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Does the Federal Reserve cause market bubbles by diverging from Taylor rule?

Finance

Master's thesis

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Abstract of master's thesis

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Abstract

In this thesis, I study how the Federal Reserve affects financial market valuations and stock market liquidity. My work relates to previous literature that uses monetary policy tools to explain stock market liquidity and stock market volatility. Previous research confirms that monetary policy affects equity valuations and risk-aversion of investors. Austrian school theory views business cycles as a symptom of central bank interventionism in credit market and monetary field. Contribution of this thesis is to provide explanation on transmission mechanism of monetary policy to financial market valuations. Emphasis is on employing stock market liquidity as a transmission channel of monetary policy.

I calculate how the Federal Reserve's short term rate has diverged from Taylor rule –implied rate, and define divergences from Taylor rule as expansive or restrictive monetary policy. I use Q-ratio to measure financial market valuations, which is a ratio between U.S. corporate equities and U.S. corporate net worth. I define stock market liquidity as price impact to dollar volume trading in NYSE/Amex stocks. Data spans from 1954 to 2007.

My first new finding shows that monetary policy affects stock market liquidity. Standard deviation effect of monetary policy increases stock market liquidity during two quarters, and explains 54.3% of variation when controlling for autocorrelation. Second new finding shows that stock market liquidity affects financial market valuations. Standard deviation increase on stock market liquidity increases level changes in Q-ratio by 4.78%, and decreases by 4.9% in previous quarter. Effects are large compared to sample mean (1.57%), and explains 18.5% of the variation in Q-ratio levels.

Results hold for numerous robustness tests. Parameter stability test shows that the estimated coefficients for my key findings are stable over time. I employ VAR –model for key variables to study joint movement of monetary policy, stock market liquidity, and Q-ratio. Based on this model, Granger causality –test shows that these variables Granger cause each other. Impulse response functions also confirm same effects I find for my new findings.

Keywords Taylor rule, monetary policy, Federal Reserve, Q-ratio, Amihud illiquidity measure, stock market liquidity, Austrian school of economics, VAR -model

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Tiivistelmä

Tutkin lopputyössäni miten Yhdysvaltain keskuspankki vaikuttaa finanssimarkkinoiden arvostuksiin sekä osakemarkkinoiden likviditeettiin. Tutkimukseni liittyy aikaisempaan kirjallisuuteen missä tutkitaan rahapolitiikkakeinojen vaikutusta osakemarkkinoiden likviditeettiin sekä osakemarkkinoiden volatiliteettiin. Aikaisempi tutkimus vahvistaa rahapolitiikan vaikutuksen osakkeiden arvostuksiin sekä sijoittajien riskinottokykyyn. Itävaltalainen taloustiede olettaa bisnessyklien olevan oireilua keskuspankin interventioista luottomarkkinoilla ja rahatalouden alalla. Tutkielmani edistää aikaisempia tutkimuksia löytämällä selityksen rahapolitiikan välittymiselle osakemarkkinoiden arvostuksiin. Painotan tutkimuksessani osakemarkkinoiden likviditeettiä rahapolitiikan välitysmekanismina.

Lasken, miten Yhdysvaltain keskuspankin asettama ohjauskorko on poikennut Taylorin säännön kehottamasta ohjauskorosta, ja määrittelen poikkeamat Taylorin säännöstä löysänä tai kireänä rahapolitiikkana. Käytän Q-suhdelukua osakemarkkinoiden arvostustasojen mittaamiseen, joka on suhdeluku Yhdysvaltojen yrityksien osakepääomien arvon sekä Yhdysvaltojen yrityksien nettovarallisuuden välillä. Määrittelen osakemarkkinoiden likviditeetin hintavaikutuksena dollarivolyymikaupankäyntiin NYSE/Amex osakkeissa. Aineisto kattaa ajanjakson vuodesta 1954 vuoteen 2007.

Ensimmäinen uusi löytöni osoittaa rahapolitiikan vaikuttavan osakemarkkinoiden likviditeettiin. Keskihajonnan kokoinen vaikutus rahapolitiikassa lisää osakemarkkinoiden likviditeettiä kahden kvartaalin aikana, ja selittää 54.3% vaihtelusta kun autokorrelaatio on otettu huomioon. Toinen uusi löytöni osoittaa osakemarkkinoiden likviditeetin vaikuttavan osakemarkkinoiden arvostuksiin. Keskihajonnan kokoinen vaikutus osakemarkkinoiden likviditeetissä kasvattaa tasomuutoksissa mitattuna Q-suhdelukua 4.78%:lla, ja laskee 4.9%:lla edellisen kvartaalin aikana. Vaikutukset ovat suuria otoksen keskiarvoon verrattuna (1.57%), ja selittää 18.5% Q-suhdeluvun tasomuutoksien vaihtelusta.

Tulokseni pysyvät vakaina useille vahvistustesteille. Parametrivakaustesti osoittaa, että arvioidut kertoimet uusille löydöilleni pysyvät vakaina ajan mittaan. Käytän VAR–mallia päämuuttujien yhteisvaikutuksien mittaamiseksi rahapolitiikan, osakemarkkinoiden likviditeetin, ja Q-suhdeluvun välillä. Tämän mallin perusteella Granger kausaliteetti–testi osoittaa, että näistä muuttujista löytyy kausaliteetti toisiinsa. Impulssivastausfunktiot vahvistavat myös samat vaikutukset jotka löydän uusille löydöilleni.

Avainsanat Taylorin sääntö, rahapolitiikka, Yhdysvaltain keskuspankki, Q-suhdeluku, Amihudin epälikviditeettimittari, osakemarkkinoiden likviditeetti, itävaltalainen taloustiede, VAR-malli

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1. Introduction

"As the quantity of money in circulation and deposits subject to check increases, there prevails a general tendency for the prices of commodities and services to rise. Business is booming. Yet such a boom, artificially engineered by monetary and credit expansion, cannot last forever. It must come to an end sooner or later. For paper money and bank deposits are not a proper substitute for nonexisting capital goods. Economic theory has demonstrated in an irrefutable way that a prosperity created by an expansionist monetary and credit policy is illusory and must end in a slump, an economic crisis. It has happened again and again in the past, and it will happen in the future, too."

– Ludwig von Mises[1]

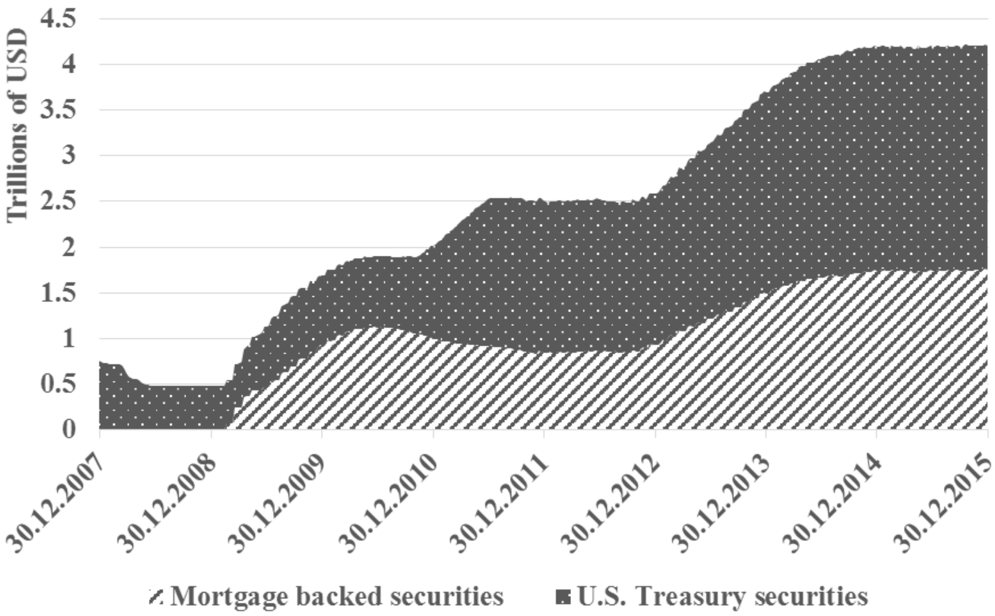
Is it necessary for capitalist society to have a top-down system, such as central bank, which is solely in charge of deciding the price and amount of credit in economy? For example, the supply and prices of cars or televisions are not delegated for public agencies in modern economies. Common perception is that free markets, where individuals reflect their preferences through action, is efficient way to organize production of goods and services. However, general exception is made regarding to financial institutions in sphere of credit market and monetary field, which are more regulated. Government grants for public agencies the right and obligation to oversee institutions that are given license to operate in financial industry.[2]

After the financial crisis, the Federal Reserve in U.S. has kept the effective federal funds rate, its main monetary policy tool, close to zero percent. In addition of these historically low rates, the Fed has intervened in markets by purchasing securities under Quantitative easing -program to stimulate U.S. economy. Total assets of all Federal Reserve banks in U.S. has increased by fourfold (from less than one trillion USD to 4.48 trillion USD) between September 2007 and December 2015.[3] In Figure 1 below, reader can see how the Fed has intervened in markets by purchasing mortgage-backed securities (MBS) and U.S. Treasury securities. As of December

[1] Published in article "Inflation Must End in a Slump", 1951. Republished in Economic Freedom and Interventionism, 1990. Von Mises is considered as a prominent figure in Austrian school of economic thought and was visiting professor at New York State University from 1945 to 1969.
[2] Regulation includes, for example, capital reserve requirements, and restrictions on holding specific class of assets for different financial institutions. The Federal Reserve lists regulations in their homepage, see http://www.federalreserve.gov/bankinforeg/reglisting.htm.
[3] Source: https://research.stlouisfed.org/fred2/series/WALCL.

31 2015, these two items are 95% of total assets held by the Fed, by amounts of 1.74trn USD of MBS and 2.4trn USD of treasury securities.

Figure 1: The Federal Reserve's two main line items in Total Assets



In the meanwhile, SP500 stock index has grown from beginning of 2009 to the end of 2015 by over a hundred percent. Many economists, especially those defined as monetarists, consider that these actions by the Fed were necessary to save the financial system from collapse during the financial crisis.[4] Previous Fed chairman Bernanke said in his speech on Friedman's ninetieth birthday, that thanks to Friedman's analysis on Great Depression, the central bank can avoid economic crises by providing low inflation –environment for everybody.[5] The monetarists' consensus is that Great Depression was a result from strict monetary policy, and Financial Crisis of 2007-2008 did not turn into such a disaster due to loose monetary policy.

In this thesis, I study how the Federal Reserve's monetary policy affects financial market valuations through stock market liquidity. I compare the effective short term rate to Taylor rule –implied interest rate, where the divergence is defined as expansive or restrictive monetary policy. Subsequently, I study how monetary policy impacts stock market liquidity. I also test how stock market liquidity affects valuations in financial markets, which I measure by changes in levels of market-wide Q-ratio. My results implicate that valuations in financial markets change due to changes in stock market liquidity in result of the Federal Reserve's monetary

[4] Monetarism is a school of thought, which believes that manipulating supply of money can, in short term, impact real economic activity.
[5] Remarks by Governor Ben S. Bernanke at the conference to honor Milton Friedman, On Milton Friedman's ninetieth birthday. See http://www.federalreserve.gov/boarddocs/Speeches/2002/20021108/default.htm.

policy. This thesis contributes to existing research by linking monetary policy's impact on financial market valuations through stock market liquidity.

1.1. Academic and practical motivation

Studying the effects of monetary policy on financial market valuations is motivated by previous literature on this topic. Monetary policy has large impact economic agents' decision-making. Hau and Lai (2013) show that loose monetary policy causes outflows from bond funds and inflows to equity funds in Eurozone. Similar behavior prevail also among banks. Altunbas et al. (2010) report that low interest rates makes banks to search for yield more intensively, which is amplified by higher valuations and future cash flows. Adrian and Shin (2008) also show that banks increase their balance sheets and take more risk in result of loose monetary policy. In addition, Bekaert et al. (2012) report that loose monetary policy decreases risk-aversion of investors.

Taylor (2009) and Kahn (2010) attributes the recent financial crisis for loose monetary policy, defined by divergence of Fed's short term rate from Taylor rule. Short term rate set by the Fed was lower than what Taylor rule –suggested for five years before subprime mortgage crisis began in 2008. However, Taylor acknowledges also that complex securitization of mortgage loans and the purchase of risky subprime mortgages by government-sponsored enterprises (Fannie Mae and Freddie Mac) amplified the crisis. In other words, not only central bank's monetary policy, but also government's interventionism under social policy to provide housing, contributed to the crisis.

My motivation to study further this topic is that it has become recently more popular theme due to the Financial Crisis in 2007-2008, and many of the explanations for this event are consistent with ideas that can be linked to previous crises'. In this thesis, I explain and compare different theories and academic discussions behind financial crises', and the role of monetary policy in them.

Austrian school of economics in the 20^{th} century claim that central banking is the main reason for boom and bust cycles in economy. The reason for this is that when central bankers collect economic data to make a decision on interest rate, this differs from the amount of investments financed by voluntary savings. The boom comes with increase of artificially cheap credit, which is used to finance business and operations. When there are no more profitable projects to finance under prevailing interest rates, market stabilizes itself back to natural level that reflects the amount of savings and investments in economy. This is very much what happened during the Financial crisis of 2007-2008, and much of the Taylor's critique is for the expansive monetary policy (Taylor, 2009). The main argument behind Austrian school of economics is that the amount of voluntary savings determines the investments, and central bankers decisions to artificially boost investments eventually hurts economy when price mechanism stabilizes itself back to the natural level. Von Hayek was awarded Nobel Prize in 1974 for this idea.[6]

1.2. Research problem and purpose

For my research, I study how monetary policy transmits to financial markets through stock market liquidity. There has been research on the effect of monetary policy on stock- and bond market liquidity. Goyenko and Ukhov (2009) report that loose monetary policy increases stock market liquidity (through bond market liquidity) in U.S. Also, Fernánderz-Amador et al. (2013) report that loose monetary policy increases stock market liquidity in Eurozone.

But are the financial market valuations driven by stock market liquidity in result of loose or strict monetary policy? In the best of my knowledge, previous research has not addressed this question. Schwert (1989), and Hamilton and Lin (1996) report that economic recessions explain the volatility of stock market returns. In addition, Næs et al. (2011) finds that stock market liquidity can predict economic recessions in U.S. and Norway..

