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Road to a Resilient Financial Sector: Impacts of the Dodd-Frank Act on Systemic Risk.

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Abstract

The U.S. financial sector has been plagued by crisis in the last few decades. The Dodd-Frank Act was the most substantial set of reforms in recent history aimed at making the financial sector more resilient and stable than before. We analyze the effects of the Dodd-Frank Act in reducing systemic risk in the financial system. We find that the Dodd-Frank Act reduced systemic risk in the financial system by conducting a panel regression on 15 of the most prominent financial institutions in the U.S. However, our results suggest that the enactment of the Dodd-Frank Act and the Global Financial Crisis '08 coincide acting as the main driver for the reduction in systemic risk. It is imperative to refine risk-management tools and make data more accessible in order to protect the financial sector from future crises as the health of our economy depends on it.

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Dedication

To my mother, who I love dearly.

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1
Introduction

The period between 2008 and 2020 marks more than a decade of difficulties for the global economy. In 2008, the Global Financial Crisis (GFC '08), left a destructive trail of losses worth trillions of dollars, and anaemic economic growths. The jolt to the economic order in the shape of the GFC '08 raised questions on the ability of the financial system to identify and manage risks.

The 20th century saw the rise of 'financial capitalism' with financial firms at its core. The financial system is an important part of the overall economy. When the system works well, it channels funds to investment projects that make the economy more productive. The financial sector is needed to deal with the short-term fall-out from any crisis and can help shape the transformation to a sustainable economy.

Later in the 20th century, the U.S. experienced a wave of consolidation in the financial sector. This consolidation caused a seismic shift in the finance industry. The financial products that began to emerge their trade was based on complex computations, and formulas underlying assets valuation. The main issue with this particular evolution of capitalism is that not many understand its working. Financial capitalism can be hard to grasp for even the brightest, but finance affects even the poorest. It is disconcerting that major gains accrue to only a very small minority but losses are shared by everyone. To put things in perspective, historically it took

the fall of empires like Rome to set-off wide-scale economic repercussions. However, in 2008 it took the fall of only two firms (Lehman Brothers and Bear Stearns) in New York to set off a cataclysmic event that not only shaved off trillions of dollars from global wealth and GDP, but also led to widespread joblessness. The failures of systemically important financial institutions (SIFIs) or too big to fail (TBTF) firms in '08 bore costs to the entire system. The risk that these TBTF firms will fail, and will have negative effects on the real economy is called systemic risk.

In normal conditions, consolidation is highly beneficial to the financial system as risk is diversified among the constituents of the financial system. Hence, under normal circumstances the firms taking larger risks, grow in size reaching a point where the failures of these firms can impose costs on the entire system. Pre-GFC '08 firms exploited loopholes in the regulatory capital requirements and took a $2 trillion to $3 trillion highly leveraged bet on the housing market. This bet was safe until the housing market took a downturn. The fact that these firms took those bets was because of the guarantees provided by the government. When these firms almost collapsed in 2008, the government was forced to rescue these firms, reinforcing systemic risk in the system. Therefore, a need emerged to assess systemic risk to ensure the financial sector has the capacity to cover its liabilities.

One of the dire consequences of GFC '08 was that the public lost faith in a system where the rules of the game seemed to be biased in a favor of a few. GFC '08 exposed the inadequate and fragmented infrastructures hindering risk identification. The 10-member Financial Crisis Inquiry Commission formed after GFC '08 said regulators failed to adequately police financial markets that led to poor risk management and corporate governance practices.

In order to restore the trust of the public in the financial system, the Obama administration enacted the Dodd-Frank Act in 2010. In a speech at the Federal Reserve's annual economic policy symposium in August 2017, Federal Reserve Chairwoman Janet Yellen claimed that the regulatory reforms instituted by the Dodd-Frank Act have boosted the resilience of the financial system, promoted market discipline, and reduced the problem of too-big-to-fail. Elizabeth War-

ren said the Dodd-Frank Act, the 2010 law that dramatically toughened financial regulation in response to the crisis, was not perfect, but it moved us in a big step in the right direction.

The Dodd-Frank Act was one of the most profound sets of regulations with broad implications for the entire financial system so it's hard to term the act as an overall success. However, an effective way to measure the success of the Dodd-Frank Act is by looking at the impact of specific laws in the act. One of the provisions of this dense Act was establishing a new Financial Stability Oversight Council ("FSOC"), charged with identifying and responding to emerging risks throughout the financial system.

In this paper, we aim to answer the question: Did the Dodd-Frank Act reduce systemic risk in the financial sector? To my knowledge, this empirical study is the first of its kind as there is no literature that uses panel regressions to evaluate the impact of Dodd-Frank Act on systemic risk.

In our study, we run a panel regression analysis on 14 U.S. bank holding companies with asset value over $50 billion in 2010 and AIG. We chose the largest banks and insurance company in the U.S. as a representation of the financial system considering the fact that systemic risk is mainly generated by the bigger banks. We use a market based measure of systemic risk, $\Delta CoVaR$, developed by Adrian and Brunnermeier (2016) to measure systemic risk in the U.S. financial system. This measure corresponds to the value at risk (VaR) of the financial system conditional on institutions being under distress. Systemic risk was seen to increase pre-GFC'08 hiting its peak in 2008. Post GFC '08 systemic risk dipped as banks became more cautious. Now can this decrease in systemic risk be attributed to the Dodd-Frank Act? To answer this question we select independent variables that capture the macroeconomic environment like GDP per capita, inflation, liquidity, and sovereign risk. Another potential confounder is the dot-com bubble as systemic risk was high when the dot-com bubble burst. Hence, we use a dummy variable to control for the effect of the Dot-com crisis. We also use a dummy variable to control for GFC '08.

According to our findings, the Dodd-Frank Act caused a meager decrease in systemic risk, however, these results are highly sensitive to the definition of the GFC '08. Hence, we can not definitively conclude if the decrease in systemic risk can be attributed to the Dodd-Frank Act. The complications of the financial system makes the study of the Dodd-Frank Act especially challenging.

Studying the impact of Dodd-Frank Act is extremely difficult as the Act affected each bank in a different way. No two banks have the same capital structure, and hence their exposure to risk varies enormously. Also, the Dodd-Frank Act is work in progress, as many provisions of the Act came into effect gradually. It is also particularly challenging to disentangle the effects of GFC '08 from the Dodd-Frank Act because it was passed in a time when banks were hesitant to take risks. We set a dummy variable to capture the effect of GFC '08. In order to make our findings robust, we consider four cases of the GFC '08 where each case is a different length of the GFC '08. The length of the GFC '08 is arbitrary as there are numerous stages of a crisis. A startlingly result emerges when we consider the extreme case of GFC '08 which stretches from 2007:Q2 to 2013:Q2. According to this result, systemic risk increased when the Dodd-Frank Act was enacted. This revelation casts doubts on the effectiveness of the Dodd-Frank Act.

We reflect whether our results are influenced by the big five banks in our sample which comprise more than 75% of total assets of all financial institutions in our sample. Our results show that the Dodd-Frank Act did not have a significantly different impact on the big five banks as their systemic almost went down by almost the same as the other financial institutions in our sample.

This paper is organized as follows. Chapter 2 presents a background to the Dodd-Frank Act and explains its main features. In Chapter 3 we review literature on systemic risk and the Dodd-Frank Act. Chapter 4 illustrates our empirical methodology, and chapter 5 concludes while presenting policy implications.

2
Background

In this chapter, we present a backdrop to the Global Financial Crisis '08 and the Dodd-Frank Act. Section 2.1 gives a summary of events that caused the financial meltdown in 2008, Section 2.2 describes consolidation as a possible cause of the GFC '08, Section 2.3 overviews macroprudential regulation, Section 2.4 overviews microprudential regulation, Section 2.5 finds commonalities between macroprudential and microprudential regulation, Section 2.6 gives a comprehensive summary of the Dodd-Frank Act, Section 2.7 assesses Dodd-Frank Act's impact on the banking industry, Section 2.8 aims to define systemic, and Section 2.9 looks at criticisms and the recent rollback of the Dodd-Frank Act.

2.1 Evolution of the Global Financial Crisis '08

The 2007-09 Global Financial Crisis (GFC) sent shock waves across the globe and left a lasting impact on the financial sector. Few could have imagined that such dramatic changes could occur within such a short time: the rescue of Bear Stearns, and American Insurance Group (AIG), the collapse of Lehman Brothers, and government takeovers of Fannie Mae and Freddie Mac.[8]. The crisis resulted in the collapse of the stock market, the loss of eight million jobs, and more than four million homes were lost to foreclosures.

The repercussions of this crisis are still felt today, such as low-interest rates and global imbalances. Escalation of oil prices and insufficient flow of capital led to an almost unprecedented rise in the US's foreign debt and deficits in the current account. More than anything this debacle exposed the deep fault lines in the global economy.

The Queen of England famously asked the top economists of the U.K why they didn't see "it" coming, where "it" referred to the GFC '08. This straightforward question raises some very serious questions on the ability of forecasters to predict an economic downturn of this nature. It was expected that a robust financial system that followed guidelines for bank capital adequacy as laid down by the BASEL accord in the late 1980's should generate early warning signals. These signals were expected to help policymakers preempt future crises by giving them time to design appropriate policy responses.

A difference of opinion exists between economists on early warning signs of a looming crisis. Some academics emphasize that all major financial crises were preceded by large run-ups in private debt burdens. The "fundamentalists" argue that recessions are caused by some fundamental shock to the economy, such as, a natural disaster or political instability. In the animal spirit's view, economic fluctuations are driven by irrational beliefs e.g prior to the GFC '08 people believed that house prices would rise forever. The banking view holds that the major problem with the economy is a weakened financial sector that stops the flow of credit. It is beyond the scope of this paper to ascertain the cause of severe recessions, but it is helpful to understand the developments in the financial sector in the last few decades to fully understand the source of GFC '08.

2.2 Consolidation in the Financial Sector

The degree of association between financial institutions is constantly increasing and becoming increasingly complicated through various ties. With the passage of the 1999 Gramm-Leach-Bliley Act (GLBA), which eliminated the Glass-Steagall Act division between investment and commercial banking, the U.S. experienced a broad-based consolidation wave in the banking sector.

GLBA led to mega-mergers in the finance sector. These mergers allowed banks to integrate different lines of business in their original business model. In 2000, Charles Schwab acquired US Trust Company and Chase Manhattan Corp acquired J.P. Morgan Co. In 2003, Wells Fargo acquired Goodritz-Emanuel Insurance, Wisenberg Insurance, and McDermott Brokerage, Inc.

Post the dot-com crash of 2002, when the technology stocks came crashing down to 2008 when the GFC'08 was at its peak, monetary policy was accommodating to risk-taking. The target federal funds rate fell from 6.50 percent in December 2000 to 1.75 percent in December 2001 and to 1.00 percent in June 2003. Low interest rates enabled an increase in activity in the housing market which contributed to the rapid growth in house prices forming a housing bubble. The banks seized the opportunity presented and innovated in the face of the housing bubble coupled with cheap and readily available credit. A benign economic environment, with low inflation, low interest rates, and steady growth increased the risk appetite for the big banks, and demand for risky assets such as mortgage-backed securities and collateralized debt obligations began to grow.

