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Bank stock returns around FOMC announcements

Evidence from the United States and Euro Area between 2004–2022

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ABSTRACT:

The transmission of monetary policy through financial markets has been extensively discussed topic over time. Traditionally, previous studies shows that the relationship between unexpected interest rate changes and bank stock returns is inverse. However, further literature indicates that the correlation may not be ambiguously negative. This thesis examines the immediate impact of changes in interest rates on bank stock returns around FOMC announcements. More detailed, it investigates the domestic effects of adjustments in the federal funds rate on U.S. bank stocks and the international spillover effects on Euro Area bank stocks during different interest rate targeting periods between 2004–2022. The study aims to answer the question whether higher interest rates decrease bank stock returns and vice versa. Hence, it adds to the existing literature by providing the latest evidence and comparing the effects during different interest rate targeting periods of the Federal Reserve.

Motivated from the prior literature, this thesis employs the event-study method and linear regression model to empirically test the proposed hypotheses. The study covers 92 FOMC meetings where interest rate adjustments are revealed. The used event-window is one-day holding period for U.S. stocks and overnight holding period for Euro Area stocks due to time differences and the opening hours of stock exchanges. Daily returns are the dependent variable while expected and surprise interest rate components are the independent variables. Dow Jones U.S. Banks Index represents U.S. bank stocks and Euro Stoxx Banks Index Eurozone banks stocks respectively. The expected and unexpected components of the interest rate adjustments are calculated from the 30-day federal funds future contracts traded on the Chicago Mercantile Exchange which reflects market expectations about the interest rate decisions.

The results shows that 1-basis-point surprise increase (decrease) in the federal funds rate decreases (increases) U.S. bank stock returns significantly by 0,10 % and Euro Area bank stock returns by 0,022 % between 2004–2019. These findings are consistent with previous studies, asset valuation models and the efficient market hypothesis. However, the results show that U.S. bank stock returns shifts in the same direction with expected and surprise interest rate changes during the full sample period between 2004–2022. Respectively, any evidence cannot find about significant spillover effects on Euro Area bank stock returns during the full sample which includes the Covid19-crisis. These findings indicate that market turmoil periods may alter the effects of interest rates on stock returns which creates challenges for central bankers to practice effective monetary policy. Moreover, these results support the further findings that the relationship between interest rates and stock returns may not be unequivocally negative as traditionally stated.

KEYWORDS: Monetary policy, FOMC, interest rates, bank stock returns

VAASAN YLIOPISTO**Laskentatoimen ja rahoituksen yksikkö**

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ABSTRACT:

Rahapolitiikan välittymistä rahoitusmarkkinoiden kautta on tutkittu laajasti kauden aikojen. Perinteisesti aikaisemmat tutkimukset ovat osoittaneet, että odottamattomien korkopäätösten ja pankkiosakkeiden tuottojen välinen suhde on käänteinen. Uudempi kirjallisuus kuitenkin osoittaa, että korrelaatio ei välttämättä ole yksiselitteisesti negatiivinen. Tässä pro gradu -tutkielmassa tarkastellaan ohjauskoron muutosten välitöntä vaikutusta pankkiosakkeiden tuottoihin FOMC:n ilmoitusten yhteydessä. Tarkemmin se tutkii federal funds ohjauskoron muutosten kotimaisia vaikutuksia yhdysvaltalaisiin pankkiosakkeisiin ja kansainvälisiä heijastusvaikutuksia euroalueen pankkiosakkeisiin eri korkotavoitejaksoilla vuosina 2004–2022. Tutkimuksen tavoitteena on vastata kysymykseen, pienentävätkö korkeammat korot pankkien osaketuottoja ja päinvastoin. Näin ollen se täydentää olemassa olevaa kirjallisuutta tarjoamalla uutta todistusaineistoa sekä vertaamalla vaikutuksia Federal Reserven eri korkotavoitejaksoilla.

Aikaisempaan kirjallisuuteen perustuen pro gradu -tutkielmassa käytetään tapahtumatutkimusta (event study) ja lineaarista regressiomallia ehdotettujen hypoteesien empiiriseen testaamiseen. Tutkimusaineisto kattaa 92 FOMC:n kokousta, joissa korkopäätökset julkistetaan. Tutkielmassa käytetty tapahtumaikkuna on yhden päivän hallussapitoaika yhdysvaltalaisille osakkeille ja yön yli hallussapitoaika euroalueen osakkeille aikaeroista ja pörssien aukioloajoista johtuen. Päivittäinen tuotto on riippuva muuttuja, kun taas odotetut ja odottamattomat komponentit korkopäätöksissä ovat riippumattomia muuttujia. Dow Jones U.S. Banks indeksi edustaa yhdysvaltalaisia pankkiosakkeita ja Euro Stoxx Banks indeksi euroalueen pankkiosakkeita. Korkopäätösten odotetut ja odottamattomat komponentit on laskettu Chicago Mercantile Exchange kaupankäynnin kohteena olevista 30 päivän federal funds ohjauskoron futuurisopimuksista, jotka kuvaavat markkinoiden odotuksia korkopäätöksistä.

Tulokset osoittavat, että federal funds ohjauskoron 1 korkopisteen odottamaton nousu (lasku) laskee (nostaa) yhdysvaltalaisien pankkien osaketuottoa merkittävästi 0,10 % ja euroalueen pankkien osaketuottoa 0,022 % vuosina 2004–2019. Nämä havainnot ovat johdonmukaisia aikaisempien tutkimusten, osakkeiden arvonmääritysmallien sekä tehokkaiden markkinoiden hypoteesin kanssa. Tulokset kuitenkin osoittavat, että yhdysvaltalaisien pankkien osaketuotto liikkuu samaan suuntaan odotettujen ja odottamattomien korkopäätösten kanssa koko otoksen 2004–2022 aikana. Vastaavasti merkittävää näyttöä ei löydy heijastusvaikutuksista euroalueen pankkien osaketuottoihin Covid19-kriisin sisältävästä koko otoksesta. Nämä havainnot osoittavat, että markkinoiden turbulenssi voi muuttaa korkojen vaikutusta osaketuottoihin, mikä asettaa keskuspankkiireille haasteita tehokkaan rahapolitiikan harjoittamiseen. Lisäksi nämä tulokset antavat lisähavaintoja siitä, että korkojen ja osakkeiden tuoton välinen suhde ei välttämättä ole yksiselitteisesti negatiivinen, kuten perinteisesti on todettu.

AVAINSANAT: Monetary policy, FOMC, interest rates, bank stock returns

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1 Introduction

The purpose of central banks is to secure stable economic conditions and well-being in society. Central banks have monopoly authority to issue money and therefore set policy interest rates, which short-term market interest rates follow. In turn, market interest rates impact on credit availability, exchange rates, bank lending rates, and asset prices (ECB, 2023a). These channels affect economic activity and ultimately price development. This is called as the monetary policy transmission mechanism, through which the central banks aim to impact on macroeconomic variables like gross domestic product, inflation rate, employment, and overall financial stability (Ioannidis & Kontonikas, 2007, p. 33). Monetary policy implementation by central banks also defines conditions for economic growth and performance of financial markets. Higher interest rates decrease economic activity such as overall spending and investments due to the higher cost of credit and vice versa. However, the stabilization of the economic environment is not clear-cut because the effects of monetary policy are usually reflected in macroeconomic variables with a delay. This makes timing and determining the magnitude of policy actions challenging.

Monetary policy transmission and the impact of interest rates on asset prices in financial markets have been widely studied in the existing literature. Prior studies show strong evidence that the relationship between interest rates and stock returns is negative (Thorbecke, 1997; Bernanke & Kuttner, 2005). According to the studies of Madura and Schnusenberg (2000), Yin et al. (2010), and Yin and Yang (2013a), this applies similarly to bank stocks. Noteworthy, with the difference that bank stocks are more sensitive to interest rate changes due to their interest income related business models. In overall, these findings are consistent with asset valuation models, which say that higher interest rates decrease stock prices as tighter financial conditions impair companies' future cash flows and reduce their present values due to the higher discount rates (Jarocinski & Karadi, 2020, p. 2). Respectively, lower interest rates work in the opposite way. Furthermore, prior literature agrees that stock prices react only to unexpected interest

rate decisions because all available information should be already reflected in stock prices in accordance with the efficient market hypothesis.

Nevertheless, Jarocinski and Karadi (2020) argue that stock prices do not unambiguously correlate negatively with interest rates around FOMC statements. In fact, they state that stock prices correlate positively to around third of the FOMC announcements between 1990–2016. This means that stock prices shift in the same direction with interest rate adjustments. According to Jarocinski and Karadi (2020, p. 2), the negative relationship between interest rates and stock prices refers to the monetary policy shock that is caused by the surprise in the interest rate decision. Correspondingly, the positive relationship indicates to the information shock that is caused by the surprise in communication of the central bank. The authors emphasize that the surprise in communication is associated to the central bank's private information about the economic outlook. With the asymmetry of information, the central bank can use communication as an additional channel to impact on the transmission of monetary policy (Jarocinski and Karadi, 2020, p. 4).

Noteworthy, the U.S. central bank started to communicate its forecasts about the economic outlook with the interest rate decision in the Federal Open Market Committee (FOMC) statements only after 1994 (Jarocinski & Karadi, 2020, p. 5). Furthermore, the U.S. central bank started to systemically communicate the likely future path of their monetary policy since 1999 in its early variant (Rosa, 2011, p. 916). This shows that the monetary policy practices may vary over time. The 2007–2008 financial crisis also serves as a good example of that as central banks were forced to expand their monetary policy practices to unconventional tools such as Quantitative Easing (QE) because decreasing policy interest rates to zero failed to stimulate economies enough in the damaged financial environment (Joyce et al., 2012, p. 271-272). This led to a prolonged period of zero interest rate, which only ended when the U.S. central bank began raising interest rates again at the end of 2015.

1.1 Purpose of the study

The purpose of the study is to examine how changes in interest rates impact on bank stock returns around FOMC statements during different interest rate targeting periods of the U.S. central bank. Hence, it aims to answer the question whether higher interest rates decrease bank stock returns and vice versa. Understanding the relationship between interest rates and asset prices provides better knowledge for the policy makers to analyze how fluctuations in interest rates impact on real economy and thus the monetary policy implementation (Rosa, 2011, p. 915). For example, to adjust policy interest rates to curb inflation without threatening economic growth. Considering financial markets, a better understanding about this relationship provides investors valuable information in their investment decisions and portfolio management.

Considering monetary policy transmission and performance of the financial markets, investigating particularly bank stocks offers a reasonable research question as banks have a special instrumental role to transmit the monetary policy into economic behavior by acting as lending channel to households and business (Yin & Yang, 2013a, p. 1755). According to Yin et al. (2010, p. 294), bank stocks are known to be more sensitive to interest rate fluctuations than regular stocks due to their business model which relates to interest income. Therefore, having a better knowledge how bank stock prices react on interest rate changes is crucial for the central bankers as it may reflect the health of banking industry and is thus strongly connected to maintaining the financial stability.

Prior studies are focused to examine the relationship between interest rates and bank stock returns before the financial crisis. This makes sense because the crisis was followed by a prolonged period of zero interest rates until 2015, when the U.S. central bank started to increase its policy rate. Bernanke (2020, p. 963) states that despite the crisis, there is still an existing research gap between monetary policy and financial stability. Hence, it is important to investigate how interest rate changes impact on bank stock returns during different interest rate targeting periods providing new insight about the monetary policy transmission mechanisms and performance of financial markets.

1.2 Hypotheses

Prior studies agree that stock prices react negatively to changes in interest rates, and the banking sector makes no exception in this respect (Madura & Schnusenberg, 2000; Yin et al., 2010; Yin & Yang, 2013a). However, Jarocinski and Karadi (2020) argue that stock prices do not unambiguously correlate negatively with interest rates because information shocks related to the Chair's communication in press releases may disrupt the negative relationship that stock valuation models suggest. Hence, the previous literature shows somehow mixed evidence in this regard. Gürkaynak et al. (2005a, p. 18) state that the policy rate adjustment is not an independent policy tool to explain monetary policy impact on stock prices around the FOMC statements. That is because the U.S. central bank started to reveal their interest rate decisions in FOMC statements with economic outlook only after 1994, so the communication effects did not exist by the same manner before it. For example, Yin et al. (2010) examine the effects of interest rate changes on bank stock returns between 1988-2007, so their study covers the era of the central bank communication only partly. Taking these observations into account, this thesis investigates the effects considering the more recent research period 2004–2022. Hence, the first hypothesis is proposed as follows:

H1: U.S. bank stock returns correlate negatively (positively) to increase (decrease) in the federal funds rate around FOMC announcements.