Purpose of my thesis is to shed light on how the Federal Reserve impacts market valuations through stock market liquidity in U.S. For this purpose, I calculate market-wide Q-ratio. This measurement is a ratio between market value of equities and net worth of corporate liabilities. More specifically, I study whether this ratio excessively hovers around its theoretical value, one, because of loose or restrictive monetary policy. Spitznagel (2013) argues that due to the Federal Reserve, market-wide Q-ratio is mean reverting because monetary policy boosts this ratio by inducing cheap credit to economy that affects the nominator.

My definition of loose and strict monetary policy is deviation between Taylor –rule implied interest rate and short term rate set by the Fed. Taylor (1993) suggest that central bank should focus on real GDP growth and inflation in setting the interest rate. If the real GDP growth rate is above the potential real GDP growth rate, or inflation growth rate exceeds the target inflation

[6] "Von Hayek showed how monetary expansion, accompanied by lending which exceeded the rate of voluntary saving, could lead to a misallocation of resources, particularly affecting the structure of capital. This type of business cycle theory with links to monetary expansion has fundamental features in common with the postwar monetary discussion", exact quote from the press release of The Royal Swedish Academy of Sciences in Oct. 9th, 1974.

rate, the rule suggests to increase short term rate. Also, I measure how monetary policy affects stock market liquidity, which I measure as Amihud's Illiquidity –ratio (Amihud, 2002).

Research on this area can help to understand why market valuations vary over time. Purpose of this thesis is to shed more light into the dynamics of market valuations, and to study how stock market liquidity transmits monetary policy effects to financial markets.

1.3. Contribution to existing literature

My main empirical findings contribute existing literature in two ways. First, I find that loose monetary policy has statistically significant impact and increases stock market liquidity in U.S.

Fernánderz-Amador et al. (2013) find similar results for Eurozone. Loose monetary policy, defined as decreasing EONIA –interest rate or increasing money growth aggregates, increases stock market liquidity. They also mention briefly that Taylor rule –residuals increase stock market liquidity. In addition, Goyenko and Ukhov (2009) report that interest rate and money aggregates impacts stock and bond market liquidity in U.S. However, they omit in their analysis whether Taylor rule –residuals can also explain this. My new finding show that Taylor rule –residual affects stock market liquidity also in U.S.

My second new finding is that stock market liquidity impacts financial markets. When measuring financial market valuations as level changes in market-wide Tobin's Q-ratio, stock market liquidity increases valuations by 4.78% at time *t*, before which it decreases it by 4.9% at *t-1*. These economic significances are large, while the sample average for level changes in Q-ratio is 1.57%.

Previous academic research has focused on stock market volatility instead of Q-ratio. For example, Schwert (1989) finds that economic recessions explain why stock markets returns are more volatile occasionally, but not single factor can explain causalities for this. Hamilton and Lin (1996) also report that economic recessions explains over 60% of the variance of stock returns.

My results brings more evidence in favor of monetary policy effects on financial market valuations through stock market liquidity. Næs et al. (2011) show that stock market liquidity estimates future state of economy in U.S. and Norway, and during economic depressions the stock market liquidity is low.

1.4. Limitations of the study

To keep my research focused, I leave out many other directions to study this same topic with different approach. Main concern for the limitation of my study is that there is not easily available data that can be extended to period before the Federal Reserve Act in 1913. Natural comparison would be to compare the financial markets before and after central banking in U.S. Another limitation is that most of the economic data I utilize in my research is not as easily available for other economies. However, by using similar methodology that I outline in this paper, my tests are easily replicable in other economies for further robustness tests.

Also, I omit from my analysis growth of credit and money aggregates. This is mainly because there has been a lot of research on this topic (see, e.g., Adrian and Shin, 2010; Schularick and Taylor, 2010; Schwert, 1989). Also, study of real savings and investments is also left out from my research. I would recommend to test whether Taylor rule –residuals misbalances savings from investments, and makes the market-wide Q-ratio more volatile. This would benefit Austrian school of economics' view on business cycle theory (De Soto, 2006).

My robustness tests suggest endogeneity between my key variables (monetary policy, stock market liquidity, and market-wide Q-ratio) in Granger causality –analysis. This can be result of omitting some important variable. For example, Goyenko and Ukhov (2009) show that monetary policy Granger causes stock market liquidity indirectly, through bond market liquidity. Inclusion of bond market liquidity may address this endogeneity issue.

1.5. Structure of the study

My thesis is structured as follows: In chapter 2, I present and discuss relevant monetary policy research and findings in academia. In this section, I also briefly describe the history of U.S. fractional-reserve banking system, and what likely side effects it has for stock market and economy in Austrian school of economics' point of view. In chapter 3, I derive my hypotheses from literature review. I explain my data and definition of key variables in chapter 4. In chapter 5, I show my methodology. I present my empirical results and robustness tests in chapter 6. Finally, I conclude my work on this subject in chapter 7, where I summarize my findings and suggest new ideas for further research.

2. Literature review

In this section, I shortly describe history of fractional reserve system in U.S., events leading to subsequent establishment of the Federal Reserve, and what likely side effects it has had on economic activity after it was established. Also, I explain how the Fed can make economy and stock markets more volatile by manipulating market interest rates and amount of credit in the view of Austrian school of economics.

For empirical part, I present most relevant empirical research on monetary policy's effect on banks' and investors' behavior, and market liquidity. In addition, I explain what alternative explanations other authors have found plausible for instability in financial markets that could explain some factors behind financial crises'.

I summarize theoretical and empirical research in last section. In addition, I derive my key variables from literature, which are the main concepts of my thesis and used in empirical analysis.

2.1. Theoretical literature

2.1.1. History of U.S. fractional-reserve banking system

Ellis (2001) describes the events leading to fractional-reserve banking in U.S. When United States declared independence in 1776 from Great Britain, this event led to civil war and left many states heavily indebted after the war. There was political dispute on repayment, and question about financing state and federal budgets arose after the United States Constitution was ratified in 1788. Southern states were less indebted than northern states, and they opposed centralizing debt for two reasons: they did not want to take responsibility for those states that had more debt, and transferring state obligations to federal level would lead to common fiscal policy and strengthen federalism. The preliminary plan was to collect taxes and tariffs to repay debt. In 1790, U.S. Congress decided to take over states' debts. Already in next year, Congress approved law for Bank of United States to act as central bank, which would take responsibility of financing federal budget, maintaining monetary system, granting loans, and buying securities.

The first and second central banks were partially government owned establishments. Their licenses were fixed for 20 years by law.[7] License for Bank of United states was not renewed due to change in political climate in congress, and it became a private bank as federal

[7] In 1927, law was changed. Dissolving the Federal Reserve requires now decision of U.S. Congress.

government sold its ownership stake. Five years later, U.S. Congress decided to establish central bank in 1817 for the second time. It had similar structure and same objectives as previous central bank, but this time it also oversaw government borrowing on behalf of U.S. Treasury through private banks, in addition of keeping the currency value stable. Main mechanisms to practice monetary policy were lending and purchasing securities. In practice, these actions restricted issuance of notes by private banks.[8] Second Bank of United States was dissolved in 1841, as President Jackson used veto power few years earlier to reject time extension for central bank.

2.1.2. The Federal Reserve System (FED)

The Federal Reserve, third central bank, was established in 1913. Main reason for establishing Federal Reserve System was to mitigate financial panics and banking crises. The banking crisis in 1907 caused debate whether a central bank should be established.[9] In the following year, Aldrich-Vreeland Act was passed in Congress, which established National Monetary Commission in 1908.[10] This commission subsequently proposed to establish central bank for controlling national currency.

President Wilson suggested adjustments for the proposal before passing the Federal Reserve Act in 1913. One of these was to move obligation of national currency from private banks to U.S. Treasury. [11] Also, the President of U.S. would appoint seven seated Board of Governors with approval of the Senate. These Board of Governors are in charge of controlling twelve regional Federal Reserve Districts. Federal Banks in each of these districts are responsible for implementing monetary policy.

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[8] Tocqueville (2003) describes in the early 19th century how the Second Bank of United States consolidates power for the federal government. The notes that were issued by Second Bank could be forced to repay in cash, which made regional banks restrained. This forces them to keep certain amount of notes circulated proportionate to their own capital assets. Compared to regional banks, the central bank had competitive advantage, which was protected by law. Also, Tocqueville mentions that the main advantage of federal banking is that the notes are of the same value independent of location.

[9] The Panic of 1907 was a result of two copper magnates who tried to corner the market by purchasing majority ownership in United Copper. After unsuccessful try, stock markets started to tumble and caused bank run on Knickerbocker Trust Company. J.P. Morgan orchestrated rescue of financial system with other bankers, and provided liquidity to banking system.

[10] Aldrich-Vreeland Act gave also national banks right to form groups of ten or more, with over five million USD capital, to create emergency currency. This currency was to be backed with U.S. Treasury bonds and banks' assets. However, banks never executed this right before it was withdrawn after the Federal Reserve Act in 1913.

[11] U.S. Dollars are now obligations of the Treasury, as mentioned in Section 411 of Title 12 of the United States Code.

Two larger amendments were made in law after 1913, which guides the Fed.[12] Federal Open Market Committee (FOMC) was established under Banking Act 1933. FOMC is in charge of practicing monetary policy through three different channels: by buying and selling treasury securities (open market operations), by changing discount rates, and by changing reserve requirements for deposit institutions. Another amendment was Federal Reserve Reform Act 1977. This act defined the objectives for monetary policy, which is to “maintain long run growth of monetary and credit aggregates commensurate with the economy’s long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates”.[13]

2.1.3. Austrian school critique against fractional-reserve banking

There are arguments against Federal Reserve System. Representatives of Austrian school of economics argue against political institutions that allow manipulation of supply of money and credit, which unbalances investments from voluntary savings. Also, it seems that the financial system has not become more stable after the Federal Reserve Act in 1913. Economic contractions, such as the Great Depression (1929-1933) and the Financial crisis (2007-2009) were unprecedented before the Fed.

De Soto (2006) argues that the central bank interventionism in credit market is the cause for economic cycles. Central bank interferes in markets by expanding credit by setting interest rates below to what the real savings and investments indicate. The disruption comes first in general boom: the economy is injected with credit, which flows from banking sector to companies in forms of lending. This changes the production structure of companies’ from consumer goods, those products that are closest to consumption, to capital intensive –stages (further away from consumption).[14] However, real savings does not back these investments. Consumers still demand same amount of goods and have not increased savings.

The lowering of interest rates below to the level which reflects balance between investment and real savings, makes less profitable projects look more profitable in discounting terms. Entrepreneurs interpret, that consumers have increased their savings by restricting their consumption, and that these savings are channeled for capital-intensive stages.

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[12] Laws for the Fed has been changed over 200 times in its history.

[13] The Federal Reserve Reform Act of 1977. https://www.gpo.gov/fdsys/pkg/STATUTE-91/pdf/STATUTE-91-Pg1387.pdf.

[14] Companies that have high beta, and strongly co-move with market, are usually most capital intensive. Lower beta –companies are not as cyclical, which focus on consumer goods.

2.1.4. Market correction after economic boom

De Soto (2006) explains how market corrects itself from credit expansion in different phases. First, entrepreneurs increase relative prices of capital goods that are required for more capital-intensive stages (labor, commodities). However, if there were savings from consumers to back up these investments, the relative prices of consumer goods and capital goods would remain same.

After this, in second phase, demand for consumer goods (and their prices) increases with higher growth rate relative to capital goods (for which prices increase at slower pace). As the monetary income of providers for capital goods grow, the monetary demand for consumer goods grow. However, entrepreneurs cannot fill the growing demand of consumer goods, because they have invested in capital-intensive goods and withdrawn investments from production stages closest to consumer goods. In other words, there is a decrease in rate of delivering consumer goods to markets, while the demand for these has grown.

Thirdly, the relative profits increase from production stages that are closest to consumption, while they increase in slower pace for capital-intensive goods. This makes entrepreneurs to rethink whether the investments made in capital-intensive stages should be transferred closer to consumption stage.

In the fourth phase, "*Ricardo effect*" decreases the real income for wages that are used for obtaining consumption goods.[15] If there were real, voluntary savings to back up the capital-intensive investments for entrepreneurs, the price for consumption goods would not increase and there would not be a decrease in real income. The effect is now opposite than would be in the case, where central bank would not interfere in credit markets by manipulating interest rate. However, to fill the increasing demand for consumer goods, entrepreneurs start to replace capital investments with labor (moving investments closer to consumption goods in production line), because the real wages have decreased and gives incentive to replace machinery with labor.

In the fifth phase, when the growth of credit starts decreasing without increase in real savings by consumers, the interest rates in credit market starts rising. The interest rate increases above

[15] Named after David Ricardo, the Ricardo –effect is a microeconomic explanation for entrepreneurs to replace labor with capital and machinery. When the real wages (price for labor) increase, it gives incentive to invest in machinery and capital-intensive stages in production line. If the real wages decrease, entrepreneurs replace capital with labor.

the level that was prior to the central bank interference. This is due to increase in prices of consumer goods that happened during credit expansion. Lenders of money require real interest rate, and add for "inflation" by requiring compensation for maintaining their purchase power. In the meanwhile, entrepreneurs demand additional credit for the investments they have already committed and made for capital-intensive phases in their production lines. They are willing to finish the extended production line -expansions they have mistakenly launched, and bid up for additional credit by paying even higher interest rates to acquire capital for finishing their projects.

At last, entrepreneurs start liquidating capital-intensive investments and notice that the voluntary savings were not enough to back up these projects, which were mistakenly launched due to central bank interference in credit market. In this last, sixth phase, a large pessimism enters the market. The companies furthest away from consumption stage incur heavier losses than those companies closer to delivering consumer goods. In short, entrepreneurs realize that the consumers did not reflect in their behavior the increased savings required to finish these investments. Economic agents express their preferences through actions and demand more consumer goods now. Entrepreneurs liquidate what they can from mistakenly launched investments and reallocate to stages closer to consumption goods.

In short, Austrian school argues that the business cycles in economy are created by errors in economic calculations of central bank interventionism in credit market and monetary field.[16]

2.1.5. Stock market reaction to credit expansion

De Soto (2006) describes how credit expansion initiated by central bank influences stock market valuations. In stock market, shares are alternative place for investors to deposit their excess cash (in addition of buying commercial paper or corporate bonds). Companies issue shares for financing their investments, and promise to investors that if they part from their capital and invest in stocks, they can in exchange receive higher returns in future.