In this suitable environment, commercial banks began to enter new lines of business such as, underwriting and trading securities, brokerage, and investment banking which proved to be detrimental to the stability of the financial system. Rising non-interest income for banks from underwriting fees, commission, etc. led to pro-cyclical behavior and herding. Banks invested in a variety of assets leading to an increase in asset prices as herd behavior triggers additional demand for these assets. Risk assessment tools like VaR reinforced risk-taking as it is naturally pro-cyclical in nature. As a result, banks started investing in risky assets leading to an extraordinary level of leverage. This leverage grew within financial institutions rather than with the outside economy. The deregulation post-GLBA and lack of effective risk management tools enabled enormous profits for a few firms creating a powerful incentive to take risk amplifying the credit cycle.

Consolidation creates a number of systemically important financial institutions. These institutions in the U.S as defined by the Federal Reserve, have significant on-and off-balance sheet

risk exposures, offer a broad range of products and services at the domestic and international levels, and are subject to multiple supervisors in the United States and abroad.

In the GFC '08, the term "Too-big-to-fail", (TBTF) was first introduced by the U.S. Congressman Stewart McKinney in a 1984 Congressional hearing, gained prominence and became a part of public discourse. This term primarily refers to systemically important financial institutions, however, TBTF emerged from government guarantees of repayment of large uninsured creditors of the largest banks so that no depositor or creditor suffers a loss. Federal Reserve Chair Ben Bernanke also defined the term in 2010: "A TBTF firm is one whose size, complexity, interconnectedness, and critical functions are such that, should the firm go unexpectedly into liquidation, the rest of the financial system and the economy would face severe adverse consequences."[18].We can deduce that if a systemically important firm or TBTF firm experiences a severe financial problem it could lead to a disorderly resolution process that could have a serious impact on both domestic and international financial markets.

Case in point: on 15 September 2008 when the insolvent Lehman Brothers, one of the five largest US investment banks, filed for bankruptcy the world witnessed the full threat potential of a global financial system with a growing population of TBTF banks. In less than a week, Morgan Stanley and Goldman Sachs, the two largest remaining US investment banks, were classified as bank holding companies, and thus given TBTF protection as they were insolvent.

The combination of consolidation and increased market activity may help an idiosyncratic shock to an individual firm to propagate more widely. For example, if a weakened firm sells a large number of marketable assets this could depress prices significantly, and thus weaken institutions that are holding similar assets. It can be argued that bank size and scope of activity is a principal cause of crises, a 2013 Bank for International Settlements (BIS) report stated: "A bank's distress or failure is more likely to damage the global economy or financial markets if its activities comprise a large share of global activity."[17].

Once a TBTF institution is in crisis, its individual risks will be rapidly transmitted through relationships of assets and liabilities, the irrational herd effect of investors and market expecta-

tions. Subsequently, other financial institutions will further magnify the external influence of the financial institutions' risks and may even cause catastrophic damage and huge systemic losses to the entire financial system and seriously jeopardize the sound and smooth operation of the entire economic society. [10].

The traditional financial supervision of individual financial institutions has made it difficult to monitor the systemic risk (discussed later) of such financial institutions. Contagion and connectedness of institutions make it easy for risks to be transferred among institutions. A long time belief that by safeguarding individual institutions, the entire financial system will be safe was seen to fail in practice as financial institutions tend to behave in a manner that jointly undermines the financial system so it is imperative to understand the difference between micro-prudential and macro-prudential regulation.

2.3 Macroprudential Regulation

Macroprudential policies address risks to the financial system as a whole. The health of Individual financial institutions are a necessary condition for a sound financial system. However due to the complexity of the financial system and due to "fallacy of composition" actions apparently suitable at the institutional level can destabilize the system as a whole because of their interaction with financial markets, the structure of the network of which they are part, and the behavior of other financial institutions. [30].

Macroprudential policy aims to lean against the financial cycle and to strengthen the resilience of the financial system. The objective of macroprudential policy is to avoid output and wealth losses in the long run by limiting the buildup of system-wide financial risk by acting as a countervailing force to the natural decline in measured risks in a boom and the subsequent rise in measured risks in the downturn. Macroprudential policy adjusts overall levels of capital based on the financial cycle and systemic relevance to guard against systemic risk buildup. The role of macroprudential policy is to identify risk concentrations, common exposures, linkages, and

interdependencies that are sources of contagion and spillover risks, and to issue advice or take action if it feels like these events may give rise to systemic concerns.

Once the financial cycle turns and losses begin to emerge, the macroprudential concern is with stabilizing the broader system and avoiding excessive deleveraging pressures that—if acute—can lead to or exacerbate a crisis, with loss of confidence and a credit crunch. The macroprudential authority seeks to detect threats to the stability of the financial system stemming from other public policy areas (e.g., microprudential, macroeconomic, structural, etc.). Macroprudential policy can help contain systemic risk by alerting relevant authorities or pushing for reaction.

2.4 Microprudential Regulation

The objective of microprudential regulation is to promote the safety and soundness of banks and the banking system. The microprudential authority performs the supervisory function and leads the relationship with the individual firm. The microprudential approach is to reduce the likelihood of failure of individual institutions and idiosyncratic risk, regardless of their impact on the economy. Microprudential policies examine the responses of an individual bank to exogenous risks and do not incorporate endogenous risk and the interconnectedness with the rest of the system.

Microprudential policy adjusts capital based on individual institutions' risks. Microprudential policy instruments, such as risk-based capital adequacy requirements, can be procyclical. For example, in times when risk is perceived to be high, selling an asset could be seen as a prudent response by an individual bank. But if many banks follow this approach, asset prices will collapse, and such generalized downswings in asset prices may lead to huge volatility in asset markets.

The microprudential supervisor is mainly concerned with the minimum level of capital needed to ensure the resilience of an individual institution at any given point in time. Once the financial cycle turns and losses begin to emerge, the microprudential concern is to ensure the stability of the individual firms. Microprudential regulation largely ignores the systemic importance of

individual institutions in terms of its size, complexity, extent of leverage, and interconnectedness with the rest of the financial system. [22].

2.5 Areas of Overlap

There are a number of areas in which macroprudential and microprudential mandates overlap. Solvency and liquidity risks which fall under the microprudential supervisor can quickly spread through the whole economy through fire sales and contagious runs increasing systemic risk. Confusion arises in who is ultimately responsible for addressing emerging systemic risk. The microprudential supervisor needs to take into account risks arising from the external environment. These system wide risk assessments are carried out by the macroprudential supervisor. We will discuss systemic risk in detail later in this chapter.

There was a need to introduce legislation that accounted for both macroprudential and microprudential regulation as separating the two roles had not been effective in reducing risk. The disorders that resulted from the GFC '08 caught the government's attention as the frequent boom-and-bust cycles left everyone worse off. To make matters worse, bankers paid themselves handsome bonuses from a public bailout. In order to restore the public's trust in the financial system, the financial system had to be redesigned to mitigate risk and protect investors from asset bubbles. The Dodd-Frank Act was proposed in Congress by Chris Dodd and Chairman Barney Frank on December 2nd, 2009.

2.6 Dodd-Frank Act

On July 21st, 2010, President Obama signed the Dodd-Frank Act which was by far the largest financial reform since the Great Depression. This Act brought changes in the financial regulatory landscape of the United States that was built over more than a century in response to crises. New regulatory institutions were formed and responsibilities increased for existing regulatory entities marking a significant shift in the complex and fragmented regulatory system in the U.S.

A central element of the Dodd-Frank Act is the requirement that the Federal Reserve and other financial regulatory agencies adopt the macroprudential approach. In concrete terms, The Dodd-Frank Act setup a new body, the Financial Stability Oversight Council, to monitor the U.S financial system by identifying risks that threaten the stability of that system, and promoting market discipline that mitigates excessive risk-taking in financial markets. The Dodd-Frank Act also established within the Treasury Department, the Office of Financial Research, which is responsible for improving the quality of financial data available to policymakers which allows regulators to see more of the financial landscape and better equip them to identify systemic risks and other emerging threats.

In terms of microprduential regulation, the Dodd-Frank Act provided its own stringent capital guidelines and introduced stress testing. The Dodd-Frank act requires bank holding companies with at least $50 billion in assets to maintain a leverage ratio of at least 6.5% to mitigate the risk of illiquidity in these firms. Furthermore, the supervisors increased emphasis on the effectiveness of banks' own capital planning processes so banks are in a better position to meet capital requirements set by regulators. Under stress testing, expected capital ratios of banks under a hypothetical economic downturn are compared to regulatory benchmarks. Stress tests are a structured way for supervisors to assess if banks hold enough capital, know whether banks can accurately assess their risk exposures, and access credible information about prospective losses at banks.

The Dodd-Frank Act has a wide scope as it aims to reduce the systemic risk in the finance sector. More broadly, this Act is a preventive measure that restricts the recurrence of potential financial catastrophes in the future by reforming the operational procedures of many institutions. It impacts a wide range of financial services companies including banks, hedge funds, thrift, mortgage businesses, insurance companies, and credit rating agencies among others. Reforming these industries which are the backbone of the financial sector in the U.S. is imperative to meet the aims of the Dodd-Frank Act which is to promote the financial stability of the U.S. by improving accountability and transparency in the financial system. In order to meet these far-

reaching and substantial goals, the Dodd-Frank Act comprises of 16 titles that each addresses a significant matter.

Title 1 takes into consideration systemic risk of the financial system and creates two new governmental agencies: the Financial Stability Oversight Council and Office of Financial Research. These agencies identify risk and promote market discipline.

Title 2 creates the Orderly Liquidation Fund to address the insolvency of financial companies.

Title 3 increases the maximum amount of deposits insured by FDIC and abolishes the Office of Thrift Supervision.

Title 4 mandates three studies by the Government Accountability Office and Security Exchange Commission and seeks to improve transparency by mandating reporting requirements.

Title 5 creates the Federal Insurance Office to identify regulatory gaps that could lead to a future crisis.

Title 6 creates a separation between banking and other types of financial services and calls for disclosure of capital requirements.

Title 7 regulates over-the-counter swaps and directs the Commodity Futures Trading Commission to define security swap terms and oversee the derivative markets.

Title 8 gives more power to the Federal Reserve to create uniform standards and regulations that target too-big-to-fail financial institutions.

Title 9 mandates the creation of the Office of the Investor Advocate to develop point-of-sale disclosure rules for investors. It gives the SEC the power to regulate shareholder proxy materials, and also regulates asset-backed securities while mandating disclosure of incentive-based compensation.

Title 10 creates an independent Bureau of Consumer Protection that is tasked to research, track complaints, ensure fair lending, and improve financial literacy.

Title 11 gives the President the authority to appoint the New York Fed President and creates a new position for vice chairman to supervise the Board of Governors. This title includes provisions for the FAO to audit the Federal Reserve.

Title 12 creates programs such as financial education, microloans, banking the unbanked etc to utilize mainstream financial services.

Title 13 amends the Housing and Economic Recovery Act of 2008, American Recovery and Reinvestment Act of 2009, and Emergency Economic Stabilization Act of 2008 while reducing the funds available to the Troubled Asset Relief Program.

Title 14 regulates mortgage originators by creating an Office of Housing Counseling within the Department of Housing and Urban Development and defining "high-cost mortgages". This title also defines property appraisal requirements and tasks the Department of Housing and Urban Development to introduce a mortgage resolution and modification program.

Title 15 includes some miscellaneous laws that relate to natural resource mining etc.

Title 16 gives a new definition to marked to market trades in Section 1256 contracts to exclude derivatives and futures contracts or options.