Smales and Apergis (2017, p. 172) say that central banks have increasingly advanced their transparency and monetary policy predictability over time. Respectively, Joyce et al. (2012, p. 271) state that the financial crisis changed the views related to the central bank's purposes to maintain financial stability. After the crisis, the Federal Reserve has been increasingly focused to anticipate and resist the emergence of asset price bubbles which was not their main goals before, alongside the inflation rate and employment targets. In other words, there have been changes in the U.S. central bank's monetary policy compared to the pre-financial crisis periods. Bernanke (2020, p. 944) also admits that the financial crisis was a critical turning point in advanced economies which

increased clear communication and predictability of central banks. Investigating the price response of bank stocks to changes in interest rates is justified because the banking sector acts as a central credit channel for households and business and is therefore strongly linked to financial stability. To test the effects of proposed increased transparency and monetary policy predictability, this thesis contributes prior studies by examining the effects during different interest rate targeting periods 2004–2007, 2015–2019, and 2020–2022 separately and comparing the effects between the periods of pre-financial crisis and post-financial crisis. Consequently, the second hypothesis is proposed as follows:

H2: The negative relationship between interest rate changes and U.S. bank stock returns around FOMC announcements is more pronounced before the financial crisis.

Yin and Yang (2013b) show that U.S. monetary policy causes international spillover effects to global financial markets alongside the domestic U.S. stock exchanges. This relationship suggests that Euro Area bank stock returns may respond to changes in the Federal funds rate, even though the Eurozone has its own monetary rate policy framework that is managed by the European Central Bank (ECB). Due to the spillover effects, Wongswan (2009, p. 345) proposes that the U.S. monetary policy may be a risk factor for other economies. This is because changes in the U.S. policy rate can influence economic activity in the Eurozone through its financial markets. In turn, this may not serve the ECB's goals. Nevertheless, Wongswan (2009, p. 364) emphasizes that interest rate decisions explain only partly the changes in foreign stock indices. To test these effects considering the previously discussed justifications and more recent research period, the third hypothesis is proposed as follows:

H3: Euro Area bank stocks returns correlate negatively (positively) to increase (decrease) in the federal funds rate around FOMC announcements.

2 Monetary policy

Monetary policy refers to the central banks' actions to manage the money supply in economy in purpose to maintain moderate inflation, stable economic growth, and overall financial stability. The economic environment can be outlined by various macroeconomic variables such as gross domestic product, consumer price index, and employment rate to which central banks try to impact indirectly (Bernanke & Kuttner, 2005, p. 1221). Central banks can practice either contractionary or expansionary monetary policy depending on the prevailing economic situation and the aim of their actions. Contractionary monetary policy means that central bank tightens financial conditions by increasing interest rates in response to high inflation and overheated economic environment. The purpose of contractionary monetary policy is to lower economic activity such as consumption or investments through the more expensive access to credit. In other words, the central bank reduces the amount of money in circulation that makes it more expensive and increases interest rates. Households and companies use less money as higher compensation is needed to pay for the borrowed money. These effects are reflected to economic behavior and financial conditions in economy (Bernanke and Kuttner, 2005, p. 1221).

Maintaining low inflation is one of the primary goals for central banks because increasingly higher prices in products and services impair consumers' purchasing power leading to harm financial stability and well-being in economy. Even though the weaker purchasing power leads to a lower demand, inflation may not be a self-correcting phenomenon because it may spread from products and services to wages. Thus, it increases the demand and prices even more sharply. To avoid that, central banks aim to restrain inflation through increasing interest rates and decreasing consumption. The flip side of these actions is a possible contraction of economic growth and recession if the economic activity cools down too much. In fact, there can be also a situation where inflation is high, but the economic growth indicates recession. This state of economy is called as stagflation. Controlling economic conditions is not unambiguous because

economic growth and financial stability is threatened also if consumer prices start to decrease too much.

Prolonged decrease in prices is called as deflation and it leads consumers to postpone their purchase decisions as they expect the prices to be even lower in the future. This is often considered even more harmful than higher prices because it can stop the functioning of the economy. To avoid deflation or otherwise stimulate the economy in purpose to promote economic growth, the central bank can practice expansionary monetary policy. Then, it aims to increase the money supply which decreases interest rates and loosen financial conditions. However, Bodie et al. (2013, p. 564) emphasize that optimizing financial conditions is difficult because expansionary monetary policy may have positive short-term effects to investment and consumption activity, but these reflect finally again as higher prices and inflation that need contractionary monetary policy to be tackled. For example, the continued expansionary monetary policy after the financial crisis created an economic environment that, along with supply shocks in commodities such as crude oil, contributed to accelerating inflation after the Covid19-pandemic and forced central banks to switch back to contractionary monetary policy.

Financial systems consist of several financial institutions like banks, insurance companies, institutional investors, financial markets, and other financial service providers that enable economic resources to flow between different market participants (Feliz, 2021, p. 47.) Therefore, the reliable functioning of these operators is needed to ensure financial stability and economic growth. However, history has shown that financial markets tend to drift into crises time to time. When a crisis strikes, the wealth in economy declines rapidly through declining asset prices in capital markets. The fall in asset valuations can cause self-feeding problems in trust, liquidity, and maintenance of the whole financial system. This is because the limits of growth will meet at some point in the overheated economic environment leading to bursting of price bubbles. This may trigger the herd behavior where confidence in the financial markets has collapsed, and investors sell their holdings simultaneously as prices fall. Turbulence in financial markets

may cause concerns toward financial stability and bank solvency, so customers may start to collectively withdraw their deposits due on declined trust. This may cause critical liquidity problems for banks and maintenance of the financial system in overall. Finally, these effects may also extend to decrease employment and the overall well-being of society that are unwanted effects in terms of the goals of central banks.

As there can be unexpected events in capital markets that undermine the financial stability, central banks are needed to ensure that economic conditions remain under control and further consequences in the crisis events are minimized. In fact, Goodhart (1988, p. 77) states that the establishment of central banks was considered necessary in several countries from the exact need to avoid financial crises caused by the unregulated banking system of that time. In the recession that followed the financial crisis in 2007–2008, the U.S. central bank among other central banks declined their domestic policy interest rates to zero to ease financial conditions and stimulate their economies (Sims and Wu, 2021, p. 135). Joyce et al. (2012, p. 271) say that the financial crisis was a turning point in terms of central banks' monetary policy due on the crisis' strong negative effects on economic development globally. The authors say that the event changed the prevailing view that monetary policy may only be used effectively to deal with the aftermath of asset price bubbles but identifying or preventing such events is not an obvious goal of central banks besides to control inflation. In other words, the crisis emphasized the role of central banks to maintain financial stability.

2.1 Transmission channels

Monetary policy can be transmitted to the real economy through several mechanisms. When the central bank changes its policy interest rate, it has impacts most directly to short-term market interest rates. Typically, to interest rates with a maximum maturity of 1 to 2 years (Bats et al., 2023, p. 2). Higher interest rates make borrowing more expensive which reduces investment decisions of households and companies. In other words, the cost of capital increases. However, interest rates are expressed in nominal values, so they

do not consider inflation which reduces the purchasing power of money. The real interest rates are important to be separated from the nominal interest rates because even in so-called risk-free assets, which are not basically considered to be exposed to default risk, there is still a risk that inflation rate will change during the holding period (Bodie et al., 2013, p. 118). This may erase the real return of investor as the purchasing power of money erodes. For example, if the U.S. government 2-year Treasury Rate is 4 % but the inflation rate rises to 5 % in the U.S., no real interest rate on the security is received.

According to Jarocinski and Karadi (2020, p. 33), the real interest rate can be determined by the Fisher Equation as follows:

$$i_t = r_t + E_t \pi_{t+1} \quad (1)$$

The formula can be rearranged to show that the real interest rate (r_t) is the nominal interest rate (i_t) minus the expectations in the inflation rate ($E_t \pi_{t+1}$). Hence, the model says that the increase in the expected inflation should be reflected to the increase in the nominal interest rates to keep the real interest rates stable. This is because the real interest rates finally determine the level of economic activity (Bodie et al. (2013, p. 121). Formulated from the Fisher Equation, McKay et al. (2016, p. 3137) say that central banks' monetary policy is simplified guided by the real interest rate rule as follows:

$$r_t = i_t - E_t \pi_{t+1} = r_t^n + \epsilon_{t,t-j} \quad (2)$$

The rule shows that, with the error of monetary policy shocks $\epsilon_{t,t-j}$, the real interest rate follows the natural interest rate r_t^n , which means the theoretical state at which the output gap and inflation is zero, allowing the economy grow at its full potential without pressure of increasing prices (McKay et al., 2016, p. 3137). Basically, it would be ideal for the central bank to set its policy rate at the level of the natural rate, but depending on the prevailing economic environment, it will set the policy rate below or above the

natural rate to practice expansionary or contractionary monetary policy. In overall, the influence of changes in interest rates to cost of capital and thus investment decisions of companies and households is called the interest rate channel in monetary policy transmission (Endut et al., 2018, p. 962). For example, expansionary monetary policy means lower interest rates and lower cost of capital which increases domestic demand and finally expand the gross domestic product (Papadamou et al. 2015, p. 168).

Noteworthy, the economic behavior of households and business may change already based on the expectations related to the future path of the policy rate. This is because consumers adjust their investment decisions, such as purchasing a new home, to the interest rate expectations and upcoming economic environment which finally impact on price developments. In fact, McKay et al. (2016, p. 3133) emphasize that central banks' forward guidance plays increasingly important role in monetary policy because the interest rate decisions are often anticipated in financial markets. Hence, the interest rate announcement may not cause significant effects on short-term interest rates which could mean that the monetary policy transmission to real economy remains weak. However, revealing intentions about the future path of interest rates may impact long-term interest rates and thus cause impacts on economic activity. According to Bats et al. (2023, p. 2), this could be the case for interest rates with maturities range from 2 to 5 years. For example, McKay et al. (2016, p. 3134) refer to the prior study of Carlstrom et al. (2015) which say the central bank's promise to keep the interest rates below the above-described natural interest rate level for two years have significant effects on inflation. Moreover, McKay et al. (2016, p. 3134) find that forward guidance may cause significantly greater effects than adjusting the current interest rates.

Monetary policy can also affect exchange rates due to fluctuations in the flows of capital (Endut et al., 2018, p. 962). Investors allocate their funds to the country with the higher interest rates that strengthen its currency against another country's currency. Endut et al. (2018, p. 962) say that the higher value of the domestic currency reduces the country's competitiveness in the global trade because the country's products are now

more expensive for foreign countries to buy. Respectively, this increases imports from other countries because their prices are lower. This may lead to a lower domestic demand and aggregate output because goods are bought from foreign markets (Endut et al., 2018, p. 962). Changes in supply and demand in goods and labor markets may cause price pressure and be reflected to wage and price-setting (ECB, 2023a). The transition of price inflation to wage inflation is considered harmful in terms of prolonged price increases and erased purchasing power of money.

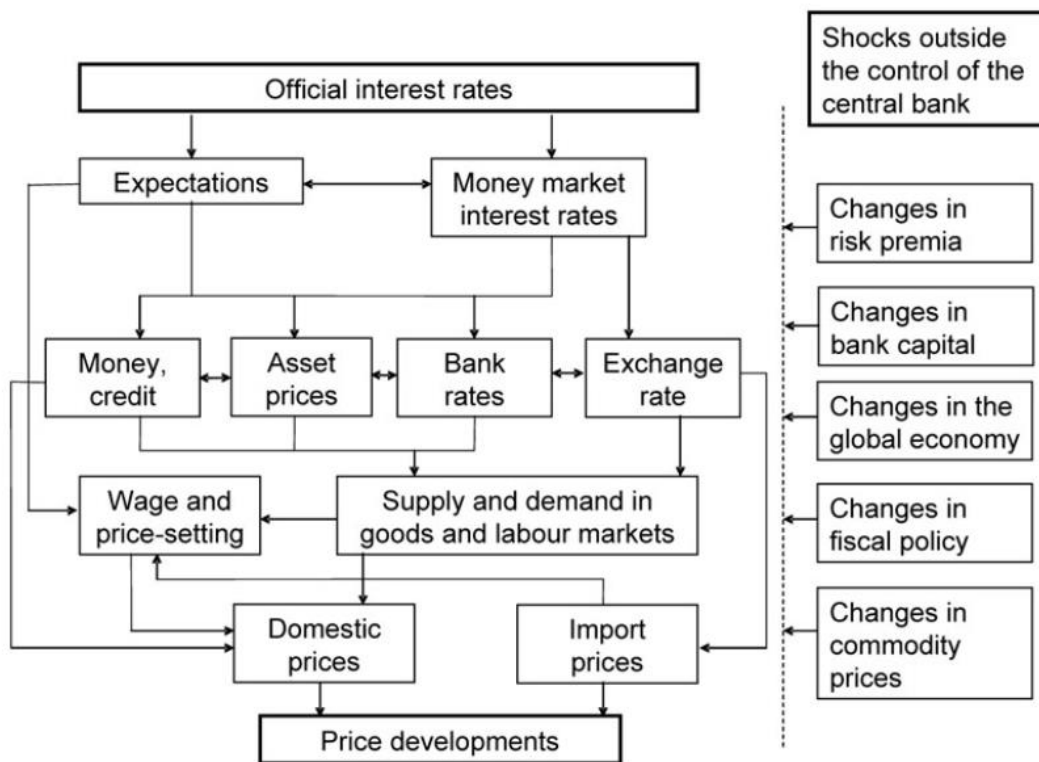


Figure 1. Monetary policy transmission channels (ECB, 2023a).

