MAPPING THE UNCONVENTIONAL MONETARY POLICY OF THE FED WITH FINANCIAL MARKET

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ABSTRACT

The value of currency in circulation and the value of the assets side of the balance sheet has become a choice variable for implementing policy under the monetary policy framework introduced by Ben Bernanke during the 2008 financial crisis. While policy responses to changing economic conditions are obvious, the macroeconomy's response to these policy changes requires more thought. To evaluate, directed acyclic graphs (DAGs) have been used to analyze the monetary policy's reaction to shifting economic indicators. I am also interested in mapping the effects of changes as well as to find out the interdependencies among the policy variables along with the financial markets. I have assessed the causal relationships in each DAG by taking into account the relevant marginal effects as estimated by seemingly unrelated regressions. Also, I have conducted Granger Causality test in order to assess our profitability analysis with the policy variables.

ACKNOWLEDGMENTS

I would like to convey my heartfelt appreciation to my adviser, Prof. James Caton, for his continued support, motivation, and guidance throughout the completion of this thesis and my graduate studies. A special thanks to Prof. Dragan Miljkovic, a member of my graduate committee, for his assistance and time spent offering me to teach different methods of econometrics modeling. I would like to express my gratitude to Prof. Fariz Huseynov for his genuine interest in the project and for serving on my graduate committee.

DEDICATION

I dedicate this thesis to my mother, sister, husband, and especially to my late father for their assistance in getting me started and eventually completing graduate school.

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LIST OF ABBREVIATIONS

ACF ....Autocorrelation Function

ADF test ....Augmented Dickey-Fuller test

DAG ....Directed Acyclic Graph

FOMC ....Federal Open Market Committee

IOR..Interest on Reserves

OLS ....Ordinary Least Squares

QE ....Quantitative Easing

KPSS test ....Kwiatkowski, Phillips, Schmidt, and Shin test

LSAP...Large-Scale Asset Purchase

NIM...Net Interest Margin

NII ....Non-Interest Income

RoE ....Return on Equity

RoA ....Return on Assets

SUR...Seemingly Unrelated Regressions

VIX ....The Chicago Board Options Exchange's CBOE Volatility Index

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1. INTRODUCTION

In order to alleviate the credit crisis that followed the financial crisis of 2007, central banks in a number of nations, most notably the United States, the United Kingdom, and the Eurozone, adopted a monetary strategy known as quantitative easing. Typically, a central bank's monetary policy entails setting a target interest rate and enforcing it by open market transactions, like the buying and selling of short-term government bonds (Curdia & Woodford, 2011). The central bank cannot reduce rates further when the target interest rate is already very low, such as at 0%. Instead, by crediting its own bank account and then using the money to purchase financial assets, it can expand the money supply (usually government bonds). The phrase "quantitative easing" is frequently used to describe this method. When a central bank engages in quantitative easing, it makes significant purchases of financial assets like stocks and bonds issued by governments and corporations. Although it might seem like a little change, interest rates on longer-term debt decrease when QE funds are not put into circulation. As a result, loan interest rates decline, which encourages economic growth (Gagnon et al., 2010). By acquiring longer-term securities, quantitative easing enables a central bank to lower market interest rates on loans and mortgages with longer terms. When the Federal Reserve employs standard rate policy, the target federal funds rate is modified. The objective is to affect the interest rates at which banks overnight lend to one another. For decades, the Federal Reserve has employed interest rate policy to sustain stable economic development and steady credit growth in the United States (Joyce et al., 2012). When the federal funds rate fell to zero during the Great Recession, the Fed used quantitative easing (QE) to keep the economy from imploding by buying mortgage-backed securities (MBS) and Treasury securities (Mendez-Carbajo, 2020).

The latest global financial crisis (GFC), which started in the US mortgage market in the middle of 2007, spread fast to other markets and is now the worst financial disaster to hit the country since the Great Depression. To stabilize the financial sector and promote a better economic recovery, the US Federal Reserve (Fed) reduced the federal funds rate to almost zero by the end of 2008 and kept it there until the end of 2015. Conventional monetary policy is no longer an option for central banks trying to push the economy into a long-lasting recovery in a time of zero-bound interest rates. Central banks frequently adopt unconventional monetary measures when traditional monetary policy cannot be implemented due to a liquidity trap.

The amount of research examining the effectiveness of unconventional policy initiatives carried out by central banks in numerous significant economies is expanding. The majority of research has focused on their domestic ramifications, with many turning to event studies that look at how announcements of QE affect asset prices (others have utilized regression analysis). Policymakers may find it easier to address the issues raised by such programs and assess the need for international policy collaboration if they have a better understanding of the monetary policy spillovers linked to QE measures. Surprisingly little research has been done on the global impacts of these unconventional policies, particularly on developing countries.

There is a wealth of research on the impact of QE policies on global financial markets. Neely (2010) draws the conclusion that US QE led bond rates in other advanced economies to fall by 20–80 basis points and the value of the US currency to fall by 4–11% by using event analysis of US asset purchases. In spite of the fact that long-term interest rates and the value of the US dollar declined following the announcement of US asset purchases, Glick and Leduc (2012) found that commodity prices generally decreased. The unorthodox monetary policies of the Bank of England, the European Central Bank, the Federal Reserve, and the Bank of Japan have had a global impact, according to research by Chen et al. (2016). In the past, US QE measures were highly successful in lowering sovereign rates and raising stock values, but that influence has now faded, claim Fratzscher et al. (2018). Estimated shadow federal funds rates are incorporated into a global VAR by Chen et al. (2014) to assess the domestic and global consequences of unconventional US monetary policy. They found that because of the significant global spillovers that the US QE had, recessions may have been avoided everywhere outside the US. In the early stages of the global financial crisis, unconventional monetary measures were beneficial in restoring market functionality and intermediation, but their continued use is risky (Imf, 2013); (International Monetary, 2013).

Regarding the outcomes of unconventional monetary policy in the world's top industrialized economies, there are primarily two schools of opinion. According to the first school of thought, such policies should only be used to address domestic situations; any unintended consequences should be the concern of other policymakers. This bolsters the claim made by Obstfeld and Rogoff (2002) that policy coordination has limited advantages when individual central banks have implemented policies that are designed to achieve domestic macro stability. A fundamental obstacle to policy coordination, in accordance with Ostry and Ghosh (2013), is a lack of understanding and agreement over the global ramifications of QE actions.

The opposing viewpoint contends that QE initiatives are less benign. One effect is that they lower the value of national currencies and increase risk-adjusted interest rate differentials in comparison to other economies, which can lead to massive capital inflows and inflationary pressures on consumer and asset prices in those nations. Rajan raises concerns about "competitive asset price inflation" in addition to those regarding competitive devaluation (2013). Taylor (2013) claimed that the cost-benefit analysis has changed since significant cross-border spillovers have appeared, indicating that the Obstfeld and Rogoff (2002) argument may be valid in normal circumstances but is no longer relevant in light of these changes. For instance, QE actions would be detrimental if they encouraged other central banks to also deviate from rules-based policies as a result of "deviations from rules-based policy" brought on by QE actions. Depending on where they are in the business cycle when QE is adopted, people in various nations may react differently to the global consequences of QE. It is generally acknowledged that during the global financial crisis and ensuing recession, QE policies contributed to stabilizing global financial markets and prevented a further decline in global economic activity. Due to the enormous currency appreciation and pressure from capital inflows that occurred while the recovery lagged in the advanced countries but surged in the emerging ones, QE may have contributed to economic overheating and asset market excesses in some jurisdictions.

The objective of this research is to determine the factors that influence the outcomes of the effects of expansionary monetary policy in the economy as well as in the financial markets. The purpose of this paper is to contribute to the body of knowledge by reviewing and examining analytical research on the effects of the usage of QE. The study will help us to understand the how the unconventional monetary policy works and what are the main drivers of this policy which are affecting the financial markets. The framework for analysis presented here attempts to remedy this opaqueness with a straightforward framework that identifies the structure of influence of unconventional monetary policy on economic activity as captured through the policy variables and the financial markets.

However, for a long time, many commentators have argued that in order to achieve macroeconomic goals, the Fed should set an annual target for the growth rate of a monetary aggregate. For a number of reasons, including the fact that a sizable portion of a primary component, currency, is retained outside the country and so is unlikely to affect domestic economic activity or prices, monetary aggregate measurements, such as the restricted measure M1, have come under scrutiny. Depository institutions' sweep operations also have an impact on M1, however estimates of sweep balances can be accounted for utilizing the procedures outlined by the Federal Reserve (Andersen & Karnosky, 1977).

Monetary base movement reflects Fed monetary actions. Meltzer (1987) and McCallum (2000) proposed policy concepts for modifying the monetary base to manage GDP and prices. The monetary basis is the Fed's total assets less the public's currency holdings and banks' reserve balances. The rise in the monetary base growth rate is expected to have a lagged effect on other monetary aggregates, which will affect spending growth and, in the short term, output and employment growth. Long-term, a faster expansion of the money supply and government spending will increase inflation.

The narrow monetary aggregate M1 multiplier is based on the ratios of public (c), bank (c), needed (p), and surplus (e) reserves to transaction deposits (D). To rectify this, the monetary base and multiplier are simplified to exclude excess reserves. This accounts for non-M1 components expressed as a ratio of transaction deposits. The surplus reserve ratio is a minor multiplier component until fall 2008, then it explodes. "Monetary base adjusted" is determined by removing surplus reserves from the monetary base provided by the Board of Governors.

In the simplest model of the Fed and commercial banks, the Fed's assets are reserve bank credit (RBC), which comprises commercial bank credit (L), other private credit (PC), and Treasury securities (TS), while its liabilities are deposits (C), needed reserve requirements (RR), and excess reserves (ER). Total currency in circulation plus needed reserves + excess reserves equals the monetary basis (MB). Credit (CR) can be in the form of securities or loans, or interest and principal (RR and ER), and liabilities might be transaction deposits. In this model:

$$M=[(1+c)/(c+p+e)]*MB \quad (1)$$

Excess reserves can be deducted from the monetary base measure to form MBA, as they absorb a component of the monetary base but do not directly contribute to M. and equation (1) may be recast as:

$$M=[(1+c)/(c+p)]MBA \quad (2)$$

This statement is more relevant from a heuristic perspective when excess reserves are relatively small, as they were before to 2008, or when excess reserves are vulnerable to severe shocks as a result of the introduction of interest payments, particularly at subsidized rates. If one is interested in a stable multiplier, the bracketed term in above Eq. is also more useful.

In 2007, the Fed increased lending to the private sector as it moved closer to adopting a credit strategy. Many commentators have characterized this as the Federal Reserve taking on a role in fiscal policy by lending to investment banks and other financial institutions that had no access to the Federal Reserve for 70 years other than as large dealers in Treasury securities. It can also be referred to as credit policy because the Fed conducted steps to accomplish credit expansions to specific financial market groups, mostly to non-depository institutions. Nelson (2013) explains why the Fed departed from conventional monetary policy, despite his efforts to otherwise be consistent with Milton Friedman's framework: "It was exactly this aspect of the Friedman-Schwartz account of the Great Depression which Bernanke (1983) (2002) used as motivation for an alternative view that the credit contraction mattered in its own right. There is a crucial role for intervention in credit markets to defend intermediation, in contrast to the actions meant to maintain the money stock that Friedman noted.

When the federal reserve changed a policy on lending to depository institutions that it had implemented in 2003, it also made a substantial change in conventional policy in 2007. Between 1986 and 2002, weekly depository borrowing had an average volume of $540 million. When the fed instituted a penalty rate of one percentage point above the federal funds rate in 2003, primary and secondary credit to depository institutions decreased to an average of $49 million and remained extremely low until 2007. The primary credit rate and its spread over the federal funds rate fluctuated greatly when the federal reserve (Fed) dissolved the fixed link between them in the middle of 2007, which significantly affected borrowing. The primary credit rate was raised by the federal reserve by 75 basis points in February 2010 and has remained there ever since, causing borrowing to drop back to low levels.

Prior to changing the penalty, the policy of a penalty credit rate had restricted borrowing and generated significant changes in the loan market. Although one may argue that the financial crisis was to blame for these significant changes, the crisis itself had little impact on them. The Federal Reserve could soon return to the higher and fixed penalty spread it had in place from 2003 to August 2007, but this may be less likely if the Fed wants to keep its ability to implement a discretionary credit policy separate from monetary policy. Depository borrowing has now decreased to a negligible level.

It was decided to abandon the new discount strategy, which was a considerable departure from earlier monetary conventions. The theoretical arguments in favor of a regulation ultimately failed, and discretion won out. Numerous economists opposed discount schemes, including Friedman (1959) who thought they just served to transfer wealth to banks in the form of subsidized loans and unusual interest rates. Furthermore, Friedman asserted that by using traditional open market techniques to distinguish between insolvent and illiquid institutions, the banking industry and credit markets may channel new credit to illiquid but not insolvent enterprises.

The Fed also created new facilities to buy asset-backed commercial paper from money market funds and to lend to financial institutions and others against such assets. Most significantly, the Fed established a plethora of new lending programs for primary dealers—banks and other financial institutions authorized to borrow, buy, sell, and lend U.S. government securities with the central bank. These amounts include contributions from numerous other kinds of Mortgage-Backed Securities, Agency Debt, Asset-Backed Securities Loan Facilities, and Maiden Lane-related projects. Businesses like TALF, AIA LLC, Aurora LLC, and ALICO Holdings LLC were housed in other places. The Fed also provided funds for the purchase and administration of a portfolio of Bear Stearns' risky assets at the time JPMorgan Chase acquired Bear Stearns in May 2008. As AIG eventually imploded in the fall of 2008, the Fed ultimately lent it more than $85 billion to keep it solvent. When the Fed makes loans to the private sector, it damages its standing in the financial markets and exposes taxpayers to a large financial risk. The purpose of Ize and Oulidi's (2009) paper was to disseminate expertise obtained from emerging nations and developing economies. In this analysis, we emphasize the possibility of unusually high profitability for weak banks, such as the Federal Reserve after 2007 (the year fiscal dominance started). Ford and Todd (2010) contend that disproportionately risky assets are to blame for the Fed's rise in profits since 2006.

The difficulties of sluggish monetary base expansion leading up to, during, and after the recession, as well as throughout crucial phases of the recovery, were brought on by focusing on credit policy, particularly the Fed's provision of private sector credit. In the aforementioned money supply process model, which incorporates both the direct RBC from the Fed and the CR supply from the banking sector, combining the balance sheets results in TC.

$$TC=M+O \tag{3}$$

The only method the Fed may modify the money supply through the money supply mechanism is by altering its "other deposits and liabilities" or the money stock. The intermediation of credit through time deposits and other non-transaction deposits can influence banks' participation in the credit that arises from public saving, but this cannot change the flow of credit created by the money supply process, given a certain money supply M. Any changes the Fed makes to its credit, especially credit given to non-depository private firms, won't affect the total credit unless they also affect M or O. A rise in RBC—whether private sector credit or Treasury securities—given M would have to be matched by a matching increase in excess reserves in the absence of a corresponding change in the credit extended by depositories.

If the Fed's "other" liability increases, such as when more Treasury money are deposited to the Fed, both RBC and TC may increase. Consider a scenario where the Treasury issues new securities and deposits the proceeds to the Fed to enhance its deposits there. The public's transfer of funds to the Treasury would result in a reduction in the required reserves, which the Fed would have to make up for by raising RBC. The overall credit amount made available to the private sector won't alter, though. While RBC and O both climbed by the same amount as the increase in Treasury deposits, the quantity of credit accessible to the private sector would stay the same. Another source of other liabilities is deposits from foreign central banks. Given the existence of MBA and M, the Fed's attempts to enhance RBC, particularly its private component, PC, by lowering TS or increasing its excess reserves are ineffective. However, a rise in these deposits could benefit RBC and TC at the expense of the RBC of the foreign nation. This consequence is one of the main issues with the Fed's proposal to increase the private sector's contribution to RBC by cutting TS or rising ER while maintaining MBA and M unchanged. RBC and TC can be increased by increasing government deposits at the Fed, but only by an amount equivalent to the new issue of Treasury notes. This indicates that the deposit hikes would not affect the total amount of credit that is accessible to the private sector. The Federal Reserve's reliance on increasing private sector credit without affecting M depends on stimulus effects that are neither theoretically explicable nor empirically supported because the Federal Reserve's credit to the private economy has a greater impact on spending than an equal amount of Treasury security purchases or loans to depository institutions. Furthermore, the magnitude of the Fed's balance sheet adjustment or other unusual policy shifts may have had a different impact on the results of typical monetary policy indicators (Tatom, 2014).In line with other developed economies, the Federal Reserve started buying a lot of assets to boost the economy after the Global Financial Crisis. These included mortgage-backed securities (MBSs), federal agency debt (such as debt from Fannie Mae, Freddie Mac, and Ginnie Mae), and long-term Treasury securities (QE). These LSAPs may affect the economy via a number of routes, including the signaling channel, the portfolio balance channel, the interest rate expectations channel, and the fiscal expansion channel (Bernanke & Reinhart, 2004) (Borio & Disyatat, 2010).

Between 2008 and 2012, three separate LSAP programs were used to lower the interest rate on long-term loans (Gagnon et al., 2010). In the end, the cost of loans such as mortgages and business lines of credit is determined by long-term interest rates. Long-Term Asset Purchase Programs bought mortgage-backed assets and long-term U.S. Treasury notes from government-sponsored companies including Freddie Mac and Fannie Mae. These two businesses contribute to the smooth operation of the mortgage market by buying mortgage loans from lenders and putting them into marketable securities. Michael Kiley (2018) draws the conclusion that LSAP programs have a favorable impact on the economy as a whole based on his results (Mendez-Carbajo, 2020).

