositors panic and rush to withdraw their money all at once. This model introduces the concept of "sunspots," which are extrinsic random variables unrelated to the bank's fundamental condition that can influence depositor behavior. For example, a bad earnings report, a run at another bank, or even an irrational event like sunspots could cause depositors to anticipate a run, thereby triggering one.

This idea is supported by formal equilibrium analyses of sunspot-induced financial crises by researchers such as Waldo (1985), Freeman (1988), Loewy (1991), Cooper and Ross (1998), Cole and Kehoe (2000), Peck and Shell (2003), Ennis (2003), Aghion et al. (2004), and Gu (2011). These works build on the notion that depositor expectations linked to extraneous variables can destabilize banks.

The traditional view, articulated by authors like Noyes (1909), Gibbons (1968), and Kindleberger (1978), considers panics as manifestations of "mob psychology" or "mass hysteria."

In modern financial theory, this randomness is formalized in the Diamond and Dybvig model, where the panic equilibrium arises due to the first-come-first-served rule for bank withdrawals.

If depositors believe others will withdraw, they too will rush to withdraw, leading to a collapse.

Therefore, the question arises: what shock caused the panic? According to the Diamond and Dybvig model, the specific shock (or lack thereof) might not matter. The model suggests that any commonly observed extrinsic factor, even one unrelated to the bank's fundamentals, can lead to a panic if it alters depositor expectations. This concept of sunspots highlights the fragility of the banking system, where even irrational fears can precipitate a run.

DIAMOND-DYBVING'S MODEL:

Consider an infinite number of agents, each with an initial endowment of one unit of the only consumer good at time 0. Each consumer learns only at time 1 whether they will want to consume this good at date 1 or at date 2 (liquidity shock).

In the first case, their utility will be U(c1), and in the second case, pU(c2), where p is a discount factor and U is an increasing and concave function. Let q be the probability (assumed to be known) of being a consumer who wants to consume at date 1 (impatient), the expected utility of each individual is:

1) $U = qU_{(c1)} + (1-q)\,pU_{(c2)}$

Let's assume there are two "technologies" available to individuals: a simple storage technology such that 1 unit of the consumer good today produces 1 unit tomorrow, and a longer-term "investment" technology, such that 1 unit of input today produces R>1 in two periods.
However, if the investment in this technology is liquidated after just one period, the gross return is L<1.
Let's consider the possible choices of our consumers based on different institutional situations.

a) Autarkic system

In the absence of trade, each consumer must independently decide how much to invest in the long-term technology and how much in simple storage.
Let I be the investment in the long-term technology. Then the consumer's consumption possibilities will be:

If a consumer needs to consume in period 1, then

2a) $c1 = (1-I) + LI$ whereas (=1 if and only if I=0)

if they need to consume in period 2, then

2b) $c2 = (1-I) + RI$ (=R if and only if I=1)

The optimal amount to invest in the long-term technology (I*) is determined by solving the problem of maximizing expected utility, subject to the constraints expressed by equations 2a) and 2b).

By substituting these constraints into equation 1), one obtains:

3) $U = qU[\,(1 - I\,(1 - L] + \,(1 - q)\,pU\,[(1 + I\,(R - 1)]$.

The first-order condition for an interior choice of I (0 < I * = max U) will be:

4) $((1 - q)p(R - 1))/(q(1 - L)) = (U'_{(c1)})/(U'_{(c2)})$

This equation equates the marginal rate of substitution between consuming in period 1 and consuming in period 2 to the ratio of the marginal utilities of consumption in these two periods, adjusted for the probability of wanting to consume in period 1 (q), the discount factor (p), and the returns of the two technologies (R and L).

b)Financial Markets

Let's now consider a scenario where trade is permitted.
We'll explore whether and how it's possible to enhance individual welfare.
Specifically, let's assume the existence of a financial market at date 1 where securities are traded at a price p. These securities guarantee one unit of the consumer good at date 2.
Naturally, the price p of these securities must not exceed 1, otherwise, every consumer would prefer to use the storage technology. In this context, by investing I at date 0, the consumption possibilities are, respectively:

5) $c1 = (1 - I) + p\,RI = 1 + \,I\,(pR - 1)$

(because the consumer who has invested I can sell the expected returns for date 2 (RI) at a price p at date 1 if they discover they need to consume on this date), and

6) $c2 = (1 - I)/p \, + RI = [1 + I\,(pR - 1)] \,/\, p$

It should be noted that if p >1/R, c1 and c2 are increasing in I, thus I* → ∞ (which implies an excess supply of securities), while if p <1/R, I* =0 (resulting in an excess demand for securities). The only possible market equilibrium, compatible with a strictly positive I*, is p =1/R.
In this case: c1=1, c2=R, with an obvious improvement in welfare compared to the autarkic case.

However, it is not given that this allocation is the best possible.
Let's characterize a Pareto optimal allocation in this economy as an allocation that solves the problem of maximizing the expected utility under the following resource availability constraints:

i) $qc1 = 1 - I$
ii) $(1 - q)\, c2 = RI$

(which can be easily combined to produce the single constraintqc qc1+(1−q)c2/R =1)

By substituting the expressions for c1 and c2 derived from constraints i) and ii) into the objective function, we get:

7) $qU((1 - I)/q) + (1 - q)\, pU(RI\ /1 - q)$

From this, by maximizing over I, the first-order condition for an optimum is obtained:
$U'_{(c1*)} = pRU'_{(c2*)}$

The equilibrium allocation in the presence of financial markets is Pareto efficient only in the specific case where:
$U'(1) = pRU'(R)$

otherwise, it is inefficient.

Specifically, assuming that the function xU′(x) is decreasing in x, it follows that:

$$pRU'(R) < pU'(1) < U'(1)$$

which implies that it is possible to improve the market allocation in a Pareto sense by increasing consumption at date 1 and reducing it at date 2 (i.e., providing more insurance against liquidity shocks to consumers).

The efficient equilibrium is then:
$c1* \geq 1$; $c2* \leq R$.

c) Intermediation

It can be shown how a Pareto optimal allocation can be replicated through an institution, an intermediary, that accepts deposits at date 0 and invests qc1* in short-term technology and (1−qc1*) in long-term technology, promising to reimburse depositors when they need to consume. The deposit contract specifies that against a unit deposit at date 0, consumers can withdraw c1 at date 1 or c2* at date 2.

Given the first-order condition $U'_{(c1*)} = pRU_{(c2*)}$), it's clear that c2*≥c1* if and only if pR≥1.
In this scenario, consumers prefer to withdraw at date 1 only if they actually need to consume on this date.
In the opposite case where pR<1, obviously, everyone withdraws their deposits at date 1: the optimal solution is thus not replicable with financial intermediation.

Therefore, under the assumption pR≥1, a Pareto efficient solution is achievable through the establishment of financial intermediaries offering deposit contracts that perfectly insure consumers against liquidity shocks.
The problem is that in the Diamond and Dybvig model, this virtuous equilibrium is not the only possible one.
Indeed, it's possible to demonstrate the existence of a second, inefficient equilibrium characterized by a panic situation in which a bank run occurs. If a patient consumer (who wants to consume at date 2) expects that all other patient consumers will withdraw at date

1, they would find it advantageous to also withdraw immediately, rather than waiting until date 2 and potentially getting nothing when the intermediary fails due to insolvency.
Are there solutions capable of preventing this inefficient equilibrium, ensuring that the allocation provided by intermediaries aligns with the Pareto optimum?

d) How to Avoid Bank Runs?

A proposed solution is what's known as narrow banking, a credit system in which the liquid reserves of intermediaries are always sufficient to meet the demand for refunds (akin to a 100% reserve requirement system).
In our scenario, the maximum amount of refunds is given in the case where q=1, meaning all consumers wish to consume at date 1. The liquidity of the banks (1−I) should be at least equal to c1. The resource availability constraints would be:
$c_1 \leq 1-I$; $c_2 \leq RI$
These can be combined into the single constraint $c_1+c_2/R \leq 1$. As can be observed, this constraint is very strict, and the solution to the problem of constrained maximization of expected utility is in this case very unsatisfactory. Specifically, this solution is even outperformed by the autarchic solution, which could be obtained by allowing the bank to liquidate its illiquid investments at date 1.
Better remedies include the suspension of refunds and deposit insurance.
In the first case, if refunds are suspended when qc_{1*} of the deposits have been withdrawn, type 2 consumers are assured they will receive what is due to them and have no incentive to withdraw early.
In the second case, deposit insurance, which can be funded both publicly and privately, secures all consumers and prevents bank runs. In the absence of bank runs, even the insurance costs are not borne.
It should be noted that these two solutions are not equivalent if q is variable. In such a case, deposit insurance still allows for the achievement of a Pareto optimal allocation because the taxes aimed at covering the insurance can be indexed to the realization of q. However, the suspension of refunds is not efficient. For a given refund threshold (let's

say f), q >f, some type 1 agents will be rationed, while for q<f, type 2 agents will receive less than promised because too little was invested in the more productive technology.

Diamond and Dybvig now provide a coherent model of demand-deposit contracts. Their model has two equilibria. One, the "good" equilibrium, is where only impatient investors who face liquidity shocks demand early withdrawal. They get more than the liquidation value of the long-term asset at the expense of patient investors, who earn less than the total long-term return when they wait till maturity. Since this intertemporal wealth transfer implies risk-sharing, it is considered welfare-improving.

The "bad" equilibrium, however, is a bank run in which all investors, including the patient investors, demand early withdrawal. Thus, the bank fails, and welfare is lower than what could be obtained without banks in the autarkic allocation.

The problem with the D&D model is that it does not provide tools for predicting which of these equilibria will occur or how likely each equilibrium is.

Since in one, banks increase welfare and decrease welfare in another equilibrium, open is a central question: whether it is desirable, ex-ante, that banks emerge as liquidity providers.

The model represents a convenient framework with which the economics of banking and related policy issues can be discussed.

It is of interest that the problems of runs and the differing effects of suspension of convertibility and deposit insurance arise in a model that does not introduce currency or risky technology.

This illustrates that many of the critical problems in banking are not necessarily related to these factors, although a general model will require their introduction.

In this paper, we examine an economy with a single bank. The interpretation is that it represents the financial intermediary industry, and withdrawals represent net withdrawals from the system.

If many banks were introduced into the model, there would be a role for liquidity risk sharing between banks, and phenomena such as the Federal Funds market or the impact of "bank-specific risk" on deposit insurance could be analyzed.

The result that deposit insurance dominates contracts, which the bank alone can enforce establishes the potential benefit from government intervention into banking markets.

Compared with ordinary tax and subsidy schemes, the intervention recommendation provides an institutional framework under which banks can efficiently operate, much as enforcement of contracts does more generally. The riskless technology used in the model isolates the rationale for deposit insurance, but it also abstracts from the choice of bank loan portfolio risk.

If the risk of bank portfolios could be selected by a bank manager, unobserved by outsiders (to some extent), then a moral hazard problem would exist.

In this case, there is a tradeoff between optimal risk sharing and proper incentives for portfolio choice, and introducing deposit insurance can alter the portfolio choice.

Of course, the moral hazard problem has been analyzed in complete market settings where deposit insurance is redundant and can provide no social improvement, but of course, in this case, there is no tradeoff.

An exciting extension of the model would be to introduce risky assets and moral hazard. Undoubtedly, it would be desirable to introduce some form of government deposit insurance, but with accompanying bank regulation. Bank regulation would play a similar role to restrictive covenants in bond indentures.

Interesting but challenging to model are questions of regulator "discretion, which then arise. In contrast, the Federal Reserve discount window could provide a service similar to deposit insurance as a lender of last resort. It would buy bank assets with (money creation) tax revenues at T = 1 for prices more significant than their liquidating value.

The same effect would set in if the taxes and transfers were set identical to that of the optimal deposit insurance. It is because the technology is riskless that the identity of deposit insurance and discount window services occurs.

If the technology is risky, the lender of last resort can no longer be as credible as deposit insurance. While bail-outs only occur when many banks fail together, there would be perverse incentives for taking risks if a lender of last resort were constantly obliged to bail out banks facing liquidity problems. For instance, if everyone expects a bailout, it will be in the best interests of all banks to take on interest rate risk through mismatches of asset and liability maturities since they all will be bailed out together.

A bank run may occur if depositor expectations about the bank's creditworthiness change in the absence of an unconditional bailout by the lender of last resort.

Even mere expectations about the overall readiness of the lender of last resort to bail out failing banks can provoke a run, as this unhappy experience of the 1930s shows when the Federal Reserve unwisely exercised its discretion and permitted little discounting. In contrast, deposit insurance is a binding commitment that can be designed to preserve the punishment of the bank's owners, board of directors, and officers in the event of a failure. The possibility of multiple equilibria when a firm's liabilities are more liquid than its assets applies more broadly, not just to banks.

Consider a firm with illiquid technology that issues very short-term bonds as a large part of its capital structure. Suppose one lender expects all other lenders to refuse to roll over their loans to the firm. Then, it may be his best response to refuse to roll over his loans even if the firm would be solvent if all loans were rolled over. Such liquidity crises can be compared to bank runs.

The protection from creditors afforded by the bankruptcy laws performs a function akin to suspension of convertibility. The viable but illiquid firm is ensured survival.

This in turn, means that the "transformation" can be performed directly by firms rather than intermediaries. That our direct interest in intermediaries is justified is further underscored by the fact that banks directly hold a significant fraction of the short-term debt of corporations.

Also, there is often a stipulation or practice that a company that issues short-term commercial paper arrange a bank line of credit sufficient to retire the issue if it cannot "roll it over." For example, a bank with deposit insurance can use its insurance to provide "liquidity insurance" to a firm, and this may prevent a firm with short-term debt from experiencing a liquidity crisis and reduce the need for the firm to use bankruptcy to halt such crises.

Almost all aggregate liquidity risks in the economy are channeled through insured final intermediaries if lines of credit embody binding commitments.

INFORMATION ASYMMETRY BANK PANIC

This new view, which minimizes or even rejects the unique features of banks concerning other financial intermediaries, gave birth to a new line of research during the seventies. It is laid down on deep grounds in the economics of information by this new line of research

that characterizes the modern theories of banking intermediaries. In particular, the credit market is a very fertile area to explore the issues involved with the assumption of imperfect and asymmetrical information flow among buyers and sellers.

Information asymmetry refers to a situation where, out of the two parties participating in the market, not all have equal access to relevant information.

The less informed side will then have no choice but to infer the quality through the pricing mechanism for that transactional object. Under information asymmetry, two phenomena may occur: adverse selection—pre-transaction hidden information—and moral hazard—post-transaction hidden actions.

"Adverse selection" was memorably brought to people's attention by G. Akerlof, in 1970, explained this in his seminal paper on the market for "lemons," a term he used to describe defective used cars. They, the less informed party in such a market, would not be able to ascertain the quality of an offered used car correctly; hence, they could not distinguish between a high-quality vehicle and a "lemon." The result is that the equilibrium price set generally in this market—if any equilibrium exists—is representative merely of the average qualities of cars available for exchange. This would eventually force the sellers of higher quality cars to leave the market, given that the equilibrium price no longer remunerates them enough. In such a case, a downward spiral in market quality can ensue. After all, even if there were buyers willing to pay a premium for high-quality used cars, the market could end up being occupied with "lemons.".

The case epitomizes an example of market failure in which the market mechanism fails to allocate resources efficiently. An additional assumption role here: the adverse selection model assumes that goods or services will be ex-ante heterogeneous.

On the other hand, "moral hazard" refers to the situation in which, during an economic transaction, one party can alter—through unobservable actions—the quality of what would otherwise have been identical goods or services.

One of the excellent examples of moral hazard comes from the insurance market. For example, consider an insurance company that is assumed to be risk-neutral and sells fire insurance to its risk-averse clients. In this case, the probability of having a fire may depend significantly on the insured's behavior.

Had the information been perfect in an ideal world, the insurer would then vary the premium by clients' behavior, thereby rewarding clients who take precautionary measures to reduce the risk of fire outbreaks. Under conditions of asymmetric information, though, an insurer cannot verify that the insured party indeed uses safety measures; in such a scenario, the uniform premium policy may be the only possible choice. This uniformity of premium rates discourages the clients from undertaking costly preventive action.

Insurers should make contracts that include explicit incentives for unlucky risk mitigation and design policies that promote prudent behavior amongst clients. These incentives will ensure that the expected utility gained through engaging in cautious behavior is always higher than the utility gained through negligence.

This requires a shift towards imperfect insurance coverage, such that the expected utility loss from receiving inferior insurance in case of a negligent fire is greater than the cost of installing safety measures.