Credit expansion, without corresponding increase in voluntary savings, presents itself as a stock market boom. The excess credit flows from banking sector to stock markets while the interest rates go down and prices of securities rise. In addition, stocks can be used as collateral for obtaining more credit, leading to vicious circle. The conclusion is that the rising stock market

[16] I have here closely explained the economic cycle as in De Soto (2006). See pp. 347-384 for more detailed view on this topic.

valuations does not signal a healthy economy, but is a symptom of accelerating credit expansion which is not backed by real voluntary savings.

The markets are self-correcting process, but it is hard to know in advance when the rising stock market valuations ends. When stock indexes stop growing, investors start doubting and sell their securities. This triggers the sell-off in markets and causes large drops in valuations. The stocks that react mostly to these booms and busts have higher beta (telecom, software, machinery) and lower beta companies are those, which focus on consumer goods (agriculture, healthcare, food, and grocery retails).[17] This confirms that the largest entrepreneurial errors are concentrated in capital-intensive industries.

If the market is allowed to correct itself without additional credit expansions by central bank, it stabilizes itself to level where savings and investments are in balance. Also, when consumers starts saving, and entrepreneurs increasing investments, the Ricardo –effect steps in and makes entrepreneurs to switch from labour –intensive stages to capital –intensive stages in production line. Now, the increased amount of savings or improved production conditions by firms creates gradual increase in stock market, but there will be no accelerating stock market growth unless new credit expansion is initiated by central bank.

2.2. Relevant empirical research

Friedman (1962) studies the control of money supply by the Fed and its impact on economic stability in general. The conclusion he makes is that Fed has made the prices, stock of money, and economic output more volatile. Even though there were banking crises before the Federal Reserve Act in 1913, the subsequent crises and major economic contractions, including the Great Depression in 1929-1933, were far larger even when taking into account both World Wars. Also, Friedman is against price stability as a general policy rule because it gives a lot of leeway for central bankers to interfere with money supply.[18] He advocates for a simple rule for central bankers to follow, instead of ad hoc policies. Reason for simple rule gives two benefits. Firstly, economic agents can prepare better against central bankers' decisions. Secondly, a simple rule helps to restrict central bankers' policy decisions. Taylor (1993) describes what a simple policy rule formula could look like, which I use for my tests.

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[17] Damodaran lists betas for U.S. companies by sector as of January 2015 for preceding twelve months. See http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html for more detailed view on these.

[18] Friedman advocates growth in money stock instead of price stability, which might have been good measure in history. Today, it is disputable which money aggregates measures this goal most efficiently. See also Schularick and Taylor (2010).

In global economy, there are many factors that impact financial market stability. For example, Rajan (2006) describes widely financial sector in globalized world, where transmission of credit and risks has made the world better off on net. However, he argues that there must be regulatory reforms to restrict excessive risk-taking of financial institutions that can cause global crises. Rajan mentions also that monetary policy seems to have achieved low-inflation environment, but outcome is that we have more asset price bubbles. His solution is to promote regulation for curbing risk-taking of financial institutions, instead of admitting that the Fed might play a larger role in affecting economic agents' behavior.

2.2.1. Interest rate impact on investors

Monetary policy's impact on equity markets has become more popular theme in academic research recently. Hau and Lai (2013) study the impact of monetary policy on asset allocation. They find that in the Eurozone, expansive monetary policy leads to outflows from money market funds and inflows to equity market funds during 2003-2010. Decrease of half-a-percentage point in real short term interest rate lead to 3.5% outflow from money market funds and 5% inflow to equity market funds. Loose monetary policy seems to alter risk aversion of investors and shift their portfolios to riskier assets.

Borio and Haibin (2012) emphasizes that central bankers should study economic agents' changing risk-aversion through risk-taking channel. Risk-taking channel is defined as changes in economic agent's risk aversion due to change in policy rate. Change in policy rate impacts risk aversion in two ways: on valuations of securities and future cash flows, and institutions' (i.e. pension funds, insurance companies) risk-tolerance to meet their long-term liabilities and return targets. Central bank also impacts through communication of future actions on interest rates and additional operations to remove uncertainty from markets. These possible future actions create asymmetry in financial markets as economic agents think that central bank will "protect" them from downside risks.[19]

Rigobon and Sack (2009) study impact of monetary policy decisions around Federal Open Market Committee (FOMC) meeting days and congressional hearings of the chairman of Fed. Their results are in line with Hau and Lai (2013). Increase (decrease) in interest rate has larger negative (positive) impact on stock market and lower positive (negative) in market interest rates.

[19] "Greenspan put" is example for central bank's commitment to ensure stable economic conditions in future. During Greenspan's era as Fed chairman in 2000's, investors thought that they had put option on their equities as the Fed would bail their positions if markets collapse.

Also, Bernanke and Kuttner (2005) focus on event-study methods to study impact of monetary policy on equities and found that decrease in interest rate by 25 basis points increases stock market indices by one percent. However, I think that event studies cannot capture longer-term impacts that central banks have on financial markets. Central banks' decisions have effects that impact markets for many periods, which event studies can miss easily.

Bekaert et al. (2012) study the impact of monetary policy on risk aversion and uncertainty of economic agents, and find supporting evidence for monetary policy's impact on investors' behavior. They divide stock-market implied volatility index (VIX) into two components, and find that expansive monetary policy decreases risk aversion and remains for two years. Also, this explains large proportion of variance of risk aversion. Authors find weaker support for uncertainty.

2.2.2. Monetary policy effect on banks' risk taking

Monetary policy affects risk-taking of economic agents also through bank lending. Adrian and Shin (2008) confirm that loose monetary policy has impact in banks' balance sheets. They show that banks grow their balance sheets by increasing less long-term assets (lending), and more short-term liabilities (borrowing). This kind of behavior makes highly leveraged banks pro-cyclical, because they are not able to curtail possible losses on asset side, and become constrained by liquidity in economic downturns.

Loose monetary policy alters investment banks' behavior, and can create instability in real economy. Adrian and Shin (2010) show that when the Fed held interest rate too low for too long, investment banks grew their balance sheets by granting more loans with given equity. Investment banks funded increasing balance sheets by repurchase agreements. They also show that growth rate of repurchase agreements is a good proxy for liquidity, which increased in periods when Taylor rule -residuals were large. However, they take asset prices as endogenous variable, and do not discuss whether the Fed had impact on them also.

According to Altunbas et al. (2010), expansive monetary policy contributed to Financial Crisis in 2007. Low interest rates caused subsequently higher equity valuations, and made banks to search for yield in low-interest rate environment from riskier assets. Authors imply that loose monetary policy can cause instability in financial markets through risk-taking channel by banks, which is consistent with Borio and Haibin (2012) results for investors.

De Nicolò et al. (2010) also study monetary policy impact on risk taking of banks. They find that some banks take more risks when interest rates fall. Two opposing forces that determine bank behavior are search for yield and limited liability protection. This is conditional on the amount capital invested of individual banks, so called “skin in the game” -effect. Those banks who have more to lose than gain behave more prudently when increasing their asset base. However, highly leveraged banks increase risk taking less than less leveraged. Authors suggest that bank regulation and monetary policy should be centralized to one agency for exercising monetary policy that aims for both price stability and financial stability. Both of these objectives are currently on the agenda of Federal Reserve, and it seems that having a monetary policy to promote these objectives simultaneously is ambitious.

2.2.3. Taylor rule and recent housing crisis

Taylor (2009) studies the financial crisis and explains that increase in Taylor rule –residuals led to increase in housing prices and to housing bust. He acknowledges that regulation and passing laws in U.S. Congress to support government sponsored enterprises (Fannie Mae, and Freddie Mac) contributed to the crisis. However, Taylor studies whether the crisis was caused by diminishing liquidity or risk. He finds out that operations to increase liquidity did not help during the crisis, and concluded that the risks in mortgage backed securities (MBS) bought by Fannie Mae and Freddie Mac explains the crisis better. His suggestions for future actions is to follow the Taylor rule, which worked seemingly well during an era considered as the Great Moderation.[20] In addition, he criticizes government’s ad hoc policies, which are not guided by policy framework during the crisis.

Kahn (2010) also shows in his tests, that difference in Taylor rule residuals’ lags led to housing market crisis in 2007. This is in line what Taylor (2009) mentions. When the Federal Reserve kept short term interest rate too low for too long, it accelerated housing prices.

In addition, Kahn mentions that it can be hard to find causalities of loose monetary policy in data, because occurring cycles are different in time. For example, he finds that there is no strong support for increase in prices during tech-stock bubble explainable by loose monetary policy. However, during late 1998 to 2000, the short term interest rate was very low. The Federal Reserve explained their actions by liquidity crisis caused by Russia’s default on their obligations, and subsequent collapse of Long-Term Capital Management. Also, 2002-2006 was

[20] Great Moderation was a time when there was relatively low macroeconomic volatility in U.S. economy, from 1985 to 2005.

a period of low real GDP output and high unemployment, during which the Fed tried to boost the economy with low interest rate. After both of these eras of low interest rates, there occurred economic busts. I consider these busts as tech-stock bubble and housing bubble. Denominator in both of these bubbles is expansive monetary policy.

Schularick and Taylor (2010) conduct time-series analysis in their research on financial crises in 12 different developed countries during 1870-2008. Their results are important link between financial instability and credit booms. Lagged credit growth is a significant predictor for financial crises. Also, they discuss that the link between monetary measures with different aggregates and credit expansion has diverged. In their tests, they use credit to measure liquidity instead of money, because it captures better time-varying features of banks balance sheets and leverage.

They also mention that government activism has played a role in increasing banking sector size and leverage, thus public policies have made the financial sector more procyclical. However, the authors fail to attribute the credit booms to monetary policy, and give credit for Minsky's (1977) and Kindleberger (1978) claims, that the financial system inherently generates instability during credit booms. Authors argue that this is due to failure of regulatory authorities to control these credit booms.

Brunnermeier (2009) goes extensively through what happened in the financial crisis of 2007-2008. He claims that the interest rate environment was very low in US due to increased savings from Asia in addition of loose monetary policy. His findings are similar to Rajan (2006), mainly that financial innovation has made financial markets more flexible, but it may have brought more fragility in financial system. In his view, oversecuritization in generating mortgage-backed securities through special purpose vehicles, and asymmetric information between financial intermediaries, were main causes for the crisis.

However, although Brunnermeier admits that banks increase funding liquidity risk through off-balance sheet vehicles, by investing in long-term assets and borrowing short-term papers, this is fully consistent during low interest rate environment. Hau and Lai (2013) show that institutions and investors in low-interest rate environment search for yield (see also Adrian and Shin, 2008). In addition, Brunnermeier dubiously claims that increase in securitized products led to excessive amount of cheap credit.[21] It would make more sense that cheap credit from

[21] "The rise in popularity of securitized products ultimately led to a flood of cheap credit, and lending standards fell.", citation from p. 82.

loose monetary policy led to innovation, mainly securitization of mortgage loans (mortgage-backed securities) which are liquid and easier to sell in aftermarket.

2.2.4. Monetary policy effects on stock market liquidity

I study impact of monetary policy on stock market liquidity in similar manner to Fernánderz-Amador et al. (2013). Their research shows that expansive monetary policy increases stock market liquidity in the Eurozone during 1999-2009. However, instead of using Taylor rule –residuals, they focus on European Overnight Index Average (EONIA) –interest rate and broad money growth as explanatory variables. These variables can theoretically measure well monetary policy, but it does not tell whether the monetary policy itself is loose or restrictive. Taylor rule is better in this sense, as it objectively describes when monetary policy is restrictive or loose. Authors argue that Taylor rule includes many variables that they have as control variables. However, they mention that their results are robust to Taylor rule –residuals.

Their main findings are that increase of EONIA –interest rate decreases stock market liquidity, and increase of broad money growth leads to increase of market liquidity. Market liquidity is measured in multiple ways for robustness tests, one of which Amihud's illiquidity is utilized. Also, they confirm Granger causality from monetary policy to stock market liquidity, while they find no evidence for causality from stock market liquidity to monetary policy.

In their paper, Goyenko and Ukhov (2009) study monetary policy impact on bond- and stock market liquidity in U.S. They define monetary policy impact as changes in interest rates and money aggregates (Fed funds rate and nonborrowed reserves).[22] Their results also confirm that monetary policy shocks impact stock market liquidity. Loose monetary policy increases bond market liquidity and stock market liquidity. However, they find that the transmission channel of monetary policy to stock market liquidity is through bond market liquidity.

2.2.5. Explanations for changing stock market volatility

Economic recessions is the biggest explanation for volatility in stock market returns. Schwert (1989) tries to explain why stock market volatility is higher in different periods. He does not attribute changing volatility to one single factor, but finds that many factors jointly contribute to this. One percent simultaneous increase in volatility of interest rate, money growth, and industrial production, increases stock volatility index by 0.45 percent for U.S. data spanning

[22] Nonborrowed reserves is the difference between total reserves minus the funds that has been borrowed through the Fed's discount window.

from 1900-1957. He finds that many of the series used in his study are most volatile during the Great Depression and states that economic recession is the likely explanation for changing stock market volatility. Author finds also that the number of trading days and trading volume growth is positively correlated with stock volatility. Trading volume growth increases stock market liquidity in Amihud's illiquidity –ratio (Amihud, 2002), meaning that stock market liquidity can affect volatility in stock market returns.

Hamilton and Lin (1996) also find that 60% of variation in volatility of stock market returns is explained by economic recessions, and confirms findings of Schwert (1989). However, Lee et al. (2002) study investor sentiment effect on stock returns in U.S. They report that conditional volatility of stock market returns increase (decrease) when investor sentiment becomes more pessimistic (optimistic). The behavioral explanation may be a result due to investors' reaction to monetary policy, which authors omit in their research (see, e.g., Borio and Haibin, 2012; Rigobon and Sack, 2009; Bekaert et al., 2012).

Næs et al. (2011) find that stock market liquidity can predict economic recessions, unemployment, and investment growth in U.S. and Norway. Standard deviation increase in stock market illiquidity (decrease in liquidity) predicts -0.3% GDP growth in next quarter. Their results remain robust for many liquidity measures. They also confirm Granger causality from stock market liquidity to real economy.

2.3. Summary of literature review

Federal Reserve is political institution that is legislated by law. Its objectives are to manipulate supply of credit in economy and control national currency to reach specific targets. The Federal Reserve Act of 1913 gives to appointed central bankers control over supply of money and price of credit. Their aim is to control amount of credit in economy, mainly through buying government securities in the market and changing fed funds rate. The amendment made in law (Federal Reserve Reform Act of 1977) sets clear objectives for central bankers to promote employment, stable prices, and moderate long-term interest rates.