A fourth LSAP program was made public in March 2020, just as the COVID-19 pandemic began to spread in the United States. The program was expanded with the inclusion of agency debt securities to the program's planned purchases of US Treasury and mortgage-backed assets in September 2019. By keeping the financial system stable, the Federal Reserve works to guarantee that people and businesses have easy access to credit.

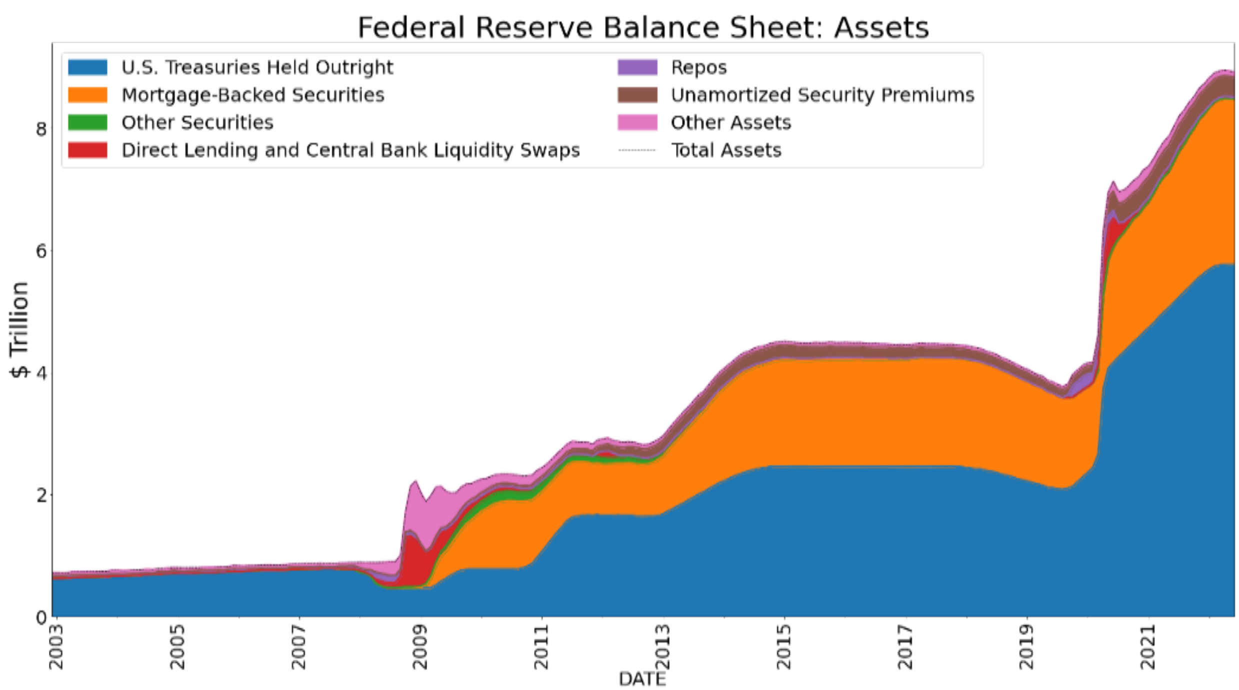

Figure 1. Federal reserve system assets

Figure 1 shows that the Federal Reserve began the first three LSAP initiatives on three different occasions: in November 2008, November 2010, and September 2012. Each initiative received a different size based on projections of the future monetary policy. The FOMC planned to gradually reduce their holdings by waiting for them to mature rather than selling them back on the stock market. An endeavor to normalize the company's balance sheet started in October of 2017 (Curdia & Woodford, 2011).

To ensure an adequate level of bank reserves, the Federal Reserve modified its balance sheet normalization policy in January 2019. Since August of that year, the principal payments from maturing agency debt and mortgage-backed securities have been used by the New York Fed to purchase short-term Treasuries. The continued decline in the balance of mortgage-backed securities and the parallel increase in the balance of Treasury bonds are both seen in Figure 1. Once the fourth LSAP program described above goes into operation, the Federal Reserve will start to accumulate more of these assets on its balance sheet.

As a result, this study uses an approach that hasn't been applied to reviews and analyses in this area of research before. an analysis of contemporaneous causal linkages using directed acyclic graphs, a relatively new statistical approach. The DAG technique is used in social sciences like computer science and epidemiology. Although it offers a mechanism for capturing crucial assumptions that illustrate how the researcher understands causal linkages, it has not gained popularity in the field of economics (Imbens, 2020). This will discuss the use of QE and its drivers and demonstrate how the studies arrived at this conclusion. Following is the rest of the thesis: The second segment, which comes next, will review relevant research on the subject. The third section will go into the data and the methods that was used to collect it. The empirical technique is covered in the fourth section, while directed acyclic graphs are covered in the fifth. Finally, I will discuss the outcomes of my models in Section 5 along with some final thoughts.

2. LITERATURE REVIEW

Since the 2008 financial crisis, the U.S. Federal Reserve, the Bank of England, the Bank of Japan, and the European Central Bank have begun monetary easing or quantitative easing. This is a unique strategy to boost the economy and cut long-term interest rates to battle a recession. Due to the global financial crisis, industrial country interest rates dropped to near zero, making further cuts difficult. Quantitative easing (QE) and other asset-buying programs are rarely used. Japan started QE in 2001. Not until the 2008 financial crisis did industrialize countries' central banks regularly use QE to bolster their economies, increase bank lending, and induce consumers to spend.

The 2007 US real estate bubble bust, which led to the 2008 financial crisis, and the more recent Eurozone sovereign debt crisis have compelled the world's top central banks to implement extreme monetary operations like QE to prevent financial instability. The US began QE1 in 2008, QE2 in 2010, "Operation Twist" in 2011, and QE3 in 2012, buying $85 billion in mortgage-backed securities and longer-term treasury securities each month. The fed buys bonds and lends them to banks. This boosts the economy, lowering long-term interest rates. In the UK, the Bank of England raises QE to £375 billion. This money mostly buys UK government bonds. Since 2008, the ECB has conducted longer-term refinancing operations across the eurozone, as well as two rounds of covered bond purchase programs in 2009 and 2011, an unlimited securities market program in 2010, and open-ended outright monetary transactions in 2012. By 2012, Japan's central bank will have loosened the country's money supply by 101 trillion. The Bank of Japan may have initiated the riskiest monetary easing in history. It aims to quadruple the monetary base in two years by buying government bonds, ETFs, and REITs. So, these central banks have tried to stop the economic downturn by expanding their balance sheets. Central banks strive to stimulate GDP, reduce unemployment, and sustain their financial systems by pushing consumers to spend more. Some critics fear these initiatives will increase inflation and government spending.

2.1. Unconventional monetary policy, interest on reserves, and the overnight lending market:

The Federal Reserve met banks' short-term liquidity requirements and maintained the federal funds rate before 2008. Before the 2008 financial crisis, bank reserves were low. To meet regulatory requirements, banks would borrow reserves from the federal funds market (Woodford & Walsh, 2005). The minimum reserve ratio became worthless. Statutory liquidity coverage ratio (LCR) was a pseudo-reserve ratio under Basel II/III, requiring banks to hold large quantities of liquid assets to compensate for high-risk investments (Slovik & Cournède, 2011); (Cosimano & Hakura, 2011); (Hummel, 2015).

Under post-crisis norms, reserves substantially surpass the requirement. Banks no longer had to choose between keeping or selling reserve cash. To prevent freshly produced money from floating in financial markets, the Fed pays interest on necessary and excess reserves. No bank with a Federal Reserve deposit account would lend reserves at a lower rate. Fed funds rate is lower than IOR since the crisis (Bauer & Rudebusch, 2016). The overnight loan market was divided. Hedge funds and government-backed businesses like Fannie Mae and Freddie Mac are active Fed money lenders but can't acquire IOR. They will lend at lower rates than IOR. Baumeister and Benati (2012) suggest IOR divides the market by capping short-term rates. They study the zero lower bound. The COVID-19 lockdowns started similarly. When rates fell, the yield curve flipped and stayed that way until the Fed lowered the federal funds rate and IOR.

Describe the Fed's actions in the overnight lending market without mentioning the new system would be an incomplete definition of the system. The Fed uses the rate it pays on reserves to calculate the federal funds rate target range. Because the Fed doesn't control most interest rates, it employs money market arbitrage to spread federal funds rate adjustments to other short-term rates. The Fed must first transfer rates to affect the actual economy. Federal Reserve's Federal Open Market Committee (FOMC) raises or lowers the federal funds rate dependent on the economy. This is the overnight lending rate. The government's financial target range went from 0 to 0.25 to 2.25 to 2.50 between 2015 and 2018. The federal spending goal range went from 2.25 to 2.50 to 0 to 0.25 between August 2019 and March 2020 (Mendez-Carbajo, 2020).

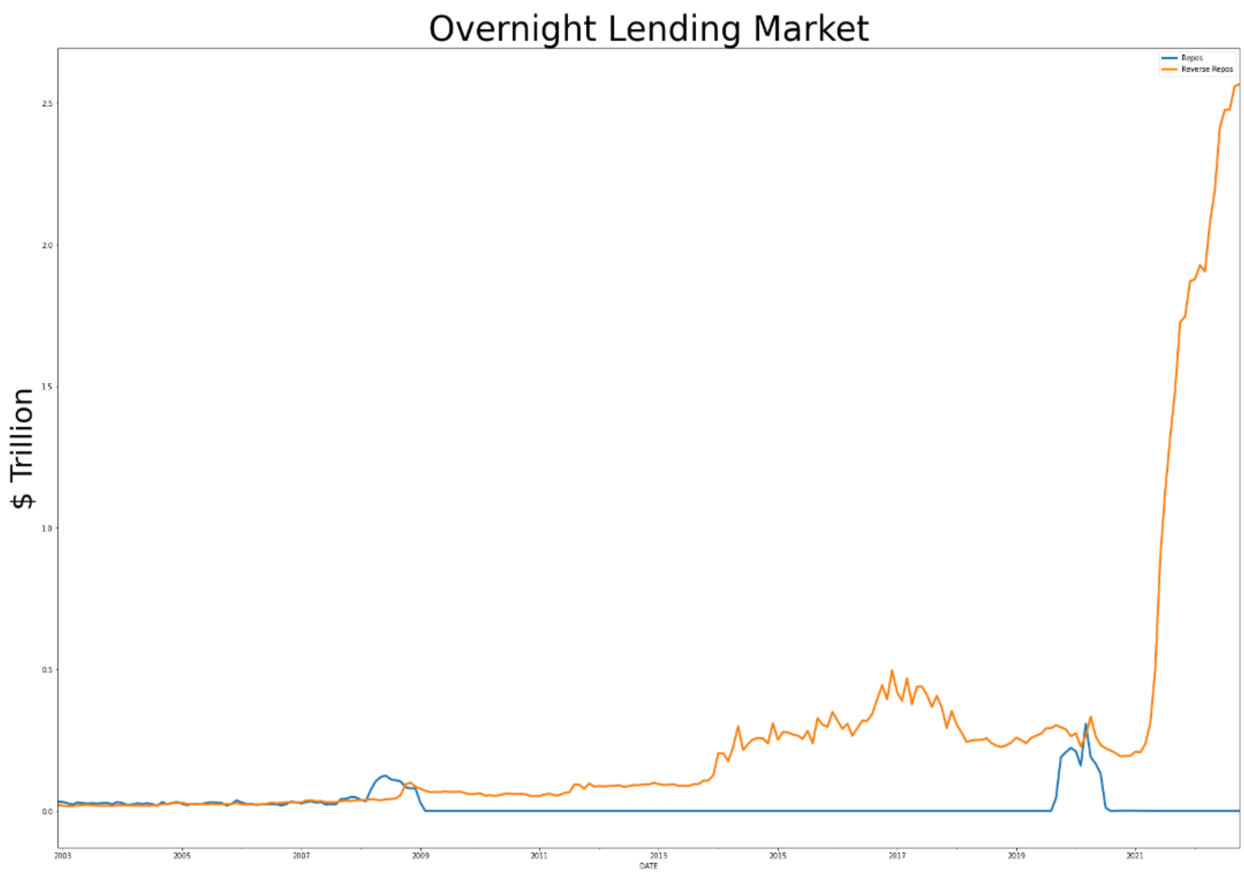

Figure 2. Overnight lending market (repo & reverse repo)

In 2013, the Federal Reserve conducted a trial run of the overnight reverse repurchase agreement (ONRRP) in order to eliminate market segmentation and to make the execution of monetary policy easier which is shown in Figure 2. The fed received overnight loans from eligible counterparties, which are then secured by the Fed's portfolio of securities. This results in an increase in short-term rates and improves trade on the money market. The new facility does not have the segmentation problems that the older one, IOR, did because it is available to a wider range of financial counterparties, such as non-bank mutual funds. This market was utilized by the Fed when the effective federal funds rate increased in September of 2019.

A momentary mismatch in the supply and demand for short-term lending between banks led to an increase in the federal funds rate. This imbalance was the source of the increase. This was brought about as a result of the United States Treasury selling debt, which removed cash from the federal funds market.

2.2. Quantitative easing & the loss function:

Does the Federal Reserve alter its balance sheet in response to changes in the money supply? What specific factors does it consider when deciding whether to raise or lower interest rates? These are the two common queries that constantly cross our minds when we consider the Federal Reserve's monetary policies. There may be conflicting interests among the Federal Reserve Board's voting members, making it difficult to always understand why a certain policy decision was taken. The precise objectives and methods for achieving them in monetary policy are frequently left up to interpretation by policymakers. This seems to be the driving force behind Woodford's fairly liberal perspective on monetary policy based on rules. As far as I can gather, central banks generally agree with this criterion and rely significantly on it when deciding how to carry out policy. For instance, the majority of economists and central bankers concur that "flexible" inflation targeting is the ideal way to conceptualize inflation targeting (Kahn, 1996); (Sellon & Buskas, 1999). The effectiveness of an inflation target can be harmed by a number of factors, and minimizing short-term swings is difficult (Mishkin, 2007). New Zealand is an excellent example since it "added legal escape mechanisms to its inflation-targeting system, allowing for inflation target range misses where there are large changes in the terms of trade, changes in indirect taxes that affect the price level, or supply shocks" (Mishkin, 2007). Meyer (2001) describes the inflation-targeting regimes in New Zealand, Canada, and the United Kingdom as having a "hierarchical" mandate for price stability, as opposed to the "dual" mandate that governs operations in Australia and the United States, despite the fact that he advocates for a numerical inflation target.

Any purpose must be pursued inside a framework that is built on rules. Even while it is incorrect to claim that monetary policy precisely complies with a rule, it is fair to use that rule in order to interpret policy. I will use a loss function that provides the deviations from goal values of the unemployment rate and the inflation rate equal weight because we must adhere to a specified format to statistically analyze data. The structure that loss functions can take is very flexible. John Taylor (2013) presented a loss function made up of the output gap and the difference between observed and goal inflation in response to decades of concern about the impact of monetary regulations on determining monetary policy (Barro, 1984); (Milton Friedman, 1968); (Johnson, 1968); (Kydland & Prescott, 1977); (Laidler, 1973). The target interest rate would decrease if there was a negative (positive) output gap or inflation below (above) the target rate (upward). Since the Federal Reserve is responsible for maintaining low and stable inflation and reducing unemployment, a response function made to resemble the Federal Reserve's monetary policy setting should track variations from the desired inflation and unemployment rates (Kilian & Manganelli, 2008).

In general, variables affecting unemployment and inflation are treated equally. Bernanke (2020) defines the loss function as "the sum of the squared deviations of inflation from target and of the unemployment rate from the natural unemployment rate (972), except that no penalty is assigned when unemployment is below the natural rate" and uses the federal reserve's new average inflation target to do so (Svensson, 2020). Svensson (2017) uses squared deviations, just like Bernanke, to assess the effectiveness of monetary policy. According to Svensson, Bernanke (2015), Yellen (2012a) and Clarida (2019) all employed the tactic. These sentences' output can be multiplied using a parameter between 0 and 1. According to Svensson, it is actually extremely close to or equal to one. Every time the unemployment rate surpasses the natural rate or the inflation rate falls short of the target, more assistance should be given.

By lowering interest rates, increasing the amount of money in circulation, or broadening the balance sheet beyond currency, the federal reserve can close these gaps. The federal reserve has historically opted for the last course of action when the zero-lower bound appears to be restricting interest rate policy. If it has boosted currency circulation, its balance sheet has increased even more. The expansion of the currency has been avoided in order to keep inflation below the target rate.

According to Rudebusch (2018), both market participants and the Federal Reserve's forward guidance overestimated the increase in the federal funds rate. Without using forecast information, the DAG model used here examines causality direction and structure. With the use of past and present values of policy variables, the model enables monetary policy to influence future values.

2.3. Longer-term correlation between monetary policy and financial markets:

Central banks affect the pricing on the financial markets through implementing monetary policy initiatives. Several research have looked at the degree to which this impact has grown over time. On the financial markets, it is clear that some long-standing connections and correlation patterns have shifted recently. There are many reasons why prices in the financial markets around the world are synchronizing more. The expanded globalization of the financial and capital markets as well as the rising parallelism of global economic and pricing trends are anticipated to be significant factors. Unconventional monetary policy actions, particularly the large QE programs that have driven up bond and equity prices concurrently, may also be a contributing factor. Large-scale securities purchase initiatives ultimately result in lower interest rates and a decrease in the availability of risk-free assets. This thus prompts investors to rearrange their portfolios in favor of riskier asset classes like stocks, which is unquestionably desirable from the perspective of transmitting monetary policy. Rising asset prices should ultimately encourage investment, consumption, and an increase in consumer prices.