Changes in interest rates affect also to asset prices and values of private portfolios in financial markets (Bernanke & Kuttner, 2005, p. 1221). Fluctuations in asset values change consumers' net worth and the overall wealth in economy that influence to the demand of products and services. Monetary policy actions that aim to impact on consumption through financial markets is called as the wealth effect or the balance sheet channel (Ioannidis & Kontonikas, 2008, p. 33). Banks are the main sources of credit to

households and companies, so they have a particularly technical role to transmit the monetary policy into economic behavior (Bernanke & Gertler, 1995, p. 40; Yin et al., 2010, p. 289). Noteworthy, the credit supply of banks is significantly affected by monetary policy decisions (Endut et al., 2018, p. 962). This can be demonstrated through the central bank's open market operations. When the Federal Reserve decides to decrease the money supply and thus increase interest rates, it sells government securities which drains money from the banking system. This reduces banks' reserves or the amount of loanable assets which leads finally to a lower level of credit supply (Bernanke & Gertler, 1995, p. 40).

Shifts in credit supply affect to the external finance premium and leads to changes in investment activity (Endut et al., 2018, p. 962; ECB, 2023a). According to the European Central Bank (2023a), higher interest rates may be associated with higher credit risks. These concerns make banks to tighten their credit terms for business and consumer loans, which cuts the amount of loans granted by the bank and reduces investments and consumption in economy. On the other hand, English et al. (2018, p. 81) say that prolonged low interest rate environment may increase banks willingness to take more credit risk in term of reaching better profitability. The increased risk taking during lower interest rates may be realized when the central bank increases interest rates and customers credit expenses rise. This may cause credit losses for banks, which undermines the bank's financial position. In addition, higher interest rates can also prompt customers to withdraw their savings due to the need for cash or concerns about the bank's liquidity. Collective trust for banks and their lending behavior is therefore strongly related to financial stability. These effects illustrate that the interest rate channel may not solely explain the effects that monetary policy cause to economic behavior, because the credit channel may enlarge the effects of monetary policy transmission (Bernanke & Gertler, 1995, p. 34). Hence, it is crucial that policymakers are aware of how interest rates impact on the health of banks because it has influence to their lending behavior, which works as a separate monetary policy transmission channel (English et al., 2018, p. 81).

2.2 The Federal Reserve

The central bank of the United States is called as the Federal Reserve (FED), and it has a mandate to practice monetary policy in the country. Respectively, the European Central Bank (ECB) and the Bank of England (BoE) have similar mandates to practice monetary policy in their regions to name a few. The U.S. is traditionally seen as the global economic leader due the size of its economy and financial markets. The development of its economy is considered to signal the direction of economic growth in a global manner which is why the monetary policy decisions in the U.S are closely followed in foreign financial markets as well. To maintain and promote the vitality of the financial systems for the public good, the Federal Reserve has two main goals that it pursues to implement. This so-called dual mandate consists of stabilizing prices by keeping the inflation rate at two percent and maximizing employment in the economy (Lucca & Moench, 2015, p. 333).

According to Feliz (2021, p. 2), the goals of the U.S. monetary policy are ruled by the Congress, but the U.S. central bank system is otherwise independent agency and can be separated into three entities which form the express Federal Reserve. These three entities are the Board of Governors, 12 Federal Reserve Banks, and Federal Open Market Committee (FOMC). The main duties for the seven board members that form the Board of Governors are to instruct the operations of the central bank system, report for the Congress, and supervise the reserve banks. Correspondingly, the reserve banks from 12 different districts provide information and data to support monetary policy decisions because they have a great overview of the regional economic conditions. That is because they have several responsibilities such as supervise the financial institutions, provide liquidity, and participate to cover payment system services. Concretely, this information of the reserve banks is utilized in a publication called the Beige Book, which is disclosed to public before FOMC meetings.

The FOMC is the entity that makes the monetary policy decisions. It consists of 12 voting members which include all the 7 members of the Board of Governors, 4 annually rotating

presidents from the Reserve Banks, and the Chair (Feliz, 2021, p. 12). The FOMC meets eight times per year in regularly scheduled meetings, but it can also arrange additional meetings if the economic conditions require that. For example, due to the Covid19 outbreak and significant uncertainty in financial markets, the FOMC arranged two unscheduled meetings in March 2020 where it declined the interest rates in response to the crisis. Generally, the purpose of the FOMC meetings is to discuss and gather views between the different entities about the current state of the economy and its prospects to make the monetary policy decisions.

The latest data about the economic indicators and surveys from the consumer interface are used to support the decision-making process, so the committee gets a comprehensive view about the national financial conditions. However, certain significant changes in economic behavior like banks' credit standards may not be immediately incorporated in the economic data, so the central bank cannot target real-time actions to these types of demand shocks (Feliz, 2021, p. 26). Moreover, monetary policy decisions impact on economy with a lag as well, so it may take a half year or more for the effects to be noticeable in the desired economic variables. This brings challenges for the central banks to adjust the proper monetary policy decisions as the current economic conditions may not reflect yet the effects of the previous decisions. For example, the effects of higher interest rates to reduce the inflation rate.

Since April 2011, the Chair has held a press conference after the FOMC meetings. The post-FOMC meeting press conference includes review about the current state of economy, monetary policy decisions made in the meeting, and discussion about the likely path of the monetary policy in future (Pooter, 2021). Its purpose is to promote the implementation of the monetary policy actions by communicating FOMC decisions and intentions to financial markets. The communication pursuits have increased during the recent years as the Chair held a press conference after only half of the FOMC meetings between 2011 and 2018 but after every scheduled meeting since 2019 (Pooter, 2021; Lucca & Moench, 2015, p. 334). These press releases are also referred as the FOMC

announcements or statements which have started since February 1994 in their earlier forms of proceeding transcripts (Pooter, 2021). Noteworthy, before 1994, the monetary policy actions decided in the scheduled meetings were not to publicly announced but only inferable from the size of the open market operations (Lucca & Moench, 2015, p. 329). The post-FOMC meeting press releases play a significant role in monetary policy transmission because besides the actual interest rate decision, the communication in the statement reveals insight about the likely future path of future policy decisions or its defined inflation targets (Bernanke, 2020, p. 954). This new post-crisis monetary policy tool in its current form is called as the forward guidance (Bernanke, 2020, p. 954).

2.3 Policy tools

Conventional monetary policy refers to the open market operations (OMOs) which aim to impact on short-term interest rates (Stein, 2012, p. 59; Joyce et al., 2012, p. 274). The open market operations can be either purchase or sell programs of the U.S. government securities and they are implemented by the trading desk of the Federal Reserve Bank of New York (Gallo et al., 2016, p. 105). Technically, the trading desk buy or sell securities according to the FOMC instructions from U.S. banks that change the fluctuations in reserves that banks hold (Gallo et al. 2016, p. 105; Joyce et al., 2012, p. 274). Commercial banks have reserve requirements which are regulated quantity of money that they must deposit in their regional reserve banks to ensure that they have enough assets to withdraw for their clients' needs and to maintain other risk-management purposes. After meeting the reserve requirements, commercial banks can lend the excess funds overnight to other banks with balance shortages to meet the reserve requirements. Purchase programs increase the cash that banks have in their reserves which leads to the fact that they have more excess reserves that they can lend to other banks. Inversely, sell programs have opposite effects on the quantity of banks' reserves.

The cost for the overnight lending is determined based on the supply and demand related to the reserves that banks have for lend to other banks (Madura & Schnusenberg,

2000, p. 422). Due on this, the open market operations impact on the federal funds rate which is the rate that depository institutions like commercial banks use to borrow reserves to each other overnight to meet the requirements in their balances (Madura & Schnusenberg, 2000, p. 422). Noteworthy, the change in the federal funds rate is not caused by the exact quantity of reserves but the fluctuations of quantity in these reserves (Joyce et al., 2012, p. 274). The FOMC cannot directly set the federal funds rate at the desired level, so they must set it to the target range by adjusting the money supply associated with bank reserves (Madura & Schnusenberg, 2000, p. 422). The federal funds rate became the Federal Reserve's primary monetary policy tool at the end of the 80s, and it is considered as the most effective monetary policy tool for the central bank because it has the most direct impact on short-term market interest rates that finally control the economic activity (Madura & Schnusenberg, 2000, p. 422; Feliz, 2021, p. 21; Wongswan, 2009, p. 345).

The FOMC decides about the open market operations that determines the federal funds rate, but the central bank can also use two other tools to impact the demand and supply of reserves that change the federal funds rate. These alternative tools are the federal discount rate and reserve requirements, and they are controlled by the Board of Governors (The Federal Reserve, 2023a). The discount rate means the rate that depository institutions use to borrow money directly from their regional Federal Reserve Banks. This arrangement is called as the Discount Window and its purpose is to secure the financial position of depository institutions in challenging financial circumstances (The Federal Reserve, 2023b). The discount rate can be set directly at the desired level, and the level is typically higher than the exact federal funds rate in purpose to guide depository institutions lend preferably from each other than the central bank. Therefore, the discount rate is considered as the secondary credit or the final option for depository institutions to get funding.

Respectively, the Board of Governors can change the amount of reserve requirements, so the depository institutions have either more or less excess reserves for lending

purposes that change the demand and supply in balances and thus the federal funds rate. In March 2020, the Federal Reserve declined the reserve requirements to zero meaning that banks are able lend out more funds against customers deposits to transaction accounts and other deposit liabilities. In theory, zero reserve requirements increases money in circulation and have stimulating effects for economic activity. However, concretely the shifts in reserve requirements do not impact on demand of reserves as the same way it did before the financial crises as the quantity of reserves have increased significantly after it (Feliz, 2021, p. 38–39). Hence, their role has weakened among the main monetary policy tools showing that the used policy tools and their effectiveness may vary over time.

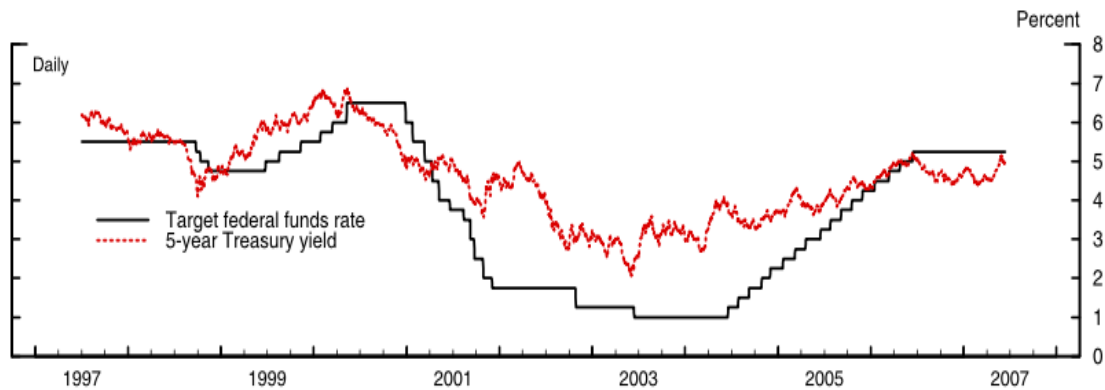


Figure 2. The federal funds rate and the 5-year U.S. Treasury yield over time (English et al. 2018, p. 83).

Figure 2 shows that market interest rates such as 5-year U.S. Treasury yield follow the federal funds rate because the policy rate is used as the benchmark for short-term interest rates in the U.S. and it also affects the whole term structure of interest rates (Afonso & Lagos, 2015, p. 263; Bodie et al., 2013, p. 565). Long-term interest rates are normally higher than short-term interest rates because the longer maturity increases the uncertainty, for example, associated with changes in interest rate and so on the risk taken. Therefore, the 5-year Treasury yield is mostly above the federal funds rate target like represented in Figure 2. However, the yield curve may also turn inverted which means that the spread between long-term interest rates and short-term interest rates is

negative. This may happen in an inflationary economic environment where investors believe that the central bank will tighten its monetary policy. Expectations about contractionary monetary policy make investors to buy increasingly bonds with longer maturity making them price to increase but lowering their yields. Respectively, short-term bonds face lower demand which increase their yields. Contractionary monetary policy decreases economic activity, so the inverted yield curve which reflects the expectations about these policy actions is historically considered a strong indicator about the economy drifting into recession.