2.7 Dodd-Frank's Impact on the Banking Industry

The segments of the markets and institutions affected by the Dodd-Frank Act include the derivatives market, insurance companies, and broker dealers. However, one of the most affected institutions by the Dodd-Frank Act were the bank holding companies. Although there is no one all-encompassing definition of a financial crisis, the GFC '08 in the United States is widely considered to have been a banking crisis. There are different charters a banking institution can choose, and regulations depend on the charter of the bank which can be obtained at the state or federal level; these charters include, foreign banking organizations, consumers and mortgage banking, commercial banks, credit unions, thrifts and bank holding companies.

Commercial banks focus on banking needs of businesses whereas thrifts serve the mortgage needs of those not served by commercial banks. Credit unions are member-owned cooperatives run by member elected boards, and serve people with modest means. A bank holding company is a corporation that owns a controlling interest in one or more banks but does not offer banking services itself. According to the Fed, Foreign Banking Organizations carry out a wide variety of

banking activities through subsidiaries, branches, agencies, and representative offices in the U.S. Consumer banks provide services to consumers such as financial advice, mortgages and saving accounts.

Broadly, bank regulators establish capital requirements, monitor a bank's financial condition, and monitor compliance with banking laws. Regulators also issue regulations, take enforcement actions, and close banks they determine to be insolvent. Section 619 of the Dodd-Frank Act directly targets banks and has been in force since July 21, 2015. This section is the Volcker rule that restricts banks from engaging in proprietary trading and sponsoring hedge funds and private equity firms. Under the Federal Reserve Board (FRB) which takes the capital adequacy provisions of the Dodd-Frank Act into consideration, banks are also required to hold sufficient capital.

With respect to Foreign Banking Organizations (FBO), an FBO is defined as a bank holding company if it has a consolidated asset value of over $50 billion, and is considered a systemically significant institution. The Financial Stability Oversight Council (FSOC) determines whether a bank is systemically important, and this decision is based on the possible threat that this foreign bank holding company poses to the U.S financial system. The regulations applicable to FBOs' in their home countries are applied to the standards for U.S. comparable U.S. bank holding companies. It is important to note that the Volcker rule does not apply to FBOs', but they are still mandated to maintain minimum capital requirements.

Mainly, the Dodd-Frank Act affected banks in two ways. One, it created downward pressure on the profitability of the banking industry. Two, it created upward pressure on capital requirements. Sufficient capital is needed to sustain losses in a downturn whereas higher compliance and regulatory requirements meant banks had to hire new people or in some cases build new departments to comply with the new regulations. Furthermore, the Consumer Financial Protection Agency creates downward pressure on profits in the shape of fees and commissions from mortgages, lending, and other credit products. The greater authority provided to this agency through the Dodd-Frank Act affects banks' profitability. Also, the swap-push out provision in-

troduced by Senator Blanche, reduced the leverage available to banks which according to some measures increased from 12-to-1 in 2004 to 33-to-1 in 2008.

One of the main features of the Dodd-Frank act was to remove TBTF banks. Specifically, Section 1101 of the Dodd-Frank Act amended section 13(3) of the Federal Reserve Act to eliminate emergency funding to individual firms. There was some skepticism around this rule if it is only adopted in the U.S as it could affect U.S's financial competitiveness. Other countries can benefit from TBTF banks as these banks generate higher investment returns making their markets more attractive to the investor. Another way TBTF and other big banks made staggering profits was through investment advisors who charge high fees and banks earn revenue. Infamously, in the follow-up to GFC '08, Goldman Sachs made tens of millions of dollars by betting against their own clients through shorting the housing market and simultaneously sold Mortgage-Backed Securities to their clients.

2.8 Systemic Risk

The Dodd-Frank Act focuses on systemic risk. Through the GFC'08 we learned a single institution's risk measure does not necessarily reflect its contribution to overall systemic risk. In times of financial crisis, losses spread across financial institutions, threatening the financial system as a whole. The spreading of distress gives rise to systemic risk—the risk that the intermediation capacity of the entire financial system is impaired, with potentially adverse consequences for the supply of credit to the real economy. The externality of financial institution risk means that a single financial institution increases its profits by expanding its balance-sheet and off-balance-sheet business scale and leverages, and controls its own risks through financial innovation; however, the risks within the entire financial system do not simply disappear but are instead transferred and redistributed. Thus, the health of a single financial institution does not necessarily mean that the entire financial system is safe. [21].

As we discussed earlier, consolidation has led to larger organizations taking on larger risk exposures to individual obligations or industries increases financial risk. Financial risk is defined

to encompass both individual financial institutions and a systemic financial crisis. A systemic crisis disrupts the stability of the financial system which has serious consequences for the whole economy. The Group of Ten has defined Systemic Risk by: "Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy. Systemic risk events can be sudden and unexpected, or the likelihood of their occurrence can build up through time in the absence of appropriate policy responses. The adverse real economic effects from systemic problems are generally seen as arising from disruptions to the payment system, to credit flows, and from the destruction of asset values."[29].

Systemic risk is one of the most elusive concepts in finance. Policymakers, regulators, academics, have yet to reach a consensus on how to define systemic risk. The European Central Bank (ECB) defines it as a risk of financial instability "so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially." [27].

Once a financial event has become systemic, effects on the real economy are generally thought to occur potentially through three channels. First, payment system disruptions, including bank runs, may cause the failure of illiquid but solvent firms. Second, disruptions in credit flows may create severe reductions in the supply of funds to finance profitable investment opportunities in the real economy. Third, collapses in asset prices may induce failures of financial firms as well as non-financial firms and households, and decrease economic activity through a decline in wealth and an increase in uncertainty.

Let's consider an example to fully understand how systemic risk perpetuated in the financial system can bring the entire economy to the brink of collapse. Suppose there are three banks in the entire economy: bank A, B, and C. Bank A has $5 billion in assets which includes $2 billion in CDOs, and $3 billion in loans. Bank A also has $4 billion in liabilities, hence, it has a net worth of $1 billion. For simplicity let's assume bank A, B, and C have the same balance sheets.

The liabilities of Bank A include loans from bank B. The loans given out by bank B to bank A are recorded as assets in bank B's balance sheet. $1 billion out of $5 billion bank A has in assets is a loan to bank C which is recorded as liability for bank C. Bank C lends $1 billion to bank B which is an asset for bank C, but a liability for bank B. When the loan from bank B made to bank A comes due, bank A has to rely on the CDOs which are its most liquid assets. However, we know that the CDOs consisted of toxic assets which even the Fed wasn't ready to accept as collateral, so bank A has to file for bankruptcy. Then bank B is in distress because it owes money to bank C, and the CDOs are worth nothing as they've been downgraded by the rating agencies, so bank B has to write down its assets to $4 billion as bank A is not coming good on the loan. Bank' B total assets now equal $2 billion down from $5 billion which are illiquid so bank B has to file for bankruptcy. Consequently, bank C comes under distress, and there is a chain reaction in the financial sector causing multiple banks to fail, and systemic risk to rise.

2.9 Criticisms and Rollback of the Dodd-Frank Act

Just like with any other piece of legislation, there were concerns on the effectiveness of the Dodd-Frank Act in making the financial system safer and efficient while fostering economic growth. In May 2018, President Trump signed an executive order that was the biggest rollback of bank regulations since the GFC. The rollback included raising the threshold to $250 billion from $50 billion under which banks are deemed too important to the financial system to fail. This implies that those institutions would not have to undergo stress testing. These measures were in line with President Trump's deregulation plan, however, aside from politics critics of the Dodd-Frank Act raise genuine concerns that demand attention.

Regarding the firm-level impact of the Dodd-Frank Act, researchers at the Minneapolis Federal Reserve estimate that the cost of increased regulation could have decreased community banks' return on assets by between 12 and 14 basis points. Due to this heavy compliance burden and loss in revenue, small banks are disappearing. Small banks or community banks focus on relationship banking which help them serve the needs of a diverse U.S. economy composed

of different businesses and consumers with diverse needs. Losing community banks exposes the financial system to higher systemic risk from larger banks as community banks pose little systemic risk to the nation's financial system.

The Dodd-Frank Act also included a provision that bans the Fed from providing emergency loans to a single firm, as it did in 2008 with AIG and Bear Stearns. Instead, these loans are offered to a category of institutions. It is feared that by restricting the Fed's ability to bailout financial we can see a number of runs on insolvent institutions leading to panic, and consequently hurting the real economy. Moreover, it can be argued that the Volcker rule has dramatically reduced the liquidity of corporate bonds and other fixed-income markets, leaving financial markets more vulnerable to future crises. In a nutshell, critics argue that the Dodd-Frank Act did little to address the root causes of the crisis, and simply expanded the federal safety net for financial firms.

By some measures, the Dodd-Frank Act can be characterized as a "work in progress" as it has some unfinished business in respect to streamlining the U.S. financial regulatory architecture. Although the Dodd-Frank Act improves access to financial data, the overlapping jurisdictions of regulatory bodies create friction and prevents a single body to take an overall view of the financial system. When it comes to credit rating agencies, the Dodd-Frank Act mandated the removal of credit ratings from regulations—a process that unfortunately remains incomplete. This mandate limits competition by curbing the entry of new firms, and hence three firms dominate the credit rating market.

The Financial CHOICE Act, passed by the House in June 2017, relaxes some Dodd-Frank regulations but leaves most of the regulatory framework in place. The CHOICE Act of 2017 allows firms to bypass quite a few amounts of Dodd-Frank regulations if financial organizations choose to be well-capitalized. The CHOICE Act proposed repealing the Volcker Rule to restructure the Consumer Financial Protection Bureau. The future of the Dodd-Frank Act hinges on the political climate and administration changes. The Biden-Sanders unity task force called for strengthening the Dodd-Frank Act, in particular calling for more separation of commercial and

investment banking activities, and the creation of a federal credit reporting bureau at the CFPB. President Biden pledged to boost the Dodd-Frank Act, but is still vague on the details.

3
Literature Review

Vast amounts of literature has been produced to answer the critical question regarding the changes in the financial system as a result of the rigorous and complex financial regulations that were imposed since GFC '08. In this chapter, we review papers that evaluate the Dodd-Frank Act (Section 3.1), define systemic risk and its implications in a crisis (Section 3.2), compare different systemic risk measures (Section 3.3), and assess the effectiveness of regulation in creating a resilient financial system (Section 3.4).

3.1 Dodd-Frank Act

The global financial crisis, which erupted in the middle of 2007, (GFC'08) has highlighted the inadequacy of existing banking regulations with regards to safeguarding systemic stability. [44]. Allen et al. (2018) consider some important questions in designing effective financial regulations to achieve financial stability and mitigate systemic risk. They conclude that regulators have placed regulations that are dependent on complex models. The authors suggest simpler and more nimble regulations as complex subjective regulation leads to ambiguity and market manipulation. An important aspect of the paper is the review of the Dodd-Frank Act which is considered the largest financial reform since the Glass Steagall Act 1935. Among other things, the Dodd-Frank Act required banks to be better capitalized to absorb unexpected losses during downturns.

Mainly, the Dodd-Frank Act serves two objectives. Its first objective is to limit the risk of contemporary finance aka shadow banking systems. The second objective is to limit the destruction caused in the event that a systemically important institution does indeed fail, despite everyone's best efforts to prevent that from happening. [40].

Balasubramniana et al. (2014) argue that the Dodd-Frank Act has statistically and economically improved market discipline even for large banks. Market discipline aids bank regulators in identifying riskier banks and in taking appropriate regulatory actions to prevent excessive risk-taking. [19].