This examination brings out how asymmetric information further complicates the attainment of an optimal distribution of risk—that wherein the whole risk will be borne by the insurer—to result in a second-best solution where some of the risks are retained by the insured. In particular, at an aggregate level, insight into the dynamics of adverse selection and moral hazard explains why there may well be credit markets that exhibit excess demand at interest rates below their Walrasian equilibrium. At a microeconomic level, the many imperfections in information economics drive home why financial intermediaries should develop spontaneously, and their operational and structural features come very close to those of traditional banks. Besides providing an insight into the economics of information, this deep dive into the micro-foundations certainly enriches our understanding of financial intermediation in general and further highlights the exact mechanisms at work in determining market behaviors and outcomes.

1.4 THE ROLE OF SIGNALS AND RUMORS

Panics are caused by rational revisions in beliefs about bank performance.

The asymmetric information theory postulates that unit banking entails inadequate diversification of asset risk across banks.

Depositors do not know the value of a bank's asset portfolio. A panic may be triggered when depositors observe a public signal correlated with the value of banking system assets.

In Gorton (1988), the signal is an increase in a leading indicator of recession; in Calomiris and Schweikart (1991), the signal is a decline in the net worth of a particular class of bank borrowers. The signal may imply very slight aggregate losses to banks, but depositors cannot directly observe the incidence of the shock across the many banks in the banking system.

Conditional on the signal, deposits appear riskier to depositors because they cannot see how the shock affects individual banks. As this risk associated with asymmetric information rises sufficiently, depositors prefer to withdraw their funds or force the suspension of convertibility, which will resolve the information asymmetry.

Intrinsic within fractional reserve banking is a severe problem of asymmetric information. That is to say, depositors, despite all their concerns regarding the illiquidity or insolvency of any bank, are constantly threatened with ex-ante exclusion should others rush to withdraw money ahead of them. There is the general feeling of uncertainty and suspicion that makes depositors pay close attention to what others do.

Accordingly, information on co-depositor activities/decisions assumes a very significant role in affecting the choices people make regarding their deposits. This issue has been vividly illustrated by the many rumors and speculations about the financial soundness of significant institutions like Bear Stearns and Lehman Brothers.

Financial news media, like CNBC, could easily play a significant role in fanning these rumors, whether true or not. Of course, the identification problem would be: It is not easy to sharply identify and trace the causal role those rumors play about the flows of information that shape depositor behavior. The challenge of identifying these information flows is redoubled in the face of rapidly changing, frequently opaque modern communication channels.

History can provide a unique and precious perspective. Periods of large-scale shifts in information flows, driven by the introduction of new communication technologies, reflect an unusual setting to observe and analyze significant changes in information flows that can provide insights into depositor behavior and the dynamics of information dissemination.

In their 2016 paper "Information Acquisition in Rumor-Based Bank Runs," Zhiguo He and Asaf Manela study how rumors can trigger bank runs and the information acquisition process.

Mainly, they consider how uncertainty regarding the liquidity of a bank leads depositors to search for more information—usually noisy—on the solvency of the bank. This produces differences in individual withdrawal speed, which, under some circumstances, may impact individual or overall bank stability.

Clearly, He and Manela illustrate that in bank runs, private information acquisition is an important dynamic. For example, when hearing a rumor, those receiving less reliable signals will delay making their decisions by gaining more insight. Such delay creates an aggregate endogenous withdrawal pace in which the different pace of individual withdrawals determines an aggregate pace.

The study also underlines the mitigating role of public information.

If banks or regulators provide public solvency information, there is less need for individual depositors to collect private information, and panic-driven withdrawals are, therefore, less likely to occur. Indeed, public information acts as a coordinating device that aligns depositors' behavior, making runs less likely to arise from groundless rumors.

From the policy angle, He and Manela emphasized effective communication strategies to avoid bank runs on the part of banks and regulators. On this, see how the transparent and timely dissemination of information is going to allay depositors' fears about the stability of the banking system.

The authors mainly identify the essentiality of managing rumors and credible public information in depositors continuing to further partake in the confidence hookup.

Precisely, in practical terms, if central bank rumors occur about the solvency of a commercial bank, then all of a sudden, depositors may start receiving signals and act on them. These may well have been noisy and mixed signals to generate different depositor behavior and, quite likely, an out-and-out bank run. In contrast, explicit and credible communication by the bank or the regulator soothes panic and reduces the run risk.

Specifically, Angeletos and Werning (2006) developed a sequential model in which decision-makers under uncertainty acted as agents who, like investors or depositors, took their decisions by various private and public signals.

This is particularly relevant for understanding phenomena such as bank runs, currency attacks, and other financial crises where individual agents' actions depend on their expectations about the actions of others.

Consider the following setting in which many agents must decide, for example, whether or not to "attack" the status quo—withdraw from a bank.

The success of this attack depends on the number of agents who choose to attack and an underlying fundamental state, θ, which represents something about the actual state of the bank or economy's health. This θ is unknown to the agents and determines how big the attack must be such that if enough agents attack, then the status quo fails—e.g., a bank becomes insolvent.

Each agent receives private signals about the fundamental state, θ.

The signals are noisy and imperfectly indicate θ; they are independent draws from some distribution centered around θ. There is also a public signal that reflects the actions of some subset of agents' choices (early movers), possibly coming from reportage in the media or observation of market behavior.

It introduces a sequential structure into decision-making and divides agents into early and late movers. Early movers make decisions based on private signals, producing a public signal observable by late movers.

In contrast, the late mover will decide by taking both private signals together with a public signal deducted from the action of early movers.

The early and the late mover implement a threshold-based strategy, attacking when their private signal is above their threshold, which depends on their beliefs about θ and others' actions. Equilibrium is characterized by individual rationality of each agent's decisions—that is, maximum expected utility given his signals. Next, the equilibrium threshold for attack will be derived from the distribution of private and public signals.

Hence, the model predicts the existence of a critical mass of attacking agents necessary for an attack to succeed, conditional on the fundamental state. If enough agents believe that θ is weak and act on this belief by attacking, the status quo (e.g., the bank’s solvency) will fail.

The authors explained how public signals can coordinate agents about their actions.

Negative public signals increase the probability of successful attacks by causing late movers to attack more, while positive signals would likely strengthen the status quo. This,

therefore, underlines how significantly available or non-available and the nature of the public information affects the outcome, calling attention to media and information transmission

It is an exposition to policymakers—leverage through control of public information—over the likelihood of a crisis. In a setting where there is distress in a bank, restricting negative public information might block a bank run because it would be hard to coordinate the withdrawal of deposits among agents.

The model has been applied very successfully to such a wide variety of both historical and contemporary financial crises, trying to understand how information dissemination and coordination among agents work and how shifts in public information manage to change agents' behavior towards stability or instability.

A particularly instructive case study is the role of radio during the Great Depression, as analyzed by Ziebarth in his 2016 paper, "The Radio and Bank Distress in the Great Depression." In this work, Ziebarth demonstrated how radio brought about a significant transformation in the dissemination of information to the public. This technological shift offers a deeper understanding of depositor behavior and the dynamics of financial stability during that period. By focusing on this specific case, this paper aims to provide further insight into the intricate flow of information, depositor decisions, and the stability of the banking system during this critical moment in history.

In this research, geographic variations in radio availability are exploited to identify the effects of public signals on bank distress and test a central prediction of a theoretical model of bank runs.

Ziebarth using the theoretical model by Angeletos and Werning illustrates early movers, who do not have radios, make decisions based solely on private signals about the bank's financial condition (θ). In contrast, late movers, with access to radio broadcasts, also receive public signals reflecting the early movers' actions. This additional information enables late movers to make more informed decisions. When the public signal is negative, indicating many early withdrawals, it heightens the likelihood of a bank run by coordinating the actions of late movers. Thus, radio amplifies the flow of information, increasing the probability of reaching a critical mass of withdrawals and causing bank distress.

As a result, though this might sound rather obvious, it is one of the meaningful implications of coordination game models. Indeed, the implications of this study are important because it puts forward the role of public information in financial stability and depositor behavior.

The analysis finds that county-level radio penetration rates in 1930 were an excellent predictor of banking distress, as defined by the decline in deposits from 1930 to 1933.

One of the fundamental problems in interpreting these regressions is the omission of variables driving radio penetration rates and later banking performance. To address this concern, the regressions control for the most obvious alternative channel through which radio penetration might be correlated with subsequent banking outcomes: the local economic environment. In particular, the study controls for agricultural conditions and nonagricultural labor-market conditions—for example, wages and unemployment rates. It also has quite a good number of controls for population characteristics, which are combined with all other variables to present a pretty long set of controls compared to those used by Strömberg 2004 in his study on the role played by radio in the dispersion of New Deal expenditure.

It is in accounting for these factors that the analysis hopes to isolate the effect of radio penetration on banking distress.

On such a count, the risk of 'confounding variables' gets reduced, strengthening the argument that the relationship, as observed, between radio penetration and banking distress is indeed causal.

The findings suggest that areas with higher radio penetration were more likely to experience declines in deposits, underlining the role of public information dissemination in depositor behavior and financial stability during the Great Depression.

The analysis indicates that an increase of 10 percentage points in the radio penetration rate leads to a decline of 2.4 to 4.3 percentage points larger in deposits from 1930 to 1933. Not having radio would not have avoided the bank runs during that depression era, but it would have mitigated average declines in deposits by between one-sixth and one-eleventh of the total decreases observed.

Results point to the fact that although not sole, radio broadcasts did play a vital role in banking disturbance levels, in effect amplifying depositor fears and behavior during this period.

The debate has turned on the nature of the banking crisis: result of illiquidity or insolvency. Friedman Schwartz (1971) and Wicker (1996) bring the argument to the side that holds that it was essentially a problem of illiquidity.
In strong contrast, with Calomiris and Mason (1997;20033) the role of illiquidity and contagion in producing banking distress was exaggerated and that the banking sector's problems were essentially rooted in bad fundamentals.
Ziebarth does not make any firm choice between illiquidity versus insolvency about the primary source of the banking crisis.
It is, however, the long-term results that may indicate authorities could have "bought time" to address the problems in these banks, whether due to insolvency or illiquidity issues.
This would mean controlling public information may offer an advantageous window within which necessary corrective measures can be taken concerning banks and thereby reduce the burden of a crisis.

Another evidence on the role of social networks and direct social contact in financial contagion is provided by works exploring the behavior of the Emigrant Industrial Savings Bank in New York City during bank runs in the 1850s, like the study of Kelly and Ó Gráda (2000) or the one published by Ó Gráda and White (2003).
They exploit that Irish immigrants coming into this country arrive from particular regions and have a history of living in the same tenements upon arrival in New York.
For instance, one of the best predictors of whether or not a depositor withdrew his funds during the Panics of 1854 and 1857 was the county from whence he came.
This confirms that the contact between the two alone was enough to provoke demands from the depositors for their money, underscoring the critical role social networks played during financial crises.

1.5 NARRATIVE EVIDENCE OF SOCIAL MEDIA CONTAGION

The potential for radio to influence the actions of those who listened almost immediately began to be recognized and studied once the technology became widespread.

The Radio Project, funded in 1937 by the Rockefeller Foundation and directed by Paul Lazarsfeld, published several works on the effects of mass media.

For instance, in "The Psychology of Radio," Cantril and Allport 1935, furnished the findings of several psychology experiments to demonstrate that reality—a news broadcast—was better at influencing action than when people just read that news as a text.

Done collectively, these experiments showed new and powerful ways by which mass media could shift the masses.

By 1937, it had become evident that the radio was a premier source of information for most Americans. Reports released during this year indicated that 70 percent of the American public relied on the radio for their daily news.

In addition to being more pervasive than the press, radio was also seen as a credible medium; 88 percent of the American public believed that radio news commentators presented truthful reports (Strömberg, 2004).

The great faith placed in the radio medium by such a large segment of society only proves the strong impact it had on public opinion and behavior at the time.

Examples of the power of the radio are numerous, but perhaps the most famous were the fireside chats of President Roosevelt. Several people at the time felt these had massive effects, mainly along the lines of synchronizing people's activities. The fact that others were also listening created an impact beyond what the actual content could achieve.

A more direct example relevant to banking occurred in Philadelphia in 1931.

In this case, community leaders utilized the radio to campaign for calm. For instance, Rabbi Fineshriber went on air and asked people not to withdraw money from banks but to continue keeping their money there. Additionally, George Norris, the Governor of the Philadelphia Federal Reserve, went on the radio asking depositors not to withdraw money from all the local banks.

These instances demonstrate the radio's capacity to mitigate tensions, suggesting it could also exacerbate them.

Another outcome of the Radio Project was Cantril's 1940 book, which argued that the power of the broadcast lay not so much in what it said but how it said it.

These examples epitomize the profound force of radio as a medium: it can enforce collective action at the exact moment that it brings about general panic.

More broadly, the Great Depression was full of incidents that tended to show how rumors—sometimes malicious—could exaggerate bank distress. Probably the most famous non-radio-related incident involves the Daily Worker newspaper, which ran several stories forecasting more bank failures. The Fish Committee, currently investigating communist aid in the United States, noted that no statute existed against spreading such false rumors.

In February 1931, a bill was considered by the House Banking and Currency Committee that defined the act of circulating false rumors distributing one or more member banks of the Federal Reserve System to be illegal. The bill consequently received warm endorsements from the Treasury and the Federal Reserve Board.

Regulatory measures like this have sharply pointed out recognition of the enormous destructive power of misinformation and took related needy regulatory measures for protection in those times of tumult to hold control over financial stability.

Comptroller of the Currency John W. Pole had publicly supported legislation that would punish a bank run by the [spreading of] false and malicious rumors about any particular bank as early as 1930.

In a related action, both houses of Congress passed legislation in July 1932 that reformed the Federal Home Loan Bank Act.

Subsection 21 was revised to add civil penalties and, in some instances, criminal prosecution with imprisonment for any person knowingly making a false statement concerning the health or value of securities issued by the Federal Home Loan Bank.

At the same time, a bill banning rumormongering for all national and Federal Reserve System banks, satisfactory to the Treasury Department itself, passed out of the Banking and Currency Committee but failed to pass in the full House.

These concerns over false information spread easily gained a lot of attention in the popular press and Congressional discussion.

For example, on February 17, 1931, there was a publication of an article entitled "Bill Against False Rumors Supported; Capital Bankers Point Out Laxity in Present Laws Over Country: 1930 Life Policies Gain" in the New York Times. Another article entitled "US to Probe Talk Causing Bank Runs" emerged on April 27, 1933, in the Washington Post. These examples demonstrate the broad disclosure of the problem caused by rumors about the stability of finance and the legislation efforts to solve the problem.

Another example of the sometimes-malign influence of information during this period involves the Reconstruction Finance Corporation (RFC). Created by the Hoover administration, the RFC was intended to lend money to banks, railroads, and other firms.
Like borrowing from the discount window, RFC loans were initially confidential.
Butkiewicz (1995) makes a good case that these loans were highly influential in saving banks early on.
However, in August 1932, Speaker of the House John Nance Garner inserted an amendment into an emergency relief act that stipulated the list above would be made available to the Secretary of the Senate and the Clerk of the House.
Although Congress assured President Hoover that these lists would remain confidential, they were not. The New York Times they published the first list in the same month.
Butkiewicz (1995) demonstrates that this publicity reduced the program's effectiveness by making institutions most likely to benefit from the funds reluctant to apply.
The exposure, therefore, caused a loss of confidence and growing hesitance of potential borrowers, definitely an example of how disclosure of sensitive financial information can have effects on economic stability and effectiveness of policy.
Examples of the probably destabilizing role of mass media continue to appear.
A second New York Times article, from April 28, 2013, titled "Twitter Speaks, Markets Listen, and Fears Rise, captures this well, It chronicled how the Dow Jones Industrial Average lost $136 billion in market value in a matter of moments before the market recovered after someone hacked into a non-governmental organization's Twitter account with a posting that claimed President Obama had been injured in a bombing at the White House.
Even in this so-called information age, when it would seem ubiquitous information is available at our fingertips, new sources and marginally quicker access to that information can be arresting.
The previous examples illustrated that, even as recently as the current era, rapid communication of information, whether correct or not, via new media means has profound potential to have straightforward implications for citizen opinion and market activity.
Holmström (2012) refers to several historical economic cases where a crisis has been accompanied by deliberate concealment of information.

As recently as the Scandinavian banking crisis of 1991 and 1992, establishments transferred so-called toxic assets to better-capitalized banks, which camouflaged the truth about the nature of banks in trouble. Another example is De Beers, which does not allow buyers to inspect diamonds individually but instead offers an opaque bag of diamonds to be accepted or rejected.