The extent to which increased equity prices in the current environment can be taken as a reflection of improving economic and profit outlooks is a related question. Intuitively, it should be clear that corporate earnings and stock prices move in tandem, at least over longer time periods, and are thus positively connected. Occasionally, it is inferred from these facts that certain financial market values have fully detached from the real economic environment and, in a sense, only respond to monetary policy. Because investors perceive unexpectedly weak economic data as a sign that expansionary monetary policy will continue, unexpectedly negative economic news is generally viewed favorably by the equity markets. The prevalence of this occurrence, however, has barely increased since the financial crisis. The financial media and investment community are also fixated on interest rates for some reason. Interest rates are the cost of borrowing someone else's money. The federal open market committee (FOMC), which is made up of five presidents of federal reserve banks and seven governors of the federal reserve board, sets the federal funds rate target, which affects not only the stock market but also how much money banks can borrow and lend to one another overnight. A change in the interest rate typically takes at least a year to affect the economy more broadly, although the stock market can sometimes react to a change much more quickly. In addition to the federal funds rate, the federal reserve also establishes a discount rate. The rate that the federal reserve charges banks to borrow money from it is known as the discount rate (Huston & Spencer, 2016); (Krishnamurthy & Vissing-Jorgensen, 2011). If a company is seen as scaling back on its expansion or is less profitable—either through higher debt expenses or lower sales—the predicted amount of future cash flows will decrease. This will lead to a decline in the stock price of the company, assuming all other variables stay the same. The Dow Jones Industrial Average, S&P 500 and other popular indices that many people associate with the market will decrease if the stock values of enough companies decline. If investors have reduced expectations for a company's growth and future cash flows, they won't get as much growth from a rise in stock price. This could make stock ownership less desirable. Furthermore, purchasing shares may seem excessively risky when compared to alternative investments. On the other hand, increases in interest rates might help some industries. One of the industries that gains the most is banking. Financial institutions include, for example, banks, brokerages, mortgage companies, and insurance firms (Rudebusch, 2018).

2.4. Unconventional monetary policy and stock market:

Quantitative easing (QE) by the Federal Reserve undoubtedly impacts the stock market, albeit it is challenging to pinpoint exactly how and to what degree. The research suggests a relationship between a QE program and rising stock prices. In actuality, some of the most significant stock market gains in US history have occurred while a QE plan was in effect. After all, the purpose of a quantitative easing approach is to foster or even hasten economic growth in a nation. In order to infuse more money into the economy, quantitative easing (QE) in practice, entails buying significant quantities of government bonds or other investments from banks. Following that, banks lend that money to companies, who utilize it to increase operations and boost sales. Investors in stocks purchase shares in anticipation of rising corporate earnings. That's the big picture, but there are other, subtler effects of QE on stock market return as well (Al-Jassar & Moosa, 2019).

As I have said above, the unorthodox monetary policy affects the economy and financial markets primarily through asset values. The unorthodox monetary policy drives interest rates lower, which could affect the value of other assets. As a result, the Fed's significant purchases of government bonds would alter the risk profile of other assets.

Furthermore, in really adverse circumstances, a central bank can cut the nominal interest rate all the way to zero while still failing to sufficiently boost the economy. The term "liquidity trap" now refers to a situation when the nominal rate reaches the zero lower bound, however it slightly departs from Keynes' original definition (Krugman, 1998). The presumption is that real interest rates (r), not nominal interest rates, are what matter most for things like aggregate demand. During severe recessions, monetary authorities may need to reduce real rates (r = I - I, where I is the rate of inflation). When it reaches zero, though, the central bank is unable to lower it any more, leaving r "stuck" at a negative value that is small or even positive. In any case, once I = 0, traditional monetary policy has no more options. Things are actually worse than that. Milton Friedman (1968) warned against setting the nominal interest rate while inflation is rising or falling in the following manner: Dynamic instability is the outcome. Naturally, the nominal rate is fixed once it is set at zero. In the event that inflation drops, the real interest rate will rise much more, putting even greater strain on the economy. An implosion caused by deflation will follow and the quantitative easing is about to begin. Assume that even with the riskless overnight rate being restricted to zero, the central bank has some unconventional policy tools, such as term premiums and/or risk premiums, that it can use to lower interest rate spreads. Monetary policy is still effective at the zero lower limits if reducing risk premiums and/or flattening the yield curve may boost aggregate demand. If the central bank pursues quantitative easing forcefully enough, it may be able to halt the potentially vicious downward circle of deflation, decreased aggregate demand, additional deflation, and so on. The one question that can be raised here is: what unconventional weapons might be found in such a collection? The following hypothetical and fictitious list has a direct analog in everything the Federal Reserve has done. We can assume that the central bank desires to flatten the yield curve, most likely because long rates have a bigger impact on spending than short rates. There are really just two options and the first one is that one may try the "open mouth policy." The central bank can guarantee that the overnight rate will remain at or near zero for, say, "a protracted period" (or a phrase to that effect) or until, say, inflation rises above a specific threshold. As long as the commitment is reliable and the term structure's (rational expectations) hypothesis is valid, doing so should bring down long rates and hence boost demand. However, such verbal assurances would not normally be regarded as quantitative easing because no amounts on the central bank's balance sheet are changed. The quantitative easing plan for the term structure is straightforward: Instead of the short-term bills that central banks generally buy, invest in longer-term government assets through open market transactions. Such operations can cut long rates by lowering term premiums if there is inadequate yield curve arbitrage, perhaps as a result of asset holders' "preferred habitats." Another area that quantitative easing is likely to concentrate on is risk or liquidity spreads. Every private debt instrument, including bank deposits and AAA-rated bonds, carries a premium above Treasury bonds for one or both of these reasons. Since private borrowing, lending, and spending decisions are likely to be influenced by (risky) non-Treasury rates, reducing the spreads between (risky) non-Treasury rates and (riskless) Treasuries lowers the interest rates that are relevant for actual transactions even if riskless rates remain unchanged. What could be done to accomplish it by a central bank? The most straightforward course of action is to buy one of the riskier and/or less liquid assets, paying for it either (i) by selling some of its Treasury holdings, which would change the composition of the balance sheet, or (ii) by releasing additional base money, which would extend the balance sheet. Both forms of quantitative easing are permissible, and their effectiveness depends on how interchangeable the traded assets are. We all understand that purchasing X or selling Y has no impact if X and Y are exact equivalents. Thankfully, it seems unlikely that some assets, like mortgage-backed securities (MBS), would be a perfect substitute for treasury bonds—certainly not in a time of crisis.

In response to the summer 2007 financial crisis, the FOMC began lowering the federal funds rate on September 18, 2007, starting from a target of 5.25 percent. Although the Fed's rate reduction was swift by historical standards, there was little indication of urgency. Until April 30, 2008, when the FOMC decided to keep it unchanged while awaiting new data, the target funds rate didn't fall below 2 percent. Perhaps more important to the story of quantitative easing is the reality that the Fed did not considerably expand bank reserves or its balance sheet during this time. The Federal Reserve was already carrying out a number of quantitative easing programs even before emergency measures like the Bear Stearns bailout were taken. Only the assets side was affected by the early quantitative easing. Beginning in 2008, the Fed started to sell its Treasury holdings and replace them with other, less liquid assets. It is clear that the Fed changed the structure of its portfolio in order to provide more liquidity to markets that were in need of it, specifically more T-bills. Its goal was to reduce what were known as liquidity premiums. If you can distinguish between the two, you might say that illiquidity and worries of insolvency were the markets' core problems, yet the underlying financial situation was undoubtedly getting worse the entire time.

The second category of initial QE actions began on the liabilities side of the Fed's balance sheet. To aid the Fed, the Treasury started borrowing more than it needed (which was not yet as enormous as it would eventually become) and deposited the surplus funds in its accounts at the central bank. These were obviously fiscal operations, but by increasing the purchases of securities and the provision of discount window loans (for instance, through the Term Auction Facility [TAF]), the Fed was able to improve its assets without increasing bank reserves. That is especially advantageous for a central bank that could still be reluctant to boost aggregate demand or that might be worried about running out of T-bills to sell, both of which were probably true of the Fed at the time. But keep in mind that, however slight, these operations marked the first crossing of the line separating monetary and fiscal policy. Additionally, the Fed began providing loans to (nonbank) main dealers not long after the Bear Stearns rescue in March 2008.

Everything changed when Lehman Brothers crashed six months later, including the Fed's monetary policy. The FOMC began lowering interest rates once more during its meeting on October 10, 2008, eventually pushing the funds rate all the way down to virtually zero by December 16. More importantly for the story of QE, the Fed quickly and significantly started expanding its balance sheet, lending activities, and bank deposits. By the fourth quarter of 2008, the Fed had no reason to doubt that aggregate demand would increase. The phrase used was "battle stations." The Federal Reserve's total assets climbed significantly between September 3, 2008, when they were $907 billion, and November 12, 2008, when they were $2.214 trillion. The Fed was simultaneously purchasing a variety of instruments, including commercial paper, and making loans of other kinds that it had never made before (e.g., to nonbanks). On the liabilities side of the balance sheet at that time, bank reserves surged significantly, climbing from roughly $11 billion to an astounding $594 billion and then to $860 billion on the final day of 2008. The fundamental reason for almost all of this expansion was an increase in surplus reserves, which were only $2 billion in the month before Lehman Brothers fell (August) but rocketed up to $767 billion by December. Since the Fed's capital hardly moved over this short time, its balance sheet became heavily leveraged. In instance, the Fed's leverage rose from about 22:1 to nearly 53:1 (assets divided by capital).

The quantitative easing plan was initially implemented in a hasty, reactive, and institution-based manner. The Fed was improvising as it went along and frequently purchased assets in connection with extremely last-minute efforts to save specific firms (e.g., the Maiden Lane facilities for Bear Stearns and American International Group). The Term Asset-Backed Securities Loan Facility (TALF), introduced in March 2009, the MBS Purchase Program (announced in November 2008), the Commercial Paper Funding Facility (CPFF), and other forward-thinking initiatives from the Fed soon started to take on a more methodical, deliberate, and market-based flavor. The goal shifted to reducing risk premiums, which had grown to outrageously high levels during the frightened months of September through November 2008, even if there may still be a need to save struggling institutions. It was notable and prudent to change the emphasis in this way. Riskless rates are largely irrelevant to economic activity, as was already proven. Because there is little variation in risk premiums between the funds rate and the relevant (risky) rates—rates on consumer and commercial loans, mortgages, corporate bonds, etc.—the funds rate has historically had a lot of influence. Consider the interest rate on instrument j as being composed of the corresponding riskless rate, r, plus a risk premium particular to that instrument, let's call it j. This interest rate is then represented by the symbol Rj. Consequently, $Rj = r + j$. If the j fluctuates modestly, controlling r is a powerful strategy for affecting the interest rates that matter—and hence, aggregate demand. This is the usual situation. However, when the j swings widely—in this case, rising—the funds rate becomes a poor tool for formulating policy. In fact, even when r was either constant or decreasing, the majority of the Rj s were still increasing. I will go into more detail on the Japanese experience later, but let's just focus on one key distinction between quantitative easing in the US and Japan for now. The BOJ targeted term premiums by concentrating its quantitative easing on buying long-dated Japanese government bonds. Until it started purchasing long-term Treasuries in March 2009, the Fed's quantitative easing programs, which included a variety of market-by-market measures, were instead focused on reducing risk premiums. It was unquestionably lot harder, but in my perspective, it was also far more successful.

Taking a look at the literature, Ugai (2007) provides a survey on the outcomes of the BOJ's QE strategy from March 2001 to March 2006. The survey demonstrates a definite impact of the QE strategy in flattening the yield curve centered on the short-to-medium-term range by enhancing private sector expectations for the trajectory of short-term interest rates. Increases in the current account balances held by financial institutions at the BOJ during specific stages helped to support expectations that the zero-interest rate would remain in place going forward. The empirical analyses produce conflicting findings regarding the question of whether the growth of the monetary base and changes to the balance sheet composition of the BOJ resulted in portfolio rebalancing. The impact of the portfolio rebalancing, if any, was thought to be less significant than the impact of the commitment. Numerous evaluations of the effects of QE on the economy of Japan through different transmission channels show that QE reduced market funding costs for financial institutions and reduced their funding uncertainties, which resulted in a more hospitable climate for corporate financing. The structural changes in the business sector and the zero-bound interest rate limitation, however, meant that the effect of QE on increasing aggregate demand and prices was frequently restricted. The quantitative easing program in Japan and its impact on stock prices are examined by Kurihara (2006) in the context of economic recovery. The effectiveness of quantitative easing is hotly contested. The relationship between Japanese stock prices and macroeconomic variables during the BOJ's QE program is examined by Kurihara (2006). Quantitative easing and stock price have a significant association, according to empirical data. Additionally, the outcome demonstrated a negative correlation between inflation and stock prices.

In the study of ten Pacific Island nations and the US, Khil and Lee (2000) examined the relationship between inflation and stock market return and discovered that it is a negative one. Geske and Roll (1983) investigated the tax-effects hypothesis, which claims there is a negative association between inflation and stock returns. Random negative or positive real shocks have an impact on stock returns, which in turn signal higher or lower unemployment and lower or better corporate earnings, according to empirical findings. In the analysis of how inflation affects stock returns, (Quail & Overdahl, 2002) took the Efficient Market Hypothesis and Rational Expectation Theory into account. The study's empirical findings indicate that there is a negative association between real stock returns, unanticipated inflation, and unexpected growth. They came to the conclusion that the real output growth control causes the negative association between these two variables to gradually dissipate.

2.5. Expansionary monetary policy & the profitability factors of banking sector:

The fact that QE may have a considerable effect on banks' profitability is another crucial concern. Lower interest rates make it less profitable for banks to engage in typical banking activities, which forces them to pursue riskier but potentially more lucrative endeavors. According to earlier research, banks are attempting to take on higher-risk projects when interest rates are low, acting in accordance with the monetary policy risk channel (Borio & Zhu, 2012); (Delis & Kouretas, 2011). The fact that central banks keep low interest rates until the economy recovers may also contribute to this increased risk appetite (Delis et al., 2017). Adrian and Hyun (2010) contend that a rise in asset values brought on by a sharp decline in interest rates boosts collateral, facilitating borrowers' access to credit. However, financial institutions also increase leverage levels when market players anticipate a policy response from the central bank to address the adverse economic situations (Diamond & Rajan, 2012); (Farhi & Tirole, 2012). As a result, larger aggregate debt levels raise risk and might result in loan losses, which could hurt bank profitability. Deleverage is crucial following the recent global financial crises because financial institutions are becoming more risk-averse.

According to Huston & Spencer (2016), QE had an overall favorable effect on bank profits. They reasoned that the positive effects of a flattening yield curve brought on by the shift in the long-term structure from QE exceed the negative effects of an appreciation of sovereign bonds on the bank's balance sheets. Varghese and Zhang's (2018) findings, which add support to these results, found that QE had an overall positive impact on bank profitability, though the EA's statistical significance was low due to a partially offsetting effect caused by a decline in interest margins brought on by negative interest rate policy and an extended low-interest-rate environment. It's interesting to note that both studies discovered higher projected inflation, which may indicate that QE boosts economic activity and growth. In contrast, Demertiz and Wolff (2016; Huston & Spencer, 2016) reported that QE has a negative impact on bank profitability since bank margins will be squeezed if deposit rates are close to zero. However, given that Swedish banks receive more money from wholesale sources than from deposits at EA banks, these associations might not necessarily hold true for Sweden (Laséen & De Rezende, 2018). The loan rate declines as interest rates do. Additionally, there is a compression on the interest margin due to the asymmetry in decline between the funding rate (FR) and the deposit rate (DR), with the former declining more.

Because the interest rate on funding, in this case deposits, is already low, banks are hesitant to lower deposit rates to negative territory out of concern about a lack of liquidity. Since a result, bank profitability suffers as only lending rates decline. The impact this has on bank profitability is largely influenced by the percentage of liabilities that are covered by deposits.

Investigating the prior literature on the effects of negative interest rate policies on Swedish bank stock prices may produce promising results in light of the paucity of QE studies (Laséen & De Rezende, 2018). While QE and negative interest rate policies differ in how they are implemented, both aim to lower interest rates. Furthermore, due to their similarity, central banks frequently deploy both of them simultaneously to have a greater impact on the economy.

The majority of the Swedish research on negative interest rates makes the case that they have a favorable effect on bank profitability. For instance, Madaschi and Nuevo (2017) examined changes in Swedish bank data throughout the period of negative interest rates and found that bank profitability had increased. They discovered that the improvement has two sources. First off, the NIM remained unchanged as a result of increased lending activity and lower interest expenses brought on by lower wholesale funding costs, which are the result of these costs being close to the monetary policy rate, which was below zero. The second effect of interest rate decreases, which raised the value of the banks' holdings of debt securities, is the growth in realized and unrealized securities gains. Due to the data's granularity and the lack of an econometric analysis, their empirical interpretation is called into question. A non-linear local projection technique is used by De Rezende and Laséen (2018) to overcome these problems. They come to the conclusion that the adoption of negative interest rate policies increased stock values; in other words, more bank profitability results from lower interest rates. Consequently, their data support Madaschi and Nuevo's conclusion (2017). Furthermore, the beneficial effects of negative interest rate policies followed by lower interest rates may imply that outright QE has the same effect on bank share prices.