The Dodd-Frank Act introduced stress testing which assesses the impact on capital levels that would result from immediate financial shocks. Acharya et al. (2017) focus on the U.S. bank stress tests – the Supervisory Capital Assessment Program (SCAP)- of 2009 and the Comprehensive Capital Analysis and Review (CCAR), conducted since 2011. The difference-in-difference method is used to study the effects of the stress tests. Their investigation is focused on the supply of credit, particularly to relatively risky borrowers. The dependent variable is loan spread whereas control variables include capital adequacy, liquidity, and the log of the book value of assets of the borrower. They conclude that banks subject to stress tests reduced credit supply to relatively risky borrowers to decrease their credit risk, uncovering a positive impact of the Dodd-Frank Act on financial stability. [3].

Schafer et al. (2013) investigate whether financial reforms over the world have had any measurable effects by carrying out an event study analysis on the four major regulatory reforms in Europe and the United States. These reforms include the Dodd-Frank Act in the United States, the reforms proposed by the Vickers report in the United Kingdom, the restructuring law and bank levy in Germany, and the TBTF regulation in Switzerland. By analyzing the reaction of stock returns and credit default spreads of banks they conclude that financial markets reacted most strongly to the structural reforms in the Dodd-Frank Act. [39].

Nolle (2012) considers US policy initiatives, the Dodd-Frank Act, related to a core dimension of a financial system reform: risks posed by systemically important financial institutions. More

importantly, this paper explores the question "Are US domestic and international financial system reform commitments in sync?". Nolle finds that the G20/FSB focus, at least over the near term, is bank-centric compared with the Dodd-Frank Act, which consistently addresses both bank and nonbank financial firms. [25].

Mohanty et al. (2018) examine the impact of the Dodd-Frank Act (DFA) and Basel III on the market risk-taking behavior of global banks by measuring the change in risk from the pre-GFC'08 period to the post-European debt crisis period. The results show a significant increase in each measure of risk (total risk, market risk, and idiosyncratic risk) for Globally Systemically Important Bank (G-SIBs) from the pre-GFC'08 period to the post-GFC'08 period, so they conclude that post-GFC'08 reforms have not been effective in reducing the risk of global banks. [34].

Ever since the Dodd-Frank Act passed there has been a copious amount of literature produced to assess the effectiveness of the Act in increasing bank resiliency among other things. Considering some important questions on the effectiveness of the Dodd-Frank Act to mitigate systemic risk in the banking sector, Allen et al. (2018) claim that not all risk taken by the financial sector is necessarily risky implying that the problem does not lie in taking risks, but in managing risks.

3.2 Systemic Risk

The traditional view of risk in the financial system is the summation of individual risks within the system. However, GFC'08 has driven home that this view of risk is inadequate. It is the interactions of financial institutions and markets that determine the risks that drive financial crises. [9]. A financial institution faces significant risks such as market, credit, operational, and liquidity risks. A critical risk that emerged from the GFC'08 was systemic risk. Note that these risks are firm-specific whereas systemic risk affects the ecosystem the firm is operating in. Systemic risk is the risk that the failure and distress of a significant part of the financial sector reduces the availability of credit, which, in turn, may adversely affect the real economy. [2].

Allen et. al (2013) identify four types of systemic risk. These are banking crises due to multiple equilibria, asset price falls, contagion, and foreign exchange mismatches in the banking system. Ozdaglar and Salehi (2015) claim that the current state of uncertainty about the nature and causes of systemic risk is reflected in the potentially conflicting views on the relationship between the structure of the financial network and the extent of financial contagion. [1].

There is a range of scholarship on the subject of financial consolidation. In their seminal paper, Allen and Gale (2000) argue that a more interconnected financial architecture enhances the resilience of the system as in a densely interconnected financial network, the losses of a distressed bank are divided among more creditors, reducing the impact of negative shocks to individual institutions on the rest of the system. [10]. Blume et al. (2013) model interbank contagion as an epidemic saying that "over-linking" in networks with contagious risk can have strong consequences for the welfare of the participants. An important reason for the growing interconnectedness of the financial system has been attributed to the shadow banking sector. [20].

Adrian et al. (2013) discuss the role of shadow banks as financial intermediaries that provide credit by issuing liquid, short-term liabilities against risky, long-term, and often opaque assets. They argue that an understanding of the "plumbing" of the shadow banking system is an important underpinning for any study of financial system interlinkages and systemic risk as the role of shadow banking in the financial system is expected to grow. [6].

Nier et al. (2008) investigate how systemic risk is affected by the structure of the financial system by constructing a banking system with high contagion. They reach the following conclusions: more concentrated banking systems are shown to be prone to larger systemic risk, better-capitalized banks are more resilient in the banking system against contagious defaults, and the size of interbank liabilities tends to increase the risk of contagion default. [12].

As Anand et al. (2013) explain firesale externalities, and funding liquidity risk also poses a huge risk to financial stability. These factors generate "fat tails" in the distribution of aggregate losses for the banking system. For instance, the interaction of people in the financial markets

who come together at the worst time, sell the same toxic assets, and generally behave in the same way increasing systemic risk which in turn causes the financial system to crash. Anand et al. (2013) obtain plausible fat-tailed aggregate loss distributions in their model consisting of a diverse set of financial agents, namely domestic banks, overseas banks, and firms, which are linked together by their claims on each other. This model is evidence that contagion or interconnectedness leads to systemic risk in the system. [14].

Tarashev et al. (2009) present a methodology that takes as inputs measures of system-wide risk and allocates them to individual institutions as it is important to distinguish between microprudential and macroprudential supervision; the former focuses on the financial system as a whole, whereas the latter focuses on individual institutions. By applying the methodology to real-world data on a sample of 20 large internationally active financial institutions, Tarashev et al. (2009) conclude that none of the financial institutions, taken in isolation, is a fully satisfactory proxy for systemic importance. [37].

Bisias et al. (2012) surveys the systemic risk measures and conceptual frameworks that have been developed over the past several years by emphasizing those analytics that could be most easily estimated and accessed. They argue that because systemic risk is a multifaceted problem in an ever-changing financial environment, any single definition is likely to fall short and may create a false sense of security. Hence, in their view, the specific measures regulators ultimately choose to deploy will become the effective definition of systemic risk. [26].

Benoit et al. (2013) defines systemic risk as measuring the contribution of a given financial institution to the risk of the system. They argue that there are two ways to measure systemic risk. One approach relies on information on positions and risk exposures. This confidential information is provided by the financial firms to the regulator. The second approach only relies on public market data, such as stock returns, option prices, or CDS spreads, as they are believed to reflect all information about publicly traded firms. [41]. In this paper, they compare the four most popular measures of systemic risk Marginal Expected Shortfall (MES) and the Systemic Expected Shortfall (SES) of Acharya et al. (2010), the Systemic Risk Measure (SRISK) of Acharya, Engle,

and Richardson (2012) and Brownlees and Engle (2012), and the Delta Conditional Value-at-Risk (CoVaR) of Adrian and Brunnermeier (2011). According to their empirical analysis of these measures, they conclude that these measures fall short in capturing the multifaceted nature of systemic risk. [41].

3.3 Systemic Risk Measures

Adams et al. (2014) propose a state-dependent sensitivity (SDS) VaR for quantifying risk spillovers among sets of different financial institutions. Reevaluating systemic risk measures such as VaR was an important lesson of GFC '08. VaR underestimated the risk magnitude of portfolios of subprime mortgages. Adams et al. (2014) estimate a system of quantile regressions for four sets of financial institutions (commercial banks, investment banks, hedge funds, and insurance companies). They find that the SDSVaR model seems useful for measuring and quantifying spillover effects, however, it does not explain the mechanisms underlying the estimated spillovers. [5].

White et al. (2010) propose a vector autoregressive (VAR) model in which the dependent variable is VaR (Value at Risk) to assess the systemic importance of individual financial institutions and of the overall market. The authors use multivariate regression quantiles to measure directly the tail dependence among the random variables of interest. Their methodology provides an alternative for stress testing, but they fail to produce a single number that can act as a measure for systemic risk. [45].

Sedunov (2016) investigates whether a systemic risk measure provides a forecast of future exposures by examining the relationship between the current measure of systemic risk and its lagged values. The three measures of institution-level systemic risk exposure he investigates are Exposure CoVaR (Adrian and Brunnermeier, 2016), systemic expected shortfall (SES, Acharya et al. 2016), and Granger causality (Billio et al. 2012). Sedunov concludes that a modified version of the CoVaR measure based on Adrian and Brunnermeier (2016) is more effective in forecasting

systemic risk exposure compared to other methods such as SES and Granger causality as they lack statistical significance in empirical tests of their forecasting ability. [32].

To assess risk at a system-wide level, we use $\Delta CoVaR$ proposed by Adrian and Brunnermeier (2016).[7]. $\Delta CoVaR$ aims to capture systemic risk in the financial system. Adrian and Brunnermeier (2016) derive $\Delta CoVaR$ from $CoVaR$ which is institution i's $CoVaR$ relative to the system. To fully understand, $\Delta CoVaR$ we need to have a solid understanding of VaR.

Before GFC '08, VaR was considered the main tool to measure risk. VaR is a very simple and popular way of measuring risk. VaR measures the maximum loss in value of a portfolio over a predetermined time period for a given confidence interval. In its most common form, it measures the boundaries of risk in a portfolio over short durations, assuming a "normal" market. For instance, if you have $50 million of weekly VaR at the 95% confidence level, that means that over the course of the next week, there is 0.95 probability that your portfolio won't lose more than $50 million.

VaR measures portfolio risk along what is called a "normal distribution curve." VaR uses this normal distribution curve to plot the riskiness of a portfolio. As you increase the confidence interval, to 99%, VaR increases as 99% VaR occurs further in the tail. There are three key elements that describe VaR: time period, dollar amount of VaR (total value of assets or portfolio), and a confidence interval.

The following mathematical formula is used to calculate VaR. Given a confidence level of $p \in [0, 1]$ and time index of $t + \alpha$, let $F_\alpha(x) = P(\Delta V(\alpha) \leq X)$ be the cumulative distribution of $\Delta V(\alpha)$ where $\Delta V(\alpha)$ is the loss in value of the asset or portfolio over the next time period α. Since $\Delta V(\alpha) \leq 0$, we can define VaR over time horizon α for p as

$$p = \mathbb{P}[\Delta V(\alpha) \leq VaR] = F_\alpha(VaR)$$

The p-quantile of $F_\alpha(x)$ is given by:

$$VaR_p = glb\{x | F_\alpha(x) \geq p\}$$

That is x such that $F_\alpha(x) \geq p$.

There are mainly three approaches to compute VAR — historical simulation method, monte-carlo simulation method and parametric approach. The most popular method is the RiskMetrics methodology to calculate VaR which was invented by J.P Morgan in the 1980s. JPMorgan's chairman Dennis Weatherstone had long been known as an expert on risk. He pushed the quant team to create VaR to gauge the possibility that any kind of portfolio could lose a certain amount of money over the next 24 hours, within a 95 percent probability. [1]

In this model, the daily log return is given by r_t and the data is given by F_{t-1} at time $t-1$. The conditional normal distribution is given by $r_t|F_{t-1} \sim N(\mu_t, \sigma_t^2)$ where μ_t is the conditional mean and σ_t^2 is the conditional variance of r_t.