The U.S. central bank utilizes the Taylor Rule to adjust the federal funds rate according to the development of inflation and economic growth. The policy guideline suggests that the U.S. central bank should increase (decrease) its nominal interest rate (i) if the economic growth and inflation are considered too high (low). According to Orphanides (2003, p. 986), the economic growth is measured by the output gap ($q - q^*$) which determines whether the actual GDP is above or below its full capacity. The positive output gap signals that the economic conditions are overheated and vice versa. Respectively, the inflation variant is determined whether the inflation rate measured by the output deflator exceeds or undercuts its targeted two percent level ($\pi - 2$). According to the Orphanides (2003, p. 986), the Taylor Rule can be formulated as follows:

$$i = 2 + \pi + 0.5(\pi - 2) + 0.5(q - q^*) \quad (3)$$

The real interest rate equals two in the formula, so it is similar theoretical concept to guide monetary policy decisions than the previously discussed Fisher Equation and the real interest rate rule, but the model helps to illustrate more detailed how prevailing macroeconomic variables are linked to the FOMC interest rate decisions. Similarly, the baseline for the federal funds rate is modeled to match the natural interest rate level which is the maximum economic growth without inflationary pressures (Orphanides, 2003, p. 985). However, it must be notice that the model meets its limits when it suggests negative nominal interest rates. According to Joyce et al. (2012, p. 272), this was also a

reason that led to use unconventional monetary policy tools such as Quantitative Easing in the financial crisis of 2007-2008 because the federal funds rate could not be decreased further after it was already at zero.

Joyce et al. (2012, p. 272) show that the U.S. central bank needed to take use unconventional monetary policy tools such as the Quantitative Easing (QE) to stimulate the economy in aftermath of the financial crisis because the policy rate was already set at zero, but it was not effective enough to recover economy. The QE refers to the large-scale asset purchases (LSAPs) which the U.S. central bank, for example, conducted from 2008 to 2013 in purpose to buy U.S. Treasuries or mortgage-backed securities in financial markets (Chen et al. 2012, p. 289; Joyce et al. 2012, p. 274). The extended balance sheets of central banks provide more money in circulation that decrease long-term interest rates and promote demand in mortgage markets (The Federal Reserve, 2023c). The QE is important to separate from the central bank's conventional monetary policy tools, like the open market operations, because it has been a crucial alternative part of the U.S. central bank monetary policy since the financial crisis. According to Figure 3, the Federal Reserve still practiced active monetary policy even though it kept the federal funds rate at zero until December 2015.

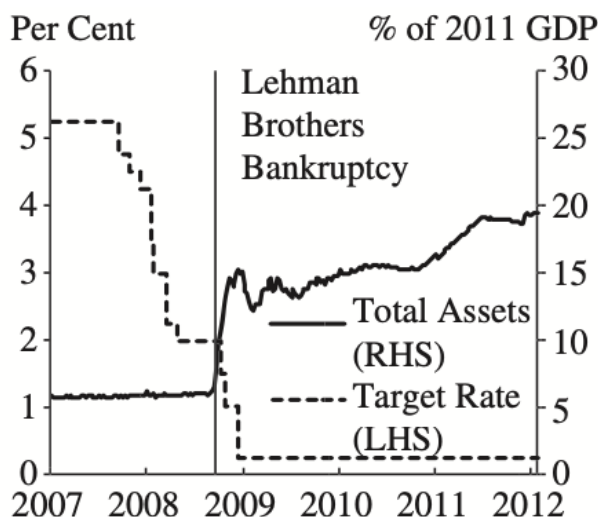


Figure 3. The federal funds rate target vs. the U.S. central bank's balance sheet (Joyce et al. 2012, p. 273).

3 Interest rates and asset prices

According to Rigobon and Sack (2004, p. 1554), the implementation of an effective monetary policy largely depends on how reliably central bankers can assess the effects of the used policy instruments on asset prices. Moreover, the authors emphasize that it is also crucial for investors perspective in terms of effective investment decisions and risk management purposes. Monetary policy of central banks has a significant influence on asset prices in financial markets, but it is expected to impact even more strongly to bank stocks than nonfinancial companies as they are more sensitive to interest rates due to their business models (Yin et al., 2010, p. 294). The following chapter covers the theoretical background of stock valuation and through which components changes in interest rates are linked to prices of stocks. Furthermore, it defines what are the special features of bank stocks and how their response to interest rate decisions may differ from regular stocks. Finally, the chapter takes a review to the market efficiency and how it is linked to asset valuation and FOMC statements.

3.1 Stock valuation

One of the features of money is that it can be invested and thus has the chance to generate additional yield. This concept is called as the Time Value of Money, and it says that a dollar is worth more to get today than tomorrow. The required rate of return means the yield that investors need as the compensation for the invested money, and it is used inversely as the discount rate when the future values are calculated in the present values (Yin & et al., 2010, p. 294). According to these key principles of finance, asset prices are the sum of the expected future cash flows discounted to the present value. The more a company is expected to generate money in the future, the higher its price is in the present moment. This applies even though these profits are not yet realized because the expectations are already incorporated to the stock price. According to Ioannidis and Kontonikas (2008, p. 36), the discounted cash flow (DCF) model is essentially a theoretical concept about the stock price (S_t) based on the conditional

estimations (E_t) of market participants about the company's future cash flows (D_{t+j}). The equation (4) also shows that stock holding period (K) and the used discount rate (R) affects to the value of the share along with the expected future cash flows.

The DCF model can be formulated as follows:

$$S_t = E_t \left[\sum_{j=1}^K \left(\frac{1}{1+R} \right)^j D_{t+j} \right] \quad (4)$$

Changes in interest rates impact on both, future cash flows and the discount rate components in the DCF model. Interest rates control financial conditions which impact on profits of companies and thus predictions about their expected future cash flows. For example, higher interest rates increase companies finance costs and makes it harder to expand their business as credit is more expensive. This leads to a lower profitability and predications related to the future earnings. Moreover, higher interest rates are often associated with the higher inflation because the central bank tries to reduce it by tightening financial conditions. Respectively, the purchasing power of customers is weaker in inflationary economic environment where prices are higher. This can lead to a lower demand in products and services, so stock prices decrease due to the lower expectations.

Interest rates also influence indirectly on discount rates through the required rate of return (Yin et al., 2010, p. 294). According to Bernanke and Kuttner (2005, p. 1223 -1224), higher interest rates reflect to higher interest costs for companies which weaker their balance sheets. Higher cost structure and uncertainty in demand leads to a higher risk related to companies' profitability. This leads to higher expected excess returns or so-called equity premiums which is the difference between holding stocks over the risk-free assets such as government bonds. Consistent with the Capital Asset Pricing Model (CAPM), higher equity premiums are linked to higher cost of equity. Finally, this means higher discount rates which lower stock prices. Hence, it can be noticed that changes in

interest rates cause typically overlapping effects on both, future cash flows and the discount rate components in asset valuation models (Ioannidis & Kontonikas, 2008, p. 33).

The discounted cash flow analysis lies to the theoretical assumptions about the company's ability to generate future earnings. This means that the expected future cash flows are not guaranteed, which is represented by the conditional estimation operator (E_t) in the model. In other words, the DCF model leaves a space for heterogenous interpretation related to the expected future net cash flows. This leads to a situation that there might be different opinions among investors how the changes in economic environment impact on companies' outlooks. According to Bernanke and Kuttner (2005, p. 1223-1224), this may make it difficult to say whether stock prices response to changes in interest rates accurately or whether there is market overreaction involved, for example, related to declining expectations in consumption and thus future earnings.

Another problematic in asset valuation takes place to the used discount rate. This is because the proper discount rate should be considered to match the risk of the investment which make it sensitive that different investors may use different risk-free rates and discount rates in their analysis. This leads finally to the different opinions in stock price analysis. Bodie et al. (2013, p. 596) suggest that the weighted average cost of capital (WACC) is often used as discount rate because it mixes the costs of equity and debt financing. Respectively, Yin et al. (2010, p. 294) say that as the discount rate can be used singly the cost of equity which can be formulated by the capital asset pricing model (CAMP).

The CAPM was first proposed by Sharpe (1964), and it shows that the expected return of individual asset depends consistently on the risk it has compared to the overall market. It means that an investor can expect higher returns only by increasing the riskiness of the investment. Therefore, the model shows a linear relationship between the expected return and systematic risk. Graphically, the model forms a linear security market line

(SML) that describes all the correctly priced securities because stocks that are above (under) the line are undervalued (overvalued) related to its risk. The systematic risk refers to a market risk that is undiversifiable, so the beta of the market is one. Correspondingly, the beta coefficient of an individual stock tells how volatile the asset is compared to the whole market and thus defines the expected returns in the model. However, the expected return on a minimum level of risk is not zero but the risk-free rate is theoretically considered to be the yield of U.S. Treasury securities which is suitable for the stock in question (Yin et al., 2010, p. 294). For example, the yield of U.S. 1-month Treasury bill for U.S. stocks (Bernanke & Kuttner, 2005, p. 1245). Nevertheless, as a risk-free rate can be used Treasury securities with different maturities and yield rates that may lead to different estimations. Yin et al. (2010, p. 294) state that also long-term U.S. Treasury bonds are strongly positively correlated with the federal funds rates and thus the required rate of return.

The CAPM can be formulated as follows:

$$ER_i = R_f + \beta_i(ER_m - R_f) \quad (5)$$

Where:

ER_i = *Expected return of the asset i*

R_f = *Risk – free rate*

β_i = *Beta of the asset i*

$(ER_m - R_f)$ = *Market risk premium*

According to Yin et al. (2010, p. 292), the future cash flows that represent the stock value can be associated with the dividends that the firm pays for its shareholders. Therefore, the more straightforward way to value shares is the dividend discount model (DDM).

The DDM can be formulated as follows:

$$P_0 = \frac{D}{(1+r)} + \frac{D}{(1+r)^2} + \dots + \frac{D}{(1+r)^\infty} = \frac{D}{r} \quad (6)$$

The DDM is based on the future dividend payments discounted to the present value. Essentially, the price of a security (P_0) is determined by the fact that the required rate of return (r) can be achieved. It is done by dividing the expected dividend payment (D) by the discount rate which is the required rate of return. In the formula, increase in the expected return decreases the price of a security and vice versa. Respectively, change in the dividend payment has similar effects to the stock value.

3.2 Bank stocks features

Banks' cash flows are more directly linked to interest rates than those of other stocks. The reason is that banks' primary source of income is the difference between interest rate charged on loans and interest rate paid on deposits. That makes banks particularly responsive to monetary policy announcements as their earnings are more sensitive to changes in interest rates (Yin & Yang, 2013, p. 1755; Ghazanfari & Rogers, 2006, p. 350). According to Yin et al. (2010, p. 292), interest income and interest expenses are both correlated strongly with policy interest rates. Higher interest rates lead to higher interest income because granted loans and mortgages are tied to market interest rates that follows the federal funds rate target. In theory, interest expenses should increase simultaneously with interest income as higher interest rates increase deposit rates in saving accounts and other borrowed funds (Yin et al., 2010, p. 292).

De facto, English et al. (2018, p. 86) say that interest rates paid on so-called retail deposits follow quite slowly market interest rates. In fact, they might not be tied to any market interest rates at all. However, banks may have to raise their interest rates on deposit accounts in response to higher policy interest rates because they must compete for customers and funding with other banks. Naturally, customer deposits flow into high-interest deposit accounts. According to English et al. (2018, p. 18), banks get higher

earnings when the spread between short-term and long-term interest rates is large which means that the yield curve is steep. Banks benefit from this because customers' deposits are the funds that banks borrow at lower short-term interest rates and they use these funds to issue loans at higher long-term interest rates, profiting from the maturity transformation (English et al., 2018, p. 18).

The difference between maturities in banks' assets and liabilities impact on how sensitive the bank is to changes in interest rates (Ghazanfari et al., 2016, p. 349). For example, asset-sensitive banks have more repriced short-term assets than liabilities, so their interest margin benefits for higher interest rates (Yin et al., 2010, p. 292). This shows that depending on the mismatch in maturities, changes in interest rates may cause uneven effects to interest income and expenses that may change banks earnings and impact on their stock valuation (Ghazanfari et al., 2016, p. 349). Nevertheless, English et al. (2018, p. 82) show evidence that even though banks' net interest margins benefit from a steep yield curve and higher interest rates, these effects may increase banks returns only during the first few quarters. The author adds that the benefits start to fade and flip significantly negative after a year as customers start to shift their low-interest deposits like core deposits, which covers demand, transaction, and savings deposits, to instruments with higher compensation like certificates of deposit (CDs). English et al. (2018, p. 95) say that this is consistent with the classic monetary theory. Opportunity costs increase in low interest rate deposits because higher market interest rates offer more profitable alternative sources. The authors also say that the outflow of core deposit to managed liabilities changes the structure of a bank's balance-sheet and increase its costs. Moreover, higher interest rates are often a response to inflation pressures which strain banks noninterest expenses such as operating and personnel costs (Yin et al., 2010, p. 292).