Gorton (1985) reports that before the creation of the Fed, clearinghouses would, during crises, "pool" groups of banks to obscure from outsiders the quality of individual banks. Information wants to be free, however, and there is an inherent pressure in the system for transparency.

Information flows are prominently involved in financial decision-making, particularly during crises. While modernity faces bombardment with a deluge of information, the pace of communication across the past provides invaluable discrete jumps in communication technology. Such historical shifts set the lay for a helpful background when studying the relationship between the dissemination of information and financial stability.

Iyer and Puri use data collected immediately following an exogenous failure event in the paper "Understanding Bank Runs: The Importance of Depositor-Bank Relationships and Networks" to show how decreasing the length and depth of bank relationships is very instrumental in reducing the probability of a bank run.

Their estimate—with measures of the relationships by the account age and loan linkages—finds that depositors with stronger relationships have reduced propensities to withdraw during a panic. Furthermore, social factors also strongly influence deposit runs: the more people in a depositor's network that withdraw, the more likely a depositor will too. However, even in these very same networks, longer and deeper previous relationships with the bank act as a steadying influence. Viewed through models like that of Goldstein and Pauzner (2005) or Morris and Shin (2003), such depositors have longer and more substantial relationships, thus receiving stronger signals about the bank's fundamentals, thereby less likely to make a run despite observing others doing so.

In terms of the bank's view, these findings offer an additional strong rationale for developing good relations with depositors: it is not only that cross-selling can increase revenues but indeed that the link can provide insurance of sorts against a crisis. Indeed, these implications extend even further into the banking literature.

It is noted that small banks often supply more credit to small borrowers and offer better terms, as they are believed to be better at processing soft information. Even in the absence of soft information, Iyer and Puri's results suggest that small banks should continue lending to their small borrowers to reduce their vulnerability to runs.

Field evidence thus suggests that this practice of better terms being given by the banks to depositors who are also borrowers could be further grounded in depositor relationship building and reducing run risk, aside from the traditional explanation of informational economies of scope.

Another significant result is the long-run consequence of bank runs, even if a bank is solvent. Their findings suggest that during a run, very few depositors who withdraw come back—permanent destruction of the depositor base and related damaging lending ability of the bank. This loss will be of particular concern for small and information-intensive firms, which bear more sharply during liquidity crunches.

Iyer and Puri also underline the importance of intervention at the right time while a run is in progress. Employing epidemiological methods, they estimate the transmission probabilities and find that the contagion probabilities are highest at the initial stage of a run. This suggests that very early intervention is likely to be most effective at limiting the spread of panic and promoting financial stability. These insights eventually improve understanding of bank runs, therefore closing the recommendation loops for both banks and policymakers in measures to strengthen banking systems against such crises.

CHAPTER 2: THE SILICON VALLEY BANK CASE STUDY

2.1 PRESENTATION OF THE CASE

Social media has gained momentum and transformed the way information is disseminated in recent years. Literature highlights that social media is becoming increasingly important in stock markets (Bales, 2023; Bianchi, 2021, 2023).

According to Baker et al. (2021), Twitter has finally played the role of a "new-era newspaper," reflecting many social media users. With the use of Twitter by investors for information, tweets can significantly move individual trading behaviors. On the other hand, Twitter does act as a conduit to spread moods and fears, which can be dangerous.

There is the case of GameStop, which demonstrates how retail investors can drive stock prices up and cause huge losses for hedge funds through coordination in a social networking site like Reddit. Twitter's global reach may impact financial stability, but the ability of social media to cause bank runs is largely unexplored.

This part discusses the involvement of social media in the stock trading of Silicon Valley Bank Company prior to its default on 10 March 2023.

The bank invested hugely in debt securities during low rates of interest. The resultant surge of rate brought about unrealized losses of a high degree. On March 8, 2023, SVB announced that it has to raise $2.25 billion to offset $1.8 billion of losses on interest. This triggered a panic situation, and by March 9th, $42 billion had been withdrawn. As a result, it resulted in the fall of 61.2% in one day in the stock of SVB.

By Friday, however, the bank got shut down by the Federal Deposit Insurance Corporation, an outcome that made it the fastest collapse in U.S. history.

Literature shows that bank run dynamics depend on social networks of depositors, herding behavior, and rumor-spreading rates. Of course, the pace of communication through social media today is much greater. In that respect, for SVB, its social depositor network impact is larger because the deposits are more concentrated among a group of venture capitalists.

Historically, negative sentiments about bank runs propagate through traditional media; social media flipped this on its head and may well have accelerated the collapse of SVB.

The problems affecting SVB made headlines, with "SVB" tweeted 207,147 times on 9th March.
Patrick McHenry, the Chairman of the House Financial Services Committee, even called it "the first Twitter-fueled bank run."

SVB was founded in 1983 and focused on startups by collecting deposits from companies that had secured venture capital funding. It expanded with the high-tech economy in the 1980s and 1990s, further benefiting from the dot-com bubble. SVB entered private banking in the 2000s and rapidly expanded internationally. By 2015, it served 65% of U.S. startups.
SVB saw a remarkable deposit growth during the loose monetary policy of the pandemic era-deposits swelling from $102 billion to $189 billion in 2021. This had put SVB in a precarious situation concerning interest rate risk, since the firm had invested in long-term fixed-rate mortgage bonds.
With over 90% of its deposits being uninsured, it posed liquidity risks.
In response to inflation caused by the pandemic, the Federal Reserve raised interest rates back in March 2022; the increased rates caused a heavy loss in the bond portfolio at SVB. Its deposits fell for four consecutive quarters before it collapsed, accelerating in early 2023.
SVB started liquidating some of its assets, taking a $1.8 billion loss in the process, while announcing it would raise $2.25 billion in capital.
On March 8, Moody's downgraded SVB, and by March 9, it was clear that SVB couldn't raise the needed capital. Depositors pulled out 25% of total deposits, forcing the bank to close on March 10. It marked the second-biggest bank failure in U.S. history.
Since the FDIC was created in 1934, no depositor of a U.S. bank has ever lost one penny of an insured deposit. Accordingly, bank runs almost never happen. But SVB was special. An astonishing 94% of its deposits were uninsured, which makes it more like the pre-modern safety net bank panics.
This failure of SVB underlined the economics of banking and systemic issues that then surfaced when other banks took a plunge.
On Sunday, March 12, the FDIC seized Signature Bank, an action that has now positioned it as the third-largest bank failure in the United States.

Regulators resorted to using emergency provisions; the FDIC declared full coverage for the uninsured depositors of both SVB and Signature.

The Federal Reserve developed an emergency-lending program. These moves curbed the deposit outflows, but did not prevent First Republic Bank's failure in May, marking the second greatest bank failure in U.S. history.

The individual causes varied, but all three failures shared some key characteristics: high uninsured deposit percentages and very significant unrealized losses.

The combination is at the heart of most financial panics but tends to be enhanced by complexity.

The case of SVB thus presents a clear example that allows insight into the general problem.

The resultant panic will spill over into Europe and create the failure of Credit Suisse this coming April 2023, the largest bank failure in world history, to be discussed in the succeeding chapter.

In the next paragraphs will be presented a deep analysis of the SVB's historical financials from 2019 to 2022 in order to understand the evolution of the bank situation leading to its collapse.

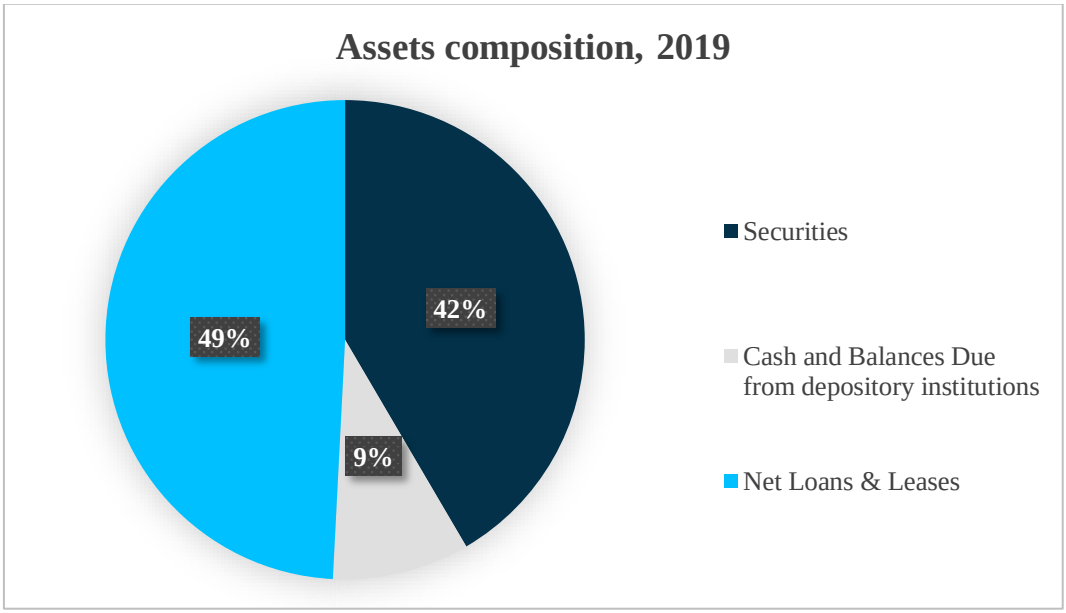
The info about Silicon Valley Bank are collected mainly from the online resources of the Federal Deposit Insurance Corporation, entitled of the financial e regulatory reporting.

2.2 FINANCIAL STATEMENT ANALYSIS

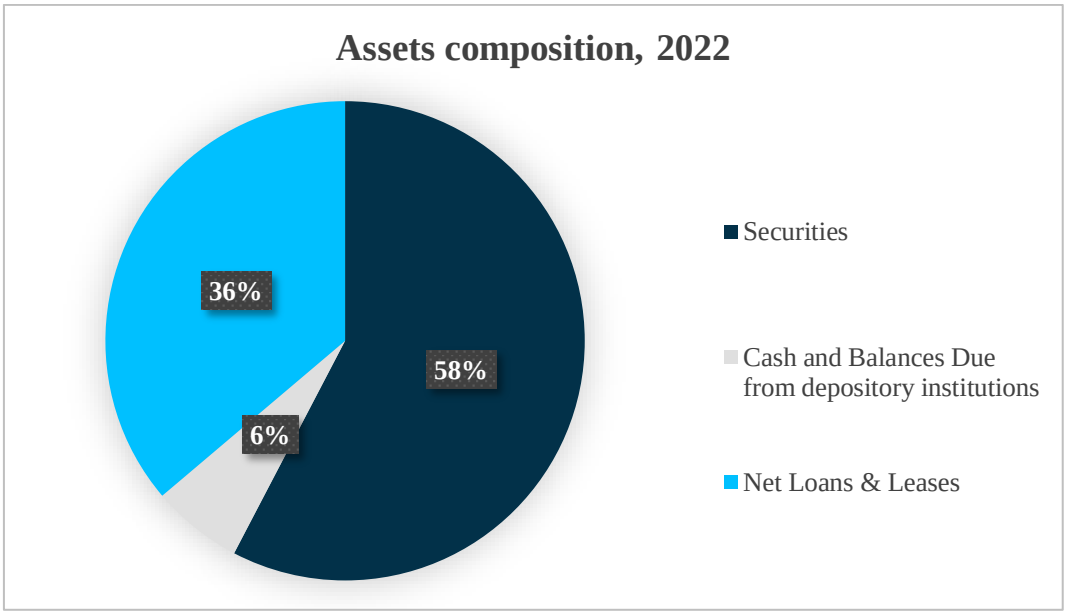
In this part will be analyzed the SVB Bank's finances paying particular attention to important indicators and statements' items.

From $70 billions in 2019, the bank's total assets tripled to $209 billion in 2022, indicating considerable asset growth.

But over time, the proportional weight of asset categories fluctuated, going from a higher emphasis on net loans in 2019 to a much stronger emphasis on securities by 2022. During this time, net loans and leases doubled from $33 billion to $74 billion, while cash and balances due from depository institutions increased from $6 billion to $12.5 billion. The largest growth was in securities, which increased from $28 billion in 2019 to $117 billion in 2022.



Graph 1.1

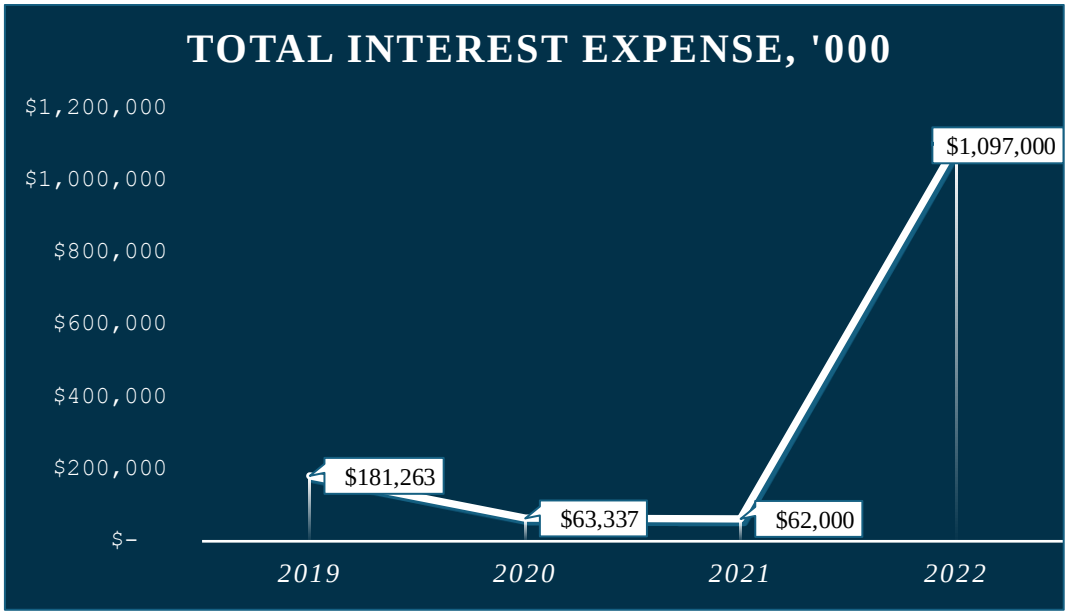


Graph 1.2

Source: https://www.fdic.gov

The bank's total assets tripled from $70 billion in 2019 to $209 billion in 2022(Graph 1.1 and 1.2), indicating considerable asset growth. But over time, the proportional weight of asset categories fluctuated, going from a higher emphasis on net loans in 2019 to a much stronger emphasis on securities by 2022. During this time, net loans and leases doubled from $33 billion to $74 billion, while cash and balances due from depository institutions increased from $6 billion to $12.5 billion. The largest growth was in securities, which increased from $28 billion in 2019 to $117 billion in 2022—an increase of more than four times. This indicates a significant change in investments toward debt securities.

The context of rising interest rates, however, is a key risk element introduced by this shift. Losses could have escalated in tandem with the bank's rising debt securities purchases. The bank may experience unrealized losses on its securities portfolio if interest rates rise because the market value of those securities usually decreases when rates rise. Even while these losses won't materialize as long as the securities are kept, they can nevertheless have a detrimental effect on the bank's bottom line.



Graph 2

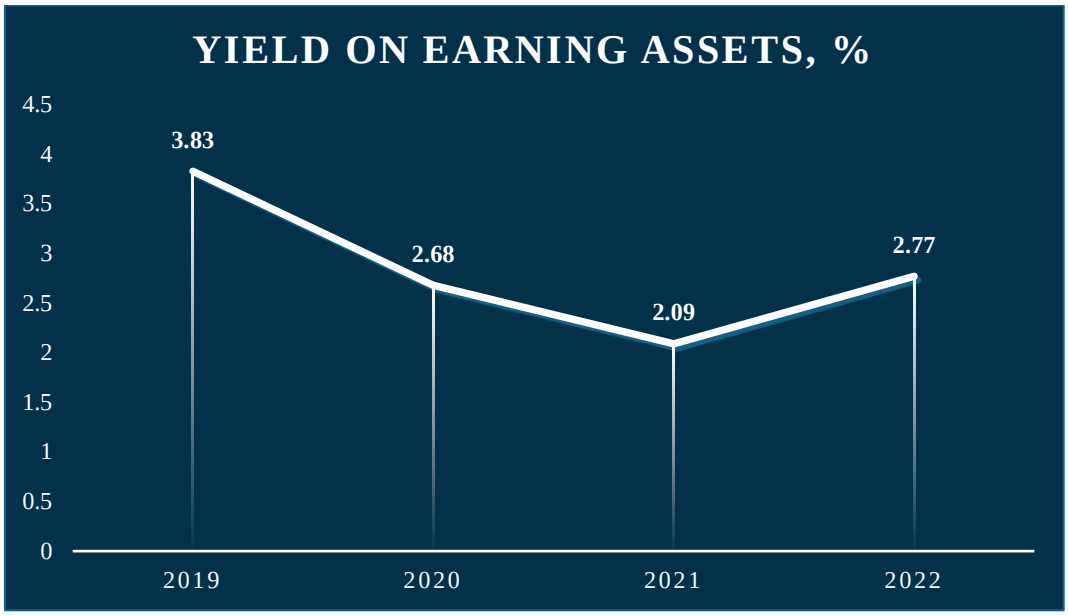
Source: https://www.fdic.gov

From $3 billion in 2019 to $7 billion in 2022, the bank's total revenue grew dramatically as well, with the majority of the income statement's primary components expanding at roughly the same rate. But interest expense (Graph 2) fluctuation is particularly noticeable. Interest costs decreased thrice between 2020 and 2021 but increased over fifteen times between 2021 and 2022, most likely as a result of fluctuations in interest rates during the pandemic. Due to its significant debt securities holdings, the bank may have been exposed to significant financial risks as interest rates rose. These risks will be discussed in more detail in the following section.