Although bank profitability has been discussed in the literature for a long time, this review's main focus is on how the financial crisis and the implementation of QE have opened up new research opportunities. A groundbreaking study on the factors influencing bank NIMs was released by Ho and Saunders in 1981. In a quantitative nonexperimental explanatory study, the researchers looked at the extent of the relationship between management risk aversion (measured as the risk-neutral spread over the cost of funds), market structure (measured by the elasticities of deposit supply and loan demand to changes in interest rates), and bank profitability (expressed by NIM, calculated as interest income minus interest expense over interest-earning assets) (reflected through U.S. government bond yields). From Q4 1976 through Q4 1979, Ho and Saunders gathered quarterly data from 100 of the largest U.S. commercial banks. The study's findings demonstrated that NIM is influenced by four variables: (a) managerial risk aversion, (b) average transaction size, (c) market structure, and (d) interest rate variation (Ho & Saunders, 1981). The findings revealed that the 1-year short-term interest rate had a substantial (p .05) and largest impact on NIM (R^2 =.52). According to the authors, market structure, not risk aversion or transaction size, was the key reason why the average NIM for large banks was.368% lower than that of small banks (p .10). The findings of Ho and Saunders (1981), who provided the foundations for the current study by examining the elements of NIM, which include short-term interest rates, are pertinent. Albertazzi and Gambacorta (2009) conducted a quantitative nonexperimental explanatory study to determine the degree to which gross domestic product (GDP), the rate of inflation, the money market rate, the long-term government bond interest rate, the stock market capitalization to GDP ratio, the ratio of total loans to GDP, stock market volatility, and other variables influence NIM behavior across different sizes of banks, large and small. Between 1981 and 2003, domestically yearly aggregated commercial banking industry data from 10 industrialized nations were included in the study. Austria, Belgium, France, Germany, Italy, Netherlands, Portugal, Spain, United Kingdom, and the United States were among the 10 nations that were examined. The idea of the business cycle, which postulates periods of expansion, recession, and recovery, served as the theoretical basis for this study. Businesses, especially banks, experience performance and profitability changes during the business cycle.

Insight into the strength of the connection between the business cycle and bank profitability was offered by Albertazzi and Gambacorta (2009). The findings of the regression analysis demonstrated a substantial positive link between NII and the GDP, total bank assets (i.e., bank size), and long-term interest rates. The findings were important and pertinent to the current study since they showed how GDP, long-term interest rates, and bank profitability are related. Furthermore, the variables in the current study, NII (i.e., NIM), bank size, and bank profitability, were all connected, according to Albertazzi and Gambacorta. Tregenna (2009) investigated the impact of concentration in the U.S. banking sector on bank profitability both before and after the global financial crisis in a quantitative nonexperimental explanatory analysis.

Additionally, the study's goal was to determine how much bank profitability as measured by ROA and return on equity is explained by market share, bank size, and operational efficiency (ROE). The capital asset ratio, bank cash and receivables as a percentage of assets, total invested assets as a percentage of total assets, and bank price-to-earnings ratios were also considered control variables. The data analyzed in the study includes quarterly individual bank-level observations from the commercial banks, national commercial banks, savings institutions, and state commercial banks from the Standard & Poor's Compustat database for the years 1994 to 2005. Both institutions without six quarters of data and those without positive mean profitability over the study period were ineligible. There were 644 American institutions in the resultant sample.

Additionally, Claessens et al. (2018) found that the yield curve slope's impact on ROA was statistically significant, positive across all banks during low-interest rate times, and negative during high-interest rate periods. Overall interest rate eras, the yield curve slope for major banks was negative and statistically significant. However, for major banks, the yield curve was positive and not statistically significant during times of low interest rates, and then it was negative and statistically significant during times of high interest rates. Across all interest rate periods, the yield curve slope had a negative and negligible impact on ROA for small banks. For small banks, the yield curve was significant and positive during times of low interest rates, but minor and negative during times of high interest rates. The results are intriguing since they varied for small and large banks throughout interest rate eras in terms of significance and impact, which suggests that banks respond to market conditions differently depending on size.

Because NIM and the slope of the yield curve are related, Claessens et al. (2018)'s findings are applicable to the current investigation. Additionally, the results were examined using the current study's variable for bank size. With bank size being examined as a moderating factor of the relationship between the slope of the yield curve and bank profitability as measured by NIM, Claessens et al. demonstrated a different reaction to the yield curve slope based on bank size, which is significant and relevant to the current study.

This section of the literature review provided a survey of the recent literature surrounding the components and measurements of economic indicators of the quantitative easing, bank profitability, indicators of share market volatility which are components of the current study. In the next section, we will discuss about the methodology of the analysis.

3. METHODOLOGY:

3.1. Data:

Variables related to the Federal Reserve's mandate and policy implementation are included in the data that the model used. Monthly data from January 2006 through February 2020 were used for all calculations. All change rates represent year-over-year changes. Except for data on inflation and the unemployment rate, all the data utilized are accessible on a weekly basis. By averaging the weekly data, monthly data are generated from weekly data. These data are only available from January 2004 because some rates are derived from level values. Every rate is computed as a change from the previous year.

The Federal Reserve is tasked with minimizing unemployment and preserving low, steady inflation. As a result, the Federal Reserve determines policy based on the unemployment rate and Core PCE inflation. The Federal Reserve's monetary policy aims and approach are explained in the well-written one-page FOMC which is known as “Statement on Longer-Run Goals and Monetary Policy Strategy" (FOMC, 2019, first approved in January 2012). The Federal Reserve must maximize employment and price stability by law. The FOMC believes a "symmetric 2% inflation aim" best meets its statutory mission over time. The FOMC observes that nonmonetary factors that affect labor market structure and dynamics determine maximum employment, unlike inflation. These elements may fluctuate and be unmeasurable. Thus, rather of setting a fixed employment target, the maximum level of employment must be assessed from a variety of indicators, which are unpredictable and susceptible to adjustment. The FOMC's longer-run normal unemployment rate estimate is essential. Given this, as stated in Svensson (2020), the mandate can be well defined by a conventional quadratic loss function of inflation and employment expressing flexible inflation targeting (where "flexible" indicates some weight on stabilizing the actual economy; "strict" means stabilizing inflation solely). For convenience, maximum employment can be replaced by the (minimum) longer-run normal unemployment rate. A quadratic loss function of inflation and unemployment expresses the mandate. The "balanced approach" might also be understood as equal weight on inflation and unemployment stability, especially given Bernanke (2015), Yellen (2012b), and Clarida (2015) expressions of "equal weight," "equal footing," and "neither one takes precedent over the other" . Each of these variables has a target set by the Federal Reserve Board. A loss function can be created using the differences between the observed values of these rates and the desired rates. The inflation and unemployment components of the loss function are as follows:

$$L_\pi = \left(\pi_i - \pi_{target}\right) \tag{4}$$

$$L_U = \left(U_i - U_{target}\right) \tag{5}$$

One might interpret the difference of these values as indicating a linear loss function:

$$L = L_\pi - L_U \tag{6}$$

Negative values of L would call for monetary support, while positive values of L, or even smaller negative values, would call for the balance sheet to get smaller. In the same way, deviations from the target are punished in proportion to how far they are from the target. Most of the time, the squared values of its parts are used to show the loss function. One could use squared values of the loss function components that keep the positive and negative sizes of the original components. This would increase the effect of deviations without making it harder to see how they affect monetary policy. This changes the function from a way to measure how well it works to an algorithm that tries to make policy decisions.

$$L_\pi{}' = \begin{cases} L_\pi{}^2 \; if \; L_\pi \geq 0 \\ -L_\pi{}^2 \; if \; L_\pi < 0 \end{cases} \tag{7}$$

$$L_U' = \begin{cases} L_U{}^2 \; if \; L_U \geq 0 \\ -L_U{}^2 \; if \; L_U < 0 \end{cases} \tag{8}$$

These could be used to construct an augmented loss function.

$$L' = L_\pi' - L_U' \tag{9}$$

In the following analysis, we will use the quadratic function. The linear function yields similar results.

Three key factors are under the Federal Reserve's control: 1) the size of the balance sheet, 2) the value of currency in circulation 3) the federal funds rate, which is a good indicator of the short-term course of the balance sheet. Although Bernanke may have targeted this gap marginally prior to October 2008, after 2008 the focus of monetary policy shifted to increasing the surplus over the value of money in circulation. Given that the Federal Reserve balances assets with a combination of liabilities and capital, a tally of total liabilities would be an insufficient indicator of financial stability.

Table 1. Summary statistics of the variables

	Federal Funds Rate	Currency in Circulation	Total Assets	Loss Function
count	206.000000	206.000000	206.000000	206.000000
mean	1.406814	0.004740	0.008487	-9.743082
std	1.616998	0.004132	0.043386	8.915218
min	0.066429	-0.004317	-0.088815	-34.235303
25%	0.142823	0.002201	-0.001899	-12.996163
50%	0.938387	0.004307	0.001970	-4.806672
75%	2.105105	0.007095	0.010400	-4.029028
max	5.258929	0.019249	0.537312	-2.991642

This model is the base model for the thesis. To elaborate this, we have used these policy implementation variables in order to see the effects of the volatility of the stock market and for this reason we have considered VIX. Also, in another section, we have used the policy implementation facts in the profitability factors of twenty mid-capitalized US banks and for this reason, we have considered ROE as a profitability tool. However, to analyze VIX we have used dataset from 2006 to 2020. The dataset of VIX is the daily dataset and the dataset of ROE is the yearly dataset from 2006 to 2020. The descriptive results of the controlling variables of Fed is shown on Table 1.

3.2. Theoretical framework

3.2.1. DAG:

I have used partially directed acyclic graphs to map the structure of Fed policy. These will be referred to as PDAGs. PDAGs look for 1) causation structure, which is represented by the presence or lack of linkages between variables, and 2) causation direction between connected variables. This type of PDAG enables bidirectional edges, implying that variables connected by such a bidirectional edge are endogenous. We would like to look at the impact of unconventional monetary policy on VIX, the profitability factors of banks and the interdependence of the economic metrics stated. I want to test the combined hypotheses that the Federal Reserve targets: 1) the size of its balance sheet to affect the loss function or its components, 2) the size of its balance sheet inversely supports its federal funds target, 3) the effects as well as the interdependency of policy implemented variables of QE on the stock market volatility, and 4) the effects of policy implemented variables of QE on the profitability factors of the US banks. To test these hypotheses, I have employed DAGs.

DAGs are used to test these hypotheses. Although PDAGs are new to economic analysis, there is increasing precedent for their application (Miljkovic & Goetz, 2020). Confounding variables are detected and corrected via a properly built PDAG. The first step in creating a graphical skeleton is to create a completely connected graph. Then, using an algorithm, it is determined if the statistical significance of a correlation between two variables can be lost by adding any combination of control variables from a separation set, S. If a set, S, that is not the null set can be located, we eliminate ties between variables (Pearl, 2009; Pearl et al., 2016).

One can try to figure out the direction of causation for a pair of variables where no such set S exists. This procedure produces a structured graph with links denoting statistically significant partial correlations for pairs selected from the entire set of variables investigated for which no non-null separation set S exists. Every algorithm starts by locating colliders in a graph. Following rules can be used to detect the remaining undirected links and generate forks and chains (Caton & Gupta, 2021). The general structure of each of these indicates an arrow from X to Z (X → Z) indicates that X causes Z.

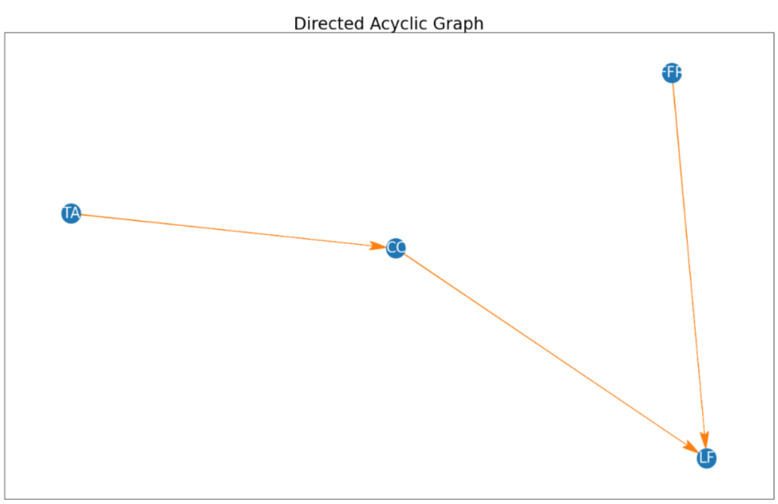

Figure 3. General outcome of directed acyclic graph
Chain: TA→CC→LF and FFR → LF
Fork: CC←LF→FFR
Collider: CC → LF ← FFR

The direction and extent of causation is indicated by do-calculus as $P(Y|do(X = x))$. This indicates the probability that event Y occurs given X while controlling for the effect of confounding variables that impact Y. For discrete and continuous variables, this the magnitude of the effect is estimated as a partial correlation between X and Y. One might expect that this could be described simply as $P(Y|X = x)$, however this presentation does not control for the full set of variables, Z, that exert influence upon Y which could obscure the effect of changes in X on Y. Indications that one has controlled for these variables, $P(Y|X = x,\ Z)$ is generalized by the do-calculus.

Partial correlations are yielded by generating a set of regressions wherein each variable is treated as the endogenous variables with the remaining variables being treated as the exogenous, or explanatory, variables. Thus for every variable selected as Y, the remaining variables are treated as $[X_j, X_{j+1}, \ldots, X_{m-1}, X_m]$, yielding the following equation for the predicted value of Y for each observation j.

$$\hat{Y}_j = \beta_0 + \sum_{j=1}^{m} \beta_j X_{i,j} + \varepsilon_j \quad (10)$$

We calculate the partial correlation of any two variables $x\ and\ y$ controlling for the remaining variables used in the set of regressions by regressing of one error term on the other with no constant. By taking the negative correlation of the residuals, we calculate whether r is positive or negative. The p-value attributed to the estimated effect of one error term on the other indicates the statistical significance of the partial correlation.

Depending upon the setup of the model, different rules can be used to tease out the direction of causation. The result of each tends to be consistent, though from time to time there are discrepancies between different algorithms. For description of a variety of these rules see Pearl (2009) and the PC algorithms provided by the pgmpy module. I have used the parallel PC algorithm presented by Le, et al., (2009). A standard of statistical significance for generating links in the causal graph is $p = 0.2$. This is the standard that determines whether or not a partial correlation is to be deemed statistically significant. Results presented tend to be consistent across different settings, including for the original PC algorithm as well as for a different choice of statistical significance, for example, $p = 0.1$. According to Peter Spirtes and Richard Scheines (2000), they have set the weight to.1 and the percentage to 0.95 for the sample size 2000 during the time of their analysis. The estimations of population covariances are less trustworthy for smaller sample sizes. As a result, conclusions about the Explanatory Principle are less trustworthy. In order to give the Falsification Principle more weight, they set the weight to 1 with a sample size of 200. Lowering the percentage for small sample sizes is also beneficial because it helps prevent less trustworthy conclusions concerning the Explanatory Principle. They fixed the percentage at 0.90 with a sample size of 200. The determination of the amount of significance to use might be thought of as an art. The underlying concept is that having more data provides justification for selecting lower significance levels, whereas having fewer observations provides justification for selecting higher significance levels.

In Pearl and Mackenzie's (2018) ‘’*The Book of Why’’*, the ladder of causality ranks causal problems by association (correlation and regression), intervention (causation), and counterfactuals. In association, researchers passively watch and make predictions. Correlation is crucial and this tier includes regression and numerous modern machine learning approaches, such as regression trees, random forests, and deep neural networks. TBOW regards regression as a framework similar to what econometricians term the best linear predictor framework, where the regression function is merely a parametric way of establishing the conditional expectation (Goldberger & Goldberger, 1991) with little causality in this rung.

Second is the intervention level. This rung concerns manipulations. These questions dominate causal inference work. Randomized trials are important here. These problems are harder to address in observational research, yet they're studied in many domains using different methods. Here, economists undertake empirical work (Angrist & Krueger, 2001) applies here.

Counterfactuals are the third causality stage. Third-level inquiries are more complex and provide conclusive answers to difficulties that depend on individual variation. The Potential Outcome (PO) paradigm does not point-identify the link between treated and untreated potential outcomes in homogeneous subpopulations. Most third-rung estimations that rely on this relationship are only partially acknowledged. This type of inquiry isn't as well-researched as the second. Bayesian networks are directed acyclic graphs (PDAGs) whose nodes reflect Bayesian variables (Pearl, 2009): observable quantities, latent variables, unknown parameters, or hypotheses. Nodes without edges represent conditionally independent variables. Each node is associated with a probability function that takes the node's parent variable values as input and returns the node's variable's probability (or probability distribution, if applicable). Pearl and Mackenzie (2018) suggest Bayesian networks are great for predicting the cause of an event.

PDAGs represent a priori hypothesis regarding variable relationships in causal structures. A PDAG shows a graph's edges (arrows), nodes (variables), and pathways. To indicate causal links, computer algorithms create graphs with nodes (variables) and edges (connections). A, B, and C are changeable nodes. The edges describe a causal relationship between nodes (indicated by the marks). A path is an unbroken sequence of nodes connected by edges; a directed path, like ABC, follows the edges in the arrowed direction. Undirected paths, like A to C, don't follow arrows. Path relationships are commonly represented using kinship words. If A leads to C, then C is A's descendant. In the directed path ABC, A is the direct cause or parent of B, B is the parent of

C, and A is C's indirect cause or ancestor. B is an intermediary variable on the directed route. It links A and C.