However, Austrian school criticizes that the booms and busts in economy are the byproduct of central banking. The amount of credit in the economy cannot grow without increased savings from economic agents. De Soto (2006) argues that this causes oversupply of credit, which are invested in capital-intensive stages in production. When the consumers reflect their preferences through actions, consuming consumption goods instead of increasing their savings required for financing credit to companies, prices on capital goods and consumption goods return to level that reflects savings and investments in the economy.

Academic research has found results that partially support Austrian school of economics' theory on business cycles. For example, Hau and Lai (2013) report that changes in interest rates cause capital inflows to equity funds and outflow from bond funds, meaning that investors search yield in riskier assets. Bekaert et al. (2012) also find that loose monetary policy makes investors less risk-averse. In addition, Adrian and Shin (2008) show that banks increase their balance sheets by lending long-term and borrowing short term, when monetary policy is expansive. Taylor (2009) also show that loose monetary policy and increasing Taylor rule –residuals before the financial crisis accelerated housing prices.

2.3.1. Theoretical background for key variables

In my research, I study whether divergence from rule-based monetary policy influences financial market valuations. I use Taylor rule –residuals which tells when monetary policy is too loose or restrictive. However, my monetary policy variable is a ratio to Taylor -rule. This means that even in some cases when there has been increase in interest rate (restrictive monetary policy), it could be loose if compared to Taylor –rule. For example, if central bank increases short term rate by 0.05pp, and Taylor rule –divergence is during this period 0.1pp, the monetary policy is expansive because Taylor rule shows that the interest rate should have increased more.

If the monetary policy has been too restrictive or expansive, I expect that this affects market-wide Q –ratio. Tobin's Q measures the ratio of market value of equities to net worth of corporate liabilities.[23] When the market value of equities is equal to net worth of corporate liabilities, this ratio has the value of one. From literature review, I interpret that monetary policy affects the amount of credit in economy and behavior of economic agents in various ways. Monetary policy should impact market valuations and therefore affect market-wide Q-ratio.

Spitznagel (2013) argues that the market-wide Tobin's Q –ratio hovers excessively around one because monetary policy manipulates growth of credit, which does not reflect the amount of voluntary savings that are needed for investments in economy. This effect boosts the aggregate profits in economy (market value of equities). However, the denominator remains unchanged, as economic agents do not increase their savings required for net capital acquisitions. Without

[23] Market-wide Tobin's Q –ratio is defined in Data -section. See equation (3).

excessive manipulation of credit supply, this ratio would be stationary (close to one), because the genuine net new savings immediately flow to net worth of corporate liabilities.

Also, I study how stock market liquidity reacts to monetary policy. Previous empirical research finds that monetary policy impacts stock market liquidity. In my research, I test whether a Taylor –rule deviations affects stock market liquidity. In addition, I test whether stock market liquidity affects market-wide Q-ratio, to see whether monetary policy effects transmit through stock market liquidity to market-wide Q-ratio.

3. Hypotheses

In this section, I present my testable hypotheses. My main objective is to study, whether divergence from Taylor rule has caused instability in financial markets. In addition, I study whether the Federal Reserve impacts financial markets through market liquidity.

I consider Taylor rule –residuals as divergence from optimal monetary policy, and market-wide Tobin's Q-ratio as a proxy for financial market stability:

***H1**: Taylor rule –residuals has statistically significant impact on market-wide Tobin's Q (Market value of equity / Net worth).*

This hypothesis tests, whether divergence from monetary policy rule has an effect on market-wide Tobin's Q. Previous studies have confirmed the hypothesis that loose monetary policy leads to increased value in equities (Hau and Lai, 2013). Also, Altunbas et al. (2010) show in their research that low interest rate environment caused overvaluation in equities and increased banks' risk taking during financial crisis. This test would confirm that when the Fed has diverged from Taylor rule –implied interest rate, this should have statistically significant effect on market-wide Q-ratio.

For the second hypothesis, I extend the previous hypothesis and look at the effect of Taylor –rule residuals in level changes of market-wide Tobin's Q:

***H2**: Taylor rule –residuals has statistically significant impact on the changes in levels of market-wide Tobin's Q.*

Monetary policy effects can affect financial market valuations through stock market liquidity. Previous research finds that expansive monetary policy increases growth rate of credit (Adrian and Shin, 2008), which they use as a proxy for banking liquidity. In my third hypothesis, I study whether cumulative Taylor rule -residuals affects stock market liquidity. Fernánderz-Amador et al. (2013) find evidence that decrease in interest rate and increase in broad money growth increases stock market liquidity in Eurozone. Also, Goyenko and Ukhov (2009) find supporting evidence that monetary policy has impact on stock market liquidity (through bond market liquidity) in U.S.

***H3**: Cumulative differences of Taylor rule –residuals has statistically significant impact on stock market liquidity.*

In my last hypotheses, I test whether stock market liquidity has an effect in level changes of market-wide Tobin’s Q. Previous research finds that economic recessions impacts volatility of stock market returns (Hamilton and Lin, 1996). Also, Schwert (1989) finds that number of trading days and trading volume growth are positively correlated with volatility of stock returns. This can imply that market liquidity can have effects on real economy, as trading volume growth is associated with stock market liquidity (Amihud, 2002). In addition, Næs et al. (2011) find evidence that market liquidity predicts economic recessions and investment growth in U.S. and Norway.

H4*: Stock market liquidity has statistically significant impact on the changes in levels of market-wide Tobin’s Q.*

4. Data

Data I use spans from 1954Q4/1955Q2 and ends in 2007Q4. Main reason for using this time period is that there is reasonable amount of observations to test my hypotheses. In addition, during this time period there occurred times when monetary policy has been expansive and contractive relative to Taylor –rule.

All the data for my hypotheses are obtained from two sources. Economic Research of St. Louis Fed has data regarding on monetary policy variables, and macroeconomic data.[24] I use this source for constructing Taylor rule and market-wide Q-ratio. For constructing stock market liquidity variable, I obtain necessary data from Center for Research in Security Prices (CRSP) on NYSE/Amex daily stock prices and trading volumes.

I have omitted data after 2007, because the Federal Reserve started to use more unconventional methods for practicing monetary policy. The main instrument, short term rate, has been set close to zero meanwhile the Federal Reserve has started additional operations that increase market liquidity (mainly by buying asset backed securities and government bonds, see Figure 1). As Taylor rule –residual is one of my key explanatory variable, I would miss most of these ad hoc –policy measures that affect valuations in financial markets. It is therefore prudent to use data, which describes most accurately monetary policy decisions and cut my sample in 2007Q4.

Below I have included correlation matrix (Table 1), and main statistics of key variables (Table 2) that I use in my hypotheses.

[24] Economic Research of St. Louis Fed publishes this data, which is available publicly from https://research.stlouisfed.org/.

Table 1: Correlation matrix of key variables

	ΔTR-residual	ΔQ-ratio	Cumulative ΔTR-residual	$LN(Q_t/Q_{t-1})$	Illiquidity
ΔTR-residual	1.00				
ΔQ-ratio	-0.141**	1.00			
Cumulative ΔTR-residual	0.188***	-0.039	1.00		
$LN(Q_t/Q_{t-1})$	-0.202***	0.922***	-0.0406	1.00	
Illiquidity	0.319***	-0.127*	0.118*	-0.158**	1.00

Table shows correlation between key variables used in hypotheses. ΔTR - residual is first difference of Taylor rule -residual, ΔQ-ratio is first difference of Q-ratio, Cumulative ΔTR -residual is quarterly incremental in ΔTaylor rule - residual, $LN(Q_t/Q_{t-1})$ is change in levels of market-wide Q -ratio, and Illiquidity is de-trended Amihud's Illiquidity -measure. Reported are also significance levels of correlations (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Data spans from 1954Q4 to 2007Q4.

Table 2: Summary statistics of key variables

Variable	Obs.	Mean	Median	Std.	Max	Min
ΔTR-residual	213	-0.00003	0.00002	0.010	0.043	-0.048
ΔQ-ratio	213	0.00185	0.00928	0.064	0.231	-0.277
Cumulative ΔTR-residual	213	-0.00604	-0.00918	0.0252	0.0980	-0.0639
$LN(Q_t/Q_{t-1})$	213	0.00286	0.0157	0.09	0.25	-0.350
Illiquidity	213	-0.00103	-0.0261	0.205	0.837	-0.492

Table shows summary statistics of key variables used in hypotheses. ΔTR - residual is first difference of Taylor -rule residual, ΔQ-ratio is first difference of Q-ratio, Cumulative ΔTR -residual is quarterly incremental in ΔTaylor rule - residual, $LN(Q_t/Q_{t-1})$ is change in levels of market-wide Tobin's Q -ratio, and Illiquidity is de-trended Amihud's Illiquidity measure. Data spans from 1954Q4 to 2007Q4.

4.1. Taylor rule -residual

I use Taylor rule –as an optimal method for practicing monetary policy, against which the actual realized monetary policy of the Fed is compared to. Reason to use Taylor –rule is two-fold. Firstly, it is objective measure and explains large amount of realized monetary policy in history.[25] Secondly, Fed funds –rate has been, in past, the main channel that Fed used to practice monetary policy.

Taylor rule –implied interest rate is calculated as:

$$i = r + \pi + \alpha \times (\pi-\pi^*) + \beta \times (y-y^*) \qquad (1)$$

where i is the Taylor rule –implied short term rate, r is equilibrium constant real interest rate, π is the inflation rate, π^* is the target inflation rate, y is the real GDP growth rate, and y^* is the potential real GDP growth rate. Coefficients α and β are 0.5 in the original model, which I also use in my hypotheses with revised data.

For the value of π, I use implicit price deflator, y is real gross domestic product, and y^* is real potential gross domestic product, target inflation rate π^* is 2%, and equilibrium real interest rate r is 2%. Taylor (1993) says that the constant equilibrium real interest rate r is close to assumed steady-state growth rate of 2.2%, which is estimated from real GDP growth from 1984 to 1992.

In addition, I use the same target inflation rate as Taylor advocates in his original monetary policy description rule. However, the Fed did not explicitly declare the target inflation rate of 2% until 2012, and before that the Federal Open Market Committee made clear in its reports that desirable inflation rate is between 1.7% and 2.0%. Only after the Federal Reserve Reform Act of 1977, stable prices became one of the parameters to follow. It seems that the Fed followed inflation target implicitly before this act. Cahill (2006) show that the Taylor -rule explains 82% of monetary policy during Burns era as Fed chairman (1970-1978), even though inflation rate was not explicitly targeted during this time.

Taylor rule as a policy function describes well monetary policy measured by Fed funds -rate especially during the Greenspan era from 1988 to 1998 (Judd and Rudebusch, 1998). However, when I define loose and strict monetary policy as deviation from Taylor rule, I omit other

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[25] Taylor (1993) shows that this is true, especially during 1987-1992 the short term rate was very close to that of Taylor rule –implied rate. Cahill (2006) shows in his regression analysis that Taylor rule explains from 65% to 82% of the short term -rate under four different Fed chairmen.

transmission channels. These transmission channels are considered as “unconventional”, because they are not main mechanisms to practice monetary policy. Other monetary policy channels include purchase of government bonds and asset backed securities in aftermarket, in addition of communication of future policy measures.

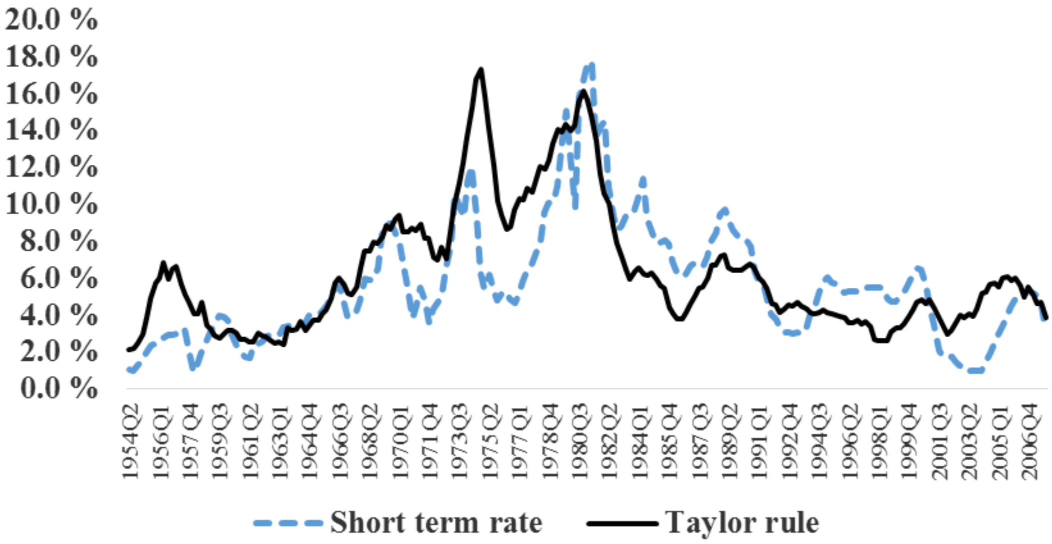
There are shortcomings of using Taylor rule as a descriptive of Fed’s monetary policy in practice. Federal Reserve uses additional information than Consumer Price Index Inflation and GDP growth rates to set interest rate (for example, changes in following aggregates: monetary base, household prices, and oil price). Also, the interest rate –decision is made with real-time data on economic activity. Orphanides (2001) confirms that the use of real-time data with noisy estimates for output gap and inflation leads to different Taylor rule –implied interest rate than revised data.[26]

I obtain data for Taylor rule –rate, and for historical effective Federal funds –rate, from Federal Reserve Economic Data.[27] Data is quarterly from 1954 to the end of 2007. See Figure 2 for graphical illustration of short term rate and Taylor rule –implied rate in time series.

Difference between Taylor-rule -implied rate and short term rate is defined as Taylor rule –residual:

$$\textit{Taylor rule –residual} = \textit{Taylor rule –implied rate} – \textit{Short term rate} \qquad (2)$$

Figure 2: Short term rate and Taylor rule -implied interest rate from 1954Q2 to 2007Q4



[26] In my research, I use revised data due to hard access to historical data.
[27] Historical effective Federal funds –rate is obtained from Section H.15 Selected Interest Rates.

I also calculate cumulative Taylor rule –residuals starting from beginning of 1954 with value of zero, after which the values increment on previous Taylor rule -residuals. Reason for this is that previous monetary policy decisions are likely to have long-term effects.