2.2.1 PERFORMANCE RATIOS

A notable drop in average performance may be seen when comparing the bank's performance ratio for the years 2019 to 2022.

The first metric is the yield on earning assets, which dropped significantly from 3.83% in 2019 to 2.77% in 2022. (Graph 3)



Graph 3

Source: https://www.fdic.gov

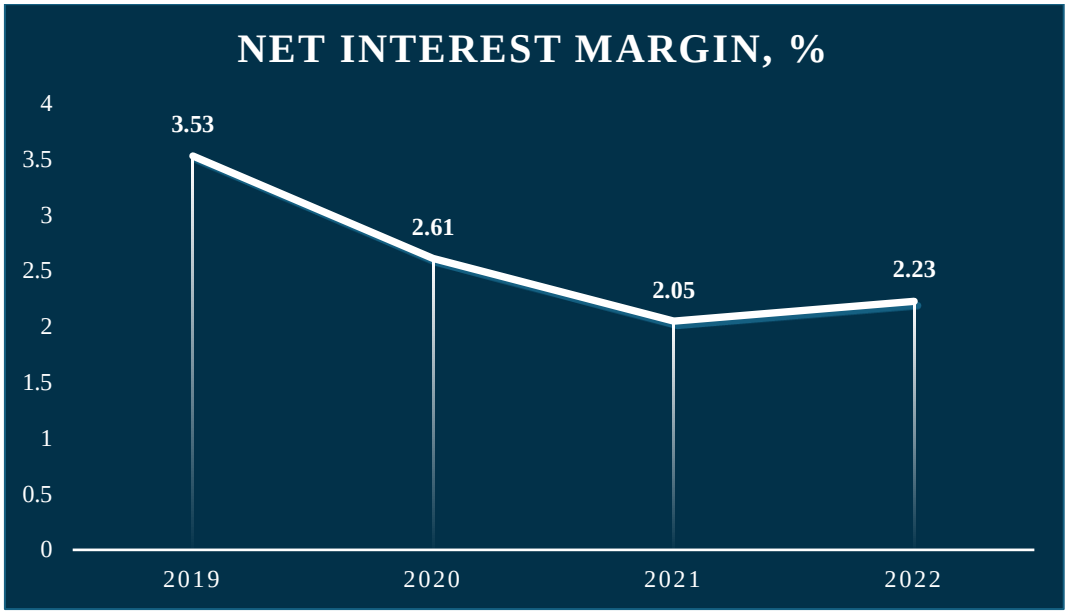
This decline was particularly concerning, as it caused the bank's performance to fall below the average for Californian banks (3.05%) and all banks nationwide (3.50%).

The lower yield suggests that the bank's income generated through its assets did not grow proportionately with industry trends, potentially due to changes in the composition of its asset portfolio or adverse market conditions during the pandemic period.

Another important indicator is the cost of funding earning assets, which increased from 0.30% in 2019 to 0.53% in 2022. This rise indicates that the bank faced higher costs in sourcing the funds required for its earning assets.

Moreover, the bank ranked higher than the average for banks in California (0.41%), suggesting it became more dependent on expensive funding sources or was less favorably positioned compared to its regional peers.

The bank's net interest margin (NIM), a critical determinant of profitability, also experienced a significant decline (Graph 4).
Over annualized assets, NIM decreased from 3.53% in 2019 to 2.23% in 2022, falling below the industry average of 2.95%.



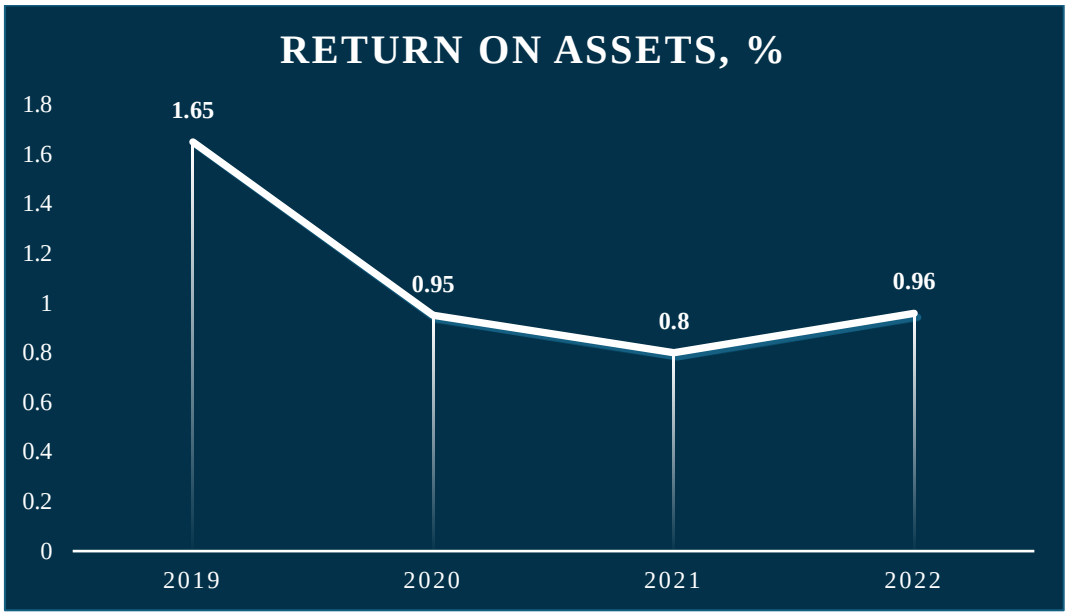
Graph 4

Source: https://www.fdic.gov

This decline indicates that profitability from the bank's core lending activities was under significant strain. The decrease can be attributed to strategic decisions made during this period, such as substantial investments in lower-yielding securities and a relatively smaller share of higher-interest-earning loans and leases.
Furthermore, it is possible to see a decline in both non-interest income and non-interest expenses, which might indicate that the bank's strategic cost-cutting adjustments were insufficient to counterbalance the rising funding costs and the decline in income streams.

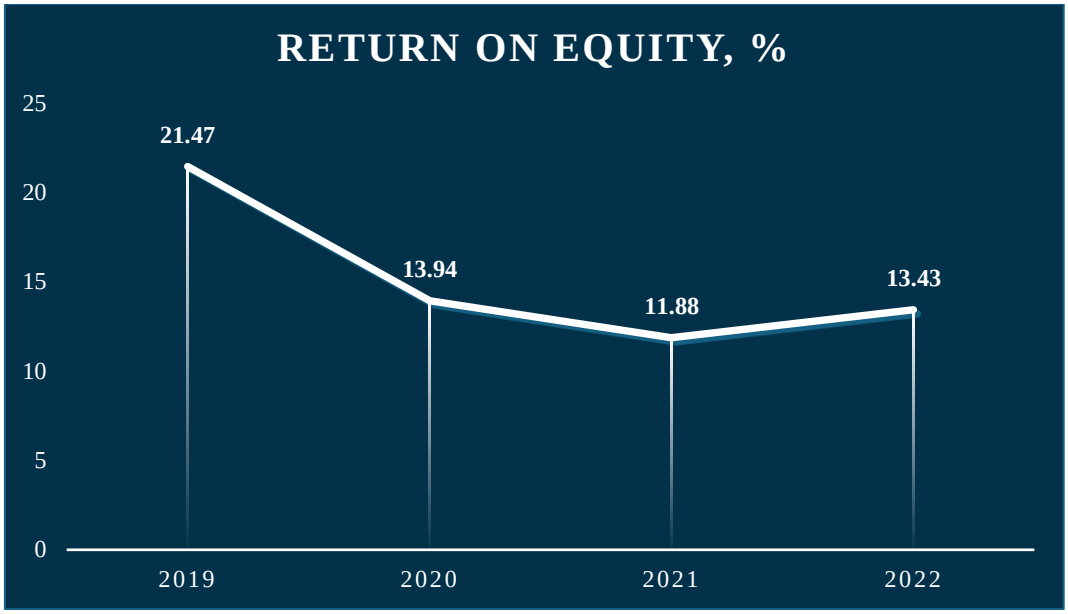
While expenses were reduced, it wasn’t enough to mitigate the negative impact on overall profitability.

Two other important indices of performance that have fallen are ROA (Return on Assets) and ROE (Return on Equity). ROA, which measures the bank's efficiency in using its assets to generate profit, dropped from 1.65% in 2019 to 0.96% in 2022. (Graph 5)



Graph 5
Source: https://www.fdic.gov

This decline suggests the bank became less efficient in utilizing its asset base, likely due to lower yields on earning assets and increased funding costs.
Similarly, ROE, reflecting the bank's profitability in relation to shareholder equity, decreased from 21.47% in 2019 to 13.43% in 2022. (Graph 6)



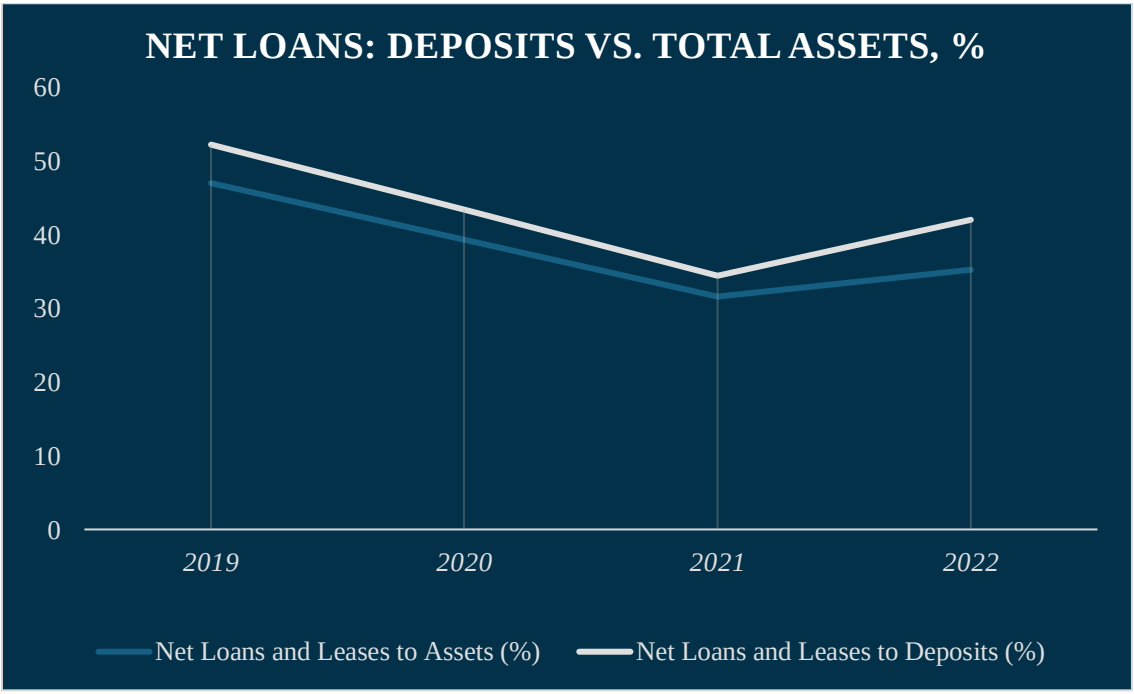
Graph 6
Source: https://www.fdic.gov

The fall in ROE indicates that the bank was less effective in generating returns for its equity investors, potentially due to lower net interest margins and other profitability challenges. Interestingly, while these performance ratios declined overall, the bank's ROE in 2022 remained above the industry average, even as its ROA fell below the industry average. This discrepancy suggests that the bank operated with a lower relative level of equity capital compared to the industry, leveraging the returns on the equity it had. While this might reflect an efficient utilization of equity, it also denotes higher financial leverage, which carries increased risk, particularly in volatile market conditions.

2.2.2 CONDITION RATIOS

Under the Condition Ratio section, is provided a deep insight into the asset composition and structure of capital changes for the bank from 2019 to 2022, with a specific emphasis on the significant decline in the share of the loans and lease portfolio.

The share of net loans and leases relative to total assets dropped from 46.96% in 2019 to 35.22% in 2022 (Graph 7 blue line), reflecting a deliberate reduction in lending activities compared to overall assets.



Graph 7

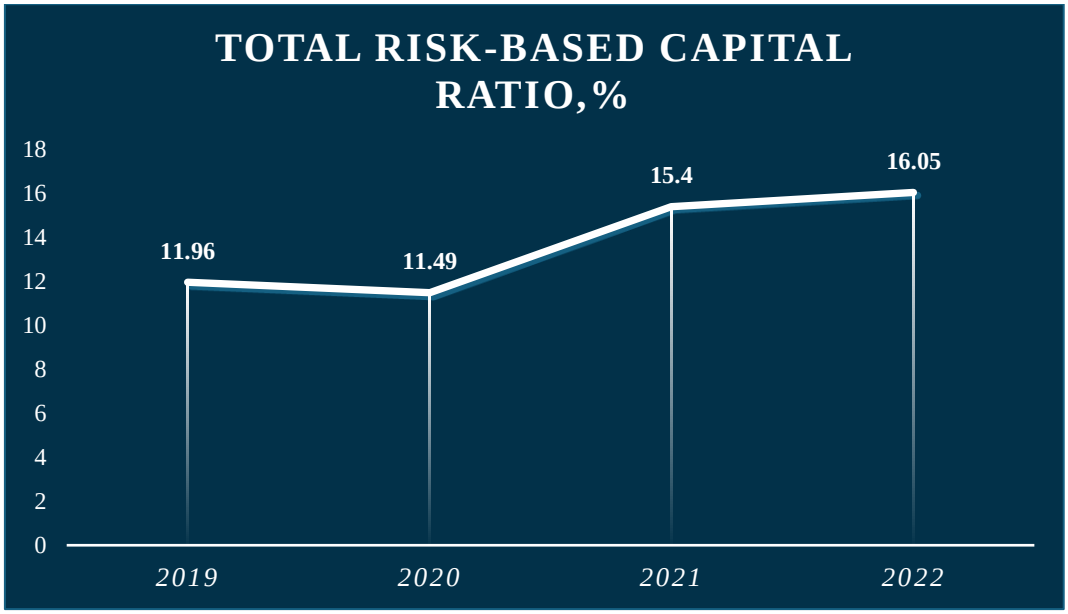
Source: https://www.fdic.gov

Similarly, the ratio of net loans and leases to deposits fell from 52.18% to 41.97% over the same period (Graph 7 white line). Both figures are well below the industry average, indicating that the bank extended fewer loans relative to its peers. This could be attributed to a more conservative lending approach or a strategic shift in favor of other asset classes, such as securities. This reduction in lending activities lowered the bank's credit risk measures, as the allowance for losses and net charge-offs as a percentage of loans and leases were substantially lower than the industry average. This may indicate that the bank

had less exposure to high-risk loans, leading to fewer losses and a reduced need for provisions against loan losses. While this appears favorable, it also implies that the bank's traditional lending activities may have been generating less income, potentially impacting overall profitability.

Changes in the funding structure were also notable. The domestic deposits-to-assets ratio decreased from 81% in 2019 to 77% in 2022. Although the reliance on deposits slightly decreased, the bank remained more dependent on deposits for funding compared to the industry average. This suggests a conservative funding approach, stable but potentially limiting the bank's flexibility in accessing alternative sources of funding. This reliance also reflects how the bank's operations were primarily limited to domestic markets. In terms of leverage and capital adequacy, the bank’s leverage ratio improved slightly from 7.30% in 2019 to 7.96% in 2022, though it remained below the industry average of 8.98%. This indicates that the bank operated with a lower proportion of equity capital relative to its total assets, making it more highly leveraged. While this higher leverage can enhance returns during periods of growth, it also introduces greater risk during economic downturns or financial stress.