No node can have an arrow pointing to itself, hence DAGs are acyclic (Greenland et al., 1999). No node can direct to itself. These rules ensure that causes come before effects. Exogenous variables have no causal input; endogenous variables do (Spirtes et al., 2000). Miljkovic et al. (2016) defined PDAG as conditional independence through recursive product decomposition.

$$Pr(v_1,\ v_2 \ldots .\ .\ v_n) = \prod Pr(v_i\,|p\pi_i) \tag{11}$$

Where, Pr is the probability of the variables ($v1$, $v2$ … . . vn). The product operator is denoted by Π, and $p\pi_i$ denotes the realization of a subset of variables that produce vi in the order (i=1,2,.n). The research that Pearls (Pearl) conducted on d-separation makes it possible to visually portray dependencies as well as causes. D-separation is a criterion that can be used to determine whether or not one set A of variables is independent of another set B of variables, given a third set C of variables, given a certain causal network. The idea is to equate "dependency" with "connectedness" (the existence of a connecting channel), and "independence" with "unconnected-ness" or "separation." This is how the notion is supposed to work. As a graphical representation of conditional independence, d-separation is recommended by Pearl (Pearl). In other words, the conditional independence relations that are defined by the equation are characterized by the d-separation. If we build a directed acyclic graph in which the variables corresponding to p-i are represented as the parents (direct causes) of vi, then we can use the idea of d-separation to read off of the graph the dependencies that are suggested by the equation. If we do this, we can read off the graph the independencies that are suggested by the equation.

When discussing d-separation, it is important to keep in mind the three variable sets A, B, and C. If there is a barrier preventing the passage of information between these nodes, then we can say that these variables are d-separated. This phenomenon is referred to as d-separation, and it can take place in one of two ways: first of all, if one variable, such as B in ABC, is the cause of the other two variables, or if there is a passthrough variable, such as B in ABC; and second of all, when a variable is caused (influenced) by two variables, such as B in ABC. Within the framework of the PC algorithm, Spirtes et al. (2000) introduced the idea of d-separation.

In contrast to the econometric framework, which is based on the utilization of various instruments, the DAG approach draws attention to the fundamental assumptions as well as the structure of the relationship. When compared to the typical econometrics' setup, which provides the main assumptions in terms of the correlation between residuals and instruments, the DAGs present a more transparent picture of the data. Researchers can use PDAGs to help them define and express their ideas about the process underlying the generation of the data, which can subsequently assist in the analysis of the statistical relationships that are found in the data. It is not always easy to develop PDAGs and doing so may require a heuristic method in which assumptions are evaluated and adjusted depending on observable statistical relationships. A methodical approach to creating PDAGs might be beneficial for presenting results and justifying covariate selection. PDAGs are also useful for causal modelling since they may infer identifiability from a complicated model.

A mediator is a variable in the causal pathway that connects the cause and the outcome (Pearl & Mackenzie, 2018). The mediator is influenced by the cause (A), which in turn influences the outcome. Confounders are factors that influence both the treatment (A) and the outcome (B). Colliders, also known as common effects, are variables that are the children of two other variables (Pearl & Mackenzie, 2018). Because the two arrows from the parents "collide" at the descendant node, the word "collider" is employed. The purpose of a causal analysis is to adjust for these other factors such that we receive the same effect size for the target variable as if the target predictor were altered in a controlled intervention (Lederer et al., 2019).

Confounding, for instance, is more specific than having a variable that connects with predictor and responder. To find genuine confounders, direction is critical. Although the collider correlates with cause and result, incorporating it (or adjusting for it) in a multiple regression creates a collider bias on the causal relationship of interest (Pearl, 2009). The bottom line of this debate is that in order to show causality for a given link, we must seal the so-called back-door routes for this link (Lederer et al., 2019); (Pearl, 2009), by controlling for confounders, not adjusting for colliders, mediator bias, and other similar linkages. Due to the nature of the results from the causal inference described above, this approach has been used to argue for the inclusion or exclusion of variables in a regression and, more generally, specification.

3.2.2. DAG algorithm used:

The PDAGs in this study were created using the PC, Parallel PC, and Stable PC algorithms implemented in Python. These algorithms were selected because they enable us to determine the reliability of the directions and relationships in the data provided by the PC algorithm. We explore the PC approach (Spirtes et al., 2000) for learning directed acyclic graph Markov equivalence classes (PDAGs). The PC algorithm is known as a constraint-based method due to the fact that it employs conditional independence principles. The PC algorithm is divided into two phases: first, it learns a skeleton graph from data that only contains undirected edges, and then it orients the undirected edges to create a class of PDAGs that are equivalent to that graph (Spirtes et al., 2000). The theoretical foundation of the PC algorithm is that there exists a collection of vertices Z that are either neighbors of X or Y and are thus independent of X and Y if there is no connection (edge) between nodes X and Y. To put it another way, Z separates X and Y. Starting with a fully linked network, the PC method uses conditional independence tests to decide whether an edge should be maintained or deleted. The PC algorithm determines, conditionally on a subset Z of all X and Y's neighbors, the independence of two variables, X and Y, connected by an edge.

The runtime of the PC algorithm, which is exponential in terms of the number of nodes (variables) when applied to high-dimensional datasets like gene expression datasets, which was not a concern in our investigation, is one of the PC algorithm's two main drawbacks, especially when applied to large biological datasets. Second, the output of the PC technique depends on the order of the variables in the input dataset, meaning that the outcome may change. In an experimental study, Colombo et al. (2012) showed that over 40% of the edges (2000 edges) acquired from a real gene expression dataset are not stable, meaning that they appear in fewer than half of the outcomes obtained with all conceivable node orderings.

In order to get around this, the idea of parallelism has been used, which is the process of dividing a major work into several smaller subtasks and assigning them to various CPU cores so that they can be completed in parallel. The results of all subtasks will then be pooled to create the main task's result. The stable PC algorithm's levels are not parallelized across levels as suggested by the parallel PC method but rather within each level. Because conditional independence tests (CI) at a specific level are self-contained, this approach is useful. The outcome of one CI test has no bearing on the outcomes of the others because the graph is only updated at the end of each level. The CI tests at a certain level can therefore be run simultaneously without impacting the result. The amount of CI tests for each level is predetermined, which is another benefit of this strategy. A parallelized technique can obtain its maximum speedup by distributing the CI tests evenly across the available cores.

An order-independent variant of the PC algorithm is PC-Stable, a well-known constraint-based strategy for causal discovery (Colombo & Maathuis, 2014). This method starts with an undirected, fully connected graph and uses conditional independence tests to eliminate any edges connecting any two variables, just like the original PC method. A connection between X and Y is then erased if the unconditional independence tests on X and Y reveal that X is independent of Y. Any remaining edges in the resulting graph that depend on some subset of their neighbors are then checked for conditional independence once the conditioning set is expanded. The process is repeated until no more edges can be eliminated in this way.

The algorithm then establishes causal direction by I orienting colliders (variables with two "parents"), (ii) foregoing the insertion of additional colliders, and (iii) foregoing directed cycles (loops) (Colombo & Maathuis, 2014). The PC-Stable bases its predictions on the following premises: the causal graph is devoid of feedback loops; each variable is independent of its direct effects given its direct causes (the causal Markov assumption); the conditional independence relations in the data are the outcome of applying the causal Markov assumption to the causal graph (the causal faithfulness assumption); and the data are free of unobserved confounders and bias.

Due to their ability to estimate counterfactual quantities from observed data, DAGs are an extremely potent tool for statistical analysis. As a result, they have flourished in industries where the gathering and processing of data is thought to be of highest importance. In general, it would not be sufficient to compare the average outcomes of those who were or were not exposed to that factor in order to identify an average causal influence, as the differences in outcomes could be caused by other variables between the groups. However, in theory, a cause-and-effect connection may be shown by contrasting the outcomes of subgroups when the distributions of pertinent elements are mostly the same. These subgroups would therefore be referred to as "conditionally exchangeable" (or exchangeable conditional on these factors). The advantage of the graphical model theory is that it provides a method for determining whether variables are sufficient to ensure conditional exchangeability for a certain DAG. The "algorithmization of counterfactuals" is made feasible by this, which formalizes counterfactual logic. In other words, a set of variables is sufficient to ensure conditional exchangeability if conditioning on it prevents all "backdoor paths" (false paths that lead to statistical dependence due to one or more common causes; this is known as "confounding") between the putative causal factor and the outcome of interest while leaving all other causal paths unblocked. Creating a regression model for the outcome that contains the alleged causal factor and a sufficient number of variables to eliminate bias brought on by confounding is typically the practical solution. DAGs make it possible to utilize conventional statistical techniques to estimate counterfactual quantities and average causal effects by creating conditionally interchangeable units of analysis.

3.2.3. Time-series econometric pretesting and specification testing:

Time series analysis is employed in this study to examine the correlation between the elements of the US's expansionary monetary policy. Even though a relationship between economic factors can seem obvious, modeling it successfully can be challenging. Therefore, I have taken the following actions which have been inspired by the paper written by Miljkovic et al.(2016) to investigate the dynamic relationship between economic variables. To determine if the data is stationary or non-stationary, I should first look for unit roots, then I would use the Auto Correlation Function to check for correlation tests and lastly, I would utilize acyclic directed graphs to determine whether the data is endogenous or exogenous. In order to achieve this, the stationarity of the series was first controlled using the unit root test. A series is considered stationary if the probability distribution of the series remains constant across time. Applying time series analysis breaks down the datasets and separates the trend, seasonal, and remaining time-series components. The differencing technique is used to convert non-stationary time-series to stationary time-series. In order to change the series, it must be determined whether the differencing is necessary. To ascertain whether such transformation is required, unit root tests are used. According to the literature analysis, there are numerous unit root tests accessible depending on the different assumptions, which occasionally produce contradicting results (Talagala et al., 2018).

3.2.4. Unit root testing:

3.2.4.1. Augmented Dickey Fuller test:

The Augmented Dickey Fuller test is used to test the data and examine the unit-root issue. The augmented dickey-fuller (ADF) test was created by Dickey and Fuller (1979), (1981) and it is mostly used as a unit root test. The ordinary least squares (OLS) estimator is used in the ADF test to assess whether a unit root exists in a series. In order to compute the p-value of gamma using the implementation of the distribution provided by MacKinnon (1994), which is available using the statsmodels package in Python, I have independently generated the code for the Augmented Dickey Fuller test in Python. Only a constant is used in the test because the directed acyclic networks do not predict a temporal trend, resulting in:

$$\Delta Y_t = \alpha + \gamma Yt-1 + \Delta Yt-1 + \epsilon \tag{12}$$

No constant is used in the test using once-differenced data. Because unit roots are prone to persistent patterns that can last for years, all of the non-differenced data from a unit root should be included. The null hypothesis that $\gamma = 1$ is not rejected by the once-differenced data of the augmented dickey fuller test. Therefore, it is sufficient to use once-differenced data. When using once-differenced data, the statistical significance of estimates for $\gamma \neq 1$ 1 is very significant for all variables.

3.2.4.2. The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test:

The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test was developed as an addition to the ADF test as a unit root test (Kwiatkowski et al., 1992). The KPSS unit root test, in contrast to the other tests, assumes that the series in the null hypothesis is level-stationary. Before doing the regression analysis, a stationarity test is required since non-stationary time series will cause spurious regression findings. Furthermore, if the time-series data were not stationary, a regression analysis would not hold true. In this instance, the regression is false (Bekhet & Othman, 2017). Before executing a bounds-testing strategy, it is vital to make sure that the variables are not at the I (2) stationary level to prevent false results (Pesaran et al., 2001). Furthermore, the variables are presumed to be stationary at I (0), I (1), or both when performing a limits test. As a result, if the variables are stationary at I, the F-statistics are invalid (2). To ensure that none of the variables are stationary at the I (2) level, the implementation of a bounds test procedure may still be necessary. breaks up a series into three parts: a deterministic trend (βt), a random walk (r_t), and a stationary error (ε_t), with the regression equation:

$$x_t = r_t + \beta t + \varepsilon_1 \tag{13}$$

The trend stationary nature of the series is the null hypothesis for the KPSS test, which raises the power of the test and makes accepting the null hypothesis more challenging. If the test's p-value is less than the significance level of 5%, we reject the null hypothesis and come to the conclusion that the time series is not trend stationary. Given that this value is higher than 0.05 and suggests that the time series is trend stationary, we are unable to reject the null hypothesis of the KPSS test.

ADF is parametric and KPSS is a non-parametric test. Nonparametric statistics provide valid testing and estimation procedures under fewer assumptions than parametric statistics. Literature is divided on how to define "nonparametric statistics." Nonparametric statistics and "distribution-free approaches" were once used interchangeably but have different meanings. Nonparametric statistics are called distribution-free because they are not reliant on a particular population distribution, such a normal distribution. Nonparametric statistics involve fewer assumptions about the population distribution being researched than parametric statistics. Nonparametric statistics are also founded on assumptions, such as the absence of ties or the independence of two random samples. They're versatile and durable. Nonparametric statistics allow researchers to draw findings based on probability and confidence interval.

Nonparametric statistics have several advantages over parametric statistics: (1) they can be applied to a wide variety of situations; (2) they are easier to understand intuitively; (3) they can be used with smaller sample sizes; (4) they can be used with more types of data; (5) they require fewer or less stringent assumptions about population distribution; and (6) they are more robust and less affected by extreme values.

3.2.4.3. The autocorrelation function (ACF):

We can use the autocorrelation function (ACF), a statistical method, to determine the degree of correlation between the values in a time series. The lag, which is expressed in terms of a certain number of periods or units, is plotted against the correlation coefficient using the ACF. A lag is the period of time after which the first value in a time series is observed.

The correlation coefficient might be between -1 (which indicates a complete negative connection) to +1. (a perfect positive relationship). There is no link between the variables if the coefficient is 0. Additionally, the most common methods of measurement are the Spearman rank correlation coefficient or the Pearson correlation coefficient.

It is most frequently employed to examine numerical sequences resulting from random processes, such as those utilized in scientific or economic measurements. In connected data sets like stock prices or weather readings, it can also be utilized to find systematic trends. The error bands are shown as blue bars on the ACF plot above, and anything inside of these bars is not statistically significant. It implies that correlation values outside of this range are highly likely the result of a correlation rather than a statistical anomaly. By default, the confidence interval is set to 95%.

3.2.5. Estimating marginal effects:

I have used seemingly unrelated regressions (SUR) with panel Granger causality as described by (Miljkovic et al., 2016) and (Miljkovic & Goetz, 2020). It is reasonable for me to assume that the SUR provides an accurate estimation of the effects that are exerted onto variables that vary rapidly, such as interest rates. I will describe SUR estimates together with DAG estimates for the mapping of fed policy wit in order to do a robustness check on persistent effects.

3.2.5.1. SUR:

Not only am I interested in determining whether one variable has an impact on another, but I also want to know how much of an impact it has. The design of the regressions that I have employed is to estimate marginal effects is guided by directed acyclic graphs. I need to estimate effects that take endogenous effects into account, which is important for the analysis. The typical OLS regression will be insufficient to estimate the statistical significance of marginal effects if two variables interact with one another. The plan consists of two components. I must first organize our equations in light of the DAG, and then we must take into account both immediate and delayed consequences. I have used seemingly unrelated regressions (SUR) to identify endogeneity concurrently (Zellner, 1962).SURs are two-stage least squares regressions in which the estimated beta vector in the second stage integrates the matrix, inferred in the first stage, which is generated from the joint covariance of residuals produced by the estimation of the equations using a simple OLS regression in the first stage.

$$\beta = (X'\Omega-1X) -1X'\Omega-1Y \qquad (14)$$

In order to initiate the first stage of the SUR, it is necessary for us to construct several equations in accordance with the graphs that were produced by the PDAG that was presented, which graphs will be the subject of a more in-depth discussion in the following section. The covariance matrix of the residuals from the first stage, on the other hand, makes it possible for the estimations to take into account the endogenous effects discovered by the DAG. Alternately, we can be worried that the consequences will last for a long period of time or that they will come about with a delay. Because the data is once differenced, with each difference covering a duration of one year, each observation incorporates changes that cover a period of time stretching over two years. We can anticipate that the SUR will be enough to capture causal effects despite the fact that structural factors may undergo modification. However, I have estimated SUR directed by the estimates of PDAG.

3.2.5.2. Granger Causality test:

The Granger (1969) causality tests are a popular method for determining the existence of causal connections among different time series. To do this, we must first determine whether or not the lags of one variable are helpful in understanding the behavior of another variable. The purpose of this test would be to investigate the effects of various policy decisions on the profitability of banks, and we would run it accordingly.