4.2. Market-wide Q-ratio

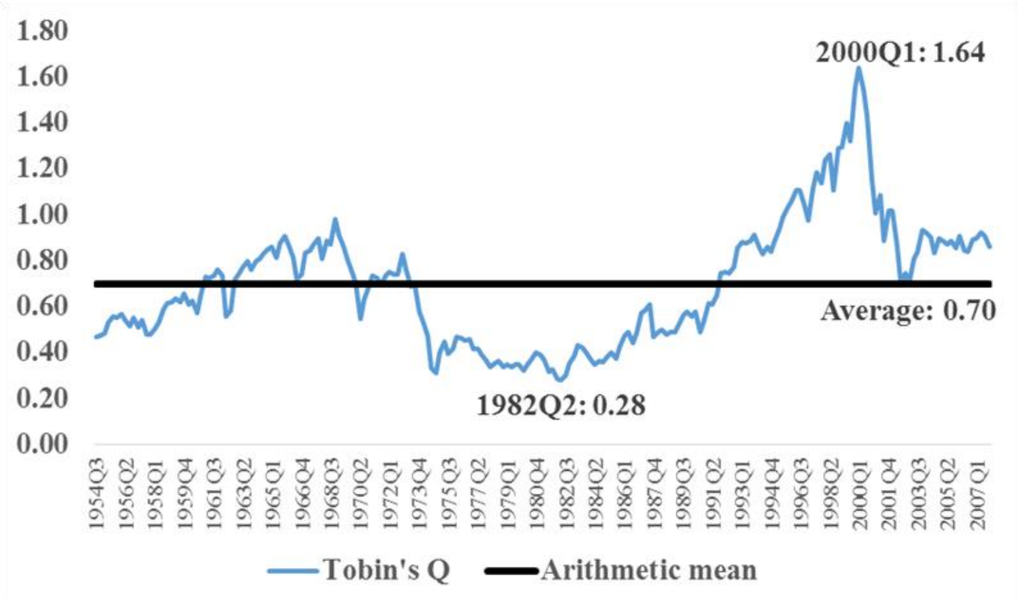
I use market-wide Tobin's Q –ratio to measure financial market valuations as one of my dependent variables. Formula for calculating Tobin's Q is:

$$Q\text{-}ratio = \frac{Market\ value\ of\ equity}{Net\ worth\ of\ corporate\ liabilities} \tag{3}$$

The Federal Reserve reports market value of equity and net worth of corporate liabilities in the Statistical Release Z.1 B.102 Balance Sheet of Nonfinancial Corporate Business, from 1954 to the end of 2007. [28] This data is also available from Federal Reserve Economic Data.

In Figure 3, I show graphically how this ratio has evolved in time. Observations for Q-ratios are by quarter.

Figure 3: Tobin's Q-ratio from 1954Q3 to 2007Q4



This is a novel way to measure instability in financial markets, which is not utilized, in the best of my knowledge, in previous monetary policy research. Historical data shows that the Q-ratio has been mean reverting (historical mean is 0.70). Tobin (1969) originated the theory of Q-ratio, which simply states that when the q > 1, the company is more valued in market than would be

[28] Exact line items are 39 (Market value of equities outstanding), which is divided by line item 36 (Net worth (market value)).

by simply buying the underlying assets at replacement cost. When q-ratio is less than one, a prudent investor could buy more equity of the company, and she would get the holdings cheaper through market than buying the underlying assets by replacement cost.[29]

Financial market stability can be defined in other ways also.[30] For example, Goyenko and Ukhov (2009) use standard deviation of daily stock returns in CRSP/Amex –stocks over a month. In addition, French et al. (1987) similarly use monthly standard deviation of stock returns to study market volatility and expected market risk premium. Schwert (1989) also uses this measure to explain changing volatility of stock market returns.

I use market-wide Tobin's Q-ratio instead of stock market returns volatility, because it has strong economic intuition. It states the relationship between aggregate profits (nominator) and net capital acquisitions (denominator). If I would use only stock market returns volatility, it would focus only on nominator and changes in denominator would be omitted. Also, market-wide Q-ratio has not been used extensively in related literature on monetary policy or market liquidity. I did not find relevant research articles that uses this variable as a proxy for financial market stability.

Another popular measure for equity market volatility is SP500 Volatility index (VIX). It is calculated from implied volatilities of call and put options on stocks listed in SP500 index, and reflects consensus view of future 30-day expected stock market volatility. However, this measure focuses only in future volatility of equity prices, whereas it is in my interest also to study the movement of net wort of corporate liabilities (denominator in equation (3)), which market-wide Tobin's Q-ratio measures. Therefore, I do not use VIX as a measure for financial market stability –variable.

I also test the pairwise correlations between VIX and Q-ratio, and between VIX and changes in levels of Q-ratio. Correlation is not high (0.21 and 0.16 respectively), and statistically significant at 10% level in the first case.[31] In addition, I also report how Q-ratio and Market value of equity –line items in equation (3) correlates with SP500 index. The co-movement is

[29] Close proxy for my measurement of valuations, Q-ratio, is P/B for individual stocks. P/B is a common measure for finding "value" companies, which are considered undervalued by markets. It measures company's market value to its book value.
[30] Financial market stability has same meaning as financial market valuations in my research. When referring to stability, my emphasis is on excess changes in Q-ratio.
[31] Data for VIX is obtained from Thomson Reuters Datastream.

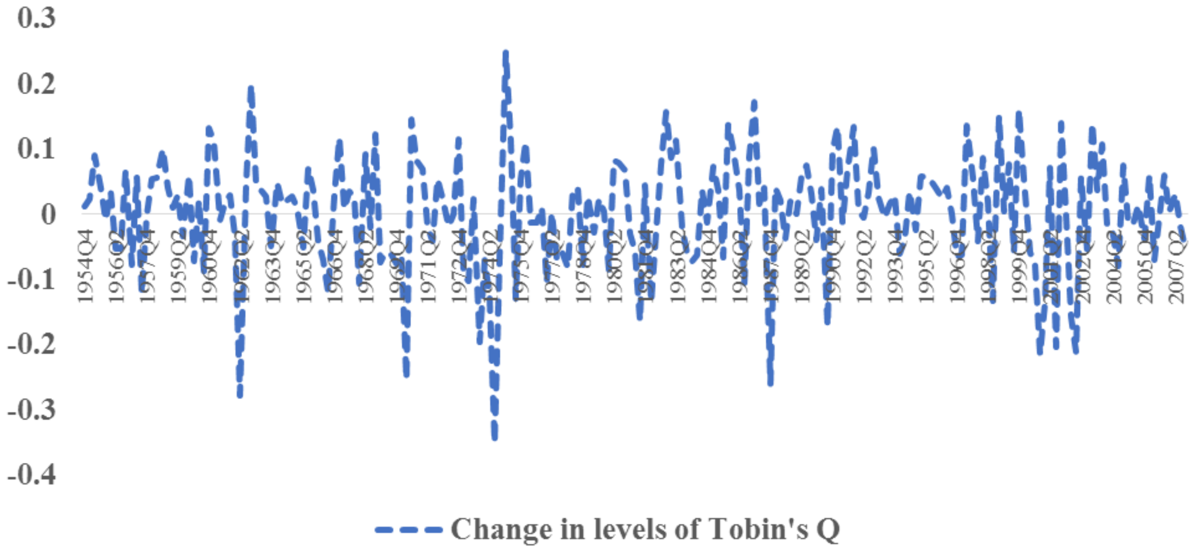
persistent, especially between Market value of equities and SP500 index.[32] Results are reported in Table 10 (see Appendix A).

I define financial market valuations as:

$$\textit{Changes in levels of Q-ratio} = \ln(\text{Q-ratio}_t) - \ln(\text{Q-ratio}_{t-1}) \quad (4)$$

where Q-ratio is defined as in (3). Figure 4 shows how this variable has evolved in time.

Figure 4: Changes in levels of market-wide Q-ratio from 1954Q4 to 2007Q4



4.3. Stock market liquidity

For measuring stock market liquidity, I calculate Amihud illiquidity –quarterly ratio from daily observations of shares listed in NYSE/Amex for time period 1954-2007. Amihud illiquidity is defined for share *i* as:

$$Illiquidity_i = \frac{|Returns_i|}{Price_i \times Volume_i} \quad (5)$$

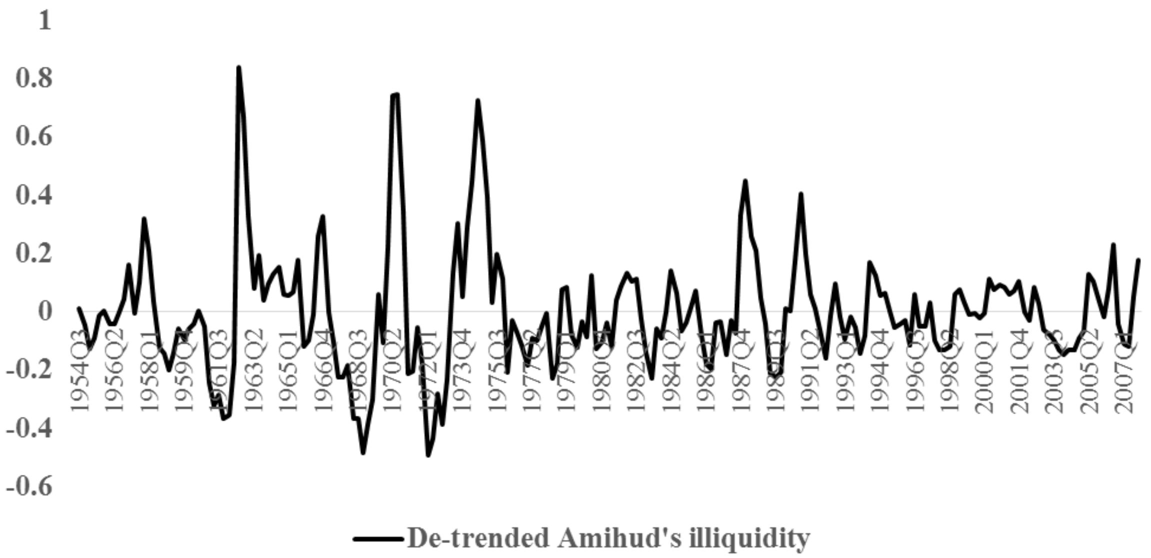
Amihud illiquidity –ratio describes price impact to dollar volume of trading. Lower (higher) illiquidity measure means that share is more (less) liquid. I obtain daily price, trading volume, and returns –data from CRSP. I limit my observations to shares with share code 11 (common securities which need no further specification) to keep the sample homogenous. Also, I take

[32] I take the SP500 index value at the final day of every quarter and calculate pairwise correlations. The correlation between SP500 and Market value of equities is almost 1 and statistically highly significant. Correlation between SP500 and Q-ratio is 0.71 and statistically highly significant. Data for SP500 index values is obtained from Thomson Reuters Datastream.

equal weighted average of Amihud illiquidity ratio for every share within a quarter to calculate quarterly illiquidity value. For convenience, I multiply illiquidity values by 10^6.

I apply Hodrick-Prescott –filter to separate trend for obtaining de-trended illiquidity –values. This methodology follows closely what Næs et al. (2011) implement in their paper. In addition, I leave out specific observations of shares that have no price, volume, or daily returns data. Furthermore, shares with price less than five dollars I leave out from my sample, because these shares make illiquidity estimates noisier (Amihud, 2002). Figure 5 shows graphical illustration of stock market liquidity measured as Amihud's illiquidity –ratio, from 1954Q3 to 2007Q4.

Figure 5: De-trended Amihud's illiquidity from 1954Q3 to 2007Q4



There are other measures for stock market liquidity. Næs et al. (2011) use two additional illiquidity measures for measuring predicting power of market liquidity on economic growth in U.S.: implicit spread estimator (Roll), and LOT –measure (Lesmond, Ogden, and Trczinka). Also, Fernánderz-Amador et al. (2013) use seven different illiquidity measures that measure price impact, trading activity, and transaction costs.[33] However, Goyenko and Ukhov (2009) use only Amihud's illiquidity –ratio to measure monetary policy impact on stock market liquidity.

For my tests, I use Amihud's illiquidity because it is easy to calculate for long time-series from daily stock price data. This measure describes price impact to dollar volume of trading. Compared to other illiquidity measures, none is superior to another but simply measure stock market liquidity from different aspects. For example, turnover rate or traded volume are

[33] Exact definitions of stock market liquidity variables mentioned here can be found in Appendix A in Fernánderz-Amador et al. (2013).

measurements for trading activity of stocks. Also, relative difference between the bid and ask prices for stocks measure transaction costs.

5. Methodology

5.1. OLS –estimators for hypotheses

I test whether Fed affects market-wide Q-ratio by changing interest rates. Increased Taylor residuals, in other words diverging from optimal monetary policy, implicates tampering of asset valuations.

The model I estimate for the first hypothesis is:

***H1**: Taylor rule –residuals has statistically significant impact on market-wide Tobin's Q (Market value of equity / Net worth):*

$$\Delta Q\text{-}ratio_t = \alpha + \beta \times \Delta Taylor\ rule\ residual_t + \varepsilon_t \tag{6}$$

where ΔTaylor rule -residual is the first difference of equation (2), and ΔQ-ratio is first difference of equation (3).

I expect that the Taylor rule –residuals should have a positive coefficient. Positive Taylor rule –residuals mean that the monetary policy is expansive compared to the rule, and this increases market value of equities. However, the impact could be also negative. For example, if the Taylor rule –implied rate is higher than the short term rate set by the Fed, and Fed increases short term rate less than what Taylor rule –implied rate grows, the monetary policy is in fact restrictive, but compared to rule expansive. Monetary policy effects can be hard to capture from time series data with expected signs.

For the second hypothesis, I estimate following model:

***H2**: Taylor rule –residuals has statistically significant impact on the changes in levels of market-wide Tobin's Q:*

$$ln(Q\text{-}ratio_t / Q\text{-}ratio_{t-1}) = \alpha + \beta_0 \times \Delta Taylor\ rule\ residual_t + \beta_1 \times \Delta Taylor\ rule\ residual_{t-1} + \varepsilon_t \tag{7}$$

Where the dependent variable is natural logarithm of first difference in Q-ratio, and ΔTaylor rule –residual is the first difference of equation (2).