Looking to the risk of its balance sheet, the bank maintained a high risk-based capital ratio. (Graph 8)



Graph 8

Source: https://www.fdic.gov

This was largely due to its substantial holdings of U.S. government securities, which are considered low-risk assets. This strong capital position, coupled with a low-risk portfolio, led U.S. regulators to classify the bank as "well-capitalized" for several years.

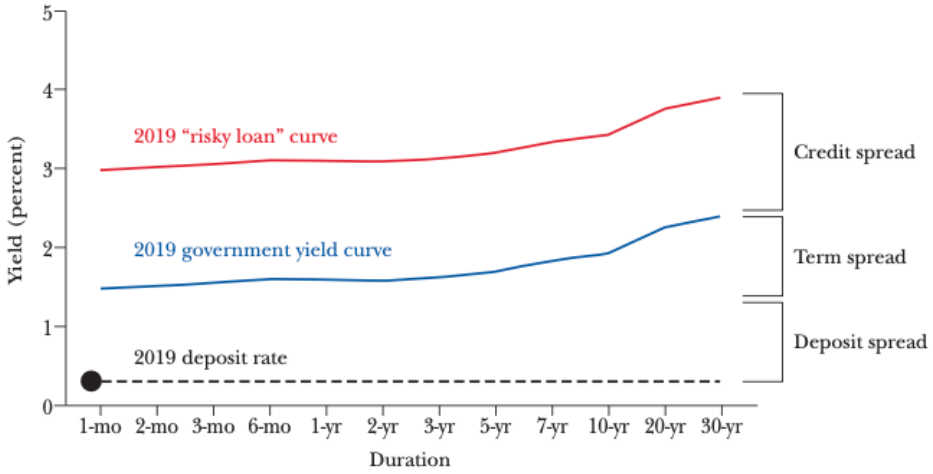
The bank's strategic shift away from loans and leases towards a higher proportion of government securities indicates a deliberate move to maintain a robust capital position with a lower risk profile. However, this strategy might have come at the cost of higher returns that are typically associated with traditional lending, as the bank's reduced emphasis on loans likely limited its profitability potential.

2.3 THE BUSINESS MODEL OF BANKING AND SVB

Silicon Valley Bank's (SVB) collapse highlights the complexity of the banking business model, where profitability hinges on managing the difference between the interest earned on assets and the interest paid on liabilities, known as the net interest margin (NIM). Banks like SVB rely on this margin to generate profits, primarily through three components: the term spread, deposit spread, and credit spread.

In 2019, SVB benefited from a favorable term spread—the difference between short-term borrowing rates and long-term lending rates (Graph 9). The yield curve represented this structure of government debt, showing that short-term rates started around 1.5% for one-month Treasury bills and gradually increased to 2.5% for 30-year bonds. SVB took advantage of borrowing at lower short-term rates and lending at higher long-term rates, capturing this spread as part of its NIM. The deposit spread further boosted profitability, with the bank paying an average of 0.4% interest on deposits, which was lower than the short-term government rate. This spread existed because customers accepted lower returns for the convenience of banking services. Additionally, SVB earned a credit spread—a premium from lending to riskier borrowers—estimated at a 1.5% premium over government securities.

Yield Comparison and Spread Analysis



Graph 9

Source: Metrick (2024) "The Failure of Silicon Valley Bank and the Panic of 2023"

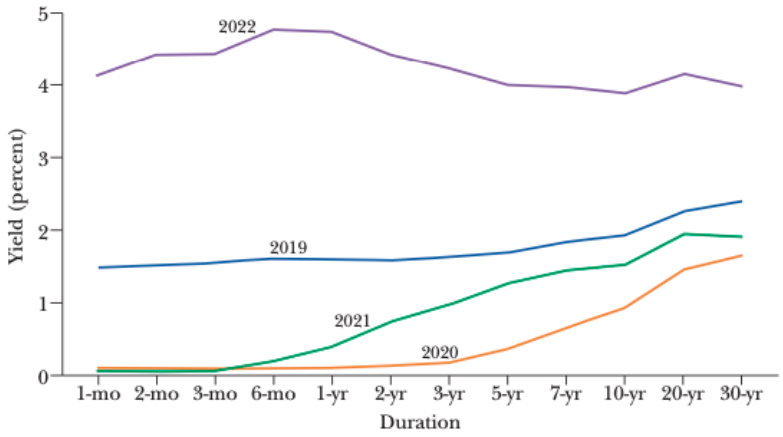
One important assumption underpinning SVB's model was the relative stability or "stickiness" of deposits. Customers typically did not move their funds even when interest rates changed, allowing the bank to continue paying lower rates on deposits even as market rates increased. This stickiness created a stable source of funding for SVB and cushioned it during periods of rising interest rates.

By the end of 2019, SVB's asset composition was balanced between government securities and traditional loans. Government securities, which were lower risk, offered stable but modest returns aligned with the yield curve, while loans were higher risk but yielded greater returns. This balance contributed to a healthy net interest margin, with SVB achieving a NIM of over 3% for the year. Careful loan selection was crucial in maintaining this margin, as poor choices could reduce the credit spread and, in turn, negatively impact profitability.

However, the economic landscape shifted dramatically in 2020 due to the Federal Reserve's response to the COVID-19 pandemic which led to a drastic reduction in interest rates. By the end of 2020, short-term rates had effectively reached zero. As a result, SVB and other banks lost the benefit of a positive deposit spread because deposit rates could

not drop below zero, and short-term borrowing became equally inexpensive. Despite the loss of the deposit spread, SVB still maintained profitability through the term spread—the yield curve remained upward-sloping—and the credit spread from legacy loans.

Yield Curve Comparison Across Years, 2019 to 2022



Graph 10

Source: Metrick (2024) "The Failure of Silicon Valley Bank and the Panic of 2023

However, 2022 marked a dramatic shift in monetary policy. To combat rising inflation, the Federal Reserve raised interest rates aggressively. By the end of the year, the yield curve had flattened, with rates hovering around 4% across all maturities, eliminating the term spread (Graph 10). Without the benefit of borrowing at low short-term rates and lending at higher long-term rates, SVB's NIM suffered, as the flattening yield curve meant the bank could no longer rely on the term spread to generate income.

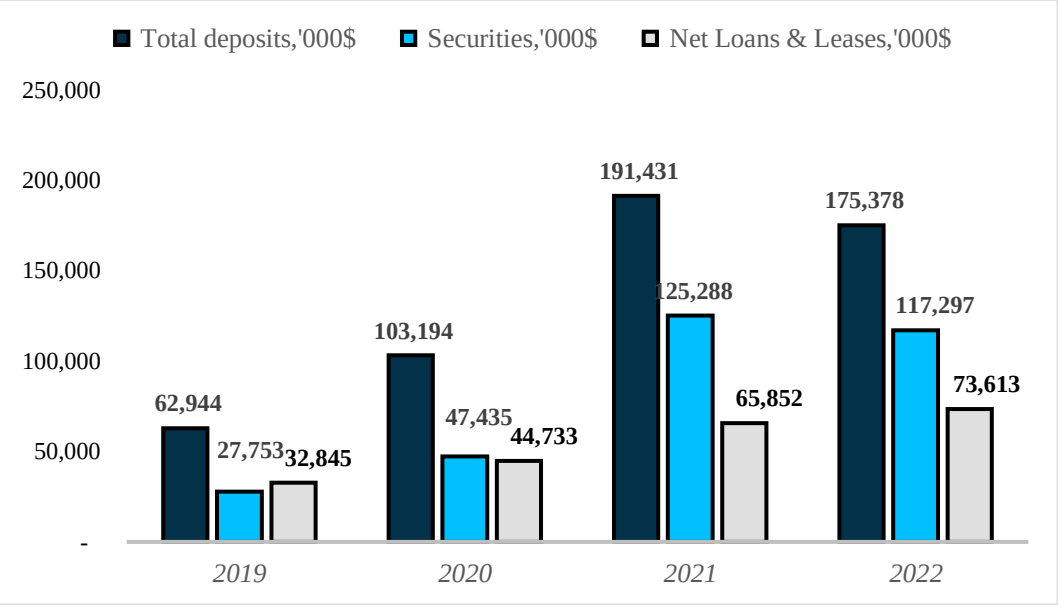
The consequences of these changes were severe for SVB. The elimination of the deposit spread in 2020, followed by the reduction in the term spread by 2022, left SVB increasingly dependent on the credit spread from its loan portfolio. However, in a changing economic environment with rising rates and tighter credit conditions, the bank's loan performance became more uncertain, adding further strain on profitability.

The evolving yield curve and shifts in monetary policy introduced significant risks for SVB. Without the term spread and deposit spread, SVB faced challenges in maintaining

its NIM. The flat yield curve also signaled that SVB could not generate substantial additional income from new long-term loans or securities, making the management of existing assets and liabilities critical. Additionally, the dramatic rise in interest rates in 2022 had a profound impact on SVB's balance sheet. As rates increased, the value of the bank's long-term assets, such as securities and loans, declined, leading to significant unrealized losses. This devaluation created financial strain for the bank, as many of these assets had been acquired during the low-interest-rate environment of 2020-2021, making them particularly vulnerable to rate hikes.

The Federal Reserve's expansionary fiscal policy and rate cuts in 2020 led to an influx of cash into Silicon Valley's tech sector, with younger firms depositing large amounts at SVB.

Deposits, Securities, and Loans, 2019-2022



Graph 11

Source: https://www.fdic.gov

Between 2019 and 2021, SVB's deposits more than tripled (Graph 11), creating a challenge for the bank to find sufficient lending opportunities. While SVB increased its lending, the expansion of the loan book was much slower compared to the rapid growth of its securities portfolio. Much of the bank's excess deposits were invested in securities during

the historically low-interest-rate environment, which would later expose the bank to significant risk when rates began to rise.

By 2022, SVB's balance sheet growth stalled as the Federal Reserve hiked rates to combat inflation. With rising rates, the market value of SVB's long-term securities fell sharply, halting its previously rapid growth. As credit conditions tightened, some of SVB's customers began withdrawing deposits or drawing on credit lines to meet their operating needs. In response, SVB increased deposit interest rates throughout the year to retain customers, but by the end of 2022, nearly half of all deposits still did not pay interest, reflecting the bank's struggle to maintain deposit stability in the face of rising rates.

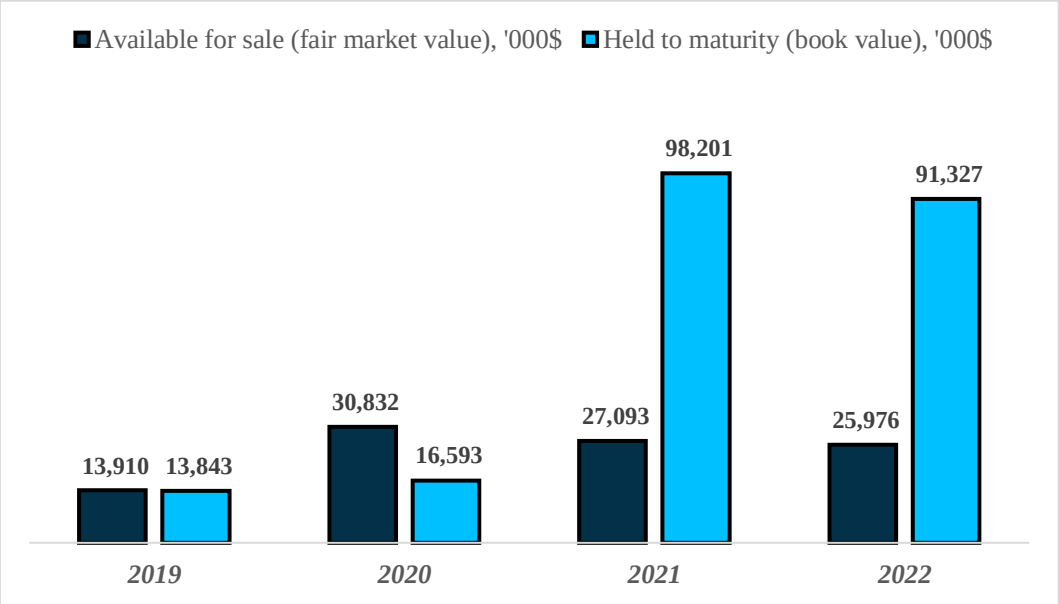
The most significant blow to SVB came from the devaluation of its long-term assets due to rising interest rates. As rates increased, the value of the bank's securities and loans decreased, leading to unrealized losses on the balance sheet. This devaluation, coupled with the earlier reliance on low-yield securities and shrinking spreads, created financial strain and weakened the bank's overall position, ultimately contributing to its collapse.

2.3.1 ASSETS AND LIABILITIES MANAGEMENT

During 2020 and 2021, Silicon Valley Bank (SVB) made substantial investments in debt securities, leading to explosive growth in this asset class—over 451% (Graph 12).

By the end of 2021, debt securities comprised a significant portion of the bank's assets, with Held-to-Maturity (HTM) securities alone accounting for 47.08% of total assets, surpassing the net loans and leases ratio. While these investments delivered reasonable yields in a low-interest-rate environment, they exposed the bank to significant interest rate risk.

Available for Sale vs. Held to Maturity, 2019-2022



Graph 12

Source: https://www.fdic.gov

The Federal Reserve's dramatic rate hikes in 2022 caused the market value of these long-duration securities to plummet, leading to substantial unrealized losses.

SVB's HTM securities had a weighted average duration that increased from 4.1 years in 2021 to 6.2 years by the end of 2022, exacerbating the impact of rising interest rates.

Although these losses were not realized immediately, they eroded investor confidence, which contributed to a decline in the bank's stock price.

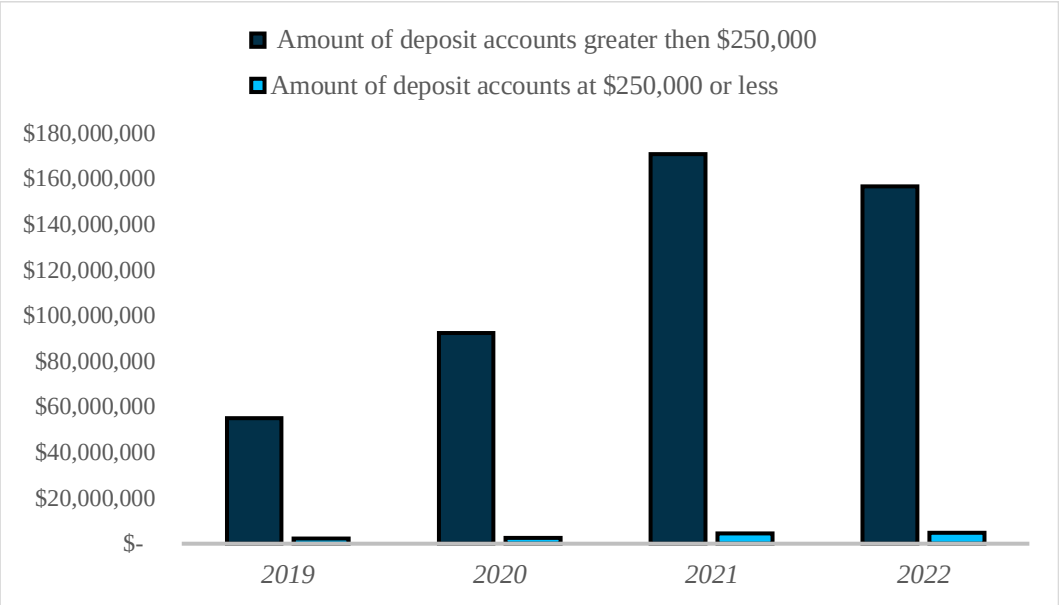
Compounding the issue was inadequate equity capital. Compared to its peers, SVB had notably lower levels of equity capital, leaving it more vulnerable to losses.

As the bank rapidly expanded its balance sheet with investments in debt securities, this lack of sufficient capital made it particularly susceptible to the effects of rising interest rates.

By the end of 2022, SVB's balance sheet reflected a negative market value of equity, further undermining its financial position.

Another major risk factor was SVB's highly concentrated depositor base, with over 89% of its total deposits in accounts exceeding $250,000, primarily from the venture capital sector. These large, uninsured deposits were held by a relatively small group of depositors, increasing the risk of a bank run.