To calculate VaR in a k-period horizon, we define $r_t[k] = r_{t+1} + r_{t+2} + ... + r_{t+k}$. Since $r_{t+1} + r_{t+2} + ... + r_{t+k}$ are independent and identically distributed as RiskMetrics VaR assumes that a portfolio's profit and loss over the VaR horizon (e.g., one day, two weeks, or one month) conforms to a normal distribution in accordance with the central limit theorem. Therefore the conditional mean is $r_t[k] = 0$. Hence $\sigma_t^2[k] = k\sigma_{t+1}^2$. So, the conditional normal distribution in a k-period horizon is given by $r_t[k]|F_t \sim N(0, k\sigma_{t+1}^2)$.

There are many limitations of VaR as a risk measure. Mainly, VaR does not meet the objective of risk management. The central objective of risk-management is to manage risks, however, VaR empowers bad policy decisions like massive leverage on positions with enormous risks in the tail. VaR creates a false sense of security among senior management as they are just looking at the worst case loss, and not how to deal with the loss when it occurs.

VaR is often measured daily and rarely extends beyond a few weeks, and because it is a very short-term measure, it assumes that tomorrow will be more or less like today. VaR also underestimates risk before a crisis as financial institutions are profitable and their strong capital

[1] Many firms still use the 95 percent VaR, though others prefer 99 percent. J.P Morgan created a small group, RiskMetrics, which later became a risk management consulting company. VaR had become so popular that it was considered the risk-model gold standard.

base allows them to take larger positions in the markets. When firms are recording higher profits the historical returns used to calculate VaR are higher, so there are less bad days than good days, hence the worst day loss will be less. Therefore, we can say VaR is pro-cyclical.

Nassim Nicholas Taleb argues that risk managers care about what happens in the other 1 percent, at the extreme edge of the curve, and not the number that falls within the 99 percent probability. He says, "You could lose $51 million instead of $50 million — no big deal. That happens two or three times a year, and no one blinks an eye. You could also lose billions and go out of business. VaR has no way of measuring which it will be." Taleb calls these events "fat tails" or "black swans." [35].

A risk measure that doesn't provide a comprehensive understanding of an organization's risk exposure if used at a system-wide level can lead to extreme events such as GFC '08. Moreover, single institution's risk measure does not necessarily reflect its connection to overall systemic risk.

CoVaR is simply the VaR of the whole financial sector conditional on institution i. $CoVaR$ of the financial system j conditional on institution i at a given quantile q can be defined as

$$P(X^j \leq CoVaR_q^{j|i} | X^i = VaR_q^i) = q$$

X^j represents asset returns of the financial system j and X^i represents the asset returns of bank i. So, we can say there is q% chance that the asset returns of the financial system become less than $CoVaR_q^{j|i}$ within a specified time period given that returns of bank i are at its q% VaR level.

$\Delta CoVaR$ is the difference between the CoVaR conditional on the distress of an institution and the CoVaR conditional on the median state of that institution.

Adrian and Brunnermeier calculate $\Delta CoVaR$ using quantile regression on weekly data with the quantile q set to 5% using a set of state variables including include the change in the three-month yield, the change in the slope of the yield curve, a short-term TED spread, the change in the credit spread, the market return, the real estate sector return, and equity volatility. They

estimate the quantile regressions in the following way: [7].

$$X_t^i = \alpha_q^i + \gamma_q^i M_{t-1} + \epsilon_{q,t}^i.$$
$$X_t^{System|i} = \alpha_q^{i|System} + \gamma_q^{System|i} M_{t-1} + \epsilon_{q,t}^{System|i} + \beta_q^{System|i}.$$

Here X_t^i denotes the quarterly return of bank i, $X_t^{System|i}$ the weekly system equity return conditional on bank i, M_t is the list of state variables, α_q^i is the intercept, and $\epsilon_{q,t}^i$ is the error term. They use q to denote the qth quantile. Then they use predicted values, denoted by the hat sign from these regressions to obtain VaR and CoVaR.

$$VaR_{q,t}^i = \hat{\alpha}_q^i + \hat{\gamma}_q^i M_{t-1}.$$
$$CoVaR_{q,t}^i = \hat{\alpha}_q^{System|i} + \hat{\gamma}_q^{System|i} M_{t-1} + \hat{\beta}_q^{System|i} VaR_{q,t}^i.$$

Finally, $\Delta CoVaR_{q,t}^i$ for each bank is computed as the difference between the q^{th} percentile $CoVaR$ and the median $CoVaR$.

$$\Delta CoVaR_{q,t}^i = CoVaR_{q,t}^i - CoVaR_{50,t}^i = \hat{\beta}_q^{System|i}(VARi_{q,t} - VARi_{50,t}).$$

Acharya et al. (2017) proposes another model-based measure of systemic risk by using a financial firm's marginal expected shortfall (MES) and components of Systemic Expected Shortfall (SES) to calculate systemic risk.[3]. Although MES and SES are coherent measures of risk their main components are both individual financial firm and sector-wide leverage. In reality, not all leverage is equivalent, whether it is long-term debt, short-term rollover debt, life insurance premiums, deposits, and so on. Moreover, some risks may not be measured at all, especially those related to off-balance sheet financing which played a role in the GFC'08.

Brownlees and Eagle (2017) introduce a measure called SRISK defined as the expected capital shortfall of a financial entity conditional on a prolonged market decline to construct rankings of systemically risky institutions. SRISK is a function of the size of the firm, its degree of leverage, and its expected equity loss conditional on the market decline. Their results show that an increase in SRISK predicts future declines in industrial production and increases in the unemployment

rate. The results also suggest that the predictive ability of SRISK is stronger at longer horizons, however, crisis can appear in the short-run due to sudden shocks to the system which someone applying SRISK might not see coming. [23].

Cao (2010) proposes a systemic risk measure to efficiently capture the systemic importance of each financial institution within a given system. To calculate each institution's marginal systemic risk contribution to the whole system, the author uses a measure called Multi-CoVaR. Then the author uses the Shapley value methodology to efficiently allocate total systemic risk to each financial institution. Although this measure is effective in allocating total systemic risk to each financial institution, a more robust forward-looking measure is needed to allocate risk for financial institutions. [46].

Gray and Jobst (2013) present a forward-looking framework ("Systemic CCA") using multivariate extreme value theory (EVT) to measure systemic solvency risk based on market-implied expected losses of financial institutions. Systemic CCA identifies endogenous linkages affecting joint expected losses during times of stress. Based on the expected losses arising from the variation of each individual firm's expected losses, the joint probability of all firms experiencing distress simultaneously is estimated. [15]. It is important to note that the assumptions that go into the option pricing theory, extreme value measurement, and non-parametric specification of dependence between individual default probabilities in the Systemic CCA approach might be defied by financial market behavior. In a financial crisis, predictable outcomes generated by historical precedent don't work as the market is not functioning rationally as it is in a panic state. Hence, there are limitations in Systemic CCA in analyzing systemic solvency risk. [15].

Ruza et al. (2019) constructed a composite indicator (CI) for analysing the resilience and stability of banking systems of developed countries. This tool is used to appraise the health of the most salient banking systems. The authors apply multiple factor analysis to identify the main determinants of banks' resilience and stability for the group of G7 countries, Spain and Portugal, from 2004 up to 2015. The results were mixed as some countries improved their ranking post the

crisis while others were evolving in the opposite direction. These findings are very broad, hence, it is difficult to ascertain the potential weaknesses and areas of improvement in each case. [24].

Segoviano and Goodhart (2009) propose a measure, Joint Probability of Default (JPoD), to assess systemic risk and estimating a set of stability measures of the banking system by using a very limited set of publicly available data. An advantage of using limited data is that JPoD can measure the distress of non-banking financial institutions (NBFIs) i.e., insurance companies, hedge funds etc. Hence, this measure works effectively for countries with a less developed financial sector where shadow banking is a major part of the financial system. [33].

Pompella et al. (2016) built a measure known as bank Resilience index (bRi) to test the soundness of accounting-based solvency of banks, over a five-year period. Their sample consists of 246 banks from across the globe, and the four indicators they select to represent a bank's vulnerability include Tier 1 Ratio, net interest spread, common equity to total assets, and non-performing loans to total loans. BRi is calculated using a series of standard deviations for each of the indicators. The authors conclude that this index is an effective test to measure the resiliency of banks as it is a continuous measure, unlike VAR. Although bRi is effective in catching any worsening tendency, in advance, the regulatory framework it uses for the indicators varies greatly across each country leading to inconsistencies in building the index. Additionally, bRi does not act as an early warning system to detect deficiencies in capital ratios. [38].

3.4 Impact of Regulations on Systemic Risk

Preceding the Dodd-Frank Act, the U.S. launched The Troubled Asset Relief Program (TARP) in response to the GFC'08 to buy "toxic" securities on the secondary market. Berger et. al (2020) investigate whether TARP reduced or increased systemic risk. By employing the difference-in-difference method their analysis examines the systemic risk contributions of TARP banks relative to non-TARP banks after the TARP program was in effect. They use Normalized SRISK (NSRISK, Brownlees and Engle, 2017), and Systemic Expected Shortfall (SES, Acharya et al., 2017) as their measures of systemic risk. Their results suggest that TARP reduced contributions

to systemic risk. However, it is important to note that TARP intervention effects are relatively short-lived and may be reversed in the long run. [11].

Xu et al. (2019) analyzes how bank profitability impacts financial stability by conducting a panel regression analysis. They also examine how bank profitability affect systemic and idiosyncratic risks for 431 publicly traded banks (U.S., advanced Europe, and GSIBs) from 2004 to 2017. They find that profitability is negatively associated with both a bank's contribution to systemic risk and its idiosyncratic risk. [42].

Huang et al. (2020) assessed the impact of Dodd-Frank Act in reducing the systemic risk in the US banking system by employing the synthetic control method combined with the difference-in-differences method. The treatment group consists of large U.S Bank Holding Companies with $50 billion or more in total consolidated assets in 2010. Large EU BHCs are included in the donor pool. Systemic risk is measured by means of the $\Delta CoVaR$ and MES approaches. They conclude that the DFA did not have a significant impact on reducing systemic risk in the US banking system. [31].

There is little doubt that regulators have an important role to play in monitoring and managing systemic risk. Anand et al. (2014) identify three basic regulatory objectives that the regulatory architecture must address: macro-economic stability typically associated with central banks in terms of implementing monetary policy and acting as lender of last resort in maintaining liquidity in the financial system; micro-prudential regulation which focuses on the financial stability of individual financial institutions; and conduct of business regulation designed to protect consumers of financial services and investors in financial institutions. Higher quality regulatory capital requirements are generally thought to lower systemic risk posed by financial institutions. [13].

Vallascas et al. (2012) identifies which bank characteristics offer a shelter from systemic shocks and compares the relative effects of several hypothetical prudential rules on a bank's risk exposure for an extensive sample of listed banks across 17 European countries. They show that imposing regulatory constraints on bank size appears the most effective tool to reduce the de-

fault risk of a bank given systemic events. While the prudential rules prospected by the Basel III Accord are useful, they argue that the rules should be accompanied by additional restrictions on banks. By running a regression analysis with systemic risk as to the dependent variable, they conclude that the risk exposure of banks, both in normal and extreme systemic conditions, increases with size, the share of non-interest income activities, and the growth of earning assets. [44].

4
Method and Results

In this chapter, we conduct an empirical study to assess the impact of the Dodd-Frank Act on systemic risk in the U.S. financial system. Section 4.1 describes our method to evaluate the effectiveness of the Dodd-Frank Act and goes over the sample data, Section 4.2 closely looks at our dependent variable, Section 4.3 introduces our variable of interest, Section 4.4 describes our independent variables, Section 4.5 provides a summary of our data, Section 4.6 discusses our main results, and Section 4.7 contains robustness checks.