For my third hypothesis, I calculate cumulative differences in ΔTaylor rule –residuals to test whether previous monetary policy decisions have lagged effects in stock market liquidity. I estimate following model:

***H3**: Cumulative differences of Taylor rule –residuals has statistically significant impact on stock market liquidity:*

$$Illiquidity_t = \alpha + \beta_0 \times Cumulative(\Delta Taylor\ rule\ residual)_t + \beta_1 \times Cumulative(\Delta Taylor\ rule\ residual)_{t-1} + \beta_2 \times Cumulative(\Delta Taylor\ rule\ residual)_{t-2} + \varepsilon_t \quad (8)$$

My dependent variable is stock market liquidity, as defined in equation (5). Cumulative(ΔTaylor rule -residual) is my independent variable, which starts cumulating from 1954Q3 onwards. I expect negative impact from statistically significant coefficients, which means that loose monetary policy would decrease illiquidity (increase stock market liquidity). However, as mentioned earlier, the rule may not capture the realized monetary policy in situations where strict monetary policy is practiced but remains loose relative to Taylor rule.

Final hypothesis tests whether the stock market liquidity has impact on financial market valuations. Model for testing my final hypothesis is:

***H4**: Stock market liquidity has statistically significant impact on the changes in levels of market-wide Tobin's Q:*

$$ln(Q\text{-}ratio_t/Q\text{-}ratio_{t-1}) = \alpha + \beta_1 \times Illiquidity_t + \beta_2 \times Illiquidity_{t-1} + \varepsilon_t \quad (9)$$

where dependent variable is natural logarithm of first difference in Q-ratio, and independent variable is stock market liquidity. I expect that increasing illiquidity (decrease in stock market liquidity) has negative impact in level changes of Q-ratio.

5.1.1. Stationarity of individual variables and lag –selection criteria

Before regression analyses and results, I make sure that all the individual variables are stationary by Augmented Dickey-Fuller -test (ADF).[34] ADF –test examines whether there is unit root in time series. The objective is to examine the null hypothesis, that $\phi = 1$ in

$$y = \phi y_{t-1} + u_t \quad (10)$$

against one-sided alternative, that $\phi < 1$. If null hypothesis is rejected, we cannot accept it and conclude that series is stationary.

[34] If individual variables are non-stationary, this means that the shocks in explanatory variable do not die away and remains in the system (regression is spurious).

For choosing the correct amount of lags, I utilize Akaike's (1974) information criterion (AIC), which takes the following algebraic form:

$$AIC = ln(\hat{\sigma}^2) + \frac{2k}{T} \tag{11}$$

where $\hat{\sigma}^2$ is residual variance, $k = p + q + 1$ is the total amount of parameters estimated, and T is the sample size. I test lag length up to five lags and choose the model that has lowest AIC with Eviews 8.0.

AIC is not consistent, but compared to Schwarz's Bayesian information criterion (SBIC) or Hannan-Quinn criterion (HQIC), it yields results that are more efficient. According to Brooks (2008), these are most popular information criterias for model selection, but none is superior to another.

5.1.2. Classical Linear Regression Model -assumptions

I test how my models for the hypotheses meet Classical Linear Regression Model –assumptions. The five assumptions are: 1. $E(u_t)=0$, 2. $Var(u_t)=\sigma^2<\infty$, 3. $Cov(u_i,u_j)=0$, 4. $Cov(u_t,x_t)=0$, and 5. $u_t \sim N(0,\sigma^2)$. If the assumptions from one to four are met, model is Best Linear Unbiased Estimator (BLUE). If assumptions two, four (and fifth) hold, model is consistent (unbiased). I use EViews 8.0 to perform tests, especially from second to fifth –assumptions.

The first assumption ($E(u_t)=0$) is met when there is a constant in the equation. For the second assumption ($Var(u_t)=\sigma^2<\infty$), I study whether the variance of error terms is constant (homoscedastic). I use White's test for heteroscadisticity. Purpose of the test is to compare obtained F-statistic to critical value, and accept the null hypothesis (homoscedastic) if F-statistic is not higher than critical value.

In third assumption ($Cov(u_i,u_j)=0$) I test for serial correlation using Breusch-Godfrey test. Obtained F-statistic from the test is compared to critical value, and on this basis, I accept the null hypothesis of no autocorrelation if test -statistic is below critical value (rejected if obtained statistic exceeds critical value).

Fourth assumption tests whether the functional form is correct ($Cov(u_t,x_t)=0$). I use Ramsey's RESET –test to compare obtained F-statistic to critical value. The functional form is correct, if the F-statistic does not exceed critical value.

Fifth assumption ($u_t \sim N(0,\sigma^2)$) is met if the error terms are normally distributed. I use Jarque-Bera –test statistic and compare it to critical value. If obtained Jarque-Bera –test statistic is lower than Chi-squared(*m*), *m* being number of coefficients, the error terms are normally distributed.

5.1.3. Chow test for parameter stability

The OLS estimators assume implicitly that the estimated coefficients are stable over time. To confirm this, I make Chow test for parameter stability. I conduct this test by splitting the data into two sub-periods, estimate models for both periods, and compare these models' residual sum of squares (RSS) to the estimated model for whole period:

$$test\ statistic = \frac{RSS-(RSS_1+RSS_2)}{(RSS_1+RSS_2)} \times \frac{T-2k}{k} \tag{12}$$

where *RSS* is estimated for whole sample, RSS_1 and RSS_2 are estimated for respective sub-periods, *T* is sample size, and *k* is the number of regressors in "unrestricted" regression.[35] The obtained F-statistic is compared to the critical value of F(*k*, *T-2k*). The null hypothesis is that the parameters are stable over time, which is not accepted if obtained test statistic exceeds the critical value. Objective of the test is to compare the RSS of the restricted model to its subparts (RSS_1 and RSS_2). If the RSS does not change significantly with restriction, coefficients of subparts remain stable.

For choosing and splitting data into sub periods, I look into the time series of dependent variable for all hypotheses to see, whether there is a structural change. Break date is chosen subjectively when the behavior of series seemingly changes after specific point in time series. In addition, I cut my sample in half to test whether the coefficients remain stable for these sub periods also.

5.2. Vector Autoregressive -model (VAR), Granger causality –analysis, and impulse response functions

In addition to my OLS regressions, I estimate Vector Autoregressive (VAR) –model to see how my key variables impact each other and move together in time. For this purpose, I make Granger causality –analysis and calculate impulse response functions. Fernánderz-Amador et al. (2013) also use VAR –model to study joint movement of central bank policy –variables, macroeconomic variables, and stock market illiquidity. Also, Goyenko and Ukhov (2009) use

[35] "Unrestricted" regression is the model where no restrictions are imposed.

in their research VAR –models and impulse response functions to study joint movement of stock market and bond market illiquidity.

For my VAR –model, I select three key variables that describe how monetary policy, stock market liquidity, and financial market valuations co-move and impacts each other in time. Generalized expression for VAR –model takes the following form, with K set of time-series variables for $y_t = (y_{1t}, \ldots, y_{Kt})'$:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \tag{13}$$

where A_i's are (K × K) coefficient matrices and $u_t = (u_{1t}, \ldots, u_{Kt})$ is error term. The main endogenous variables I choose are Cumulative(ΔTR-residuals), Illiquidity, and LN(Q-ratio$_t$/Q-ratio$_{t-1}$). Also, I choose the number of p lags that minimizes Multivariate Akaike Information Criterion (MAIC):

$$MAIC = ln|\Sigma^\wedge| + \frac{2k'}{T}; \tag{14}$$

where $\Sigma^\wedge$ is the variance-covariance matrix of residuals, T is number of observations, and k' is number of regressors in equations.

Based on this VAR –model, I make Granger causality –test to see whether endogenous variables Granger causes each other. Granger causality tests whether current endogenous variable correlates with past values' of other endogenous variables. The estimated trivariate VAR(p) is:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix} = \begin{pmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \end{pmatrix} + \begin{pmatrix} \beta_{11}\beta_{12}\beta_{13} \\ \beta_{21}\beta_{22}\beta_{23} \\ \beta_{31}\beta_{32}\beta_{33} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \\ y_{3t-1} \end{pmatrix} + \cdots \begin{pmatrix} \gamma_{11}\gamma_{12}\gamma_{13} \\ \gamma_{21}\gamma_{22}\gamma_{23} \\ \gamma_{31}\gamma_{32}\gamma_{33} \end{pmatrix} \begin{pmatrix} y_{1t-p} \\ y_{2t-p} \\ y_{3t-p} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{pmatrix} \tag{15}$$

The null hypothesis is that the lags of particular variable is restricted to zero. In Table 3 below, I formulate hypotheses and necessary restrictions for Granger causality –test.

Table 3: Granger causality -test and implied restrictions in VAR -model

	Hypothesis	Implied restriction
1	y_{1t-p} do not explain y_{1t}	$\beta_{11} = 0$ and $\gamma_{11} = 0$
2	y_{1t-p} do not explain y_{2t}	$\beta_{21} = 0$ and $\gamma_{21} = 0$
3	y_{1t-p} do not explain y_{3t}	$\beta_{31} = 0$ and $\gamma_{31} = 0$
4	y_{2t-p} do not explain y_{1t}	$\beta_{12} = 0$ and $\gamma_{12} = 0$
5	y_{2t-p} do not explain y_{2t}	$\beta_{22} = 0$ and $\gamma_{22} = 0$
6	y_{2t-p} do not explain y_{3t}	$\beta_{32} = 0$ and $\gamma_{32} = 0$
7	y_{3t-p} do not explain y_{1t}	$\beta_{13} = 0$ and $\gamma_{13} = 0$
8	y_{3t-p} do not explain y_{2t}	$\beta_{23} = 0$ and $\gamma_{23} = 0$
9	y_{3t-p} do not explain y_{3t}	$\beta_{33} = 0$ and $\gamma_{33} = 0$

Granger causality does not necessarily mean causality. It tests whether changes in y_{1t} causes changes in y_{2t} and/or y_{3t}. For example, if y_{1t} causes changes in y_{2t}, the lags of y_{1t} should be significant in the equation for y_{2t}. Conclusion would be that y_{1t} Granger causes y_{2t} (unidirectional causality). Effect can be bidirectional, if the lags of y_{2t} also causes changes in the equation for y_{1t}. Granger causality means correlation of one, current variable, with past values of other variables. Test in this form is named after Granger (1969).

With impulse response functions, I trace responsiveness of dependent variables in the VAR. The ordering of endogenous variables is crucial for calculating impulse responses, because error terms in VAR –model (15) are assumed to be independent from each other. I order the variables in a similar manner to my hypotheses, that is: Cumulative(ΔTR-residuals), Illiquidity, and LN(Q-ratio$_t$/Q-ratio$_{t-1}$). One Cholesky –standard deviation is the unit shock applied to the errors for each equation for endogenous variables. This shows the magnitude of impact on other endogenous variables in the system, and how many periods the effects remain.

6. Analysis and results

In this section, I first show regression results from first hypothesis to last. Also, I discuss how my findings are in line in literature review. In addition, I test how my models meet the CLRM –assumptions. I have summarized results for this analysis in Table 11 (see Appendix B).

After my empirical results, I show results for parameter stability (Chow test) to confirm whether my estimators for hypotheses have robust coefficients. In last two sections, I make Granger causality –test and calculate impulse responses for analyzing causalities and effects between my key variables.

6.1. Impact of ΔTaylor rule -residuals on ΔQ-ratio

In first hypothesis, I test whether model (6) has statistical significance on explaining changes in market-wide Tobin's Q.

H1*: Taylor rule –residuals has statistically significant impact on market-wide Tobin's Q (Market value of equity / Net worth).*

I take the first differences in both, endogenous and exogenous variables to make these variables stationary. In Table 4 below, I show my result for first hypothesis. Changes in Taylor –rule residuals has statistically significant impact on changes of Q –ratio at 5% level. One standard deviation impact of ΔTaylor rule residual on ΔQ-ratio is -0.0095 (0.01×-0.948). Compared to sample mean of ΔQ-ratio (0.00185), effect is economically significant on endogenous variable. R-squared value is low (2%), indicating that the model does not explain variation in changes of Q-ratio very much. In addition, the coefficient for TR –residual is negative, where I expected it to be positive. Also, the estimated model (6) passes the first four assumptions of CLRM, making it BLUE (Best Linear Unbiased Estimator).

*Do not reject **H1**. Taylor rule –residuals has statistically significant impact on market-wide Tobin's Q –ratio.*

Table 4: Impact of ΔTaylor rule -residuals on ΔQ-ratio

Dependent variable	ΔMarket-wide Q-ratio
Model number	(6)
ΔTR -residuals	-0.948**
	(0.419)
Constant	0.002
	(-0.270)
Observations	213
R-squared	0.020

Reported is the regression result for impact of ΔTaylor rule -residuals on Δ Q-ratio in U.S. for the period from 1954Q4 to 2007Q4. Robust t-statistics in parentheses (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Also reported are the amount of observations and R-squared.

This finding is partially in line with previous research. For example, Hau and Lai (2013) show in their research that interest rate decisions set by central bank in Europe (ECB) has direct effect in investors' decisions: increase (decrease) in interest rate leads to outflow (inflow) from equity (bond) investments and inflows to bonds (equities). Rigobon and Sack (2009) also show that increase (decrease) in interest rate decrease (increase) stock market valuations. In addition, Bernanke and Kuttner (2005) report that hypothetical increase in interest rate by 25 basis points decreases stock market indices by one percent.

My finding confirms that monetary policy, in my case a deviation from Taylor rule, impacts the ratio between market value of equities and net worth of corporate liabilities as defined in equation (3). However, the effect (sign of coefficient) is not expected.

6.2. Impact of ΔTaylor rule -residuals on changes of levels in Q-ratio

From my first hypothesis, I change the endogenous variable to changes in levels of Q-ratio for studying the percentage changes. This sheds more light on what is the exogenous variable's percentage impact on level changes in the Q-ratio.

H2*: Taylor rule –residuals has statistically significant impact on the changes in levels of market-wide Tobin's Q.*

For model (7), AIC –criterion suggests one lag –variable for Taylor rule –residual. In left column of Table 5 below, I present my results. Due to heteroscedasticity, I estimate Newey-West –adjusted t-statistics. Both exogenous variables are statistically significant. ΔTR –

residual$_t$ and ΔTR –residual$_{t-1}$ are significant at 5% and 10% -level respectively. Also, the model's R-squared improves marginally, to 5.6% -level. The economic significance of one standard deviation impact in ΔTR -residuals$_t$ on endogenous variable is -2.02% (0.01×-2.021), and for ΔTR -residuals$_{t-1}$ this is 1.16% (0.01×1.164). Compared to sample mean of $LN(Q_t/Q_{t-1})$ (1.57%), economic significances of Taylor rule -residuals is meaningful.