Deposit Account Distribution, 2019-2022



Graph 13

Source: https://www.fdic.gov

As these depositors were interconnected, any perceived instability could—and eventually did—lead to rapid withdrawals. When SVB's financial position deteriorated and credit conditions tightened, these depositors began pulling their funds, further straining the bank's liquidity.

SVB's reliance on deposit stability, a core part of its risk management strategy, had become increasingly fragile. The bank had depended on the assumption that deposit rates were inelastic to market rates, believing that deposits would not be quickly withdrawn even as rates rose. Academic research supported the idea that increasing market rates would boost the deposit spread and the franchise value of deposits, but this assumption would soon be tested.

In 2022, the Federal Reserve's sharp interest rate hikes led to significant mark-to-market losses on SVB's long-duration securities. By the third quarter of 2022, these losses were publicly disclosed, leaving SVB "insolvent on paper."

Balance Sheet Comparison: 2019 vs. 2022, Mark-to-Market

Dec. 31, 2019 ($billions)

Assets		Liabilities + equity	
Cash	6	Deposits	63
Securities	28	Other debt	2
Loans	33		
Other	3	Total liabilities	65
		Equity	5
Total	70	Total	70

Dec. 31, 2022 ($billions)

Assets		Liabilities + equity	
Cash	13	Deposits	175
Securities	117	Other debt	19
Mark-to-market	*99*		
Loans	74		
Other	5	Total liabilities	194
		Equity	15
		Mark-to-market	*−3*
Total	209	Total	209
Mark-to-market	*191*	*Mark-to-market*	*191*

Graph 14

Note: Mark-to-market equity represents author's calculations of adjusted (mark-to-market) assets less book liabilities.

Source: Metrick (2024) "The Failure of Silicon Valley Bank and the Panic of 2023"

In March 2023, the bank sold $24 billion in securities at a $1.8 billion loss in an attempt to raise liquidity, which only triggered a crisis of confidence among investors and depositors. With the realization of these losses, SVB's fragile financial state was fully exposed. On March 9, 2023, uninsured depositors began withdrawing their funds at an unprecedented rate—$42 billion was withdrawn in a single day. This massive outflow was driven by shifting risk perceptions, as uninsured depositors increasingly questioned the safety of their funds in SVB. The following day, on March 10, 2023, the FDIC took control of SVB, marking its first-ever intraday receivership. The FDIC moved quickly to protect insured depositors, while also offering partial protections to uninsured depositors, highlighting the systemic risk posed by SVB's collapse. The regulatory response included invoking the systemic risk exception, a rarely used measure that required high-level approval but was deemed necessary to prevent broader fallout in the financial system.

SVB's collapse had ripple effects across the banking industry, particularly for other institutions with similar vulnerabilities. Signature Bank and First Republic Bank, both of which had large amounts of uninsured deposits and unrealized losses, also experienced deposit outflows and eventually faced closure. The Federal Reserve established the Bank Term Funding Program, which let banks to borrow against government assets at par value, in an effort to strengthen the banking sector. The goal of this innovative strategy was to support liquidity and stop additional bank runs. The systemic risk exemption and other regulatory measures assisted in short-term stabilization of deposit outflows, but they did not address the fundamental solvency issues inside the banking sector. Many banks were grappling with large unrealized losses due to the high-interest-rate environment, and the fundamental risks remained. The events of March 2023, particularly the government's unprecedented use of measures like Section 13(3) of the Federal Reserve Act[1], revealed the fragility of certain banking institutions and the risks posed by large unrealized losses in a rising-rate environment. While these regulatory actions slowed the deposit outflows, they did not entirely stop them, signaling ongoing vulnerabilities in the financial system.

[1] Section 13(3) of the Federal Reserve Act grants the Federal Reserve emergency lending powers, allowing it to extend credit to individuals, partnerships, and corporations during unusual and exigent circumstances. This provision was instrumental during the 2008 financial crisis, enabling the Fed to support non-bank financial institutions and stabilize the financial system.

2.4 EMPIRICAL EVIDENCE OF SOCIAL MEDIA AND BANK RUN RELATIONSHIP

The paper titled "Social Media as a Bank Run Catalyst" by J. Anthony Cookson, Corbin Fox, Javier Gil-Bazo, Juan F. Imbet, and Christoph Schiller explores the significant role that social media, particularly Twitter, played in the bank run that led to the failure of Silicon Valley Bank (SVB) on March 10, 2023.

The study delves into how public discourse on social media platforms by depositors hastened the withdrawal of funds, thus precipitating the bank's collapse.

This case represents an unprecedented instance of rapid and widespread depositor coordination facilitated by modern communication technologies.

The failure of SVB was characterized by a substantial increase in Twitter discussions about the bank's financial health. Many users, presumably depositors, openly shared their concerns and intentions to withdraw funds, creating a feedback loop that exacerbated the bank's troubles.

This phenomenon aligns with classical models of bank runs, which highlight the critical role of communication and coordination among depositors in triggering runs. Authors sought to empirically confirm that social media significantly magnified these risks, contributing to broader instability in the banking sector.

To investigate this, the researchers compiled an extensive dataset of tweets about U.S. banks using Twitter's API, covering the period from January 1, 2020, to March 13, 2023. This dataset included over 5.4 million tweets mentioning the cashtags (stock symbols preceded by a dollar sign) of publicly traded banks. The sentiment of each tweet was analyzed using the VADER[2]algorithm, which assigns sentiment scores based on the content of the tweets.

Additionally, content dictionaries were created to identify tweets related to specific themes such as "run behavior," "contagion," and the involvement of the startup community.

[2] VADER (Valence Aware Dictionary and sEntiment Reasoner) is a sentiment analysis tool optimized for social media text, providing sentiment scores based on a lexicon of words and rules. It is particularly effective at capturing the nuanced sentiment expressed in short, informal texts like tweets.

The analysis revealed that banks with higher levels of Twitter activity prior to the run period suffered significantly larger stock market losses during the run period. This relationship was particularly strong for banks with a high percentage of uninsured deposits and substantial mark-to-market losses.

Moreover, the intensity of Twitter activity, measured by the number of tweets per hour, was identified as a strong predictor of stock market losses during the run period.Tweets expressing negative sentiment led to immediate declines in stock prices, especially for banks with existing vulnerabilities.

One of the key findings was the prominent role of the Twitter startup community in amplifying the bank run risk.

The study finds that tweets originating from members of the startup community, who were likely depositors, had a notably stronger impact on stock market losses during the bank run. This intensified effect is attributed to the high level of communication and interconnectedness within the startup community on Twitter. These individuals, many of whom had large, uninsured deposits in banks like Silicon Valley Bank (SVB), used Twitter as a platform to discuss their concerns and intentions, which rapidly spread panic among other depositors.

Empirical results strongly support this finding. The study employs high-frequency analysis of bank stock returns and Twitter activity, showing that the negative sentiment of tweets had a significant impact on stock prices, particularly when these tweets were authored by members of the startup community. Specifically, the results indicate that a one-standard-deviation increase in negative tweet sentiment led to a 1.60 basis point drop in stock prices, and this effect more than doubled when the tweets came from startup community members. The pronounced impact of these tweets is further highlighted by a significant interaction effect, where tweets from the startup community during the run period led to an even sharper decline in bank stock prices.

Moreover, the study's analysis reveals that this effect was not just about the volume of tweets, but also the content. Tweets containing keywords related to bank runs and contagion had a particularly strong influence on market reactions. The combination of high tweet volume, negative sentiment, and the use of specific, panic-inducing language by the startup community amplified the market's response, leading to rapid and severe stock market losses.

The study finds that tweets mentioning terms related to withdrawals or contagion were particularly strong indicators of larger stock market losses during the bank run. This outcome can be understood by examining the mechanisms through which social media amplifies financial risks and facilitates the coordination of depositor behavior.

At the core of this finding is the concept of depositor coordination. Bank runs occur when depositors, fearing that others will withdraw their funds, decide to do the same to protect their own assets. This creates a self-fulfilling prophecy where the mere perception of instability can lead to actual financial collapse. Social media platforms like Twitter dramatically enhance the ability of depositors to coordinate their actions in real time, making it easier for these fears to spread rapidly and widely.

The researchers identified a significant interaction between the intensity of Twitter conversations before the run and specific bank characteristics, such as the percentage of uninsured deposits and mark-to-market losses. The intuition behind this is that banks with a higher proportion of uninsured deposits are inherently more vulnerable to runs. Uninsured depositors, lacking the protection of federal insurance, have a greater incentive to withdraw their funds at the first sign of trouble. Similarly, banks with substantial mark-to-market losses are financially weaker, further increasing their susceptibility to runs.

When pre-run Twitter activity is high, particularly with tweets discussing withdrawals or contagion, it signals to the market and other depositors that these vulnerabilities are widely recognized. This widespread recognition acts as a catalyst, prompting more depositors to withdraw their funds, thereby intensifying the run. The content of the tweets—especially those mentioning contagion—plays a crucial role by framing the situation as not just a problem for one bank but potentially for the entire financial system. This amplifies the panic, leading to even larger market losses.

Moreover, the real-time nature of Twitter accelerates the spread of these concerns. In the past, such fears might have spread more slowly through traditional media or word-of-mouth, giving banks more time to manage the situation. However, with social media, the timeline compresses drastically. A tweet can go viral in minutes, triggering a cascade of withdrawals before the bank has a chance to respond effectively.

Psychologically, the repeated exposure to tweets about withdrawals or contagion reinforces the fear among depositors and investors. Even those who might not have been

initially concerned can be swayed by the sheer volume of negative sentiment on social media. This collective anxiety, magnified by the interconnected nature of the Twitter community, can lead to a rapid and widespread reaction, culminating in significant stock market losses.

Keywords for the content dictionaries that authors employed to classify tweets in to "Run", "Contagion", "Balance Sheet", "Cryptocurrency" and "Startup Community". For example, words like "VC", "entrepreneur", "start up, "founder" are classified under the Startup Community dictionary or "run" and "withdraw" under the Run Behavior one, and so on.

To establish a causal link between social media activity and bank run risk, the researchers conducted both cross-sectional and high-frequency tests.

The cross-sectional analysis explored how preexisting exposure to Twitter conversations interacted with bank characteristics to predict stock market losses during the run period. The high-frequency tests, which used hourly stock return data, provided further evidence that intense Twitter conversations in the preceding hours were associated with negative stock returns during the run period. This effect was stronger for banks with higher levels of uninsured deposits and greater mark-to-market losses.

High Frequency Return Responses to Tweets

$$\Delta p_{i,t} = a + b \times \text{VADER Pos (z)}_{it} + c \times \text{VADER Neg (z)}_{it} + \gamma_i + \epsilon_{i,t}$$

	(1) $\Delta p_{i,t}$	(2) $\Delta p_{i,t}$	(3) $\Delta p_{i,t}$	(4) $\Delta p_{i,t}$	(5) $\Delta p_{i,t}$	(6) $\Delta p_{i,t}$
VADER Pos(z)	-0.06	-0.02	-1.59	-1.46	-1.54	-0.79
	(0.16)	(0.16)	(1.43)	(1.44)	(1.57)	(0.92)
VADER Neg(z)	-1.60***	-1.56***	-2.72	-2.62	-3.21	-4.61***
	(0.27)	(0.28)	(2.20)	(2.38)	(1.97)	(1.41)
Startup Flag		3.49***	4.92			
		(1.29)	(10.86)			
VADER Pos(z) × Startup Flag		-1.49*	9.85			
		(0.82)	(8.89)			
VADER Neg(z) × Startup Flag		-2.13**	-21.82***			
		(0.93)	(7.29)			
Contagion Tweet				41.71		
				(36.77)		
VADER Pos(z) × Contagion Tweet				21.68		
				(23.73)		
VADER Neg(z) × Contagion Tweet				-28.18**		
				(14.32)		
Run Tweet					-2.68	
					(8.12)	
VADER Pos(z) × Run Tweet					5.32	
					(7.63)	
VADER Neg(z) × Run Tweet					-0.52	
					(9.69)	
VADER Pos(z) × High Exposure Bank						-0.79
						(2.41)
VADER Neg(z) × High Exposure Bank						1.93
						(3.23)
Constant	-0.78	-0.85	-26.17***	-26.06***	-25.90***	-26.19***
	(0.78)	(0.76)	(4.79)	(4.88)	(4.83)	(4.63)
Observations	1521078	1521078	43597	43597	43597	43597
R^2 (%)	1.01	1.02	2.47	2.47	2.46	2.45
Bank FE	✓	✓	✓	✓	✓	✓
Sample	All	All	≥ Mar09	≥ Mar09	≥ Mar09	≥ Mar09

Table A
Source: Cookson, Fox, Gil-Bazo, Imbet, and Schiller (2023), "Social Media as a Bank Run Catalyst"

In the concluding phase of the empirical analysis presented in the paper, the authors examine changes in bank stock prices over short time intervals around tweets referencing banks.

Specifically, they observe changes in the logarithmic prices of bank stocks within 10-minute intervals surrounding the tweets in their dataset. This high-frequency analysis aims to precisely identify the impact of real-time social media discussions on stock prices, assuming that no other significant events influence prices within these narrow windows.

The log return of a bank's stock over the 10-minute window around a tweet at time t containing the bank's cashtag is defined as:

$$\Delta p_{i,t} = p_{i,t+\tau} - p_{i,t-\tau},$$

where $p_{i,t+\tau}$ and $p_{i,t-\tau}$ are the log prices of the last trade in the [t − 15′, t − 5′] window and the first trade in the [t + 5′, t + 15′] window, respectively. This method allows for capturing the starting price before the tweet and the ending price after, addressing concerns that stock prices might drive Twitter activity rather than the reverse.

In the main high-frequency specification, the researchers regress the log returns of bank i on the tone of the tweet:

$$\Delta p_{i,t} = a + b \times VADER\ Pos_{i,t} + c \times VADER\ Neg_{i,t} + \gamma_i + \varepsilon_{i,t} \quad (6)$$

Here, Δpi,t is winsorized (outliers are removed) at the 1% level and expressed in basis points. VADER Posi,t and VADER Negi,t represent the positive and negative sentiment components of the tweet, as assigned by the VADER algorithm. γi denotes bank fixed effects.

For comparability, both sentiment components are standardized to have a mean of zero and a standard deviation of one across the sample. Standard errors are clustered at the bank-day level.

Table A presents the results of this regression.

Column 1 shows a strong and immediate negative price response to negative sentiment tweets, with a one-standard deviation increase in negative sentiment associated with a 1.60 basis point drop in returns.

Conversely, positive sentiment tweets did not have a significant effect, with the coefficient estimate being economically small and statistically indistinguishable from zero, despite the large sample size (N = 1,521,078) and relatively small standard error (SE = 0.16).

The study further explores the startup community's role in driving this effect by interacting both sentiment components with a 'Startup Flag' variable, identifying tweets from authors in the 'Startup community' dictionary.

SVB's deposits were heavily concentrated among this community, which is highly networked and active on Twitter.

The researchers find a significantly negative interaction effect of −2.13 for

VADER Negi,t × 1(Startup Community), indicating that negative sentiment tweets from startup community members have more than double the impact on bank stock returns.

Additional tests in Table A restrict the sample period to post-SVB run onset on March 09. Comparing estimates from the full sample to those from this post-run period reveals that the SVB run amplified the effects of tweet sentiment and user identity.

Post-run, the negative sentiment impact on returns and the startup community's influence became even more pronounced, with the coefficient for VADER Negi,t × 1(Startup Community) increasing to −21.82 (significant at the 1% level). Tweets in the 'contagion' dictionary also had a stronger negative impact.

There are pronounced unconditional negative returns in the post-run period, indicated by the large and significant negative constant term in columns (3) through (6).

Even neutral tweets had a negative impact during the run period.

Interestingly, interactions involving the “run behavior” dictionary or banks with high exposure did not show significant sentiment interactions. This could be due to the market needing more time to absorb information related to these characteristics or the volume of "run behavior" tweets being more informative than sentiment alone.

The sentiment analysis using the VADER tool confirmed that negative tweet sentiment had a significant and immediate impact on stock market losses. This effect was amplified by tweets from the startup community or those containing terms related to bank runs and contagion.

The paper concludes that social media, especially Twitter, played a key role in the SVB bank run. Preexisting exposure to social media discussions strongly predicted stock market losses during the run. The intensity and sentiment of these conversations had immediate and significant effects, especially for banks with high vulnerabilities.

The rapid evolution of digital communication and the pervasive influence of social media have revolutionized the landscape of information dissemination and financial markets.

Traditional analytical tools often fall short in capturing the high-frequency, dynamic interactions characteristic of today's information flows.

Consequently, there is an urgent need to develop and adopt sophisticated analytical instruments capable of investigating the complex interplay between social phenomena and market behavior in real-time.