Banks can also use alternative wholesale funding if the primary sources of liability funding like core deposits are insufficient (Yin & Yang, 2013a, p. 1757-1758). Federal funds market is one of these sources and it means that the spot rate of these borrowings

is directly linked to changes in the federal funds rate. This makes the wholesale funding more sensitive to the FOMC interest rate decisions. According to Yin and Yang (2013a, p. 1757) larger banks typically finance their loan portfolios from the federal funds market with a higher degree compared to smaller banks. The high correlation between the bank size and purchases from the federal funds market means that changes in the central bank's policy rate impact more directly to the cost of capital of large banks, making them more sensitive to interest rate changes (Yin & Yang, 2013a, p. 1757).

Noteworthy, the existing literature documents that this works inversely in non-financial companies where large companies are considered less sensitive to changes in interest rates due to the better collateralized compared to small nonfinancial peers (Thorbecke, 1997). The loan portfolios of large banks contain more alternative short-term loans from the money market compared to small banks. The Federal Deposit Insurance Corporation (FDIC) protects bank deposits such as core deposits up to the 250 000 U.S. dollars, but the federal deposit insurance does not cover borrowings from the money market such as the wholesale funding. Hence, banks that rely on more non-deposit funding are more responsive to interest rate risk because fund providers without the deposit insurance may withdraw their deposits more sensitive in response to concerns related to credit risk and bank solvency (Yin & Yang, 2013a, p. 1758). This also shows that banks may react heterogeneously to interest rate changes based on their different characteristics.

English et al. (2018, p. 81) say that higher interest rates lower the values of banks' long-term assets, such as bonds or other securities, that can cause capital losses. This may fade out the short run benefits of higher interest rates in increasing interest income. However, lower bonds' market values may not be necessarily a problem for the bank unless the bonds are needed to be sold before the maturity date. This can be the case in the so-called bank-run where the clients' withdrawals may cause liquidity problems for the bank, so it needs to get more liquid assets by selling the bonds at decreased market values. Typically, these investments are held until maturity, so the bank gets back the bond's face value. If the bonds are recorded on the balance sheet at face value, selling

the bonds at reduced market values causes capital losses, to which investors react by pricing the bank's shares at a lower price. This is an example how interest rate risk may be realized. Oppositely, lower interest rates increase the values of securities that banks have. This is positive for the bank's balance sheet, but also for the fact that the securities in question can be held as collateral for loans. When their value increases, it can make it easier for the bank to access credit with better loan terms. This enables the bank to increase its credit granting, so actually a decrease in interest rates can be a positive thing for the bank.

However, Ghazanfari et al. (2016, p. 349) say that changes in interest rates have uneven impacts on the market values of assets and liabilities with different maturities because longer maturities are more sensitive. For example, long-term bonds have more coupon payments remaining making them riskier because there is more uncertainty associated with them. As these coupon payments are discounted to the present value based on the interest rates formulated on discount rates, the market values of long-term bonds are affected more strongly compared to short-term bonds. If the bank has a lot of bonds in its assets, the above-mentioned changes may reflect to the bank's overall book- and market value. English et al. (2018, p. 96) summarize that banks may benefit for higher interest rates and a steeper yield curve only transitory, but they eventually lead to decreased future cash flows, and together with higher discount rates, lower bank equity values.

The loan demand of banks may explain also partly the lower profits associated with higher interest rates. However, Yin et al. (2010, p. 294) say that the relationship between interest rates and loan demand is not straightforward because the effects may depend on the type of granted loan. The customer segments of commercial banks can be roughly divided to personal customers, small and medium-size enterprises (SMEs), and large corporates and institutions (LC&I). Respectively, commercial banks' loan demand is composed to consumer-, mortgage-, and business loans. Yin et al. (2010, p. 294) say that changes in short-term interest rates have only minor impacts on consumer loan demand.

These type of loans are typically taken to cover certain everyday purchases which may explain why the effects are not so significant. Respectively, mortgages and real estate loan demand correlate negatively to changes in interest rates. These loans are typically tied to certain long-term like 30-years fixed rate in the United States, but the effects can be explained as higher short-term interest rates reflect expectations which in turn increases long-term interest rates (Yin et al., 2010, p. 293).

Noteworthy, Yin et al. (2010, p. 294) say that the demand for commercial and industrial (C&I) business loans correlate positively with interest rates. They emphasize that central banks raise interest rates to moderate inflation caused by an overheating economy. However, the mitigating effects of tighter financial conditions may affect to the demand with a lag, so companies must invest in expanding their operations due to high demand for their products and services. This requires companies to finance their operations despite higher interest rates which means that the loan demand of banks still increases. Noteworthy, Yin et al. (2010, p. 293-294) say that most of the loans granted by the U.S. banks are real estate loans rather than C&I loans, so higher interest rates lower bank profits through declined loan demand in overall. Respectively, Ampudia et al. (2022, p. 50) say that lower interest rates may increase the loan demand for banks because they lower funding expenses of households and business. This reduces credit risks due to customers not being able to repay their loans due to tight financial conditions. Lower credit risk helps banks get credit more easily with the lower financing costs. Investors, on the other hand, see the reduction of risks related to the bank's operations as a positive thing that can increase the value of its shares.

3.3 The efficient market hypothesis

The primary role of financial markets is to allocate the economy's capital resources between different market participants. It is driven by supply and demand causing assets to flow between financially surplus and deficit counterparties. According to Fama (1970, p. 383), this purpose is implemented efficiently if the market participants like

corporations and investors can consider their investment decisions on the basis that all the available information is always reflected in the prices of securities. The market which has an active competition among large group of rational investors, who tries to maximize their profits by utilizing freely available information, leads to a situation where the market can be called efficient (Fama, 1995, p. 76).

Fama introduced the Efficient Market Hypothesis (EMH) in 1970 which can be seen one of the most essential theories in finance as it revealed a new insight to explain the behavior of security prices (Ball, 2009, p. 10). The theory says that due on the competition of investors, the information which is available in the markets reflects instantaneously to the prices of stocks (Fama, 1970, p.386; Bodie et al. 2021, p. 332). Hence, only new information, which must be unexpected, can change the stock prices. Bodie et al. (2021, p. 332) illustrate this by saying that investors do not wait until tomorrow to take advantage of information about an undervalued stock, so their trading corrects the price to the fair level. As information must be unexpected to cause the price reaction, stock price changes must also be unexpected and follow the so-called random walk model (Fama, 1970, p. 386; Bodie et al. 2021, p. 332).

The Efficient Market Hypothesis was partly motivated by the pioneering evidence of Kendall (1953) who showed observations about the role of information in the capital markets. He suggested that against the common believe, the series of stock prices do not seem to follow any systematical patterns but rather wandering randomly. This early-stage evidence about the random walk model leads to a conclusions that the future prices cannot be predicted by using the historical trends of price series as the consecutive price changes are independent from each other (Kendall, 1953). This notion was also agreed by Fama (1970, p. 387) as he states that no excess returns can be achieved by using any trading strategy related to historical information.

Besides the observation of independency, Fama (1970, p. 386) shows that the series of stock prices have also an identical probability distribution. Basically, it means that the

price change can move in both directions but the probabilities for these events are equal. Based on this notion, the best prediction for the future price is the current price (Fama, 1970, p. 386). However, this does not mean that good news can cause randomly either negative or positive price reaction, but it emphasizes that the actual news can be as probably good or bad. Noteworthy, as the competition makes the prices to reflect all the available information at any time, the actual prices can reflect both already realized and anticipated events because capital markets try to see forward (Fama, 1995, p. 76).

Fama (1970, p. 387) refers to three different market conditions that should be conceptually sufficient to make the theory of the market efficiency hold true. He proposes that there are no transaction costs involved in trading, all information is available for all investors free of charges, and all the market participants share the common opinion how the information impacts on the current and expected prices of securities in the markets. However, he grants that all the above-mentioned conditions may not be fully implemented in practice, but it is not an indication of the market inefficiency. This is a crucial conception to understand the market efficiency correctly. For example, what does not EMH states is that the market is inefficient if a single investor can beat the market equilibrium and gain excess returns (Ball, 2009, p. 10).

More detailed, the market efficiency means essentially that, on average, it is as probable for investors to beat the market than lose to the market. Respectively, stock prices can be either over- or underpriced related to its intrinsic value but both scenarios are equally probable as the prices fully reflect the information that is available in the markets. That is why Fama (1970, p. 388) emphasizes that different opinions among investors do not make the theory fallacious, but there cannot be investors that are able to consistently predict the prices better and beat the market if the theory holds true.

3.3.1 Three forms of the market efficiency

To determine the market efficiency more detailed, Fama (1970, p. 383) distinguish the market efficiency to three different degrees based on the information they include. These following levels are weak form, semi-strong form, and strong form. The weak form covers only historic price data, and it echoes the previously discussed notion of the random walk model. Because the price series of securities are supposed to be independent and acting randomly, the historic price behavior does not indicate any information about the development of the future price changes. The weak form tests include previous information such as trading volume and different price patterns which the technical analysis focus to utilizes predicting stock price behavior (Fama, 1970, p. 388).

The second degree of the market efficiency is the semi-strong form which states that stock prices fully reflect all the publicly available information in the present moment, so it is more robust way to test whether the market efficiency applies. According to Fama (1970), the semi-strong form includes public information such as stock splits or earnings announcements which are immediately reflected in share prices. Hence, the semi-strong form argues against the fundamental analysis because it evaluates based on the public information the securities fundamental values, towards which the market prices should move (Fama, 1995, p. 75). Therefore, the fundamental analysis can be interpreted as predicting the development of the share price, so it is also against the weak-form degree and the random walk which are included in semi-strong form (Fama, 1995, p. 75).

Correspondingly, the strong form tests consider whether there is any inside information among certain groups or investors that can be utilized to gain excess returns in the markets. In other words, the strong form focuses to investigate the impact of asymmetric information on the market efficiency. Fama (1970, p. 414) describes that the strictest form is more a theoretical illustration to show the meaningful of market efficiency rather than a principle that would be conducted flawlessly in the real world. A monopoly access to information distorts the competition leading to a situation where the stock prices

does not reflect all the information because it is not available to all market participants. Hence, the economy's total benefit suffer as the resources are not allocated efficiently (Bodie et al., 2021, p. 341).

3.3.2 Market efficiency and interest rate announcements

The FOMC interest rate decisions reveal important insight for investors about larger guidelines for economic development in the future which are linked to the prospects of companies' profits and finally stock valuations. Due to this, rational investors try to predict future interest rate decisions by relating current macroeconomic data like inflation rate to the Federal Reserve's communication around the periods between the scheduled announcement days (Madura & Schnusenberg, 2000, p. 424). Financial markets form a consensus about the expected interest rate decision utilizing available information and value stocks based on it before the actual interest rate announcement. The private sector spends numerous resources to forecast the FOMC decisions which highlights the significance of U.S. monetary policy for financial markets (Wongswan, 2009, p. 344). This is consistent with the idea of the efficient market hypothesis because prices should reflect all available information even though it is just anticipated but not yet occurred. Hence, there should be a reaction in stock prices to the Federal reserve's interest rate decision only if the decision is a surprise and thus discloses new information. For example, Yin et al. (2010, p. 289) show supporting evidence for the efficient market hypothesis by stating that bank stock prices respond only to surprises in the interest rate announcements.

However, Romer and Romer (2000, p. 455) find evidence about information asymmetry stating that due on the position of monetary authority, the Federal Reserve has more information to evaluate the development of economy indicators like inflation which is not available for the market participants. Romer and Romer (2000, p. 455) emphasize that the Federal Reserve's additional information affects to its interest rate decisions which may cause a difference against the consensus of market participants. Hence, the

possible asymmetrical information may influence that financial markets do not have all the existing information at their disposal, so the final interest rate announcement comes as a surprise for them. Eventually, leading to changes in asset prices when it occurs. This can be seen as problematic regarding the strongest level of the efficient market hypothesis which includes the fact that there should be no inside information. Even though the Federal Reserve is not a market participant who competes about stock returns with investors, they still have interests to affect asset prices in terms of monetary policy transmission. Utilizing additional information impact that asset prices do not reflect all the information available. Hence, the market is not working as efficiently as it could. This raises the transparency of the Federal Reserve into an essential role when speaking about the relationship between market efficiency and interest rate decisions.

According to Smales and Apergis (2017, p. 172), central banks have focused increasingly to advance transparency and predictability in their operations as these factors are seen to be key conditions to practice effective and credible monetary policy. Although the central banks do not aim to surprise the financial markets, it does not mean that the interest rate decisions always meet the market expectations. Besides the surprise which may cause from the actual interest rate decision, Smales and Apergis (2017, p. 172) consider another factor which may impact on the market reaction and implementation of the central bank's monetary policy. They highlight that the Chair's press release or so-called FOMC statement also have an impact via used rhetoric in communication. This is because it provides indications of how the central bank sees the development of economy in the future and it impacts on the expected future earnings of companies. As rational investors consider their investment decisions by looking to the future, they analyze closely whether the future monetary policy actions can be deduced based on the communication in the FOMC statement.