*Do not reject **H2**. Taylor rule –residuals has statistically significant impact on changes of levels in Q-ratio.*

My finding remain same as in my first hypothesis. The simultaneous standard deviation effect on contemporaneous and lag variable for ΔTR –residuals decrease changes in levels of Q-ratio by 0.84%. The economic significances are however much lower when introducing lag variable and looking at level –changes in Q-ratio. The model still explains small amount of variation in my dependent variable, and has low R^2 -value.

Table 5: Impact of ΔTaylor rule -residuals in the changes of Q-ratio levels

Dependent variable	$LN(Q\text{-ratio}_t/Q\text{-ratio}_{t-1})$	$LN(Q\text{-ratio}_t/Q\text{-ratio}_{t-1})$
Model number	(7)	
ΔTR -residuals$_t$	-2.021**	
	(-2.04)	
ΔTR -residuals$_{t-1}$	1.164*	
	(1.81)	
Cumulative(ΔTR -residuals)$_t$		-1.96*
		(-1.93)
Cumulative(ΔTR -residuals)$_{t-1}$		2.87**
		(2.32)
Cumulative(ΔTR -residuals)$_{t-2}$		-0.0765
		(-0.0875)
Cumulative(ΔTR -residuals)$_{t-3}$		-1.03*
		(-1.744)
Constant	0.003	0.001
	(0.486)	(0.190)
Observations	212	210
R-squared	0.056	0.07

Reported are the regression results for impact of ΔTaylor rule -residuals in the changes of Q-ratio levels in U.S. for the period from 1955Q1 to 2007Q4. Additionally, I report results for impact of Cumulative(ΔTR -residuals) in the changes of Q-ratio levels in U.S. from 1955Q3 to 2007Q4. Robust HAC (Newey-West) -adjusted t-statistics are in parentheses (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Also reported are the amount of observations and R-squared.

I also tests how results change if I switch my exogenous variable to Cumulative(ΔTR –residual), for which AIC suggests three lags. I calculate Cumulative(ΔTR –residual) by cumulating from 1955Q1 onwards, and report regression result on the right column in Table 5. Cumulative(ΔTR –residual)$_t$ is statistically significant at 10% -level, and lags of one and three of this variable are statistically significant at 5% and 10% -level respectively. The economic significances of one standard deviation impact on changes of Q-ratio levels at *t*, *t-1*, and *t-3* are -4.94% (0.0252×-1.96), 7.23% (0.0252×2.87), and -2.6% (0.0252×-1.03) respectively. Summing up these impacts, simultaneous standard deviation effect on statistically significant variables decrease level changes in Q-ratio by 0.31%.

In model (7) where I use ΔTR –residual as exogenous variable, the impact at time *t* is negative, and at *t-1* positive. When compared to model with Cumulative(ΔTR –residual) as my exogenous variable, on the right column at Table 5, immediate effect is negative at *t*, positive at *t-1* and negative again at *t*-3. However, the economic significances in latter case (Cumulative ΔTR –residuals as exogenous variable) exceeds by large amount compared to the case with ΔTR –residuals as exogenous variable. This can result from the reason that previous monetary policy decisions are persistent in the model, and they have larger effect than plain periodical change in Taylor rule -residual. It is therefore prudent to take into account cumulative effects of previous ΔTR –residuals.

6.3. Impact of cumulative differences in Taylor rule –residuals on stock market liquidity

For third hypothesis, I use Cumulative(ΔTR –residuals) as my exogenous variable and study, how Taylor rule –residuals cumulatively impact stock market liquidity.

***H3**: Cumulative differences of Taylor rule –residuals has statistically significant impact on stock market liquidity.*

AIC –criterion suggests two lagged exogenous variables. Due to the presence of serial correlation in model (8), I add two control variables for Illiquidity and estimate additional OLS -model. I show my results for third hypothesis in Table 6 below.

Table 6: Impact of cumulative differences in Taylor rule -residuals on stock market illiquidity

Dependent variable	Illiquidity	
Model number	(8)	
Model description	No control for autocorrelation	Control for autocorrelation
Cumulative(ΔTR -residuals)$_t$	6.602***	3.276***
	(4.57)	(3.04)
Cumulative(ΔTR -residuals)$_{t-1}$	-3.35	-4.375***
	(-1.58)	(-2.82)
Cumulative(ΔTR -residuals)$_{t-2}$	-3.01**	0.985
	(-2.08)	(0.9)
Illiquidity$_{t-1}$		0.847***
		(12.2)
Illiquidity$_{t-2}$		-0.249***
		(-3.37)
Constant	0.002	-0.0005
	(0.122)	(0.005)
Observations	211	211
R-squared	0.124	0.543

Reported are the regression results for impact of Cumulative(ΔTaylor rule -residuals) on market liquidity of U.S. shares listed in NYSE/Amex for the period from 1955Q2 to 2007Q4. Additional model is studied due to presence of autocorrelation in model (8), which disappears when including two lags of dependent variable. Robust t-statistics are in parentheses (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Also reported are the amount of observations and R-squared.

The coefficients Cumulative(ΔTR –residuals)$_t$ and Cumulative(ΔTR –residuals)$_{t-2}$ are statistically significant at 1% and 5% level respectively, and R-squared is 12.4% for model (8). When I control for serial autocorrelation, model improves. Covariance between previous error terms, and between error terms and endogenous variables disappears. The coefficient for Cumulative(ΔTR –residuals)$_t$ remains significant at 1% level, and Cumulative(ΔTR –residuals)$_{t-1}$ becomes significant at 1% level also, while second lagged term becomes statistically insignificant. Also, R-squared increases to 54.3%. In addition, model with control variables meets the first four CLRM –assumptions and is BLUE.

Next I calculate the economic significances in model (8). Without control variables, standard deviation impact in Cumulative(ΔTR –residuals)$_t$ increases market illiquidity by 0.166 (0.0252×6.602). For standard deviation impact in Cumulative(ΔTR –residuals)$_{t-2}$, market illiquidity decreases (increase in market liquidity) by 0.076 (0.0252*-3.01). The market illiquidity seems to increase in result for loose monetary policy as a whole, which is unexpected result. Simultaneous standard deviation impact in both statistically significant variables increase market illiquidity by 0.09, which is high compared to sample median of Illiquidity –variable (-0.026).

Interpretation for economic significances change when I control for autocorrelation. Standard deviation impact in Cumulative(ΔTR –residuals)$_t$ increases market illiquidity by 0.083 (0.0252×3.276), and standard deviation impact in Cumulative(ΔTR –residuals)$_{t-1}$ decreases market illiquidity (increases liquidity) by 0.11 (0.0252×-4.375). When controlling for autocorrelation, loose monetary policy increases market liquidity as a whole. Simultaneous standard deviation impact on statistically significant variables increases stock market liquidity by 0.027 (0.11-0.083). This effect is close to a median of Illiquidity –variable (-0.026) in absolute terms.

*Do not reject **H3**. Cumulative differences of Taylor rule –residuals has statistically significant impact on stock market liquidity.*

Fernánderz-Amador et al. (2013) study stock market liquidity by using VAR –model with many different monetary policy variables, including interest rate decisions and money aggregate growth rate. They find that expansive (restrictive) monetary policy increases (decreases) market liquidity in Eurozone, and that their results are robust when using Taylor rule –residual also. My OLS model (8), when controlling for autocorrelation, confirms this finding for U.S. data. In addition, Goyenko and Ukhov (2009) report that stock market liquidity increases in result of loose monetary policy in U.S., but they do not use Taylor rule –residuals. In section 6.5., I study also VAR –model to see whether my findings remain same.

6.4. Impact of stock market liquidity in the changes of Q-ratio levels

In my last hypothesis, I test how stock market liquidity affects financial market valuations.

***H4**: Stock market liquidity has an impact on the changes in levels of market-wide Tobin's Q*

AIC –criterion suggests two lags for exogenous variable. In Table 7, I show my results. Due to the presence of heteroscedasticity, I estimate Newey-West adjusted t-statistics. Illiquidity and its lag variable are both statistically significant at 1% level, and R-squared is 18.5%. One standard deviation change in Illiquidity at *t*, and *t-1*, impacts -4.78% (0.205×-0.233) and 4.9%

(0.205×2.39) respectively in the changes of Q-ratio levels. Compared to sample mean of dependent variable (1.57%), the periodical economic significances are high.

*Do not reject **H4**. Stock market liquidity has an impact on the changes in levels of market-wide Tobin's Q.*

Compared to model (7) in my second hypothesis, model (9) explains better changes in Q-ratio –levels (higher R-squared -value), and coefficients are statistically more significant.

Table 7: Impact of stock market illiquidity in the changes of Q-ratio levels

Dependent variable	$LN(Q\text{-}ratio_t/Q\text{-}ratio_{t-1})$
Model number	(9)
$Illiquidity_t$	-0.233***
	(-3.23)
$Illiquidity_{t-1}$	0.239***
	(5.64)
Constant	0.003
	(0.579)
Observations	213
R-squared	0.185

Reported is the regression result for impact of market liquidity of U.S. shares listed in NYSE/Amex in the changes of Q-ratio levels for time period from 1954Q4 to 2007Q4. Robust HAC (Newey-West) -adjusted t-statistics in parentheses (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Also reported are the amount of observations and R-squared.

In the best of my knowledge, no previous academic research has used market-wide Tobin's Q –ratio as a measurement for valuations in financial markets. Results reported here are therefore new in this sense. Stock market liquidity has impact on level changes in market valuations as a whole, and has high explanatory power. Schwert (1989) reports that trading volume growth, and trading days, are positively correlated with the volatility of stock market returns, which is in line with my finding. However, he also reports that single factor does not explain why volatility in stock market returns change, but that volatility of many factors jointly affects it (mainly in interest rates, industrial production, and money growth). In addition, Hamilton and Lin (1996) studies why volatility in stock markets change. They also find that economic recessions changes the volatility of stock market returns.

Næs et al. (2011) find some supporting evidence between stock market liquidity and business cycles. However, they study predictive power of liquidity on economic cycles. In their research, market liquidity has predictive power on economic recessions from 1947 to 2008. Standard deviation impact in Amihud's illiquidity measure predicts future period's economic GDP growth by -0.3%, when median growth for the period is 0.8% per quarter.

My results show that increase in same period stock market illiquidity (liquidity) decreases (increases) changes in Q-ratio levels by almost 5%, while mean for this variable is 1.5%. This is new empirical finding.

6.4.1. Results for parameter stability (Chow test)

I test whether the estimated models for all of my hypotheses have robust coefficients. For all models, I look in dependent variables' time series data for possible structural change and choose break date subjectively. Results are reported in Table 8 below.

Table 8: Chow test for parameter stability

Hypothesis	H1	H2	H3	H3	H4
Model number	6	7	8	8*	9
Break date	1992Q2	1996Q1	1985Q2	1985Q2	1996Q1
	1.75				
	(0.175)				
		0.778			0.743
		(0.508)			(0.527)
			0.386	0.0652	
			(0.819)	(0.999)	

Table shows t-statistics and p-values below (in parentheses) of parameter stability for estimated models. Null hypothesis is that the parameters are stable over time. * is model with control variables.

Test results show that the coefficients remains stable for all models for selected break dates. In addition, χ^2 -test statistics do not exceed critical values. Also, the results do not change when choosing break date in the middle of my sample.[36] Conclusion from this test is that all estimated coefficients for my models are robust and do not change over time.

[36] Results for χ^2 -test and Chow test for break date in the middle of the sample are not reported here.

6.5. Granger causality between key variables in VAR -model

In Table 9 below, I show results of Granger causality –test for Cumulative(ΔTR –residuals), Illiquidity, and $LN(Q_t/Q_{t-1})$ –variables. MAIC suggests VAR(1) model, which I use for Granger causality –test and calculating impulse responses.

Table 9: Granger causality test between Cumulative Taylor rule -residuals, stock market illiquidity, and market-wide Q-ratio

	Cumulative(ΔTR-residual)	$LN(Q_t/Q_{t-1})$	Illiquidity
Cumulative(ΔTR-residual)		0.059 (0.807)	4.22 (0.04)
$LN(Q_t/Q_{t-1})$	16.66 (0.00)		51.82 (0.00)
Illiquidity	9.89 (0.0017)	7.69 (0.0056)	

Table shows χ² -statistics and p-values below (in parentheses) of endogenous variables in VAR -model. Null hypothesis is that row -variable does not cause column -variable. Cumulative(ΔTR-residual) is quarterly incremental in Taylor rule -residuals, changes in levels of Q-ratio is logarithmic differences in Market value of equities divided by net worth of corporate liabilities, Illiquidity is de-trended Amihud's Illiquidity -measure calculated from daily returns of NYSE/Amex stocks and made equal-weighted for every quarter. Data covers time span from 1954Q3 to 2007Q4.

I report here Granger causalities with p-values under 5% in Table 9. Cumulative(ΔTR –residuals) Granger causes Illiquidity, and Illiquidity Granger causes $LN(Q_t/Q_{t-1})$. These findings are in line with my hypotheses. However, $LN(Q_t/Q_{t-1})$ has Granger causality for other variables: it Granger causes Illiquidity and Cumulative(ΔTR –residuals). Also, Illiquidity Granger causes other variable; in addition of Granger causing $LN(Q_t/Q_{t-1})$, it Granger causes Cumulative ΔTR –residuals.

If financial market valuations ($LN(Q_t/Q_{t-1})$) impacts monetary policy -variable, my findings may suffer from endogeneity. It can be possible that monetary policy reacts to general equity –market conditions. For example, Rigobon and Sack (2003) finds that short-term rate reacts to changes in stock market conditions: increase in stock prices increase probability of rising up short term rate. Important note is that positive outlook of general economy tends to boost up stock market movements (i.e. unemployment and inflation rate, which are incorporated in Taylor –rule, see equation (1)).[37] It makes more sense that central bankers focus on real economic data, and equity prices are usually co-moving with these. I do not think that equity valuations is a variable that central bankers focus on when deciding interest rates.