4.1 Empirical Methodology

In our model, we have a long, narrow panel as we have a considerable amount of time series observations on a relatively small number of cross-sectional units. We select panel data because of its capacity to capture the complexity of the financial system as in this model we have more degrees of freedom and variability. Variability is created through combining variation across units with variation over time, solving multicollinearity problems. Another advantage of using panel data is that it uncovers dynamic relationships by exploiting information on the dynamic reactions of each of several financial institutions. Most economic behavior is inherently dynamic so most econometrically interesting relationships are explicitly or implicitly dynamic. [36].

Our panel data set consists of 14 U.S. Bank Holding Companies (BHC) with consolidated assets equal to or greater than $50 billion in 2010 from the years of 1995:Q1 to 2013:Q2 and American International Group (AIG). The rationale for picking banks with an asset value over $50 billion is the Financial Stability Oversight Council's 2013 annual report which explains that many provisions of the Dodd-Frank Act are issued to limit the incentives and abilities of financial institutions with consolidated assets equal to or greater than $50 billion to take risks. All 14 BHC's are included in Federal Reserve's stress testing introduced in 2012. There are five big BHC's as they account for 78.7% of the total assets in 2010 of the 14 BHC's and AIG in our sample. These five BHC's are a subset of the big six that are subject to higher regulatory standards as they are usually perceived as TBTF financial institutions. AIG got the systemically important financial institution label after it was rescued from bankruptcy in 2008 by a government bailout of $182 billion. AIG was considered a heavyweight in selling insurance against investment losses making it susceptible to downturns in the financial market. Although the systemic risk label for AIG was removed in 2017, we still use it in my sample as my data goes to 2013.

Every financial institution has its own distinct characteristics that are embedded in its DNA like their investment strategy, appetite for risk and capital structure which contribute to systemic risk. These characteristics usually don't change with time as decisions are made at the board-level which hardly sees any substantial changes over time. We call these characteristics time invariant.

Regression analysis typically uses a methodology called Ordinary Least Squares (OLS). OLS fits the regression equation that minimizes the sum of the squared residuals by taking the square of each residual before adding them all up. For our empirical study, we do not use the OLS method as we would get different intercepts for each financial institution in our sample because there are a number of unmeasured variables that determine our dependent variable. Hence, we can say that OLS is biased unless the influence of these omitted variables is uncorrelated with the other independent variables. This bias is known as omitted variable bias. Omitted variable bias

can lead to endogeneity which occurs when the independent variables may be influenced by the dependent variable or both may be jointly influenced by an unmeasured third. We can remove this bias by putting in a dummy for each individual financial institution so each individual financial institution has its own intercept. This is known as the fixed-effects model.

The fixed-effect model uses the fixed effects estimator to make the difference between financial institutions systematic by removing the unobserved effect that is correlated with the independent variables. In this model, the observations of each individual financial institution have subtracted from them the average of all of the observations for that individual financial institution. Hence, our original equation will look like this:

$$\bar{Y}_{it} = \beta_0 + \beta_1\bar{x}_{1it} + \beta_2\bar{x}_{2it} + \beta_3\bar{x}_{3it} + \beta_4\bar{x}_{4it} + \beta_5\bar{x}_{5it} + \beta_6\bar{x}_{6it} + \beta_7\bar{x}_{7it} + (c_{it} + \bar{\mu}it)$$

$$Y_{it} - \bar{Y}_{it} = \beta_1(x_{1it} - \bar{x}_{1it}) + \beta_2(x_{2it} - \bar{x}_{2it}) + \beta_3(x_{3it} - \bar{x}_{3it}) + ... + \beta_7(x_{7it} - \bar{x}_{7it})(\mu_{it} + \bar{\mu}it)$$

However, the fixed effects model has certain disadvantages. In this model, there is a trade-off between consistency and efficiency as by adding a different intercept we lose degrees of freedom. Also, by applying the fixed effects model we wipe out all explanatory variables that do not vary within an individual financial institution so we cannot estimate a slope coefficient for time-invariant variables. Keeping in mind that our dataset consists of numerous financial institutions that differ in investment strategy, areas of business, and capital structure it is highly possible that these time-invariant characteristics impact our independent variables.

Another way to allow for different intercepts is by using the random-effects model. In this model, we have an overall intercept as intercepts are interpreted as normally distributed, and a composite error. The composite error contains the time-invariant error, however, the random-effects model recognizes that the variance-covariance matrix of this composite error is non-spherical. The variance-covariance matrix is created as observations on different financial institutions are assumed to have zero correlation with their composite errors. The random-effects estimator essentially transforms the data by "partially demeaning" each variable and estimates the variance-covariance matrix. Instead of subtracting the entire unit-specific mean, only part of the mean is subtracted. We use the Hausman statistic to determine which model is more

appropriate for our study by testing if the random effect estimator is unbiased. The estimates from running the fixed effects and random effects are stored in the vectors $\hat{\beta}^{FE}$ and $\hat{\beta}^{RE}$. The Hausman test is based on seeing if the random effects estimate is insignificantly different from the unbiased fixed effects estimate. The Hausman statistic is computed as follows:

$$H = (\hat{\beta}^{FE} - \hat{\beta}^{RE})'[Var(\hat{\beta}^{FE}) - Var(\hat{\beta}^{RE})]^{-1}(\hat{\beta}^{FE} - \hat{\beta}^{RE}).$$

When the Hausman statistic is computed, if we get a value of 1 the null is not rejected, hence the random effects estimator is used. If the Hausman statistic is equal to 0 the null is rejected and the fixed effect estimator is used.

4.2 Dependent Variable

Our dependent variable is $\Delta CoVaR$ calculated at a 95% confidence interval. $\Delta CoVaR$ is in units of quarterly percent of total market equity loss rates, and is used to measure systemic risk. $\Delta CoVaR$ is the difference between the financial system's VaR conditional on firm i's distress and the financial system's VaR conditional on firm i's median state. We obtain the data for $\Delta CoVaR$ from New York Fed's website.

4.3 Variable of Interest

Our vairable of interest is the Dodd-Frank Act which was introduced in July 2010 to mitigate systemic risk. This variable codes for 1 when the Dodd-Frank was actually enacted, i.e 2011:Q1 to take into account any time lags for implementing policy, and 0 preceding 2011. We expect the coefficient of this variable to be negative as under the Dodd-Frank Act a Financial Stability Oversight Council was formed to identify systemic risks and recommend policies to regulatory bodies. The council recommended policies such as risk-based capital requirements, leverage limits, and liquidity requirements which are focused on reducing systemic risk in the system.

4.4 Independent Variables

Our original panel regression is estimated as follows:

$$\Delta CoVaR = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \beta_4 x_{4it} + \beta_5 x_{5it} + \beta_6 x_{6it} + \beta_7 x_{7it} + (c_{it} + \mu_{it})$$

Where x_{1it} denotes GDP per capita for financial institution i in quarter t.x_{2it} represents quarterly GDP deflator for financial institution i in quarter t. x_{3it} captures the quarterly LIBOR rate for financial institution i in quarter t. x_{4it} denotes the quarterly government benchmark bond yield for financial institution i in quarter t. x_{5it} is the dummy variable Dodd-Frank Act, x_{6it} is the dummy variable GFC'08, and x_{7it} is the dummy variable for the dot-com crash. c_{it} is the time time-invariant part of the error term and μ_{it} is the time variant part of the error term.

In our empirical analysis, we control for variables that can impact systemic risk in the financial system in different ways. To capture macroeconomic fundamentals, we use economic growth measured by quarterly GDP per capita and inflation which is measured by GDP deflator.

We use GDP per capita as a proxy for cyclical conditions in the economy. Economic growth is often linked to financial liberalization as firms are taking on more insolvency risk. It is widely believed that a risky economy will, on average, grow faster than a safe economy hence higher economic growth leads to more systemic risk-taking, and as a result financial fragility increases in the financial system leading to a crisis. Therefore, we expect β_1 to be positive.

Rising inflation points to an overheating economy. According to the quantity theory of money, an increase in money supply leads to an increase in inflation. On the other hand, low and stable inflation can help the economy recover from a recession so we can say inflation and economic recovery go hand in hand. For our study, we expect inflation to have a negative correlation with systemic risk as when inflation rises we can expect a stimulated economy with high levels of growth so the capital base of firm improves as they are getting higher returns on their positions. So, we expect β_2 to be negative.

Liquidity risk plays a central role in perpetuating systemic risk in the system. A liquidity crisis emerges when financial institutions that have fragmented capital structures hold assets with long-term duration or low liquidity and highly short-term liabilities on their balance sheets.

To reflect liquidity in the money market, we control for interest rate captured by LIBOR which is the daily average interest rate at which leading banks borrow funds of a sizable amount from other banks. We convert the daily LIBOR rate to quarterly by taking the average LIBOR rates in that quarter. A low-interest rate means a lower effective cost of capital which allows borrowers to attain greater leverage and invest more. Additionally, debt servicing cost decreases for firms so due to these reasons, a lower interest rate is often associated with lower systemic risk. This positive relationship between interest rate and systemic risk implies β_3 is positive. During GFC'08, the fed created massive amounts of liquidity through an economic stimulus program known as quantitative easing and reduced the interest rate.

Our other potential confounder government benchmark bond yield reflects a country's sovereign risk. To measure the government benchmark bond yield, we use the monthly yield on the 10-year government benchmark bond. The monthly yield is converted to quarterly by taking the average of the monthly yields in that quarter. A sovereign bond yield can be defined as an interest rate the government pays to service its outstanding yield. Risk premiums imposed on corporations are also calculated using sovereign bond yields so it is important to take sovereign bond yields into consideration when talking about systemic risk. Usually, a higher bond yield denotes high-interest rates in the country which means the country has a high sovereign risk implying higher systemic risk. Hence, we expect β_4 to be positive.

The other control variable we use in our study is a dummy variable for the dot-com crash of 2000. The dot-com bubble burst in 2000 leading to high systemic risk in the financial system from 2000-2002. This variable codes for 1 when the dot-com crash was at its peak and 0 at all other times. We expect β_7 to be positive due to the high systemic risk during the dot-com crash.

Lastly, the other dummy variable we use is the GFC '08. This variable codes for 1 when the GFC '08 was at its peak and before any policy response from the government was launched and

0 for all other times. To make our findings robust we include using various lengths of GFC '08. We observe a clear impact from GFC '08 when systemic risks got elevated which makes our results are highly sensitive to the definition of the length of GFC '08. We consider four different scenarios regarding the duration of GFC '08 which are as follows:

1. Base case: 2008:Q3-2010:Q4
2. Moderate case: 2008:Q3-2012:Q3
3. Conservative case: 2007:Q2-2009:Q2
4. Extreme case: 2007:Q2-2013:Q2

During the GFC '08, systemic risk was at its highest as most financial institutions were under distress so we expect β_6 to be positive.

Overall, these variables help us isolate the statistical relationship between systemic risk and the Dodd-Frank Act while taking into account other factors that might affect systemic risk.