Wongswan (2009, p. 345) emphasize that financial markets may face surprises related to the central bank's monetary policy also in terms of central bankers' speeches or other remarks outside of the FOMC statements. These effects are harder to capture based on

their variety, but it may highlight the sensitivity and relative complexity of monetary policy communication. Noteworthy, no indications related to the likely path of the FOMC's monetary policy actions can be made by central bankers during the blackout period that is one week before the scheduled FOMC meeting (Lucca & Moench, 2015, p. 335). However, despite the efforts toward transparency and predictability, it is still difficult to predict future, so the central bank also must be careful in its statements to maintain credibility. For that reason, investors may have to partially interpret the central bank's communication between the lines which may lead to mixed interpretations among investors. Partly, the drive for greater transparency has made the announcements more complex, length, and difficult to interpret (Smales & Apergis, 2017, p. 172). Therefore, a clear communication plays a crucial role how the financial markets react to the announcement as ambiguity leads to heterogeneous opinions between investors which increase uncertainty in the markets and may damage the market efficiency (Smales & Apergis, 2017b, p. 339).

4 Literature review

The research around the relationship between interest rates and bank stock returns has evolved from a general explanation of the effects of interest rates, to distinguishing the components of expected and surprise changes, and to considering the difference between the actual interest rate decision and the communication in the FOMC statement. Considering this, the next chapter introduces first the existing literature related to interest rate impact on bank stock returns in overall. Then, the chapter delves deeper into presenting the findings of prior literature regarding the effects of the surprise component. Finally, the spillover effects of U.S. monetary policy to foreign markets are discussed.

4.1 Interest rates impact on bank stock returns

Madura and Schnusenberg (2000, p. 424) refer to earlier studies of Born and Moser (1990), Kohers and Nagy (1991), and Mansur and Elenysiani (1995) who show strong evidence that the relationship between interest rates and bank stock prices is negative. These studies focus to investigate the impact of the federal discount rate or market interest rates on bank stock prices. In fact, Booth and Officer (1985) show early evidence from the years 1966–1980 that changes in market interest rates impact more strongly on banks stock prices compared to nonfinancial securities. This can be explained by the fact that banks' income is more closely linked to interest rates than other stocks because the main source of income for banks is the spread between interest charged on loans and interest paid on deposits. Although the previous literature captures widely the inverse relationship between interest rates and bank stock returns, no study focuses to the federal funds rate in this area. Hence, Madura and Schnusenberg (2000) extend these studies by examining the first how bank stock prices response to the changes in the federal funds rate. That is, whether the decisions reveal new information which changes bank stock prices, or whether interest rate decisions can be accurately predicted

in advance. This would mean that bank stock prices reflect this information in advance according to the efficient market hypothesis.

Madura and Schnusenberg (2000) find that, without considering the direction of the change in the federal funds rate, the relationship between the federal funds rate and bank stock returns is significantly negative. It means that 1 percentage point change in the federal funds rate leads to a 0,81 % inverse change in commercial banks returns during the years 1974-1979, and to a 0,62 % inverse change during the years 1987-1996. These results show that the FOMC interest rate decisions have effects on bank stocks in the U.S. financial markets. In other words, the price reactions indicate that the FOMC announcements reveal new information despite the market participants efforts to predict the interest rate decisions in advance (Madura & Schnusenberg (2000, p. 446). The authors refer to the previous research of Thorbecke (1997) who shows that the relationship between interest rates and returns of general stock market is negative. Similarly, they find a strong positive correlation between the returns of commercial banks and the S&P 500 index. Hence, they suggest that bank stock prices may response negatively to the interest rates because they co-move strongly with the general stock market performance.

More detailed, the authors find that the direction of the interest rate decision causes asymmetrical effects on bank stock prices. It means that reductions in the policy interest rate increase bank stock returns significantly, but hikes do not have significant effects to decrease prices. They suggest as an explanation for the asymmetrical results that the loan demand may increase more when the interest rates decrease than it decreases when the interest rates increase. In addition, banks may lower their deposit rates faster than lending rates during the interest rates reductions that improve their profit margins and increase stock valuations (Madura & Schnusenberg (2000, p. 437). However, the authors do not explain in more detail the relationship between banks' interest income and loan demand. For example, can higher interest rates increase interest income enough to improve returns despite the decrease in loan demand.

4.2 Surprise component

The pioneering study of Madura and Schnusenberg (2000) do not measure the market expectations in the interest rate decisions but rather show that FOMC statements reveal new information because interest rate decisions cause response in bank stock prices. The authors cannot fully show whether bank stocks react only to unexpected interest rate decisions or whether the expected announcements cause price reactions as well. Nevertheless, they recognize the surprise component by stating that according to the market efficiency, there should not be a significant reaction in stock prices if the interest rate decision meets the market expectations. This is because information or expectations about the interest rate change would already be incorporated in stock prices. The authors note that ignoring the element of the surprise component may bias the results, as fully expected decisions may weaken the observed impact of FOMC announcements on bank stock prices in the overall sample. In other words, the effects of interest rate decisions that are surprises.

To tackle this issue, Bernanke and Kuttner (2005, p. 1226) determine the surprise component by the difference between the actual interest rate decision and the 30-day federal funds future rate which reflects market expectations. The authors find that 1-basis-point surprise interest rate change shifts value-weighted CRSP equity index returns by 0,0468 % in the opposite direction between 1989-2002. Moreover, the authors suggest that the price reaction is mainly due to changes in future dividend expectations, not in the real interest rates. Similarly, Yin et al. (2010) examine the relationship between interest rates and stock prices but focus on the banking sector between 1988 and 2007. The authors find that 1-basis-point surprise causes 0,04 % change in the opposite direction in the daily returns of bank stocks. Moreover, they show that bank stock returns react more sensitive to interest rate adjustments with a new policy direction. However, Yin et al. (2010) say that the magnitude of the surprise change does not impact on the price reaction, so hypothetical 50-basis-points or 25-basis-points surprises cause relatively equal effects.

In accordance with Bernanke and Kuttner (2005), the authors show that bank stock returns do not react differently to the surprises of negative or positive interest rate adjustments. These results are controversial to the evidence of Madura and Schnusenberg (2000) who document that the direction of the policy rate change matters. Furthermore, Chuliá et al. (2010, p. 839) report that 1-basis-point surprise adjustment in the federal funds rate change daily stock returns by 0,0722 % in the opposite direction and similarly by 0,0458 % if measured by 5-min scope. The authors state that the price response is asymmetrical which means that the magnitude depends on whether the monetary policy surprise is positive or negative. The authors say that the difference in results compared to Bernanke and Kuttner (2005) can be explained by the more accurate intraday data instead of daily stock returns. Therefore, these prior studies with different research periods and approaches show somewhat mixed results in this regard.

Rosa (2011, p. 916) support these results by saying that surprises in interest rate decision have statistically significant impacts on general stock prices. The results are consistent with the study of Yin et al. (2010) as they show that a hypothetical unexpected 25-basis-points cut in the interest rates increases general stocks prices by around 1 %. Rosa (2011, p. 916) shows that securities react instantaneously to the monetary policy shocks and after 1 hour all the new information is incorporated to the asset prices. Based on this observation, the author emphasizes the meaning of high-frequency data which help to capture the rawer effects of the FOMC announcements to stock prices than examining the effects using daily returns. This is because one-day holding period may involve also other events or news that are separate from the FOMC statement but may impact on stocks prices.

The study points out the significance of the Chair's communication regarding the U.S. central bank's future monetary policy. Rosa (2011) defines that the FOMC's communication about future monetary policy can be divided into three styles based on the rhetoric used in the press release. If the communication indicates that the monetary policy will be tighter in the future, the FOMC statement can be considered hawkish.

Oppositely, the signs to ease the current monetary policy can be considered dovish statement (Rosa, 2011, p. 916). It is noteworthy that keeping monetary policy neutral is also a decision that may cause surprise among market participants if they expected the federal funds rate to change.

Jarocinski and Karadi (2020, p. 2) support these observations by separating the effects of FOMC statements to monetary policy shocks and information shocks when examining the U.S. monetary policy between 1990–2016. The authors show evidence that the central bank has more accurate information about the economic outlook than public sources and it reveals the private information through the communication in FOMC statements in purpose to impact on economic behavior. Jarocinski and Karadi (2020, p. 30) say that the U.S. central bank have access to information advantage as they work closely with various financial intermediaries while being their supervisors. Consistent with similar findings of Romer and Romer (2000), information advantage leads to a situation where the central bank can forecast economic outlook better than the private sector. Moreover, Jarocinski and Karadi (2020, p. 5) argue that statements with updated insight about economic outlook reveal that the Federal Reserve has an information advantage which it can use through communication as a separate channel to practice monetary policy besides the actual interest rate changes in the press releases.

Based on these observations, the authors say that traditional predictions that increase (decrease) in interest rates decreases (increases) stock prices around the FOMC statements may not be as unambiguous. For example, they show that the FOMC cut interests rates 50-basis-points in March 2001, and it was more than the market expected. According to asset pricing theory, the surprise should have led to an increase in asset prices, but the S&P 500 stock index still ended up decreasing. Jarocinski and Karadi (2020, p.2) say that alongside the actual interest rate decisions, the press release included policy makers pessimistic communication about the economic development which led finally to a decrease in broad stock market despite the good news related to the interest rate cut. The authors suggest that negative correlation between stock prices and the

change in the federal funds rate is a sign of the actual interest rate surprise or so-called monetary policy shock. The negative relationship follows traditional asset pricing models which show that higher interest rates decrease stock prices and vice versa. However, when stock prices move in the same direction with the interest rate decision, it is caused by the communication or so-called information shock. This indicates that the FOMC future monetary policy or economic outlook do not follow the market expectations which makes investors revisit their investments decisions.

4.3 The spillover effects

The European Central Bank (ECB) is the institution that determines the policy rate in the Euro Area, and it is used as the benchmark for market interest rates in that region. Economic conditions such as inflation can vary between countries, so it is important for central banks to manage interest rates in their own regions to restrain or stimulate the economy. However, Wongswan (2009) says that there is significant evidence that Eurozone and other foreign stock market indexes respond to surprises in FOMC announcements alongside the domestic effects in the U.S. The author explains that changes in the federal funds rate by the FOMC impact global market interest rates and therefore change eventually the discount rates for Eurozone stocks as well. Financial markets partly transmit monetary policy actions into economic behavior, so U.S. monetary policy may be a risk factor for foreign economies as it has a strong impact on foreign financial markets, and it may cause undesirable effects through it to economies of foreign countries (Wongswan, 2009, p. 344). For example, the ECB may decide to keep its interest rate decision neutral despite the inflation concerns because certain economies in Eurozone may not withstand higher interest rates and tighter financial conditions. Nevertheless, the U.S. central bank may simultaneously decide to increase its policy rate which may be reflected to market interest rates in Euro Area. Eventually, this may be contrary to what the ECB is aiming for.

These type of financial linkages between different countries are referred as the spillover effects which means that seemingly unrelated events in one country extends to impact on the economy of other country as well. The 2007–2008 financial crisis is a good example of the spillover effects as it shows how the subprime loan crisis in the U.S. extended to worldwide and caused economic crises in several other countries as well. This is due to increased globalization in financial activities and cross-border trade that have made the economies more sensitive to each other. Moreover, Elyasiani and Mansur (2003, p. 304) say that the international banking system risk and the interdependence have likely increased with regulation collaboration between the central banks. Wongswan (2009, p. 360) shows that countries that are more connected to global financial markets react more sensitively to U.S. monetary policy announcements.

The author show that the spillover effects are significant in Euro Area, but only stock indexes in Hong Kong and Korea react more strongly to U.S. monetary policy shocks than the S&P 500 index between 1998-2004. For example, the author finds that 1-basis-point change in the federal funds rate shifts the France's CAC 40 index by 0,051 % and the Korea Composite index by 0,0978 % in the opposite direction measured by the overnight returns. Respectively, the domestic effects in the S&P 500 index futures are 0,0715 % in the opposite direction. These results mean that the impacts of U.S. monetary policy on stock returns remain still stronger in the U.S. than in Eurozone on average. Despite the significant spillover effects from the U.S. to European financial markets, Wongswan (2009, p. 364) reminds that U.S monetary policy and surprises around the FOMC statements determine only partly the returns in foreign financial markets.