I compare my results to Goyenko and Ukhov (2009), where they find similar causalities for U.S. markets. They report that both, short term rate and non-borrowed reserves Granger causes stock market illiquidity. My results supports this pervious finding, as Cumulative(ΔTR –residuals) Granger causes stock market illiquidity. However, authors do not report or discuss whether they have bi-directional effects between monetary policy variables and stock market illiquidity. In my case, I find bi-directionality between these variables. In addition, they find that volatility of stock market returns Granger causes stock market illiquidity, and that the effect is one-directional. This can explain partially why my $LN(Q_t/Q_{t-1})$ Granger causes stock market illiquidity, because I have market value of equities in nominator for Q-ratio, as defined in equation (3).

Fernánderz-Amador et al. (2013) also report similar results for Eurozone. Monetary policy Granger causes stock market liquidity, when using base money growth and EONIA –interest rate as monetary policy variables. Authors do not find that stock market liquidity Granger causes monetary policy. However, I find bidirectional effect between stock market illiquidity and Cumulative(ΔTR –residuals).

There are arguments that monetary policy decisions can be affected by market liquidity conditions. For example, Taylor (2009) argues how monetary policy authorities attributed the financial crisis of 2007-2008 to diminishing market liquidity and acted on it, to ensure that liquidity remains in financial markets.[38] This can partly explain why market illiquidity Granger causes my monetary policy –variable (Cumulative(ΔTR –residuals)).

Summary from Granger causality analysis is that the variables I have selected and formulated for my hypotheses Granger cause each other. Monetary policy -variable Granger causes stock market liquidity, which in turn Granger causes the Q-ratio. However, there are many bi-directional Granger causalities between these variables, which can be a result of endogeneity.

[37] When the output is above its full-employment level, inflationary pressures increases and the rule suggests tightening monetary policy by increasing short term rate.
[38] Taylor defines market liquidity as LIBOR-OIS –spread (difference between London Interbank Offered Rate and Overnight Indexed Spread), which is common measure for describing liquidity between banks.

Goyenko and Ukhov (2009) report that monetary policy impacts stock market liquidity through bond market liquidity. Therefore, introduction of bond market liquidity could mitigate endogeneity among my key variables for Granger causality –test.

6.6. Impulse response functions (IRF) for VAR -model

I also calculate impulse response functions to analyze effects of my key variables in VAR – model. In Figure 6 below, I show my results graphically. For calculating IRF, it is important to set the endogenous variables in proper order. I set the following order: Cumulative(ΔTR – residuals), Illiquidity, and LN(Q_t/Q_{t-1}). This ordering is similar to my hypotheses with individual OLS –estimators, where I study monetary policy impact on stock market illiquidity, and subsequent effect on level changes of market-wide Q-ratio.

Graph B in Figure 6 shows that standard deviation impact of Cumulative(ΔTR –residuals) increases market illiquidity during first three periods, and after fourth period the effect is reversed (market illiquidity decreases). This finding is in line with my OLS –estimator (model (8) with control variables) in section 6.3. Monetary policy impact remains in the system for many quarters, and decays slowly.

In Graph C, a standard deviation impact of market illiquidity decreases changes in Q-ratio levels (LN(Q_t/Q_{t-1})) during first period, and then increases after second period. The effect disappears during sixth period. The first two -period effects are in line with my results for model (9).

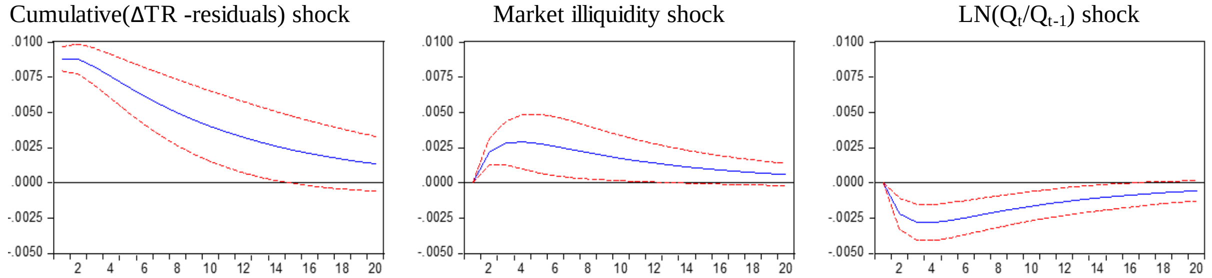
Due to the Granger causes of other endogenous variables in previous section (6.5.), I shortly describe whether they have economic theory supporting the effects that IRF suggests. In Figure 6 (Graph A), changes in Q-ratio levels Granger causes Cumulative(ΔTR –residuals). The interpretation from IRF is that when Q-ratio increases, this leads to restrictive monetary policy. This is in line what Rigobon and Sack (2003) report. They find that increase in stock prices (SP500 index) increase the probability of restrictive monetary policy (increase in short term rate). As mentioned in previous section (in Granger test), stock prices usually co-move with economic growth and inflation pressures. This explains why central bank may react indirectly to rising stock prices by increasing short term rate.

Another Granger causing variable in Figure 6 (Graph A) is market illiquidity on Cumulative(ΔTR –residuals). When market illiquidity increases, Cumulative(ΔTR –residuals) increase. This finding suggests that increasing market illiquidity causes loose monetary policy. This makes sense in theory, because it is in the interest of central bankers to ensure market liquidity during crises by practicing loose monetary policy. As Taylor (2009) mentions, the monetary policy authorities tried to ensure market liquidity by establishing special programs for giving credit to banks during Financial Crisis in 2007-2008. This is in line with the dynamics that IRF suggests for these two variables.

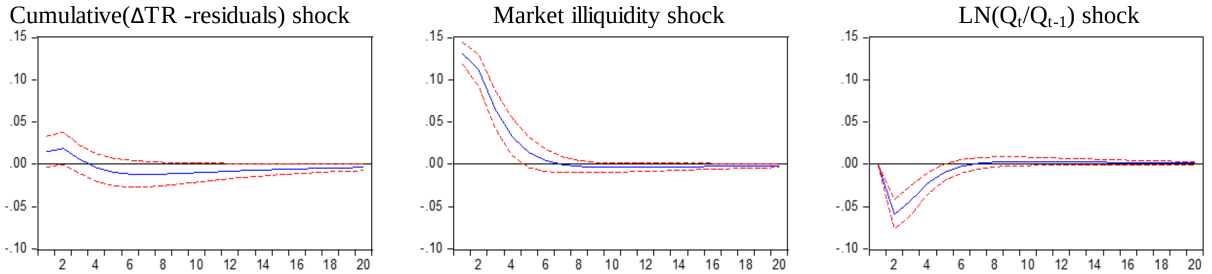
In Graph B, changes in Q-ratio levels Granger causes market illiquidity. Impact of $LN(Q_t/Q_{t-1})$ decreases market illiquidity. This finding makes sense in theory. If Q-ratio increases due to increase in market value of equities (nominator in equation (3)), market conditions are likely to be favorable in terms of stock market liquidity. However, causality stems more likely from stock market liquidity to stock market valuations. For example, Amihud (2002) reports that unexpected increase in stock market liquidity increases contemporaneous stock returns.

Figure 6: VAR impulse responses

Graph A: Response of Cumulative(ΔTR -residuals) to endogenous variables



Graph B: Response of market illiquidity to endogenous variables



Graph C: Response of LN(Q_t/Q_{t-1}) to endogenous variables

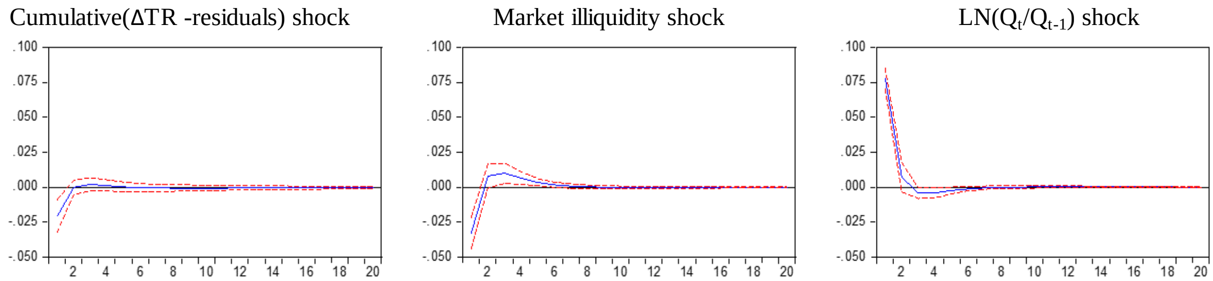


Figure shows one Cholesky standard deviation impact on endogenous variables. Dashed lines are ± 2 s.e. confidence bands. Graph A shows response of Cumulative ΔTR -residuals on innovations in endogenous variables. Graph B shows response of market illiquidity on innovations in endogenous variables. Graph C shows response of LN(Q_t/Q_{t-1}) on innovations in endogeonus variables. Cumulative(ΔTR-residual) is quarterly incremental in ΔTaylor rule -residuals, Market illiquidity is de-trended Amihud's Illiquidity -measure calculated from daily returns of NYSE/Amex stocks and made equal-weighted for every quarter, and LN(Q_t/Q_{t-1}) is logarithmic differences of changes in levels of Q-ratio. Data covers time span from 1954Q3 to 2007Q4.

7. Summary and conclusions

In this research, I study how the Federal Reserve affects valuations in U.S. financial markets through stock market liquidity from 1954 to 2007. For this purpose, I use divergence from Taylor -rule as an objective definition of expansive and restrictive monetary policy. For modeling stock market liquidity, I use Amihud's illiquidity -ratio to study the transmission of monetary policy to financial market valuations. I define financial market valuations as market-wide Tobin's Q –ratio, which measures the ratio between market value of equities and net worth of corporate liabilities.

My empirical results show that monetary policy impacts market-wide Q-ratio. However, the explanatory power is low. I then study stock market liquidity as a transmission channel of monetary policy to financial market valuations. This reveals that, when controlling for autocorrelation, loose monetary policy increases stock market liquidity. Also, the explanatory power increases considerably. In turn, stock market liquidity has large impact in financial market valuations. Standard deviation increase on stock market liquidity increases level changes in Q-ratio by 4.78%, and decreases by 4.9% in previous quarter. Effects are large compared to sample mean (1.57%), and explains 18.5% of the variation in Q-ratio levels.

Empirical findings are robust for numerous tests. Parameter stability test shows that the estimated models have robust coefficients for different time periods. Also, Granger causality -test shows that my independent variables Granger causes dependent variables. However, I find bi-directionalities between my key variables, which may result from endogeneity. In addition, I calculate impulse responses for testing whether the effects between monetary policy, stock market liquidity, and market-wide Q-ratio remain same. This test supports my findings for OLS -estimators.

My contribution to existing research is two-fold. First, divergence from optimal monetary policy affects stock market liquidity. Fernánderz-Amador et al. (2013) report that in the Eurozone, loose monetary policy impacts stock market liquidity from 1999 to 2009, and their results are consistent when measured by Taylor rule -residuals. In addition, Goyenko and Ukhov (2009) report that interest rate and changes in non-borrowed reserves impacts stock market liquidity (through bond market liquidity) in U.S. My new finding contributes their research, and confirms that these findings are robust also when using Taylor rule –residuals as a monetary policy variable.

Second new finding is that stock market liquidity affects financial market valuations, measured as market-wide Q-ratio. Schwert (1989) reports that economic recessions explain why stock markets returns are occasionally more volatile, but single factor cannot explain this. One of his result is that share trading volume growth is positively correlated with volatility of stock market returns, which supports my new finding. In addition, Næs et al. (2011) show that stock market liquidity predicts economic recessions in U.S. and Norway.

For further research, I recommend to replicate the hypotheses in this research with datasets for other economies. Also, my research can be improved by introducing alternative definitions for measuring stock market liquidity, or switching Q-ratio with volatility of stock market returns. In addition, I suggest to study bond market liquidity to test whether this explains possible endogeneity in Granger causality -test between my key variables. Another interesting extension for my research is to study, whether divergence from optimal monetary policy misplaces savings from investments in the economy, as suggested by De Soto (2006) in Austrian school of economics' perspective.

Does the Federal Reserve cause market bubbles by diverging from Taylor rule? In light of my results, it does. If it was the objective for the Fed to make financial markets less volatile, my results suggest that following Taylor rule would achieve this objective.

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Appendix A.

Table 10: Correlation matrix of additional variables

	SP500	VIX	Market value of equities	Q-ratio	$LN(Q_t/Q_{t-1})$
SP500	1.00				
VIX	0.166	1.00			
Market value of equities	0.997***	0.074	1.00		
Q-ratio	0.708***	0.214*	0.689***	1.00	
$LN(Q_t/Q_{t-1})$	0.032	0.156	0.097	0.102	1.00

Table shows correlations of additional variables, SP500 and VIX, with other variables. SP500 is the index value at the end of every quarter, VIX is the index value of implied volatility on SP500 index options at the end of every quarter, Market value of equities is line item 39 reported by the Federal Reserve Statistics Release, Q-ratio is Market value of equities divided by net worth of corporate liabilities, and changes in levels of Q-ratio is logarithmic differences in Market value of equities divided by net worth of corporate liabilities. Reported are also significance levels of correlations (* significant at 10% level, ** significant at 5% level and *** significant at 1% level). Data spans for SP500 from 1963Q4 to 2007Q4, and for VIX from 1990Q1 to 2007Q4. For other variables, data spans from 1954Q4 to 2007Q4.

Appendix B.

Table 11: Classical Linear Regression Model -assumptions

Hypothesis	H1	H2	H3	H3	H4
Model number	6	7	8	8 with control variables	9
1. $E(u_t) = 0$	Passed	Passed	Passed	Passed	Passed
2. $Var(u_t) = \sigma^2 < \infty$	Passed	Not passed	Passed	Passed	Not passed
3. $Cov(u_i, u_j) = 0$	Passed	Passed	Not passed	Passed	Passed
4. $Cov(u_t, x_t) = 0$	Passed	Passed	Not passed	Passed	Passed
5. $u_t \sim N(0,\sigma^2)$	Not passed	Not passed	Not passed	Not passed	Not passed

Table shows properties of models estimated for hypotheses. First assumption is met when there is constant in the model (average value of the errors is zero). Second assumption is passed when the variance of error term is homoscedastic (White's Test for heteroscedasticity is applied). Third assumption is that the covariance of error term is 0 for $i \neq j$ (Breusch-Godfrey test for autocorrelation is applied). Fourth assumption is met when there is no relationship between disturbance term and corresponding *x* variate (Ramsey's RESET test is applied). Fifth assumption is passed when the disturbance term is normally distributed (Bera-Jarque normality test is applied).