Considering the scenario in which Y and X are two different stationary series. If previous values of X are significant predictors of the current value of Y even after adding prior values of Y in the model, then X is said to have a causal influence on Y. In other words, this means that Y is affected by X. In order to accomplish this, I would perform a regression on Y based on delayed values of Y and X, which would give us the unconstrained regression.

$$y_t = \alpha + \sum_{k=1}^{K} \gamma_K y_{t-k} + \sum_{k=1}^{K} \beta x_{t-k} + \varepsilon_t \text{ with } t = 1 \ldots, T.$$

By just considering Y's lagged values, I have estimated a constrained regression. The group of coefficients linked to the lagged values of X are then examined to see if they differ significantly from zero using the F-test. If they are substantial, we can rule out the idea that X is not the cause of Y because X's past values helped to explain why Y is now where it is. We can claim that X Granger causes Y when the delays of one variable help to explain another. To test for causation in the opposite directions, the x and y variables can be switched, and bidirectional causality is evident (also called feedback). For the purpose of finding causal connections in panel data, the conventional Granger Causality can be expanded. The fundamental regression is as follows:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_{i,k} y_{i,t-k} + \sum_{k=1}^{K} \beta x_{i,t-k} + \varepsilon_{i,t} \text{ with } i = 1 \ldots, N \text{ and } t = 1 \ldots, T$$

Where, y and x are two stationary variables measured on t periods with i cross-sectional dimensions. The assumptions made by various panel causality tests about the homogeneity of the coefficients across cross-sections differ. For figuring out causality in panels, there are two approaches. First, treat the panel data as a single, massive collection of stacked data. Next, perform the standard Causality test, with the exception that data from one cross-section is not permitted to enter the lagged values of data from the next cross-section. This approach is predicated on the assumption that all coefficients are constant throughout all cross sections, i.e.

$$\alpha_{0,i} = \alpha_{0,k}, \alpha_{1,i} = \alpha_{1,k}, \ldots . \alpha_{n,i}, = \alpha_{n,k}, \forall i, k$$

$$\beta_{1,i} = \beta_{1,k}, \ldots . , \beta_{n,i} = \beta_{n,k}, \forall i, k$$

Dumitrescu and Hurlin (2012) take a more generic method, allowing all coefficients to vary across cross-sections:

$$\alpha 0, i \neq \alpha 0, k,\ \alpha 1, i \neq \alpha 1, k,\ \ldots .\ \alpha n, i, \neq \alpha n, k,\ \forall i,\ k$$

$$\beta 1, i \neq \beta 1, k,\ \ldots ,\ \beta n, i \neq \beta n, k,\ \forall i,\ k$$

Each cross section is subjected to a specific Granger Causality regression in order to calculate this test. The test data are then averaged, which is done using the W-bar statistic. They show that the standardized form of this statistic follows a typical normal distribution when properly weighted in imbalanced panels. I have described this using the Z-bar statistic. The Dumitrescu and Hurlin test was used as the research methodology. The method for determining causality is to look at how past values of x have affected present values of y, much like the traditional Granger Causality test. Thus, the null hypothesis is defined as:

$$Ho = \beta 1, i = \cdots = \beta 1, K = 0$$

This suggests that there is no causal connection between any of the cross sections of the panel. The test makes the assumption that while causality may be conceivable for some cross-sections, it is not always the case. Alternatively, if the null hypothesis is not rejected, there is no causality in any cross-sections. If the null hypothesis is rejected, causation may exist for some cross sections but not necessarily for all. Rejecting the null hypothesis does not rule out the possibility of noncausality for any cross-sections because the panel granger causality test is designed to evaluate causality at the panel level. By using Monte Carlo simulations, Dumitrescu and Hurlin (2012) show that the derived Wald statistic is asymptotically accurate and can be used to investigate panel causality.

The standardized statistic Z when T comes first and then N comes second (often translated as "T should be huge in contrast to N") follows a conventional normal distribution, provided that the Wald statistics are distributed independently and uniformly among persons(Lopez & Weber, 2017). Last but not least, the null hypothesis testing strategy is predicated on $\bar{Z}$ and $\tilde{Z}$. The null hypothesis should be rejected and Granger causality should be assumed if these values exceed the conventional critical values. For large N and T panel datasets, $\bar{Z}$ may be taken into account. For datasets with a high N but a low T, $\tilde{Z}$ should be chosen. In this study, the $\tilde{Z}$ statistic is investigated. This test will be used in this thesis to assess how Quantitative Easing affects the profitability of US mid-capitalized banks.

3.2.5.3. Unit root test:

I have independently applied the ADF test and the Levin, Lin, and Chu unit root tests to test for unit roots in the Panel Granger Causality Test. When performing cross sectional time series analysis of panel data, which is a standard process, it is necessary to ascertain whether unit roots are present. This panel unit root testing developed from time series unit root testing, but in contrast to time series testing, we take into account cross-sectional dimensions and time series asymptotic behavior. In general, the following procedure is used for panel unit root testing:

$$\Delta y_{it} = \alpha y_{it-1} + \sum \beta_{ij} \Delta y_{it-j} + X_{it}{}' + \varepsilon_{it}$$

While allowing the lag order for the difference terms, ρi to vary among cross-sections, we assume a common α=ρ-1 in this scenario. The deterministic (exogenous) portion of the model is represented by $Xit\,'$. The tests' null and alternative hypotheses can be represented as H_0: = 0 and H_1: 0 respectively, denoting that there is a unit root under the null hypothesis and no unit root under the alternative.

4. RESULTS

I have three sets of the analysis presented. The effective federal funds rate, the loss function, the amount of money in circulation, and the total amount of assets held by the Federal Reserve are all included in the first set of analyses. The third set of analysis includes the effective federal funds rate, the loss function, currency in circulation, and total assets held by the Federal Reserve with the profitability factor (ROE) of mid-capitalized US banks. The second set of analysis includes the effective federal funds rate, the loss function, and total assets held by the Federal Reserve with stock market volatility. For both sets of analysis, data from February 2006 to February 2020 are employed. Data from the crisis period is highly volatile, with monetary policy mostly responding to changes in real-time. High volatility of this period swamps the smaller changes that predominated after the crisis period. The findings from this time period show how the balance sheet responds to changes in the loss function and changes in the federal funds rate, even though the data for this wider time range are not provided. Throughout the investigation, I have estimated both the reaction of the loss function to changes in the monetary policy as well as the response of the monetary policy to changes in the loss function.

The relative independence of the Federal Reserve's balance sheet is a significant difference between monetary policy before and after the financial crisis of 2008. During this time, the federal funds rate target was mostly changed to implement monetary policy. If during the pre-crisis years changes in the loss function led to changes in the amount of money in circulation and assets owned by the Federal Reserve, the magnitude of this response was constrained by the status quo. Although the Federal Reserve's early response to the emergence of global financial instability in the second half of 2007 included measures to provide liquidity without raising the rate at which money is being printed, these efforts have since been followed by other approaches.

4.1. Mapping Fed policy:

In this part, I have used directed acyclic graphs (DAGs) to assess how the monetary policy has changed in response to shifting economic indicators. Both the impact of changes in the federal funds rate and the effects of changes in the value of assets owned by the Federal Reserve are of interest to us. By taking into account the pertinent marginal effects estimated by matching, at first seem unrelated regressions, we analyze the causal chains shown in each DAG.

In this section, I will examine the effects of unconventional monetary policy's policy variables on stock market volatility. As a result, I have used the variables total asset (TA) and currency in circulation (CC) of the Fed balance sheet, federal funds rate (FFR), loss function (LF), and VIX throughout this study to examine the effects of policy variables on stock market volatility as well as to determine whether any interdependency between the variables still exists.

4.1.1. Pretesting and specification testing of time-series econometric models:

Although a relationship between economic factors may appear obvious, modeling it successfully can be challenging. To investigate the dynamic relationship between economic factors, we have taken the following steps: Check for unit roots to determine whether the data is steady or random; use the autocorrelation function to determine the autocorrelation of any series with its lagged values; and employ acyclic directed graphs to determine whether the data is endogenous or exogenous.

4.1.1.1. Augmented Dickey Fuller test:

Policymakers are responding mainly to changes that persist over time. Loss functions typically consider year-over-year inflation rates, not monthly rates. Calculating year-over-year rates creates a unit-root for the data. To investigate the unit-root problem, we test the data using the Augmented Dickey Fuller test. Since the data frequency is monthly and the lags and differences used in are annual, we create our own Augmented Dickey Fuller test with using one annual lag in Python, calculating the p-value of gamma using the implementation of the distribution provided by MacKinnon (1994) available using the statsmodels module in Python.

It is a test to determine whether or not the variables are stationary; if a series is stationary, then all the typical regression findings are affected by spurious regression (Granger & Newbold, 1974; Gujarati & Porter, 2003). Regarding this, the Augmented Dickey Fuller, ADF(1979, 1981) test was conducted on both the levels and the initial differences of the variables. The first or second differenced terms of the majority of variables are often stationary, according to Ramanathan (1992). When the dataset is differentiated once, the ADF suggests that VIX and the policy-implemented variables are stationary, as depicted in the figure below. I have presented the results in the below figures:

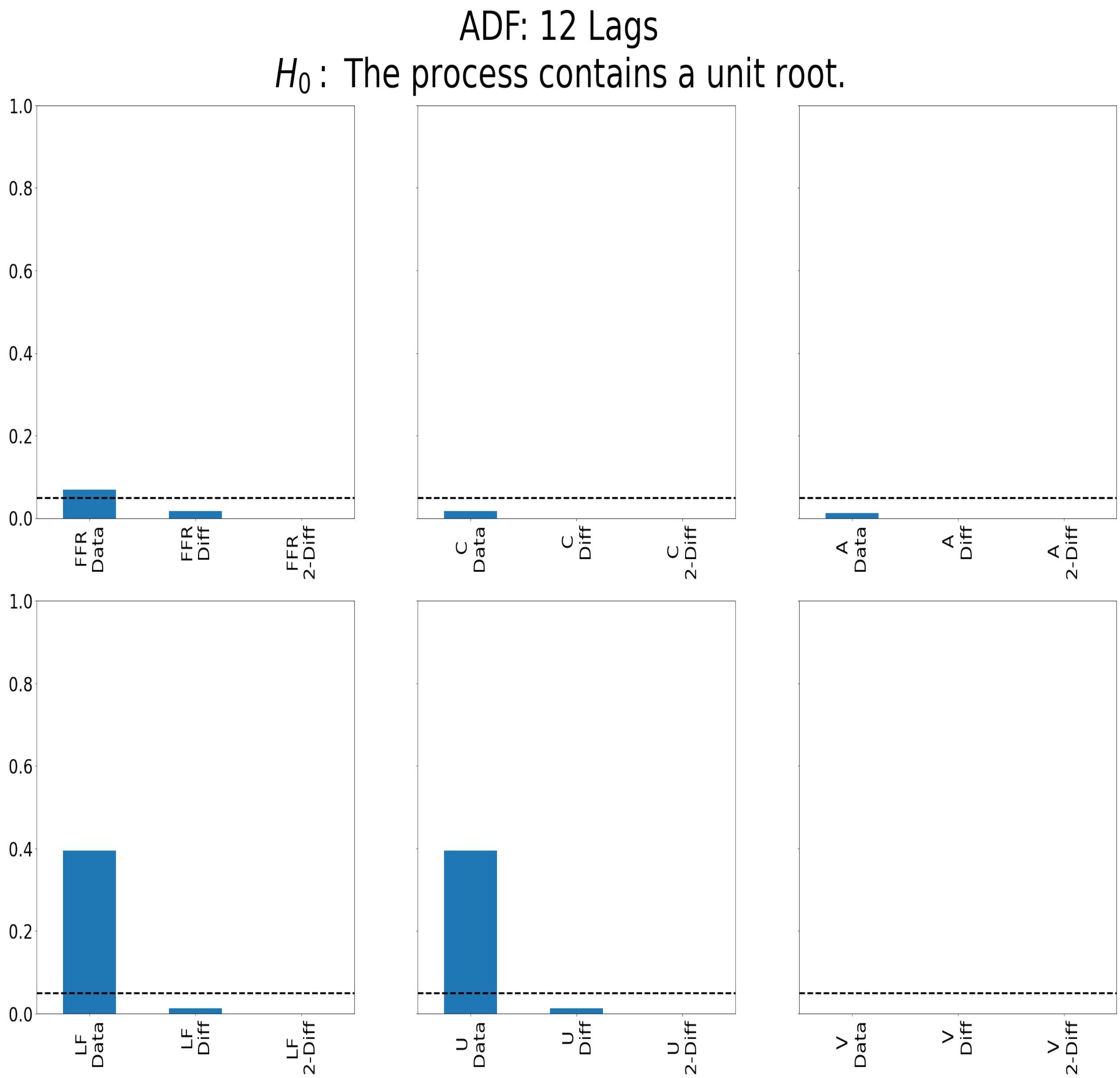

Figure 4. ADF test with 12 lags

4.1.1.2. The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test:

As noted previously, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test (Kwiatkowski et al., 1992) was developed as a unit root test to complement the ADF test. The null hypothesis of the KPSS test is that the series is stationary, which makes accepting the null hypothesis more challenging and boosts the test's power. The KPSS test compares the null hypothesis of no unit root (stationary) to the alternate hypothesis of a unit root (non-stationary). In the analysis of VIX with policy factors, the test results of KPSS are as follows:

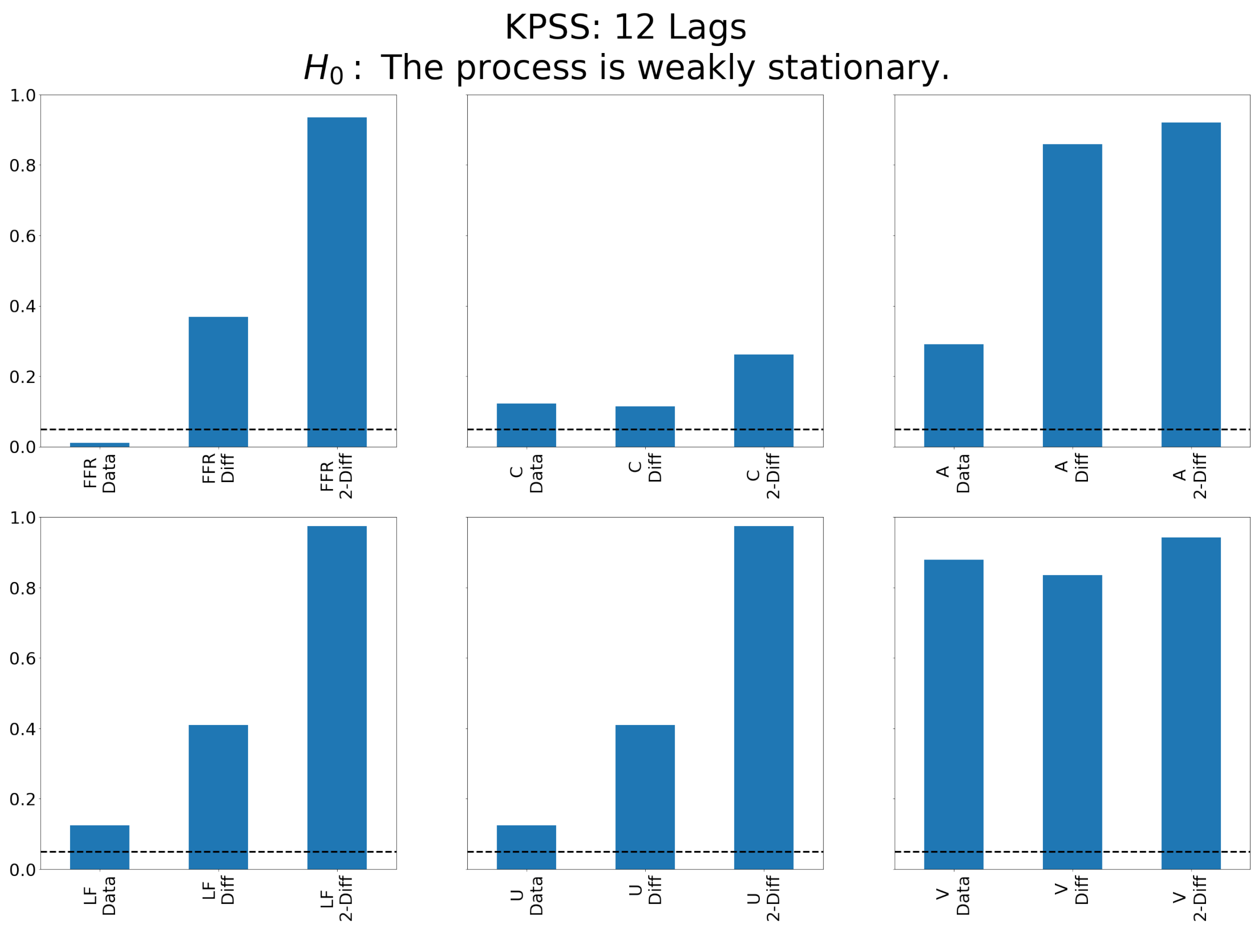

Figure 5. KPSS with 12 lags

We reject the null hypothesis and come to the conclusion that there is no unit root or that the time series is stationary because the total test statistics of the ADFs are less than the crucial regions. We accept the null hypothesis and come to the conclusion that the data series is stationary around a deterministic trend since the test statistics for both the KPSS tests and the test statistics are all less than the p-values.