Brusa et al. (2020, p. 264-265) find evidence that the Federal Reserve has a strong impact on nearly all global stock markets besides the domestic one and can be safely called the leading central bank to determine monetary policy globally. Brusa et al. (2020) do not find that other major central banks, such as ECB, would have similar domestic or spillover effects on foreign stock markets compared to U.S. monetary policy. The authors say that uncertainty around the FOMC press releases increases risk premiums required by

investors and leads to significantly higher stock returns consistent with the CAPM. These results highlight the fact that alongside the size of the U.S. economy and its financial markets, U.S. monetary policy has a stronger impact on global financial systems than others which makes it particularly important for investors globally (Brusa et al., 2020, p. 302). For example, the United States dollar plays the most important role in global trade and unlike other central banks, the Federal Reserve does not need to control the dollar against any foreign currencies. These observations match to the previously discussed study by Wongswan (2009, p, 357) which shows that the Hong Kong stock exchange has the strongest response to U.S. monetary policy since its policy rate moves directly by the federal funds rate target.

Kim et al. (2013) study the international spillover effects and how listed commercial banks in German response to the Federal Reserve's interest rate decisions between 1995-2009. Respectively, they compare whether the ECB causes similar cross-border effects to U.S. financial markets and how domestic bank stocks response to the own country's interest rates decisions. First, the Kim et al. (2013) find that the U.S. central bank's unexpected interest rate decisions have a significant inverse impact on U.S. bank stock returns which is consistent with the previous literature. Respectively, the ECB interest rate decisions have only weak effect on German bank stock prices, which may be explained by the prior findings that the ECB is more efficient and transparent in implementing its monetary policy, making the decisions more predictable (Kim et al., 2013, p. 15-17; Bohl et al., 2008). Second, the authors find that U.S. interest rate changes have significantly inverse influence on German stock market and the effects are even stronger when considering particularly bank stocks. However, the effects are asymmetrical as the magnitude of the spillover effect to German bank stocks is stronger during good financial cycle but weaker in recession. Finally, the authors show that the ECB interest rate announcements have only inconsistent and weak spillover effects on U.S. bank stocks prices. Hence, these results show that the transmission of international monetary policy differs from the domestic one and its magnitude depends on the prevailing economic cycle.

Table 1. Summary evidence from the prior studies on the relationship between interest rates and stock prices.

Authors	Dependent Variable	Data period	Effects of 1-basis-point (surprise) change in the FFR	Key observations
Madura & Schnusenberg, (2000)	98 and 69 listed U.S. banks depending on subperiod	1974–1979 & 1987–1996	-0,0081 % & -0,0062 %	Surprise and expected components are not separated
Bernanke & Kuttner (2005)	CRSP value-weighted index	1989–2002	-0,0468 %	The price response is mainly due to revisited future dividends expectations
Wongswan (2009)	Country index returns like CAC 40, Korea Composite index, and S&P 500 index futures	1998–2004	-0,05 % (France) & -0,0978 % (Korea), and -0,0715 % (U.S.)	U.S. monetary policy is a potential risk factor for foreign economies
Yin et al. (2010)	Fama-French U.S. bank industry index	1988–2007	-0,04 %	Bank stock returns are state dependent
Chuliá et al. (2010)	S&P 100 index	1997–2006	-0,0722 %	Positive and negative surprises cause asymmetrical effects
Rosa (2011)	DJIA, Nasdaq 100, and S&P 500	1999–2007	-0,04 %, on average	Stock returns are explained more by communication surprise
Yin and Yang (2013)	401 U.S banks	1988–2007	-0,014 %	Bank characteristics such as size affect response sensitivity

Note: This table summarizes the previously discussed evidence from the existing literature. Dependent variable are different bank stock returns depending on the used

sample. The FFR refers to the Federal Funds Rate and 1-basis point equals to 0,01 %. Hence, a hypothetical 25-basis-point increase (decrease) shifts bank stocks returns by 1 % in the opposite direction, for example, considering the results of Yin et al. (2010).

5 Data and methodology

This thesis examines how bank stock returns response to interest rate adjustments around FOMC announcements. To measure these effects empirically, the following chapter describes the used data and methodology behind the results. More detailed, section 5.1 describes the used stock price data and FOMC meeting days during the research period. In turn, section 5.2 explains the regression model behind the event-study method and how market expectations in interest rate changes are separated and computed from the actual interest rate announcement.

5.1 Data description

Bank stocks in the U.S. are defined as the Dow Jones U.S. Banks Index (PI). The index is launched on February 14, 2000, and it measures the performance of publicly traded U.S. banks. The bank stock index information is collected from the S&P Global (2023) and it includes 43 companies in the U.S. banking sector such as JP Morgan Chase & Co, Bank of America, and Citigroup Inc. The mean and median total market caps of the index are 36 billion and 8 billion USD. The market caps vary from the smallest 4 billions to 410 billions USD. The largest constituent has 27 % weight in the index while the largest ten companies have 81 % weight. Respectively, bank stocks in the Euro area are defined as the Euro Stoxx Bank Index (PI) and its specification information is collected from the index provider Qontigo (2023). The index includes bank stocks such as BNP Paribas, Nordea bank, and Deutsche bank and the number of the index components is variable. The mean total market cap of the index is slightly smaller compared to its U.S. peer as being 20 billion, but the median is bigger as being 14 billion EUR. The market caps vary from the smallest 4 billions to the biggest 61 billions EUR. The largest company weight is 14 % while the biggest country weight is 24 % for Spain.

The calculation frequency for both bank stock indexes is real-time, and they are market cap weighted. This means that the weights of components are based on their market

capitalization, so the large firms have a bigger portion of the index. Considering the above-mentioned mean markets caps of the indices, they are constructed, on average, large banks. This is a good reminder considering the previously discussed effects of bank characteristics on how they response to changes interest rates. These indices are selected to represent bank stocks in U.S. and Euro Area as they track the most important banks in their targeted regions and give therefore a comprehensive picture about the banking sector development. Furthermore, the S&P 500 index is used to represent the general stock market, so the suggested magnitude difference in price response between non-financial and financial stocks can be observed. The daily price data of bank stock indexes is collected from the Thomson Reuters, and they cover the period between January 1 of 2004 to December 30 of 2022. Figure 4 below shows the price development of both bank stock indexes against the effective federal funds rate (EFFR) level during the research period. As an exception, the 100 based index comparison data in Figure 5 is collected from the S&P Global for both indexes. Noteworthy, the price data that is scaled to 100 is available only since 2013. Based on this data, Figure 5 shows how the Dow Jones U.S. banks index correlates with the S&P 500 index.

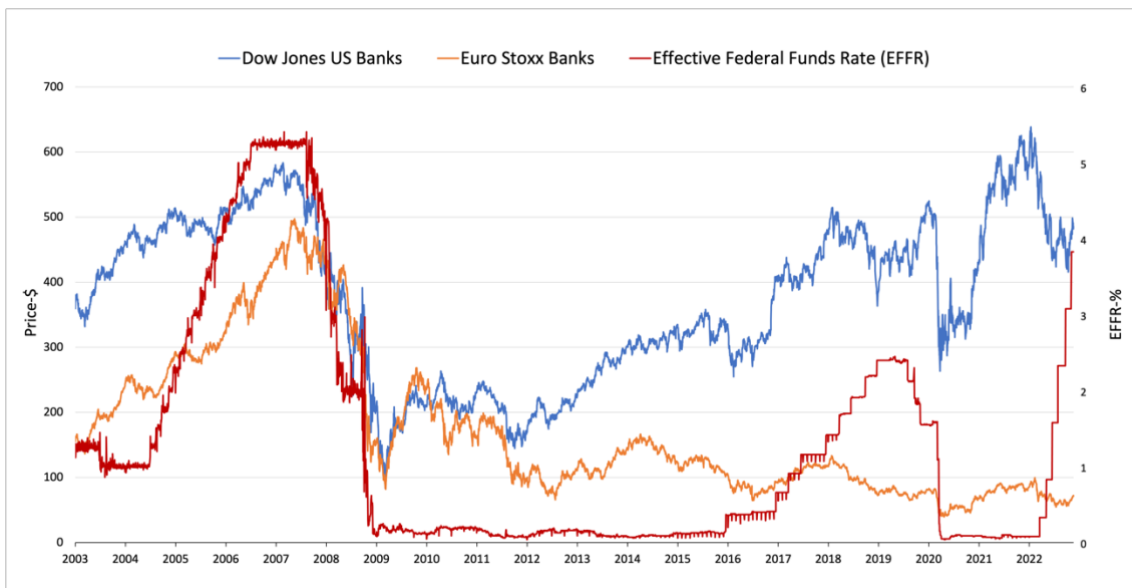


Figure 4. Bank stocks performance vs. the EFFR between 2004–2022.



Figure 5. Dow Jones U.S. Banks Index vs. 100 based S&P 500 performance between 2013–2022

The study period covers the years 2004–2022. The full sample period can be separated to three different data samples based the interest rate targeting periods and practiced monetary policy by the FOMC. Information about the FOMC meeting days and changes in the federal funds rate is gathered from the Federal Reserve (2023d). The first data sample covers the period between January 2004 to December 2007 and it includes 34 FOMC meetings where the central bank announced its interest rate decision. During this period, the FOMC decided to change the federal funds rate 20 times and kept it unchanged 14 times. Interest rate changes included one 50-basis-points and two 25-basis-points declines. Respectively, the FOMC raised the policy rate 17 times by 25-basis-points. During this data period, the highest level for the federal funds rate was 5,25 percent in June 2006. This can be observed in Figure 6, which shows the overall development of the federal funds rate over time. The starting date for the sample is selected because the Federal Reserve started to raise the federal funds rate again in 2004 after the U.S. economy showed signs of the recovery from the Dot Com bubble that hit the economy in the early 2000s, which forced the central bank to decrease its policy rate. Respectively, the period ends in December 2007 because the U.S. economy faced again

another asset price bubble that caused the global financial crisis and prolonged time of lower interest rates with the great recession.

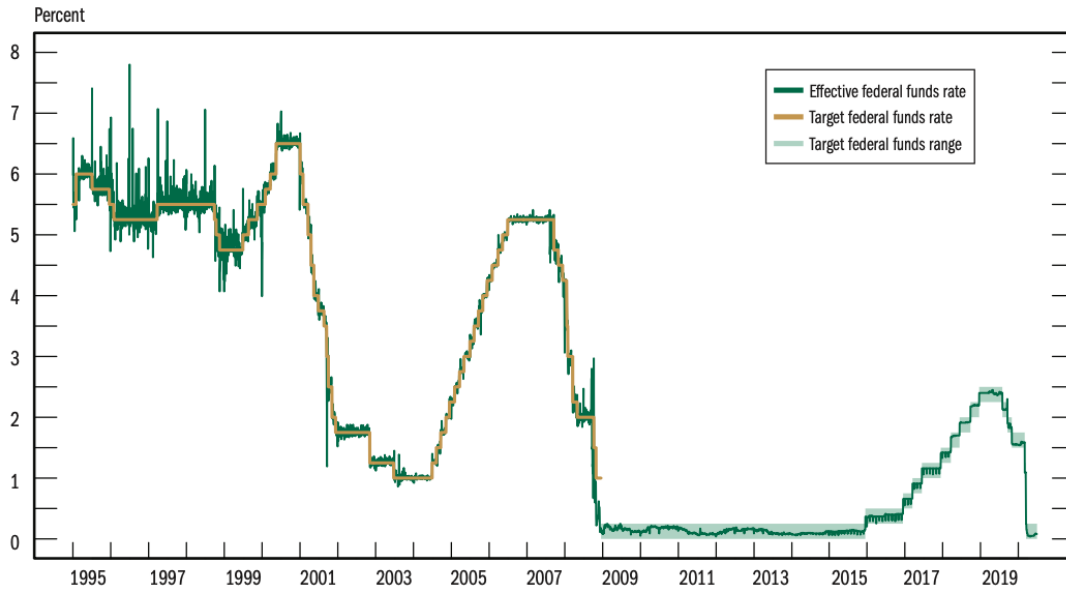


Figure 6. The federal funds rate between 1995–2020 (Feliz, 2021, p. 25)

Due to the financial crisis in 2008, the Federal reserve turned to use unconventional monetary policy tools such as the quantitative easing (QE), because the federal funds rate was already close to zero and could no longer be decreased to loosen the financial conditions and stimulate the economy. Hence, the central bank focused to use the large asset purchase programs to stimulate the economy while it did not make any changes to the federal funds rate during January 2008 to November 2015. Therefore, this period is excluded from the treatment of the FOMC interest rate announcements, so the focus stays on conventional monetary policy. However, the Federal Reserve turned back to use conventional monetary policy by starting to steadily increase the federal funds rate target again since December of 2015. With a few decrease adjustments, the period of interest rate increases last to March 2020 until the outbreak of the Covid19-pandemic causes a new crisis in the financial markets globally. For this reason, the second data period covers the years between December 2015 to December 2019. It includes 33 FOMC meetings with 12 interest rate changes and 21 meetings with no change in the federal funds rate. More detailed, it includes 9 interest rate announcements with 25-

basis-points increase and 3 with 25-basis-points decreases. The highest level of the federal funds rate target was 2,25-2,50 percent in December 2020.