4.5 Summary Statistics

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
deltacovar95	1110	.016	.008	.001	.067
gdppc	1110	47639.135	3763.554	39729	52049
libor	1110	3.328	2.194	.242	6.602
yield	1110	4.6	1.414	1.643	7.837
gdp deflator	1110	85.486	9.351	71.344	101.431
dfadummy	1110	.135	.342	0	1
gfc original	1110	.324	.468	0	1
dotcomdummy	1110	.108	.310	0	1

The table above provides summary statistics of our dependent and independent variables. In terms of contribution of systemic risk, $\Delta CoVaR$ has a mean of 1.6% which means that on average we are 95% confident that over the next quarter the financial sector won't lose more than 1.6% market equity conditional on the financial sector being in distress in excess of the

CoVaR of the system in the median state. Low standard deviation of 0.7% points to relatively less volatility in systemic risk from 1995Q1 to 2013Q2. Systemic risk was mostly stable, and gently rising until it touched its peak of 6.7 % in 2008.

Market equity is the market capitalization of any institution which is the product of current stock price and total number of outstanding shares. Market equity is also known as market capitalization which is the product of current stock price of an institution, and its total number of outstanding shares. If a firm has negative market equity, they are considered insolvent as they have more liabilities than assets. In our study, the market equity is the average market equity of the 15 biggest financial institutions in the U.S. It is important to note that 1.6% might not be an accurate depiction of the growing risk in the system, as for the maximum time in our data set the market value of these financial institutions was growing. The mean is a measure of central tendency which is a manageable and meaningful summary of the data set as mean merely takes the sum of $\Delta CoVaR$ and divides each by the number of observations which are 1110. Hence, mean is not an accurate measure for our purposes as we're looking to assess the impact of the Dodd-Frank Act.

Matrix of correlations

Variables	(1)	(2)
(1) deltacovar95	1.000	
(2) dfadummy	-0.055	1.000

To study the relationship between the Dodd-Frank Act and the $\Delta CoVaR$ we can use covariance and correlation as they describe how two variables are related. Covariance is not a good interpretation of how strong the relationship is between two variables is because you can't compare variances over data sets with different scales so we use correlation coefficient because its numerical limitations, -1 to 1, are more useful for determining how strong the relationship is between the two variables. In my dataset, shown in the figure above, the correlation coefficient is -0.055 implying that the relationship between the Dodd-Frank Act and $\Delta CoVaR$ is weak, but

the negative sign indicates that the Dodd-Frank Act and $\Delta CoVaR$ are negatively correlated which means systemic risk went down in the system when the Dodd-Frank Act was enacted.

4.6 Panel Regression Results

As many factors contribute to systemic risk, as we discussed before, we control for a number of variables when we run our random effects panel regression. We got a value of 1 for our Hausman statistic so we couldn't reject the null in favor of the fixed-effects estimator. The Hausman statistic suggests the random effect model is more appropriate pointing to large heterogeneity in our sample. Based on this result, we can say that that the variations between the 14 BHC'S and AIG is random and not systematic. This result is in line with our expectations as each financial institution has its own distinct characteristics which do not change with time. The random effect estimation does not wipe out the explanatory variables that are time invariant. It is important to consider these time invariant factors as a shock affects each financial institution differently.

In GFC '08 some banks suffered more than others e.g Lehman Brothers suffered more than Goldman Sachs due to the difference in their business models. Each financial institution in our sample has different values for variables that capture an institution's business model. For instance, no two banks have the same debt-to-equity ratio, return on assets, price to book ratio, etc. Each bank had its own business strategy of when to enter and exit the housing market leading up to GFC'08 which affected its problem loan ratio and leverage ratio. [1] In 2007, Goldman Sachs had a leverage ratio of 25, whereas, Lehman Brothers had a leverage ratio 31 making Lehman more susceptible to a downturn in the housing market. All these variables contribute to idiosyncratic risk, and could be extended to systemic risk. Hence, we can safely conclude that for the purposes of our analysis the random effects model is superior to the fixed effects model.

[1] According to the CFI, the problem loan ratio is a ratio in the banking industry that compares the percentage of problem loans to the percentage of sound loans. A leverage ratio is any kind of financial ratio that indicates the level of debt incurred by a business entity against several other accounts in its balance sheet, income statement, or cash flow statement

Our findings reveal that Dodd-Frank Act is negatively associated with systemic risk. According to our limited data, when the Dodd-Frank was enacted in July 2010 $\Delta CoVaR$ went down by 0.44%. Technically, this means that if we were 95% confident that over the next quarter the financial sector won't lose more than 8.44% of market equity conditional on the financial being in distress in excess of the CoVaR of the system in the median state, after the Dodd-Frank Act passed we are 95% confident that over the next quarter the financial sector won't lose more than 8% of market equity in excess of the CoVaR of the system in the median state. Hence, systemic risk went down by 0.44%, making the financial system somewhat safer. Moreover, our p-value is 0.00 which means we can safely reject the null hypothesis that the coefficient of the Dodd-Frank Act is 0 making our result statistically significant.

An intuitive explanation is that financial institutions become more conservative when regulations get tighter as they engage in less risk taking activities. This reduction in risk can be contributed to the numerous features of the Dodd-Frank Act that were aimed at reducing systemic risk in the financial sector. Initiatives like The Office of Financial Research (OFR), stress tests, and regulation of OTC derivatives helped decrease potential risk exposures. A top-down analysis backed by data collected by the OFR helped regulators look beyond the traditional accounting-based measures. The regulators conducted scenario analysis on the major financial institutions to determine the needed capital buffer. This tailored analysis led to firm-specific policy actions which allowed market participants to price risk more accurately.

However, in the scheme of things, we would expect the Dodd-Frank Act to have a more profound impact on systemic risk than our results reveal. Overall, our results suggest that the Dodd-Frank Act did not have a significant impact on systemic risk. When we look at the peak value of the mean $\Delta CoVaR$ in 2008 which was close to 5%, as shown in the figure on the next page, then a reduction of 0.44% associated with the Dodd-Frank Act is a blip. The figure on the next page confirms that the Dodd-Frank Act was unable to bring systemic risk down to pre-GFC'08 levels which were close to 2%. However, the sudden decrease in $\Delta CoVaR$ post-GFC'08 and pre-Dodd-Frank Act can be attributed to the Great Recession and slowdown of economic

activity in 2009-10. These results are by no means encouraging and point to bigger issues in the risk-taking culture of banks. Our findings are in line with other studies done on effectiveness of the Dodd-Frank Act who are skeptical of the Dodd-Frank Act's effect on systemic risk. Huang et al. (2020) and Acharya et al. (2017) find that the passage of the Dodd-Frank Act did not reduce systemic risk in the financial system. [4] [31].

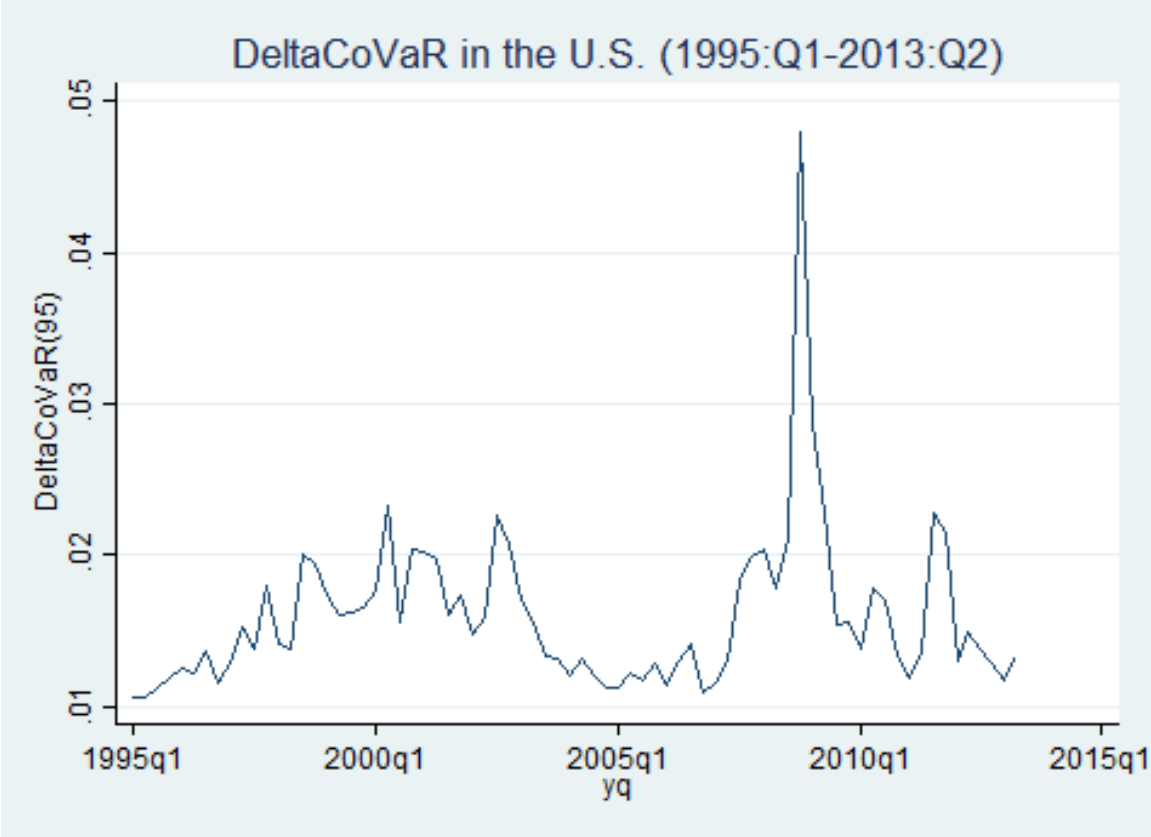

Table 1
Panel Regression with varying lenghts of GFC '08

	(1) deltacovar95	(2) deltacovar95	(3) deltacovar95	(4) deltacovar95
gdppc	0.000000209	0.000000282	-0.000000133	0.000000786
	(0.180)	(0.048)	(0.247)	(0.000)
libor	0.00132	0.00139	0.000247	0.000763
	(0.000)	(0.000)	(0.074)	(0.000)
yield	-0.00128	-0.00143	-0.000595	-0.00121
	(0.000)	(0.000)	(0.063)	(0.000)
gdp deflator	-0.0000408	-0.0000944	-0.00000211	-0.000626
	(0.621)	(0.213)	(0.973)	(0.000)
dfa dummy	0.000589	-0.00462	0.000500	-0.00370
	(0.528)	(0.000)	(0.491)	(0.000)
dot com dummy	0.00456	0.00458	0.00423	0.00437
	(0.000)	(0.000)	(0.000)	(0.000)
gfc original	0.00737			
	(0.000)			
gfc moderate		0.00808		
		(0.000)		
gfcconservative			0.00932	
			(0.000)	
gfc extreme				0.0119
				(0.000)
constant	0.00944	0.0108	0.0227	0.0313
	(0.056)	(0.025)	(0.000)	(0.000)
N	1110	1110	1110	1110

Note: p-values in parentheses

4.7 Robustness

A number of further robustness checks were carried out, including varying the length of our data, and running a separate regression for the big 5.

When we consider a full sample that embeds both crisis (Dot-com crash and GFC'08) and normal times from 1995 to 2013, the Dodd-Frank Act reduces systemic risk in the moderate and extreme case. We reject the base case and extreme case as the p-value is well over 0.05 so the results are statistically insignificant.