4.1.1.3. The autocorrelation function (ACF):

One of the statistical methods for determining the reliance of succeeding items in a given time series is the autocorrelation function (ACF). As a result, it is used to gauge the stock market's volatility as well as the dependence of subsequent share price fluctuations. The results are presented below:

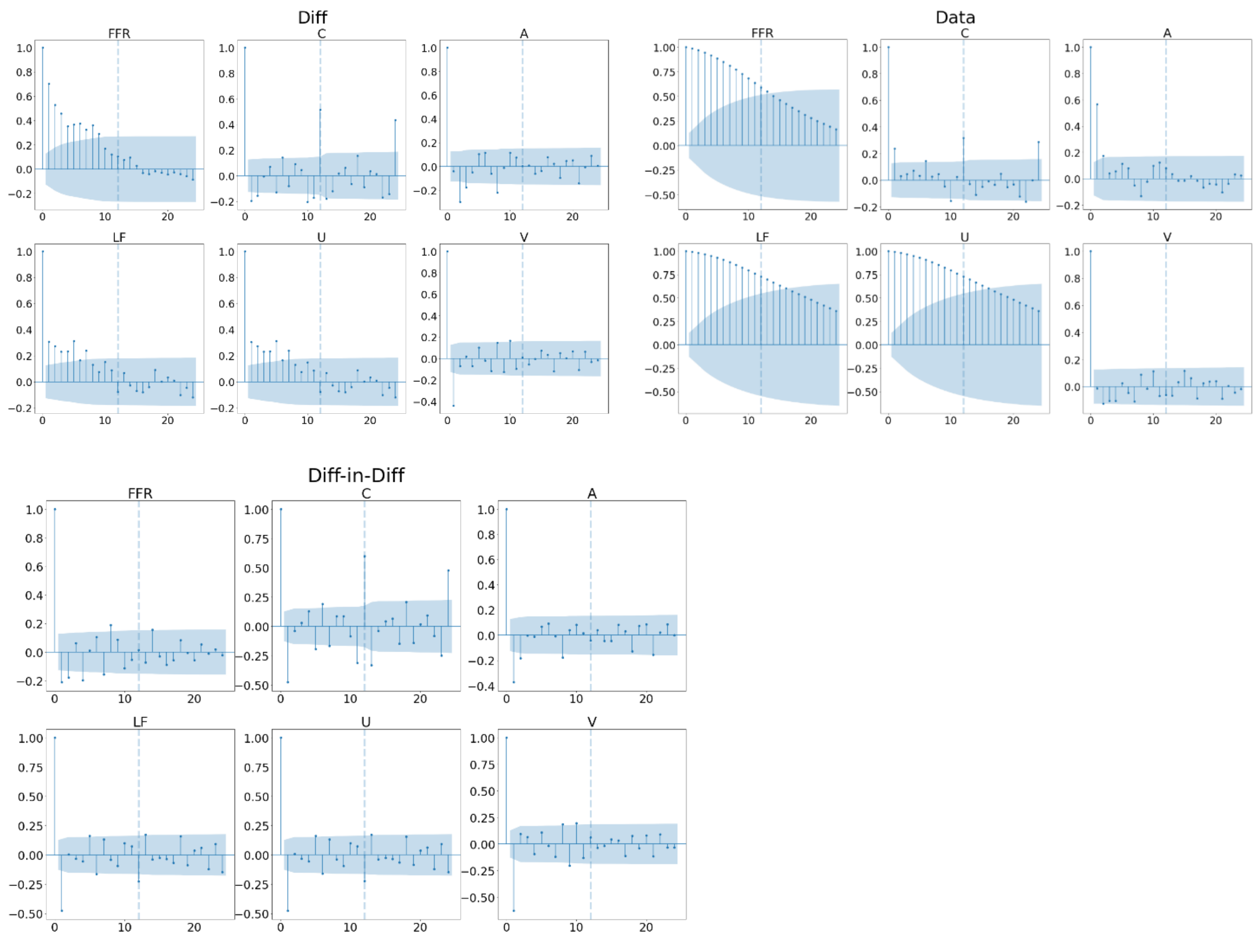

Figure 6. The autocorrelation function (ACF)

ACF is always equal to one for lag zero, which makes sense given that the signal is always perfectly correlated with itself. In summary, the ACF plots the correlation coefficient versus the lag and serves as a visual representation of autocorrelation. Autocorrelation is the correlation between a time series (signal) and a delayed version of itself. Therefore, it is also obvious to us from the above image that we can continue with the modeling of the study using twice different data.

4.1.2. Directed acyclic graph:

In this study, the structure of Fed policy and stock market volatility are mapped using partially directed acyclic networks. I would like to examine how unconventional monetary policy affects stock market volatility as well as how the aforementioned economic metrics are interdependent. These theories are put to the test using DAGs. The study looked at the different elements of the quantitative easing policy and how they affected the stock market volatility index (VIX). The findings are displayed as a matrix with columns denoting the significance level examined and rows denoting the algorithm.

From the Figure 7, it can be seen that federal funds rate is caused by loss function and total assets held by FED. The same situation goes for the other two indicators: currency in circulation as well. However, loss function is getting affected by VIX in all scenarios and is affected by federal funds rate and currency in circulation in the above two scenarios ($p \leq 0.2$ and $p \leq 0.3$). Thus, moving forward we will continue with the $p \leq 0.2$ & in the next section, we will estimate the marginal effects of the variables with seemingly unrelated regression (SUR) model.

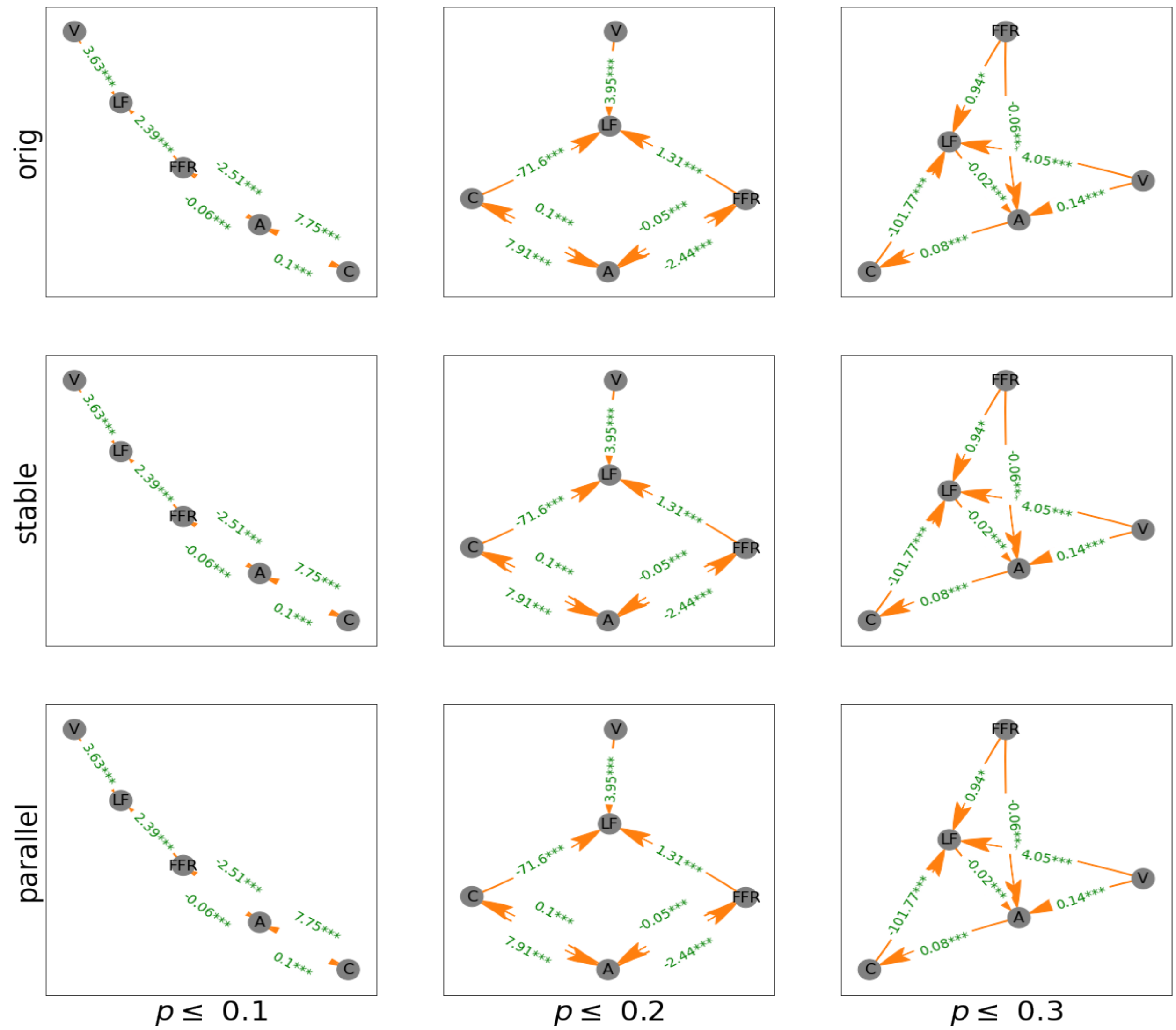

Figure 7. DAG with marginal estimates

4.1.3. SUR Model:

Multiple equations with various dependent variables and exogenous explanatory factors are used in an SUR, although error terms are believed to be associated across equations (Zellner, 1962). Furthermore, the SUR is concerned with stationary series. Ordinary least squares (OLS) can be used to estimate the equations individually, however the SUR technique is more efficient when the error factors are connected across equations. Except for the federal funds rate, all of the variables are in log form, allowing the predicted coefficients to be interpreted. In this analysis, we are not only interested in determining whether one variable has an impact on another, but also in estimating the degree of that impact. What is the direction of response of variables used to implement monetary policy to changes in economic indicators? And how do the indicators react to changes in the variables under the Federal Reserve's control? The structure of the regressions that we use to estimate marginal effects is informed by directed acyclic graphs. For the sake of argument, I need to estimate effects that account for endogenous influences. The typical OLS regression will be insufficient for calculating the statistical significance of marginal effects if two variables impact each other. I have used seemingly unrelated regressions (SUR) to detect simultaneous endogeneity (Zellner, 1962). The two equations in the SUR model are as follows:

$$\Delta \ln TA_t = \alpha_1 + \alpha_2 \Delta \ln FFR_t + \alpha_3 \Delta \ln CC_t + \varepsilon_{1,t}$$

$$\Delta \ln LF_t = \gamma_1 + \gamma_2 \Delta FFR_t + \gamma_3 \Delta \ln V_t + \gamma_4 \Delta \ln CC_t + \varepsilon_{2,t}$$

$$\Delta \ln FFR_t = \beta_1 + \beta_2 \Delta \ln TA_t + \varepsilon_{3,t}$$

$$\Delta \ln CC_t = \Theta_1 + \Theta_2 \Delta \ln TA_t + \varepsilon_{4,t}$$

From the results of the SUR model (Table 2), the effect of total asset of FED represents that 1% growth increase in total asset is estimated to decrease the federal funds rate by 0.05% and currency in circulation by 0.1% with the significance level of 1%. Similarly, total assets of FED is affected by currency in circulation and federal funds rate. From the results, we can state that, 1% increase of federal funds rate will decrease the balance sheet size of FED by 2.45% and 1% increase in currency in circulation will increase the growth of FED balance sheet by 7.89%.

Similarly, loss function is also affected by federal funds rate, currency in circulation and stock market volatility. Thus, 1% growth increase in currency in circulation is estimated to decrease the growth of loss function by 71.28% and significance level of 1%. On the other hand, 1% growth decrease of federal funds rate and stock market volatility will decrease the loss function by 1.32% and 3.94% respectively and here the confidence interval level is 99% for both scenarios.

Table 2. SUR with marginal estimates

SUR				
Independent Variable	Dependent Variable			
	Total Assets	Federal Funds Rate	Currency in Circulation	Loss Function
Total Assets		-0.05***	0.1***	
Loss Function				
Federal Funds Rate	-2.44***			1.31***
Currency in Circulation	7.91***			-71.6***
VIX				3.95***

*10% significant, ** 5% significant, *** 1% significant

Thus, the result indicates that, total asset and federal funds rate is having a negative relationship which aligns with the literature as well as with the hypothesis. Moreover, the result also reflects one of the important concept which I have discussed throughout the study. The result shows that Fed is not increasing the growth of currency in circulation of its balance sheet as like the way it is increasing its total asset size. On the other hand, currency in circulation of the balance sheet of Fed is showing a negative relationship with the loss function which means that with the increase of it, the inflation is actually decreasing, which is one of the goals of Fed in order to execute QE. Another positive result is that the volatility of the stock market shows a positive relationship with the inflation rate. That means if the volatility increases, then inflation will decrease which eventually impacts the economy negatively. Thus, the market needs to remain more stable to decrease the inflation rate.

In the next section, I have employed the policy variables to analyze the effects on the profitability factors of the banks.

4.2. Mapping fed policy with the profitability factor of banks:

In this section, I want to analyze how the policy variables of the unconventional monetary policy is impacting the volatility of the stock market. Also, I want to see the effects of policy variables on the stock market volatility and also to find out if there is any interdependency remains on the variables and for this reason, throughout this study I have used the variables of total asset (TA) of Fed balance sheet, federal funds rate (FFR), loss function (LF) and profitability factor (ROE).

4.2.1. Panel Granger Causality test:

4.2.1.1. Unit roots results:

To test for unit roots in order to conduct Panel Granger Causality Test, I have used both the ADF and the Levin, Lin, and Chu unit root tests separately. There is a need to determine the presence of unit roots when conducting cross sectional time series analysis of panel data, which is a standard procedure. This panel unit root testing evolved from time series unit root testing, but unlike time series testing, I have considered the asymptotic behavior of time series and cross-sectional dimensions. In general, the following procedure is used for panel unit root testing:

$$\Delta y_{it} = \alpha y_{it-1} + \sum \beta_{ij} \Delta y_{it-j} + X_{it}' + \varepsilon_{it}$$

In this case, we assume a common $\alpha = \rho - 1$ but allow the lag order for the difference terms, ρ_i to vary across cross-sections. X_{it}' represents the deterministic (exogenous) component in the model. The null and alternative hypotheses for the tests can be written as H_o: $\alpha = 0$, H_1:$\alpha<0$ indicating that there is a unit root under the null hypothesis and no unit root under the alternative.

Panel unit root tests are performed on all variables used in the panel granger causality analysis. The results of the panel unit root tests are presented in the table 3 and table 4. Both the ADF and the Levin, Lin, and Chu tests show that all the series are stationary at less than a 1% significance level. This implies that the meanings and/or trends of all the averages are likely to change over time. I have used RStudio to conduct the unit root test of the panel data and to get the result, I have used tseries library of RStudio.

Table 3. ADF test

Variables	ADF test-levels (p value)	ADF test- first diff (p value)
Return on Equity	0.01***	0.01***
Total Assets	0.01***	0.01***
Effective Federal Funds Rate	0.01***	0.01***
Loss Function	0.01***	0.01***

*, ** and *** denote statistically significant level at 10%, 5% and 1% respectively

Table 4. Levin, Lin and Chu test

Variables	Levin, Lin and Chu test-levels (p value)	Levin, Lin and Chu test-first diff (p value)
Return on Equity	2.429e-11***	2.429e-11***
Total Assets	0.01866***	<2.2e-16***
Effective Federal Funds Rate	2.2e-16***	<2.2e-16***
Loss Function	0.3896	2.296e-14***

*, ** and *** denote statistically significant level at 10%, 5% and 1% respectively

From the above table of ADF test and Levin, Lin and Chu test, it can be seen that with the first differenced of the dataset, the data set became stationary. Thus, for continuing with the model, we will be using first differenced dataset further.

4.2.1.2. Granger Causality test:

The Granger causality tests (Granger, 1969) can help identify if variables that are assumed endogenous can be treated as exogenous. The null hypothesis is that "X does not cause Y.". An F-test determines if lagged values of X significantly impact Y, and if they do then X is said to Granger cause Y. The variables in the study were differenced once and tested. Moreover, to conduct the Panel Granger Causality Test, the entire analysis has been done in "plm" library and "tseries" library of RStudio.

Table 5. Panel Granger Causality test

Variables	ROE_x	Federal Funds Rate _x	Total Assets _x	Loss Function _x
ROE_y	1.00	0.00	0.00	0.01
Federal Funds Rate _y	0.02	1.00	0.00	0.01
Total Assets _y	0.09	0.00	1.00	0.01
Loss Function _y	0.27	0.00	0.78	1.00

From the table 5, the rows are the response (Y) and the columns are the predictor series (X). If a given p-value is < significance level (0.05), then, the corresponding X series (column) causes the Y (row). For example, p-value of 0.00 (column 2, row 1) represents the p-value of the grangers causality test for federal funds rate causes return on equity which is less that the significance level of 0.05. So, we can reject the null hypothesis and conclude federal funds rate causes return on equity of the banks. Here, 0.000 means (column 3, row 4): federal funds rate has significant effect on total assets and accordingly it significantly effects loss function at 1% significance level.

Accordingly, we can see that total assets have significant effects on return on equity, federal funds rate at 1% significance level. However, total assets have no significant impact on loss function. On the other hand, loss function has significant impact on almost all the variables. For example, loss function causes total assets at 1% significance level; federal funds rate and currency in circulation at 5% significance level; return on equity at 10% significance level. However, return on equity is only significantly affecting total assets by 5%.

There is evidence from the results obtained from the panel granger causality test to reject the null hypothesis that total assets cause profits of the banks in US, federal funds rate and accept the alternative that the mentioned variables caused the profitability for these two variables (ROE and FFR) with a 99% confidence interval level.

4.2.2. Directed acyclic graph:

In this section, we have used partially directed acyclic graphs to map the structure of Fed policy with the profitability of the banks. We would like to look at the impact of unconventional monetary policy on the profitability of the banks as well as the interdependence of the economic metrics stated. DAGs are used to test these hypotheses. The study examined that the components of the quantitative easing policy and the impacts of those variables on the profitability of the banks have been examined. The results are presented in a matrix with rows representing the algorithm and columns representing the significance level tested.