In the paper "Public Attention, Sentiment and the Default of Silicon Valley Bank," authors Stephan Bales and Hans-Peter Burghof (2024) investigate the dynamics between

social media-driven public attention and the collapse of Silicon Valley Bank (SVB) on March 10, 2023.

The study provides an in-depth analysis of how investor behavior and market dynamics are influenced by social media, particularly Twitter, in the context of a significant financial event.

The authors employ a robust methodological framework using intra-day data in 15-minute intervals to assess SVB market excess returns.

They match these returns with intra-day measures of investor attention derived from the relative number of tweets and Google searches. Public attention was quantified using the number of tweets containing terms like 'Silicon Valley Bank', 'SVB Financial Group', 'SVB', and '#SVBcollapse', collected via the Twitter developer API.

Google search volumes for similar terms were also used to gauge public attention. Both tweet counts and Google search data were scaled to a peak of 100 to normalize the measures.

SVB's stock returns were calculated at 15-minute intervals, adjusted for market risk factors. This included controlling for general market movements using the S&P 500 index, financial uncertainty using the CBOE Volatility Index (VIX), and sector-specific risk using the KBW Nasdaq Bank Index.

The core analytical tool utilized is wavelet analysis, which enables the examination of time-varying lead-lag relationships between public attention and stock returns.

Wavelet analysis is employed to decompose the time series data into different frequency components, allowing for the detection of lead-lag relationships at multiple time scales. The wavelet transform decomposes a time series into time-frequency space, using a mother wavelet to generate scaled and translated versions. In this study, the Morlet wavelet [3] is utilized due to its effective balance between time and frequency localization. This function allows the authors to analyze localized variations in the time series data, making it suitable for detecting the rapid changes in public attention and stock returns. The cross-wavelet transform (XWT) measures the local correlation between two time series, identifying periods where one series leads or lags the other. The cross-wavelet spectrum is computed as the product of the wavelet transforms of two time series, allowing for the

[3] The Morlet wavelet is a function used in signal processing to analyze signals by decomposing them into various frequency components. It allows researchers to decompose financial signals, helping to identify patterns, cycles, and trends over various time scales.

visualization of coherency plots where coherency values range from 0 to 1, indicating the strength of the correlation. Phase arrows within these plots show the direction of influence between the time series.

The study's results reveal significant bilateral lead-lag patterns between public attention and SVB's market performance.

Specifically, it was found that higher levels of public attention, measured through spikes in Twitter activity and Google search volume, led to substantial decreases in SVB's stock returns.

This negative feedback loop is indicative of a panic-driven response were increased public scrutiny and concern precipitate further financial instability.

The authors demonstrate that Twitter, as a low-cost and highly effective information dissemination platform, played a crucial role in amplifying the bank's collapse dynamics thanks to its ability to spread information rapidly and allow for direct communication, bypassing traditional media filters and delays, thus enabling real-time coordination among investors and depositors.

CHAPTER 3: THE CREDIT SUISSE CASE

3.1 INTRODUCTION TO THE STUDY

This study started out trying to explain the SVB crisis by examining whether there was a correlation at all, and if so, how strong it was, between mood on social media and market-wide stock returns. The study's conclusions showed that quickly spreading false information and opinions on social media might have immediate and severe financial repercussions, such a bank run and the financial institution's subsequent demise. I expanded and repeated a study on the Credit Suisse default in response to this observation to see if the same trends might be seen in the market and on social media.

One of the biggest financial organizations in the world, Credit Suisse (CS), became entangled in a crisis characterized by a string of financial blunders, difficulties with regulations, and problems with management. In contrast to SVB, which mostly catered to the IT industry inside Silicon Valley, Credit Suisse's problems had their roots in the company's intricate financial processes and a long history of scandals.

In February 2020, a scandal arose regarding Credit Suisse's employment of private investigators to spy on former executives. The controversy led to the resignation of CEO Tidjane Thiam.

Since this was a part of a larger espionage trend between 2016 and 2019, the Swiss financial regulator found that the bank had serious organizational weaknesses.

A scandal surrounding Credit Suisse's use of private investigators to snoop on former executives began in February 2020.

CEO Tidjane Thiam resigned as a result of the scandal. The bank had major organizational flaws, as the Swiss financial authority discovered, as this was not an isolated event but rather part of an espionage trend between 2016 and 2019.

Due to high-risk endeavors and bad investment choices—most notably, the demise of Archegos Capital Management and Greensill Capital—the bank suffered large losses.

These incidents damaged the bank's standing in the marketplace in addition to draining its cash reserves. Furthermore, Credit Suisse faced severe regulatory oversight and penalties from multiple financial regulators. In addition to increasing the financial strain, this regulatory pressure also fostered mistrust and uncertainty among clients and investors.

Within the organization, there was increased instability and uncertainty as a result of frequent changes in leadership and strategic direction.

The bank's problems were made worse by the inconsistent leadership, which made it challenging to put a cogent recovery plan into action.

The disastrous losses connected to Archegos and Greensill Capital set off a chain of events that ultimately led to Credit Suisse's takeover by UBS. The fall of the first, a family office that failed on margin calls and caused significant losses for its prime brokerage clients, including Credit Suisse, cost the financial institution over $5.5 billion in 2021.

Greensill Capital's insolvency shortly afterward, to which Credit Suisse was heavily exposed via its supply chain finance funds. Following the bank's forced $10 billion fund closure, its management came under regulatory investigation and faced enforcement actions. The bank's balance sheet was negatively affected by the cumulative impact of these financial setbacks, which also reduced investor trust.

Credit Suisse's reputation was further damaged in February 2022 when a massive data leak revealed that the bank had enabled accounts for corrupt officials and criminals.

A month later, the bank was ordered to pay $553 million in damages in Bermuda due to a long-running fraud involving a former employee, adding to its legal troubles. However, Credit Suisse was found guilty later that year of neglecting to stop a Bulgarian cocaine-trafficking organization from laundering money.

The bank was fined CHF 2 million by the court after it was determined that appropriate organizational controls may have prevented the crime.

News of Credit Suisse potentially dividing its investment bank and alerting investors to a potential capital increase surfaced on September 22, 2022. This conjecture added to the unease, and by the beginning of October, things had gotten worse.

Reports surfaced on October 2, 2022, suggesting that Credit Suisse might be seeking to raise capital. At the same time, the price of Credit Default Swaps (CDS) for Credit Suisse shot up, indicating mounting market concerns about the bank's viability.

By October 27, 2022, Credit Suisse had declared major layoffs, acknowledged that it was raising capital, and provided an outline of a new strategy plan meant to stabilize the company.

The market's lack of confidence persisted in spite of these attempts, and on November 1, 2022, S&P reduced Credit Suisse's credit rating to BBB-, which is slightly above junk status, worsening the bank's financial problems.

The situation took another turn for the worse in February 2023 when Credit Suisse reported massive outflows, with customers withdrawing over CHF 110 billion. This marked the beginning of a terminal decline in investor confidence.

Subsequently, on March 15, the head of Saudi National Bank, a prominent stakeholder in Credit Suisse, declared that the bank would not be augmenting its stake in Credit Suisse. The market's confidence was severely damaged by this announcement, which resulted in a precipitous drop in the price of Credit Suisse's stock and more liquidity issues. The crisis got worse when the bank saw a dramatic rise in withdrawals and a decrease in its share price. Concerned about the possible systemic risk that the failure of Credit Suisse posed, the Swiss government and banking regulators stepped in to help calm the situation. In a deal mediated by the Swiss government, UBS agreed to buy Credit Suisse that same month following a tense weekend of talks.

The purchase was intended to stop a further financial disaster and bring stability back to the Swiss financial sector. Significant guarantees to cover any losses were included in the agreement, and the Swiss National Bank offered significant liquidity support. Credit Suisse's independent existence came to an end with this transaction, which led to one of the biggest consolidations in the banking industry's recent history. For background, the price of Credit Suisse's stock dropped from $12.5 in January 2022 to $6.5 by May 2023, indicating mounting concerns in the market over the bank's sustainability.

Similar to its effect on SVB, social media had a more covert role in exacerbating the Credit Suisse disaster. This study concentrated on Reddit discussions, where there were lively debates regarding the bank's possible failure and the ramifications for international markets in financial communities like the well-known r/WallStreetBets.

Memes, calls to action, and speculative analysis were common elements of these conversations that contributed to the spread of fear and false information. Prominent financial

analysts and commentators offered updates and thoughts on Twitter constantly, and they quickly gained traction by being quickly retweeted and reposted.

As a result of trending hashtags like #CreditSuisseCollapse and #BankingCrisis, anxiety and uncertainty increased. Information from reliable sources like Reuters, Bloomberg, and The Wall Street Journal was also widely shared on social media, frequently with sensational headlines that increased public fear. Financial news websites and journals also contributed to this information flow.

Due to the continual flow of rumors and information, clients and investors felt pressured to take swift action—often without completely understanding the circumstances.

Social media had a crucial part in both SVB and Credit Suisse crises, despite the fact that their underlying reasons were different. In the instance of SVB, social media rapidly exacerbated rumors and panic regarding the bank's financial problems, resulting in a bank run.

A feedback loop of anxiety and conjecture was sparked by tweets, blog postings, and online discussions, which resulted in a large-scale fund withdrawal.

In a similar vein, unfavorable information and conjecture on Credit Suisse's financial situation spread quickly via social media, escalating public anxiety and investor flight.

Reports that were concerning were disseminated by prominent financial pundits and media sources, which in turn caused market movements. Social media's reach and quickness affected stakeholders' decisions in both situations.

This resulted in large-scale depositor withdrawals for SVB, but it also caused investors and clients at Credit Suisse to lose faith in the company and sell their assets. Quick action was made possible by stakeholders' instant access to information—and disinformation—often without thoroughly checking the facts.

The scale was the primary distinction. Initially, Silicon Valley Bank was a regional bank in the US with a concentration on venture capital and the technology industry. Thus, venture capitalists and entrepreneurs made up the majority of its clientele. Credit Suisse, on the other hand, was a multinational financial behemoth that offered a wide range of services, such as asset management, wealth management, and investment banking. Its clientele included a far wider range of industries and geographical areas.

Undoubtedly, both establishments found it difficult to control the story after it acquired traction on the internet. Negative reaction went viral and frequently overshadowed official declarations and assurances. It is important to comprehend how the SVB bank run and Credit Suisse's default are related for a number of reasons. It draws attention to the dangers that financial institutions face in the fast-moving digital age of information (and misinformation). Social media's immediate nature has the power to escalate a localized problem into a worldwide disaster in a matter of hours. Because financial institutions are interconnected, crises have the ability to spread quickly and have a greater impact on the economy.

Fear may spread swiftly through markets, affecting not only the institutions involved but also their clients, investors, and the larger financial system, as the SVB and Credit Suisse incidents show. Understanding how social media contributes to financial crises might help develop more effective legal frameworks and strategic communication plans to reduce similar dangers in the future. Financial institutions and regulators must adjust to the reality of the digital era by creating plans for efficiently monitoring and handling social media dynamics.

3.2 DATA AND MEASUREMENT

I created a code in the Jupiter Notebook environment using the Python programming language.

Selecting the social network to conduct the sentiment analysis on is the first step in the analysis.

Reddit is becoming increasingly important in financial and economic conversations among investors and individuals who want to stay up to date on news, which is why I chose it for my extended study. Reddit is organized into "subreddits," or channels, where users can participate in a community discussion on a particular subject. Subreddits like "r/Finance," "r/Investing," and "r/WallStreetBets" have become into important gathering places for traders and investors to exchange ideas, conjecture, and analysis. Community-driven debates are facilitated by these forums, which also offer a plethora of qualitative data that can be used to gauge mood in the market.

Renowned for its high-risk, high-reward stock trading conversations, the subreddit r/WallStreetBets sprang to prominence amid the GameStop share scandal, proving the influence of community mood on stock prices. The GameStop shares and r/WallStreet-Bets story is a perfect illustration of how community emotion may affect the financial market. Significant price fluctuations resulted from the collective actions and thoughts stated in this subreddit, demonstrating the power of individual investors coming together on a single platform.

Sentiment analysis on these subreddits allows us to understand the aggregate thinking of many investors. Due to the abundance of data accessible, X (previously Twitter) is frequently chosen as the platform of choice for researching online financial debates; however, Reddit differs in important aspects that impact the type and extent of research conducted on the site. Within particular subreddits, Reddit's forum-style structure with threaded discussions facilitates more in-depth and targeted debates.

This format can result in more comprehensive and thoughtful posts, as users engage in longer-form content and back-and-forth dialogue. In contrast, X's format is more immediate and concise, with real-time updates and a broader reach due to its more prominent

public profiles. The brevity and speed of X make it a powerful tool for capturing instantaneous market reactions and trending topics, whereas Reddit's discussions may evolve over time and provide deeper context

Despite these strengths, Reddit also has limitations for this type of research. The platform's user base can be more niche, particularly within finance-related subreddits, which may not fully represent broader market sentiments. Additionally, the anonymity and community-driven nature of Reddit can sometimes lead to the spread of unverified information or highly speculative content. These factors can introduce noise into the data, requiring careful filtering and analysis to extract meaningful insights.

Developing a code to perform this analysis the first instrument required is an API. An API, or Application Programming Interface, is a set of protocols and tools that allows different software applications to communicate with each other. In this study, the Reddit API is used to fetch large volumes of posts related to Credit Suisse efficiently. The API enables the extraction of data such as post content, timestamps, and other metadata, which are then processed and analyzed to determine sentiment trends and their correlation with stock returns. The use of an API automates and streamlines data collection, making it possible to handle and analyze vast amounts of data that would be impractical to gather manually. Through the API, researchers can programmatically access real-time and historical data, facilitating a comprehensive analysis of social media sentiment and its potential impact on financial markets.

The costs associated with using the APIs of these platforms highlight another significant difference. Reddit's API is free, allowing developers to access a wide range of data without incurring costs. This makes it highly accessible for researchers and developers working on budget constraints. In contrast, X's API, which has undergone significant changes, now comes with a price tag that can be restrictive. X's API pricing plans vary, but they can be expensive, especially for extensive data collection and analysis needs, making it less accessible for large-scale academic or independent research projects. Ending, about the stock data, I used the Alpha Vantage API which provide free access to daily stock price for free.

3.2.1 IMPORTING LIBRIARIES, API SET-UP AND TIMEFRAME

I begin by importing several libraries essential for my analysis. The *praw* library allows me to connect to Reddit's API and extract posts. pandas and *numpy* are used for data manipulation, while re helps me clean text data through regular expressions. The *alpha_vantage.timeseries* module is utilized to retrieve stock market data, specifically for Credit Suisse. For sentiment analysis, I rely on flair, a powerful library for natural language processing. I also bring in *plotly.graph_objects* and *matplotlib.pyplot* to visualize my data effectively, and finally, I import *statsmodels* and *sklearn* to run regressions and evaluate model performance.

Next, I set up my Reddit API credentials, including my client ID, secret key, and user agent. This is critical for accessing Reddit's API, which I will use to search for posts related to Credit Suisse.

I then define the timeframe for my analysis—starting from October 15, 2022, and ending on March 24, 2023. A timeframe determines the period for which Reddit posts and stock data will be collected and analyzed. Limiting the time range helps focus on a specific period of interest, ensuring that the analysis is concentrated and relevant. This timeframe is essential as it encapsulates significant events related to Credit Suisse during that period, such as the capital raise in December 2022 and the UBS takeover in March 2023.

3.2.2 DATA COLLECTION AND PROCESSING

I build a function, *fetch_reddit_posts*, that fetches Reddit posts based on my query. The function uses pagination to gather up to 10,000 posts by continuously retrieving batches of posts after the previous one. This is helpful because Reddit limits how many posts I can retrieve at once, and I need to gather a large dataset to conduct meaningful analysis. The function fetches posts related to my search query "Credit Suisse OR Debit Suisse OR CSGN" across all subreddits.

In my analysis, I use a function called fetch_reddit_posts_from_subreddits to search for a specific query, which in this case is the ticker symbol "*CS*" for Credit Suisse. The reason

for this focused approach is that "CS" can be an equivocal abbreviation—while it represents Credit Suisse in the context of finance, it could also refer to other unrelated topics if searched across all subreddits. For instance, "CS" might be used to refer to "Computer Science" or "Counter-Strike" in non-finance-related subreddits, which could introduce irrelevant or misleading data into my analysis.