An interesting finding emerges when we change the beginning of our data to post 2002:Q2 from 1995:Q1. On running the conservative case, systemic risk actually increases in the system by 0.3%. We discuss this result as it has the highest Wald statistic suggesting the model is a good fit, and a p-value of 0 making it statistically significant. This is an exceptional finding that is in direct contradiction with our previous results. A possible explanation of this result is that we assume GFC '08 ended in 2009:Q2 so banks began taking moderate risks to make up for the losses they incurred in the crisis. Additionally, banks exploited the low interest rate environment and continued borrowing at lower rates than are necessary for their risk levels because the market believes these banks are still protected by the government. Another explanation might be as Mehrsa Baradaran (2014) explains that regulating banks under hypothetical risk modeling in the Dodd-Frank Act lead to an increase private financial risk taking. [16].

4.7.1 Endogeneity

There is a concern that endogeneity may arise in our model as banks might have responded to the Dodd-Frank Act in advance to avoid stricter regulation making it difficult for us to observe the treatment effect of the Dodd-Frank Act to reduce systemic risk. Banks could do this by shrinking their assets less than $50 billion. We address this concern by using systemic risk measures that are based on market data rather than financial data of banks. It is nearly impossible for institutions to manipulate market data, so we are confident that we avoid the endogeneity concern.

4.7.2 Big 5

It is generally thought that the Dodd-Frank Act had a larger impact on the big six banks: J.P Morgan, Wells Fargo, Citibank, Morgan Stanley, Bank of America, and Goldman Sachs. We don't include Goldman Sachs due to lack of data so we consider the big five for our robustness check. Running a separate panel regression for just the big five banks using a moderate length of GFC'08 we find that the Dodd-Frank Act reduced systemic risk in the big five by 0.46 % compared to 0.44 % for the other fifteen financial institutions. These results suggest that the Dodd-Frank Act exerted a slightly greater impact on the big five relative to the other financial institutions in our sample. However, this difference is so minuscule that we can say the Dodd-Frank Act impacted both the big 5 and other financial institutions in a similar fashion.

Table 2

Post-2002 Data With Varying Lengths of GFC'08

	(1) deltacovar95	(2) deltacovar95	(3) deltacovar95	(4) deltacovar95
gdppc	-0.00000719	-0.00000627	-0.00000494	-0.00000519
	(0.000)	(0.000)	(0.000)	(0.000)
libor	0.00272	0.00294	0.00145	0.00303
	(0.000)	(0.000)	(0.000)	(0.000)
yield	0.00131	0.000893	0.00215	0.000643
	(0.015)	(0.102)	(0.000)	(0.197)
gdp deflator	0.00197	0.00154	0.00111	0.000612
	(0.000)	(0.000)	(0.000)	(0.000)
dfadummy	-0.00349	-0.000969	0.00303	0.00143
	(0.007)	(0.256)	(0.000)	(0.086)
gfc original	-0.00263			
	(0.017)			
gfc moderate		0.00112		
		(0.217)		
gfcconservative			0.00767	
			(0.000)	
gfc extreme				0.00940
				(0.000)
constant	0.188	0.180	0.149	0.207
	(0.000)	(0.000)	(0.000)	(0.000)
N	660	660	660	660

Note: p-values in parentheses.

Table 3

Impact of Dodd-Frank on the Big 5

	(1) deltacovar95	(2) deltacovar95	(3) deltacovar95	(4) deltacovar95
gdppc	0.000000319	0.000000391	-8.72e-08	0.000000882
	(0.252)	(0.125)	(0.673)	(0.001)
libor	0.00130	0.00138	0.000180	0.000710
	(0.000)	(0.000)	(0.469)	(0.003)
yield	-0.00118	-0.00133	-0.000472	-0.00111
	(0.052)	(0.023)	(0.412)	(0.055)
gdpdelfator	-0.0000768	-0.000131	-0.00000757	-0.000667
	(0.603)	(0.334)	(0.947)	(0.000)
dfa dummy	0.00106	-0.00461	0.000636	-0.00369
	(0.525)	(0.000)	(0.625)	(0.001)
dotcomdummy	0.00494	0.00497	0.00460	0.00475
	(0.000)	(0.000)	(0.000)	(0.000)
gfc original	0.00801			
	(0.000)			
gfc moderate		0.00873		
		(0.000)		
gfcconservative			0.00964	
			(0.000)	
gfc extreme				0.0124
				(0.000)
constant	0.00641	0.00792	0.0203	0.0294
	(0.458)	(0.346)	(0.013)	(0.001)
N	370	370	370	370

Note: p-values in parentheses.

5
Conclusion

Financial firms play a critical role in the economy. They act as intermediaries between parties that are looking to invest and parties that need investment to finance their businesses. This intermediation affects society at large as financial transactions are a part of everyday life, for example, student loans, house mortgages, automobile loans, business loans, etc. Finance has tremendous potential to benefit society if this intermediation works seamlessly.

The cyclical nature of the modern economy is inherently unstable, so when we are faced with a crisis financial intermediation is impaired. The challenge remains to limit finance's ability to do damage while harnessing its benefits to drive economic growth. This can only be done by making the financial sector antifragile. Anti-fragility, a concept developed by Nassim Nicholas Taleb, goes beyond robustness; it means that something does not merely withstand a shock but actually improves because of it.

Our results help us identify the challenges in identifying and measuring systemic risk. Understanding and overcoming these challenges is critical in laying a framework for future reforms that can make the financial sector antifragile. Systemic risk emerges when the financial sector is not capitalized enough to cover its liabilities, however, there is no widely accepted measure of systemic risk. Academics have taken the initiative to develop systemic risk measures which we talk about extensively in the literature review chapter. So far, none of them have been able

to develop a measure that can precisely measure risk, leverage, interconnectedness of complex financial institutions. Hence, at the regulatory level there is no measure deemed accurate enough to act as a systemic measure. In our paper, we use $\Delta CoVaR$, but we face several difficulties because of limited data. Developing a single systemic risk measure implemented at the regulatory level is the first step towards identifying and consequently mitigating risks.

The Dodd-Frank Act is an attempt to solve the issues relating to systemic risk by recommending a variety of criteria for the systemic risk regulators. This criterion falls short of reducing systemic risk, as by simply creating guidelines we cannot tackle the issue of systemic risk. While the Dodd-Frank Act includes stricter standards such as, leverage limits, capital requirements, liquidity requirements, etc., the Dodd-Frank Act does not impose restrictions on bank holding companies like that in the Glass-Steagall Act. These strict regulations may not be too costly for the TBTF firms. We observed in our results, that the Dodd-Frank Act affected the big 5 in a similar fashion to the other financial institutions in our sample. This can be attributed to a clause in the Dodd-Frank Act that states that in a crisis the solvent part of the financial sector should cover the losses of the failed part of the sector. The moral hazard created by this clause, and the TBTF guarantee does not disincentivize the big banks from taking excessive risks. TBTF firms can be disincentivized from indulging in risky activities if they are forced to internalize the systemic risk costs imposed by the TBTF firms on the financial system.

The negative externality of systemic risk can be taxed through Pigouvian taxes. Pigouvian taxes are efficient as they don't require a heavy-handed government intervention into the decision making of firms. The systemic risk tax has been implemented in quite a few developed countries like the UK, France, and Germany. U.K imposed a 0.07 % tax on risky liabilities as an incentive for firms to reduce risk. However, this tax is not particularly sophisticated as the definition of risky liabilities is loose. There are mainly two ways to implement a systemic risk tax: regulator-based and market-based.

Acharya (2011) proposes a regulator-based approach to calculate systemic risk tax. He suggests that the tax should equal the sum of the following two components: firm's expected losses upon

default and the product of the expected systemic costs in a crisis and contribution of the firm to these costs. Every firm has a different expected loss upon default, so to make the calculation simpler the expected loss upon default is equal to the government guarantee the firm enjoys. Whereas, the contribution of the firm to systemic risk will increase when the firm is under-capitalized and holding increasing tax. [4].

A market-based solution entails buying insurance from the private market for insurance against a firm's own losses. In the event of a payout, the government will receive the payment in place of the firm. This approach will allow the market to determine the firm's contribution to systemic risk, while the firm will be forced to internalize the costs of risk-taking by paying a premium. We suggest a public-private partnership in executing this tax as not all insurers are capitalized enough to cover losses incurred in a systemic event. Under this partnership, the insurer will have to pay the government a percentage of every dollar by which the institution's capital falls below the required capital. This will push the insurer to price the systemic risk accurately. The insurance plan will be reviewed twice a year to ensure effective monitoring of risk, and prevent sudden high insurance premiums.

There are many challenges in imposing this tax. Firstly, a resolution authority like that of FDIC needs to be set up to deal with short-term liabilities like foreign deposits, uninsured deposits, etc. Short-term liabilities have implicit guarantees that need to be priced appropriately. Secondly, it is extremely difficult to calculate the expected systemic risk costs of a financial crisis as we need to consider asset bubbles, market volatility, and leverage. These factors make the calculations pro-cyclical.

In the future, we need counter-cyclical and forward-looking risk measures that generate warning signs helping us preempt systemic risk, and a looming crisis. This can be made possible through a fully transparent bottom-up approach to systemic risk categorization. Every firm needs to publicly disclose their positions which allows regulators to produce systemic risk reports. The TBTF guarantees should be contingent on providing comprehensive systemic risk

reports. A resolution authority can then utilize these reports to establish a systemic risk measurement framework and a recapitalization plan to wither a crisis.

The Dodd-Frank Act lays out requirements and standards for capital buffers to ensure banks have adequate capital to cover exceeding the loan loss provisions. It is difficult to ascertain requirements and standards for capital requirements as each bank imposes a different risk to the system. Current policy efforts should be geared towards establishing a regulatory framework that includes a market-wide perspective of supervision rather than being concerned with the viability of individual institutions only. Developing a sound understanding of systemic risk is crucial for formulating policy to build a more resilient financial system.

This system isn't fragile because of bubbles it's fragile because we haven't designed systems to respond to crises. Future regulation needs to be "dynamic" as a rigid regulatory system soon becomes obsolete. Moreover, a "one size fits all approach" is not viable as regulation has varying impacts for different countries depending on the robustness of their banking sector. The financial sector is the brain of the modern economy, so making the financial sector safe gets one step closer towards the goal of economics which is to improve the human condition.

Appendix A
Tables

Data Sources

Variable	Symbol	Description	Source
Economic Growth	gdppc	Quarterly real GDP per capita	FRED, Federal Reserve Bank of St. Louis
Inflation	gdp deflator	Quarterly implicit price deflator	FRED, Federal Reserve Bank of St. Louis
Government Bond Yield	yield	Monthly yield on 10-year government benchmark bond	FRED, Federal Reserve Bank of St. Louis
Interest Rate	libor	Daily average interest rate at which banks borrow	FRED, Federal Reserve Bank of St. Louis

Sample Data (U.S. Financial Institutions)

No.	Name	Ticker	Assets in 2010 ($ billion)
1	American Express Company	AXP	143.65
2	American International Group	AIG	284.60
3	Bank of America Corporation	BAC	2264.91
4	Bank of New York Mellon Corporation	BK	247.26
5	Capital One Financial Corporation	COF	197.50
6	Charles Schwab Corporation	SCHW	92.40
7	Citigroup Inc.	C	1913.90
8	JP Morgan Chase & Co.	JPM	2117.61
9	KeyCorp	KEY	91.41
10	M&T Bank Corporation	MTB	68.02
11	Morgan Stanley	MS	807.70
12	PNC Financial Services Group Inc.	PNC	264.28
13	State Street Corporation	STT	158.72
14	U.S. Bancorp	USB	307.79
15	Wells Fargo & Company	WFC	1258.13

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