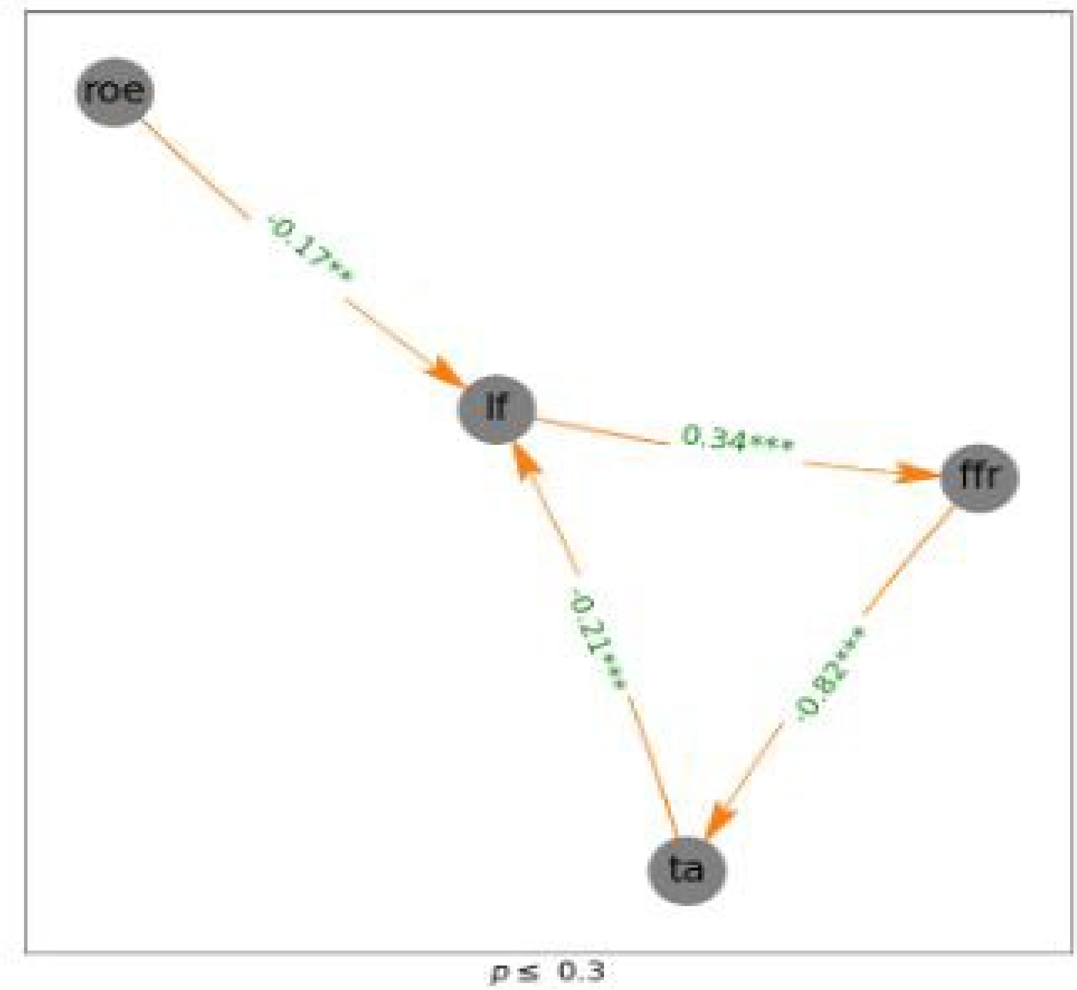

Figure 8. DAG estimates with marginal effects. ** and *** denote statistically significant causations at 5% and 1% respectively.

From the above graph, it can be seen that loss function is exogenous and is caused by total assets and return on equity. However, the size of the balance sheet is affected by the federal funds rate whereas federal funds rate is affected by loss function at the significance level. Following the relationship of DAG and Granger causality, in the next section, I will run SUR model.

4.2.3. SUR Model:

Directed by DAG model and Granger Causality, we use seemingly unrelated regressions (SUR) again to detect simultaneous endogeneity (Zellner, 1962). The two equations in the SUR model are as follows:

$$\Delta lnFFR_t = \alpha_1 + \alpha_2 \Delta lnTA_t + \alpha_3 \Delta lnLF_t + \varepsilon_{1,t}$$

$$\Delta lnLF_t = \gamma_1 + \gamma_2 \Delta lnROE_t + \gamma_3 \Delta lnTA_t + \varepsilon_{2,t}$$

Table 6. SUR estimates

	SUR	
Independent Variable	Dependent Variable	
	Federal Funds Rate	Loss Function
Total Assets	-3.99***	-7.09***
Loss Function	0.025***	
Return on Equity		-0.854***

** and *** denote statistically significant causations at 5% and 1% respectively

From the results of the SUR model, the effect of total assets of FED represents that 1% growth increase in total assets is estimated to decrease the federal funds rate by 3.99% with the 1% significance level. Accordingly, the effect of total assets of FED represents that 1% growth increase in total asset is estimated to decrease the loss function by 7.09% with the 1% significance level.

Federal Funds rate also showed a positive relationship with loss function which is consistent with our hypothesis. Thus, 1% growth rate decrease of loss function is estimated to decrease the federal funds rate by 0.025% at the 99% confidence interval level. Similarly, return on equity shows a negative relationship with loss function. The answer articulates that, 1% growth rate increase of the profitability of the banks will decrease the growth rate of loss function by 0.854% at 99% confidence interval level.

Thus, the result indicates that total assets and federal funds rate is having a negative relationship which aligns with the literature as well as with the hypothesis. Also, increasing total assets of the balance sheet of Fed is showing a negative relationship with the loss function which is reflecting that with the increase of the total asset, the inflation is actually decreasing which is one of the goals of fed in order to execute QE. Another positive result is that the profitability of the banks are showing a negative relationship with the inflation rate. That means if the banks' profitability increase, then inflation will decrease which eventually impacts the economy positively.

5. CONCLUSION

The unconventional monetary policy was embraced as a solution to the financial crisis in 2008. Some critics question the effectiveness of unconventional monetary policy and as per them, there is a risk of inflation due to it. I have mapped Federal Reserve policy and used monthly data to account for policy changes from the reign of Bernanke and afterwards. The results are consistent before and after Bernanke's framework. All statistically significant partial correlations in both date ranges have the same magnitude. Increased unemployment lowers the federal funds rate. According to a positive association between the federal funds rate and the loss function, slowing the rate of rate growth may boost unemployment, lower inflation, or both. The Federal Reserve's ongoing credit allocation and low federal funds target may cause this consequence.

The tool boosts economic activity without increasing inflation or inflation expectations. Since 2004, Bernanke has been careful to keep inflation and inflation expectations under control (Bernanke, 2007). The loss function and its inflation component negatively affect the balance sheet controlling for currency in circulation, whether directly or via the federal funds rate. DAGs reflect the structure of monetary policy and confirm some priors about the federal funds rate and balance sheet size and money in circulation. Results question how changes in the federal funds rate and balance sheet size affect the loss function and inflation and unemployment. If causal force travels from the loss function components to the balance sheet and federal funds rate, results support a heuristic interpretation of the federal reserve's reaction function. Falling loss functions lower interest rates and increase the balance sheet relative and currency circulation. If so, unorthodox monetary policy raises unemployment and lowers inflation. Hogan (2021) and Selgin (2018) agree that credit allocation has hindered production and that the federal reserve's sequestering of excess reserves has hurt lending. Policies indirectly affect unemployment. These detrimental consequences on real productivity must be thoroughly proven. Since 2003, marginal development of this concept to incorporate nominal income can enlighten this discourse. The most interesting finding is that, stock market volatility is positively affecting the loss function and return on equity is also affecting the loss function inversely. Overall the analysis shows the effectiveness of the quantitative easing in lowering the loss function level.

Also, quantitative easing can cause the stock market to boom, and stock ownership is concentrated among Americans who are already well-off, crisis or not. An era of relatively high unemployment and historically low inflation have followed in the wake of unconventional monetary policy. This could be a coincidence; in which case the economy must have entered a historically unique period compared to the previous century or some other policy changes are causing this change. In the least, we have observed a collapse in the velocity of currency in circulation from 2002. The findings are consistent with the intuition that the change in monetary policy has had a significant impact on policy implementation and the financial markets and interestingly, stock market is also affecting loss function. Moreover, this conclusion is also similar with the banking profitability factor as well. Since unconventional monetary policy was embraced as a solution to the financial crisis in 2008, the approach has avoided criticism within the Federal Reserve. While some critics have voiced suspicion of the new approach, the impact of these critiques has done little to move the discussion.

I have used a unique technique to explain monetary policy and financial markets. The structure and direction of variable affects must be agnostic. The results challenge post-crisis monetary policy presuppositions but not monetary theory. This study does not assess Bernanke's main priority, preventing "Too Big to Fails" collapse (Bernanke, 1983); (Hummel, 2011); (Caton, 2020). Consistent readings of the effect of monetary policy mechanisms, whether before or after 2008, show that policy executed through these channels may have had unintended effects.

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APPENDIX A. MAPPING FED POLICY

In the below figure, we have basically analyzed the interdependency of variables from 2003 to 2006 and that was represented here:

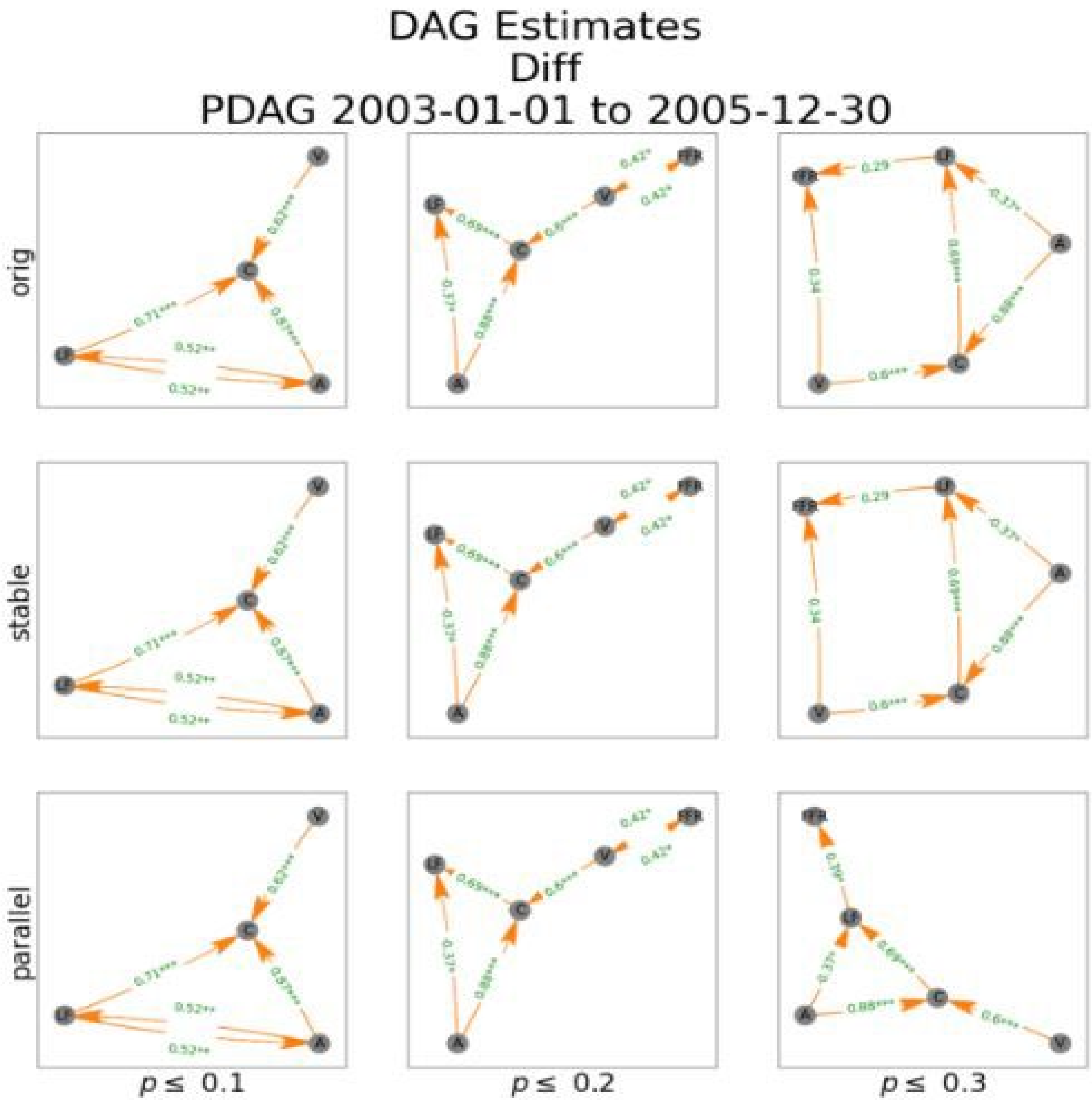

Figure A1. DAG estimates

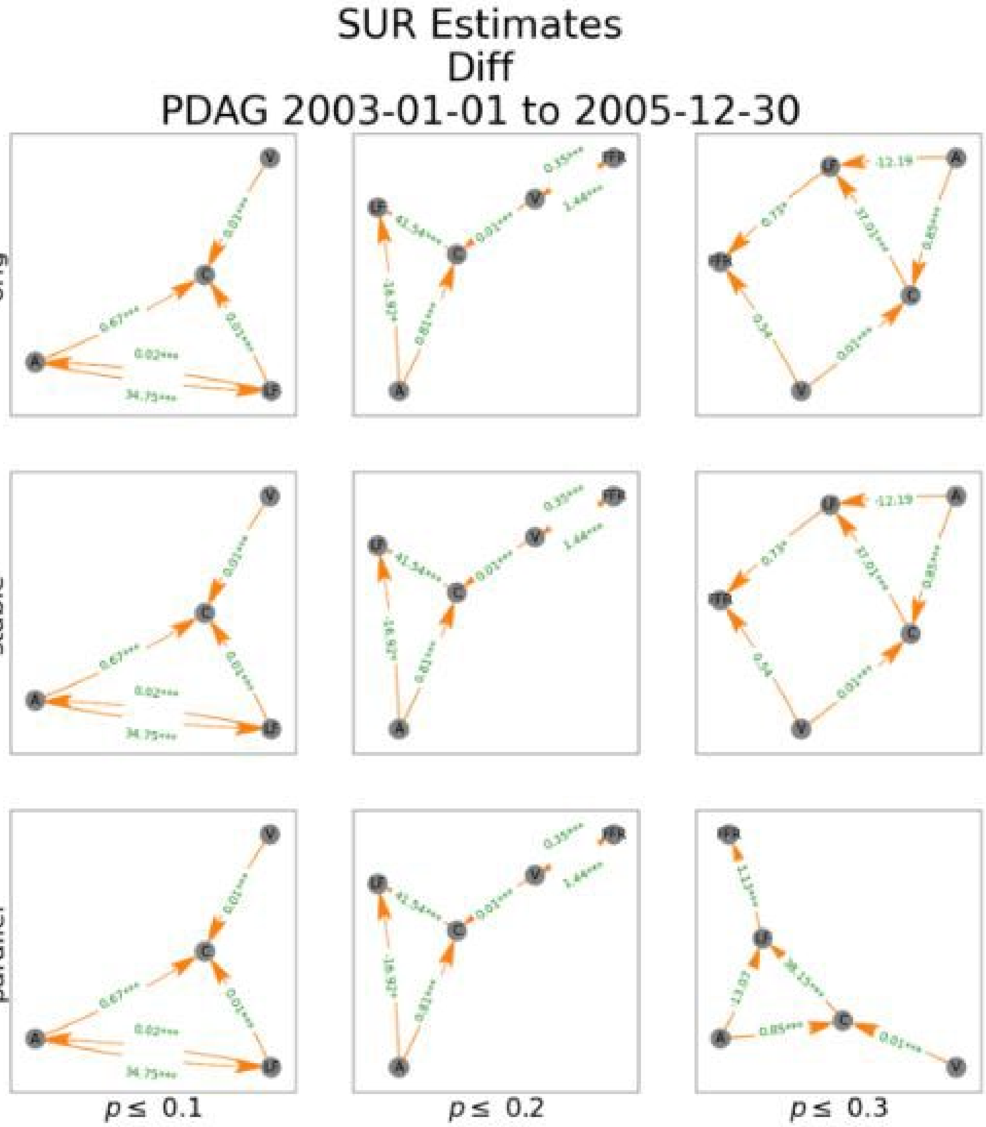

Figure A2. SUR estimates

APPENDIX B. MAPPING FED POLICY WITH PROFITABILITY OF BANKS

In order to analyze the banks, we have initially conducted Pooled OLS method, Fixed Effect and Random Effect model and the results are below:

Table A1. Panel Analysis

Variables	Fixed Effects Model	Random Effects Model	Pooled OLS Model
TA	-0.06359744*** (0.01386035)	-0.06359744 *** (0.01386035)	-0.06359744*** (0.01790291)
FFR	-0.00393280** (0.00134578)	-0.00393280** (0.00134578)	-0.00393280 (0.00328559)
CC	0.09454816*** (0.02424029)	0.09454816*** (0.02424029)	0.09454816** (0.03425906)
LF	0.00161893*** (0.00040175)	0.00161893*** (0.00040175)	0.00161893*** (0.00034738)
Constant Term		0.37211476***	0.37211476***
	N =380 R-squared = 0.30474 Prob > F = 2.22e-16	N = 380 R-squared = 0.29384 Prob > F = 2.22e-16	N = 380 R-squared = 0.22603 Prob > F = 2.22e-16

From the above table, we can see that the estimates of the variables are similar in three of the models. Though Hausman test reflected that random effect model will be appropriate in this scenario. However, we did not include these models in the main part of our analysis.

Also, while running DAG, we have found out that, mean values across the entities are not statistically different than zero and thus we can assume that there is an absence of entity effects and considering this, we have run DAG with the policy variables. The t statistics results are:

roe: 0.009428

ta: 0.019

ffr: -0.007

lf: 0.073