By restricting the search to specific finance-related subreddits like “wallstreetbets”, “Superstonk”, and “CreditSuisse”, I ensure that the results are highly relevant to Credit Suisse and its financial context. This approach minimizes the risk of collecting off-topic posts, leading to more accurate sentiment analysis and preventing noise from irrelevant discussions. Ultimately, this step is crucial to maintaining the integrity of the data and ensuring that the sentiment data accurately reflects discussions about Credit Suisse in a financial context.

Once I have the Reddit posts from both all subreddits and specific subreddits, I combine them, ensuring I remove any duplicates. I then filter the posts to retain only those that fall within my specified timeframe (October 2022 to March 2023. This helps ensure I’m analyzing sentiment around Credit Suisse during critical periods of its financial instability.

Next, I define a function called preprocess to clean the text data. This function removes unwanted elements like URLs, mentions, and special characters from the posts. It also converts all text to lowercase, which helps to standardize the data for more accurate sentiment analysis.

3.2.3 SENTIMENT ANALYSIS AND STOCK DATA

To perform sentiment analysis, I utilize *flair*, a natural language processing library[4]. I load a pre-trained sentiment model (*en-sentiment*), provided by the Flair natural language processing library. This model is specifically designed to analyze English text and classify it as either "positive" or "negative." It is trained on a large dataset of labeled sentiments, allowing it to predict the overall emotional tone of a given piece of text.

[4] A natural language processing (NLP) library is a set of tools and algorithms designed to help computers understand, interpret, and generate human language. These libraries enable tasks like sentiment analysis, text classification, translation, and more by analyzing the structure and meaning of text data

When used, the model assigns a sentiment label to the text (either "POSITIVE" or "NEGATIVE") and also provides a confidence score, which indicates how strongly the model believes the text belongs to that sentiment class. This makes it useful for tasks such as analyzing social media posts, reviews, or news articles to determine the general mood or opinion being expressed.

Then I define the *get_flair_sentiment* function. This function assigns sentiment scores to each post, labeling them as either positive or negative. If a post is positive, it gets a positive score, and if it's negative, it gets a negative score. Neutral posts are assigned a score of zero.

I extract the dates and sentiment scores for each post, then store this information in a *pandas* DataFrame. I group the posts by date and calculate the average sentiment for each day, allowing me to see how overall sentiment around Credit Suisse changes over time. Additionally, I calculate a weighted sentiment score based on the number of posts each day, giving more weight to days with more posts.

I then normalize the weighted average sentiment by subtracting the mean and dividing by the standard deviation. This standardization helps me compare sentiment values more meaningfully across different days. To make the normalized values more interpretable, I scale them by a factor of 10.

Next, I handle any missing dates in the sentiment data by creating a complete range of dates for the timeframe and filling in any gaps with linear interpolation. This ensures my dataset has no missing values, which is important when performing regression analysis later on.

With my sentiment data ready, I move on to stock market data. Using the "Alpha Vantage" API, I fetch daily stock data for Credit Suisse. After filtering the data to match my timeframe, I calculate the daily returns based on closing prices. Again, I handle any missing dates by interpolating the data, ensuring that every date in my analysis has corresponding stock data.

I then merge the sentiment data and stock data on the date column, ensuring each day has both a sentiment score and a corresponding stock return. After merging, I drop any remaining rows with missing values to ensure the dataset is clean and ready for analysis.

3.2.4 REGRESSION ANALYSIS

With the merged dataset, I perform a regression analysis using *statsmodels*. In this analysis, I use the normalized sentiment as independent variable and the daily stock return as the dependent variable. Hence, I run an Ordinary Least Squares (OLS) regression with robust standard errors (cov_type = 'HC3') to account for any heteroscedasticity in the data. This regression allows me to quantify how changes in sentiment impact Credit Suisse's stock returns.

I then evaluate the regression results by examining key metrics like the coefficient for sentiment, R-squared, p-values, and Mean Squared Error (MSE). The coefficient tells me the strength and direction of the relationship between sentiment and stock returns, while the R-squared value indicates how much of the variation in stock returns can be explained by sentiment.

The MSE provides a measure of how well the regression model fits the data. I calculate the correlation between normalized sentiment and stock returns, which helps me further understand the strength of the relationship between these two variables.

To visualize the stock price and sentiment over time, I create plots using *plotly*. One plot shows Credit Suisse's stock price over the entire timeframe, while another compares the stock returns with the normalized sentiment scores. These visualizations help to see how sentiment trends correspond with stock price movements.

3.3 RESULTS

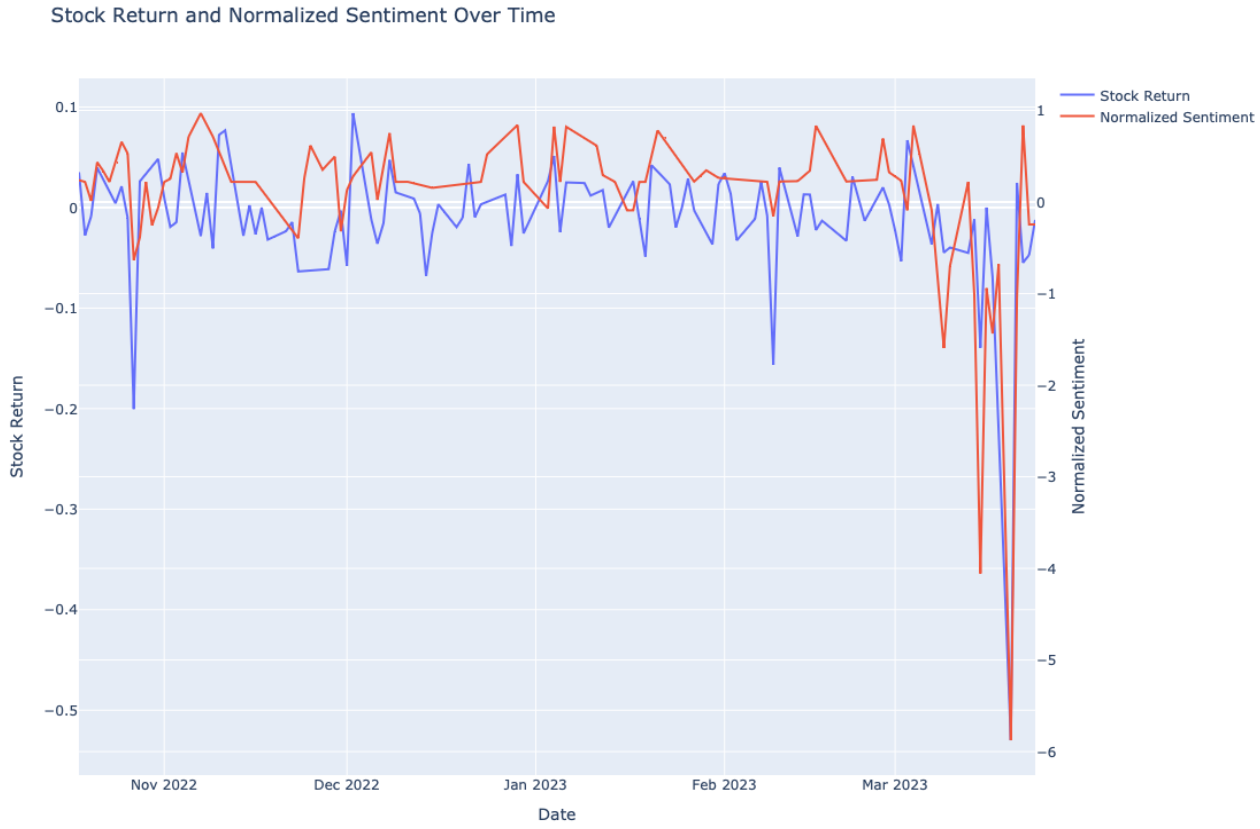
The regression analysis presents an investigation into the relationship between sentiment, measured through Reddit discussions, and the stock returns of Credit Suisse over the timeframe from October 2022 to March 2023.The analysis reveals several key findings that highlight a meaningful link between sentiment and stock performance.

```
Regression Analysis Results for the Entire Timeframe:
                            OLS Regression Results
==============================================================================
Dep. Variable:                 Return   R-squared:                       0.529
Model:                            OLS   Adj. R-squared:                  0.526
Method:                 Least Squares   F-statistic:                     11.55
Date:                Thu, 05 Sep 2024   Prob (F-statistic):           0.000858
Time:                        17:45:22   Log-Likelihood:                 264.67
No. Observations:                 158   AIC:                            -525.3
Df Residuals:                     156   BIC:                            -519.2
Df Model:                           1
Covariance Type:                  HC3
============================================================================================
                               coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------------------
const                       -0.0207      0.006     -3.587      0.000      -0.032      -0.009
normalized_sentiment         0.0062      0.002      3.399      0.001       0.003       0.010
==============================================================================
Omnibus:                       21.087   Durbin-Watson:                   1.467
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               42.798
Skew:                          -0.594   Prob(JB):                     5.09e-10
Kurtosis:                       5.256   Cond. No.                         7.96
==============================================================================

Notes:
[1] Standard Errors are heteroscedasticity robust (HC3)
Overall Mean Squared Error (MSE): 0.00205
Overall R-squared (R²): 0.53
Overall P-value for Normalized Sentiment: 0.00068
Overall Correlation between Sentiment and Stock Return: 0.72730
```

First, the sentiment gleaned from Reddit discussions accounts for roughly 52.9% of the variability in Credit Suisse's stock returns, according to the R-squared value of 0.529. Although other factors obviously affect the movement of the stock, this somewhat strong link indicates that sentiment has a major impact on the price of the company. We are able to reject the null hypothesis, which states that sentiment has no bearing on stock returns, because the sentiment variable's p-value of 0.001 indicates that there is a

statistically significant association between sentiment and stock returns. This finding suggests that sentiment shifts do, in fact, affect the stock's performance in a quantifiable way. According to the regression's positive sentiment coefficient of 0.0062, Credit Suisse's stock returns typically rise as sentiment does. More specifically, stock returns are predicted to improve by 0.0062 for every one-point increase in normalized sentiment.
Even while this rise appears little, over time, even little changes can have a big impact on financial results.
The negative intercept (-0.0207) suggests that the projected stock return would be somewhat negative if sentiment were neutral, that is, neither positive nor negative. This implies that the stock may have been declining throughout this time regardless of mood, maybe as a result of external market factors or difficulties facing the company itself.
The F-statistic (11.55) and corresponding p-value (0.000858) show that the model is statistically significant overall. This demonstrates that the model is not only a result of random noise, and that sentiment actually influences the prediction of stock returns.



Graph A

Furthermore, the result that negative sentiment is linked to deteriorating market performance and greater sentiment is generally associated with higher stock returns is supported by the substantial positive correlation (0.727) between sentiment and stock returns, as is showed in the graph A. Finally, the model's predictions of stock returns are rather close to the actual values, as evidenced by the mean squared error (MSE) of 0.00205. This supports the notion that sentiment is a useful predictor of changes in stock prices, even though more refinement could increase the accuracy. Next, we focus on the individual business events that occurred within the chosen period. Two noteworthy events are the December 8, 2022, execution of the CHF 2.24 billion capital raise and the March 19, 2023, UBS acquisition of Credit Suisse.

Additional understanding of the dynamic relationship between sentiment and stock returns is gained from the analysis of these occurrences. Stock returns showed moderate positive for the "Capital Raise CHF 4bn" event on December 8, 2022, with an average return of 0.00479. With a cumulative sentiment change of 16.01659 and a mean value of 3.20332, the sentiment was primarily favorable throughout this period.
This suggests that the capital increase elicited an overall good mood among investors, which was mirrored in the stock's somewhat positive performance. The skewness and kurtosis values indicate that the emotion distribution tends toward positive extremes, with days of more optimism being represented by a longer right tail.

On the other hand, a quite different image is painted by the events of March 19, 2023, when UBS announced its takeover of Credit Suisse. With a mean of -0., the stock returns in this case were extremely negative, indicating a significant drop in the stock's value. With a cumulative sentiment change of -123.07221 and a mean value of -24.61444, sentiment was extremely negative during this time. Sentiment's distribution is strongly skewed toward negativity, as indicated by its skewness and kurtosis, which is consistent with the market's strong reaction as investors voiced their doubts and disapproval of the transaction.

CONCLUSIONS

With a focus on bank runs and stock market reactions during times of crisis, this thesis has examined the intricate link between social media mood and financial market activity. The analysis shows that social sentiment, especially on platforms like Twitter or Reddit, has become a critical factor in modern financial markets by looking at both historical and contemporary events, such as the collapse of Silicon Valley Bank (SVB) and Credit Suisse.

I examined the literature on the history of banking, the dangers associated with financial intermediation, and the frequency of bank panics in the past in the first chapter. A thorough examination was conducted of the theoretical underpinnings of bank runs, encompassing the function of rumors and signals. Traditionally, research on bank panics has focused on the psychological impact on depositors and the informal networks that facilitate the dissemination of information. But as more recent events have shown, the emergence of social media platforms has fundamentally changed these dynamics. Social media has accelerated the circulation of rumors and information considerably, creating new avenues for the spread of fear. As a result, it can be said that although the basic ideas of bank runs are still valid, they need to be reconsidered in the context of digital communication channels.

The SVB bank run case study was examined in the second chapter, with an emphasis on social media's contribution to the crisis. Even neutral tweets during the run period had a detrimental effect on the bank's stock performance, and a financial statement analysis was performed to delve deeper into the understanding of SVB's business model. The sentiment research verified that SVB's stock losses were directly and significantly impacted by unfavorable Twitter sentiment. These effects were enhanced by tweets from the startup community or those that specifically mentioned bank runs and contagion. This demonstrates the critical function that social media plays as a vehicle for the expression of investor sentiment in real time, as well as a potent amplifier of financial instability. It was reasonably studied that prior exposure to social media conversations may serve as a warning flag for stock market losses, especially when susceptibility is at its highest. This case

study emphasizes how important it is for contemporary financial institutions to keep an eye on social media trends and modify their risk management plans accordingly.

In the third chapter, the analysis was expanded to include the Credit Suisse case, where a preliminary study was carried out on the connection between the stock returns of the company and the sentiment of Reddit's community before it was acquired by UBS. The findings demonstrated a robust, favorable relationship between social media sentiment and changes in stock prices. The attitude that investors expressed on social media at uncertain times, such as the last few weeks before the acquisition, turned out to be a good predictor of stock price behavior. Although social emotion had a significant role in determining market movements, the study also recognizes the impact of events related to the company and macroeconomic considerations. These extra variables highlight how complex stock price swings are, suggesting that social media opinion is just one of many crucial elements to take into account when doing financial analysis.

However, a key limitation encountered during this research was the choice of social media platforms for data collection. While Twitter (now X) is one of the most widely used platforms for real-time sentiment analysis, accessing its data required a paid API subscription, which posed challenges in terms of resource allocation. In contrast, Reddit's API is free to use, making it a more accessible platform for sentiment analysis.

However, the different nature of Reddit's forum-based discussions, which are often more detailed and threaded, contrasts with Twitter's shorter, real-time posts. This discrepancy may have influenced the scope of the findings, as the broader (in terms of posts' volumes) social sentiment captured on Twitter was only partially represented through the Reddit dataset.
Similarly, Alpha Vantage was the only free stock data API provider used in the study. While it offered hourly stock price data, it did not provide the shorter timeframes that would have allowed for a more detailed and granular analysis of stock price movements in real time.

This thesis' main finding is that social media has significantly altered the way that financial decisions are made and information is disseminated. With the use of social media platforms, investors and the general public can communicate effectively and at a minimal cost. These platforms circumvent established media routes and facilitate real-time debates that have the potential to quickly impact market behavior. Both the SVB and Credit Suisse case studies show how social sentiment, especially when negative or driven by fear, may have a substantial impact on stock prices and the stability of the market as a whole. In times of crisis, when there is a great deal of uncertainty and vulnerability, this effect is especially noticeable.

The results of this thesis also urge the creation of more sophisticated analytical instruments capable of capturing the intricate and quick-changing dynamics of social sentiment in financial markets. The real-time, frequent nature of social media conversations is frequently overlooked by traditional financial models, which leaves gaps in risk management and market forecasts. As social media keeps evolving, our understanding of its impact on financial behavior must also adapt.

To conclude, this thesis has added to the expanding corpus of knowledge that studies the relationship between financial markets and social media mood. Through the case studies of SVB and Credit Suisse, it is shown how important social media is in influencing market responses, especially in times of crisis. Both qualitative and quantitative studies have demonstrated an association between social sentiment and stock returns, highlighting the growing significance of sentiment monitoring in contemporary finance. Subsequent investigations into this correlation should continue, with an emphasis on how various sentiments—such as fear, confidence, and uncertainty—manifest across different platforms and sectors. By doing this, we can enhance our understanding of the rapidly changing financial markets of the digital era.

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