The third data sample covers the period from January 2020 to December 2022. Due to uncertainty and high volatility caused by the Covid19-pandemic, the S&P 500 index declined roundly 34 % between February 20th and March 23th in 2020. Hence, it caused a crisis in the financial markets. The FOMC responded to the significant market turmoil and decreased the federal funds rate 50 and 100-basis-points in March 2020. However, the financial markets and economies recovered from the crisis relatively quickly as financial conditions and monetary policy were expansive after the Covid19 outbreak. Due to the post-covid demand growth and supply shocks in certain commodities, inflation started to increase strongly, and the Federal Reserve returned to the path of higher interest rates. Hence, it made one 25-basis-point, two 50-basis-points, and four 75-basis-points increases in the federal funds rate during the third data period. In overall, it changed the policy rate 9 times and kept it neutral for 16 times in the FOMC meetings. The highest interest rate level was 4,25 % percent in December 2022.

5.2 Event-Study characteristics

Each of the FOMC interest rate announcements can be divided to the actual interest rate change, the expected change, and the unexpected change. Noteworthy, the interest rate decision can be a surprise for the market participants even though the FOMC decides to keep the federal funds rate neutral. The previous studies use widely the 30-day federal funds futures contract as an indicator to capture market forecast about the upcoming FOMC interest rate decisions (Bernanke & Kuttner, 2005; Yin & Handorf, 2010; Yin & Yang, 2013). This is due to its convenient and market-based characteristics, which makes it the best predictor for distinguishing monetary policy shocks (Yin & Handorf, 2010; Gürkaynak et al., 2007; Bernanke & Kuttner, 2005). Hence, it is selected to be used separate the expected and unexpected interest rate decisions from the actual interest rate announcement. The federal funds futures contracts can be traded on the Chicago

Mercantile Exchange, and they are used to hedge against unfavorable changes in interest rates or to speculate on the FOMC interest rate decision. The monthly contract price for the 30-day federal funds futures follows the average effective federal funds rate considering the maturity month in question and is quoted as 100 minus the rate (Yin et al., 2010, p. 302).

Investors who are holding futures contracts have right to buy or sell the derivative at the strike price and their trading reflects the probability for the future target ranges. Hence, the futures contracts reflect market expectations for the FOMC interest rates in a monthly basis for the 60 months ahead. The one-day change in the federal funds futures contract can be used to identify a surprise in the FOMC interest rate decision, as it reflects the market's revised expectations about the future monetary policy (Gürkaynak et al., 2005, p. 430). The settlement price of the 30-day federal funds rate futures is the last trading day of the maturity month, so the one-day surprise following the FOMC announcement must be scaled by the number of days in the maturity month (Bernanke & Kuttner, 2005, p. 1224).

Motivated by Yin et al. (2010, p. 302), the one-day surprise in the FOMC interest rate decision can be calculated as follows:

$$\Delta r_t^u = \frac{m}{m-t} (f_{s,t}^0 - f_{s,t-1}^0) \quad (7)$$

Where:

Δr_t^u = the unexpected or the surprise component of the interest rate decision

m = the number of days in the month

$m - t$ = the number of days in the month scaled by the announcement day

$f_{s,t}^0$ = federal funds futures rate on the day t when the FOMC announcement occurs

$f_{s,t-1}^0$ = federal funds futures rate on the day before the FOMC announcement

s = the maturity month

Noteworthy, the model has two exceptions which says that if the FOMC announcement occurs on the first day of the month, then the $f_{s,t-1}^0$ is replaced by the f_{s-1}^1 which is the future contract rate from the last day of the prior month. Furthermore, if the FOMC interest rate decisions take place during the last three days of the month, then the change in the federal funds future rate stays unscaled and can be calculated simply by subtracting $f_{s,t-1}^1$ from $f_{s,t}^1$.

According to Yin et al. (2010, p. 302), the expected component can be derived as follows:

$$\Delta r_t^e = \Delta r_t - \Delta r_t^u \quad (8)$$

Where:

Δr_t^e = the expected component of the interest rate decision

Δr_t^u = the surprise component of the interest rate decision

Δr_t = the actual interest rate decision

Table 2 documents the descriptive statistics of the expected and unexpected components separated from the FOMC interest rate announcements between 2004–2022 in the selected interest rate targeting periods. The full sample includes 92 FOMC announcements where the maximum expected interest rate change is 79-basis-points and the minimum 0 basis-points. Respectively, the maximum surprise change is 24 basis-points and the lowest surprise 0 basis-points. The average surprise change varies during different sample periods as it is 0,294 basis-points during 2004–2007 but decreases to 0,061 during 2015–2019. Noteworthy, the average surprise change decreases to -2,235 between 2020–2022 meaning that there have been bigger surprises on average. Is it possible that this roots from the Covid19 crisis and the subsequent market turmoil in March 2020 to which Federal Reserve responded with heavy 50 and 100-basis-points interest rate declines. If these statistics are compared to the study of Yin et al. (2010, p. 306), they report mean surprise change of 5,426 basis-points during 1988-2007. This can

be speculated to be due on the increased transparency and monetary policy predictability during the recent years as suggested by Smales and Apergis (2017, p. 172).

Table 2. Descriptive statistics about the FOMC interest rate announcements.

	Expected change	Unexpected change
<i>Full data sample (2004–2022)</i>		
Mean	8,629	-0,477
Median	0	0
Standard deviation	23,366	4,741
Minimum	0	0
Maximum	79	24
Count of events	92	92
<i>Data sample A (2004–2007)</i>		
Mean	9,265	0,249
Median	3	0
Standard deviation	16,926	5,048
Minimum	0	0
Maximum	26	24
Count of events	34	34
<i>Data sample B (2015–2019)</i>		
Mean	4,485	0,061
Median	0	0
Standard deviation	14,149	1,478
Minimum	0	0
Maximum	25	4
Count of events	33	33
<i>Data sample C (2020–2022)</i>		
Mean	13,235	-2,235
Median	0	0
Standard deviation	36,921	6,543
Minimum	0	0
Maximum	79	3
Count of events	25	25

Motivated by the study of Yin and Yang (2013, p. 1759), Figure 7 shows visualization how the expected and unexpected interest rate components differ from the actual federal funds rate decision. Especially, it illustrates that even the neutral interest rate announcements can cause surprises in both directions if market participants expect the

federal funds rate to change. The figure shows that large interest rate changes cause more dispersion between the components, but in general, actual interest rate changes have been quite well predicted during the study periods.

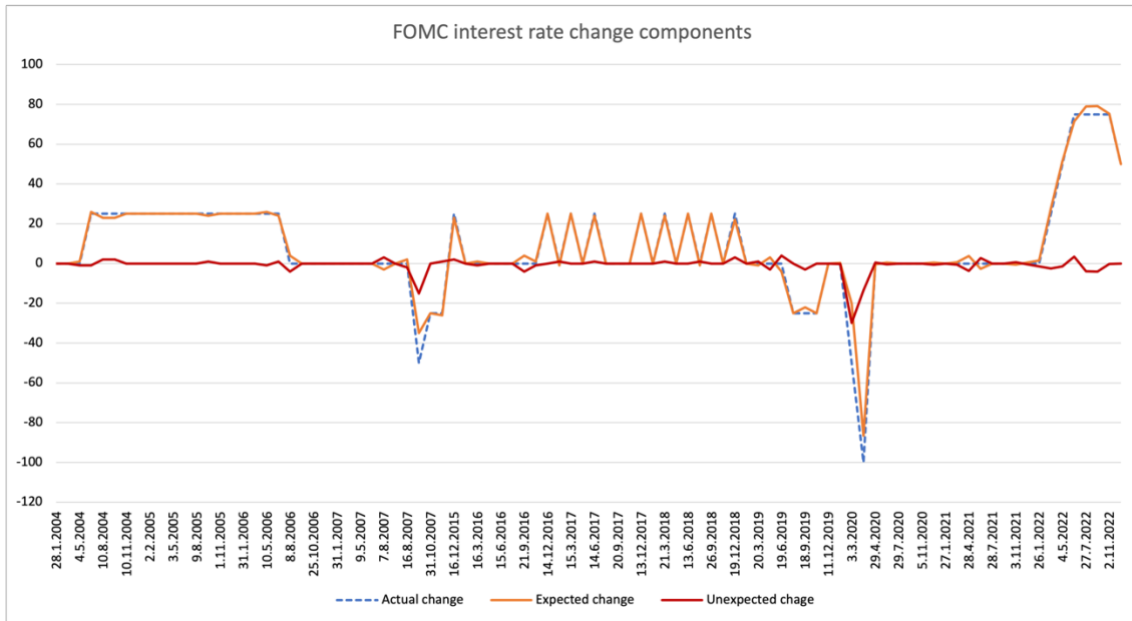


Figure 7. FOMC interest rate change components between 2004–2007, 2015–2019, and 2020–2022 combined.

Motivated by Yin et al. (2010), through the unexpected and the expected components the following linear regression model can be run to examine the relationship between the change in the federal funds rate and bank stock returns:

$$R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t \quad (9)$$

Where:

R_t = the bank stock index return on the day t

Δr_t^u = the unexpected component in the federal funds rate change

Δr_t^e = the expected component in the federal funds rate change

γ_u = the response of bank stock returns to the surprise in interest rate decision

γ_e = the response of bank stock returns to the expected interest rate decision

ε_t = the error term

The prior literature show evidence that stock prices should response only to the surprises in the FOMC announcements (Bernanke & Kuttner, 2005; Yin et al., 2010, Yin & Yang, 2013). This is because, within the efficient market hypothesis, all available information should be incorporated to stock prices and thus the expected FOMC interest rate decisions do not reveal any new reaction in this case. According to this assumption, γ_e is expected to be zero, meaning that stock prices do not react to the expected interest rate decisions. Respectively, γ_u is expected to be lower than zero meaning that there is a negative relationship between unexpected interest rates changes and bank stock returns like the existing literature widely documents.

Motivated by the study of Yin and Yang (2013a, p. 1759), the one-day holding period R_t , which is the dependent variable in the regression, is calculated by $\frac{(P_t - P_{t-1})}{P_{t-1}} * 100$ for the Dow Jones U.S Banks index and the S&P 500 index. In other words, the change in the closing values between the day before and the day of the FOMC announcement is used as the event window to measure the immediate impact of the interest rate adjustment to bank stocks returns. Respectively, expected and unexpected components are the independent variables. Noteworthy, the FOMC interest rate decisions are released at 2:00 p.m. Eastern Time (ET) which means 8:00 p.m. at Central European Time (CET). For example, the Deutsche Börse Xetra closes at 5:30 p.m. CET, so the effects of the FOMC announcement is not captured in the announcement day's closing values in the bank stock prices in Euro Area that the Euro Stoxx Banks Index tracks in real-time. Hence, motivated by the Kim et al. (2013, p. 10-11), the return horizon for the Euro Stoxx Banks Index is defined by the overnight holding period which is the close value at day $t - 1$ to open value at day t .

H2 states that the negative relationship between interest rate changes and bank stock prices is more pronounced before the financial crisis around FOMC announcements. Therefore, another regression model is needed to test the statistical significance of the

proposed magnitude difference. Motivated by Yin et al. (2010, p. 298), the regression model can be formulated as follows:

$$R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \theta_y \cdot D_y \cdot \Delta r_t^u + \varepsilon_t \quad (10)$$

All the earlier determined variables in the regression stay same, but the dummy variable is added to separate whether the different conditions are met. In the second regression model, the dummy variable equals to 1 if the interest rate announcement takes place between 2004–2007 and 0 if between 2015–2019. In other words, this means before and after the financial crisis during the eras when the Federal Reserve practiced conventional monetary policy. Due to this, the D_y refers to years condition. The value for θ_y is expected to be significantly less than zero, which means that the effects are more pronounced before the financial crisis.

6 Empirical results

The following chapter presents the empirical results of the thesis based on the previously discussed data and methodology. First, the relationship between FOMC interest rate announcements and U.S. bank stock returns are examined. Moreover, these results obtained from the different interest rate targeting periods of U.S. monetary policy are compared. Second, the relationship is examined similarly considering the general stock market to make observations about the potential sensitive difference between financial and non-financial stocks. Third, the proposed spillover effects of U.S. monetary policy on Euro Area bank stock returns are studied with the aim of analyzing international monetary policy transmission.

6.1 Domestic stock returns around FOMC announcements

6.1.1 U.S bank stocks

The theory behind the market efficiency suggests that asset prices should reflect all available information and thus response only to new information that is unexpected. Accordingly, the prior studies such as Yin et al. (2010) show that bank stock prices response only to surprise adjustments around FOMC interest rate announcements. More detailed, the previous literature shows strong evidence that the relationship between unexpected interest rate decisions and bank stock returns is significantly negative (Bernanke & Kuttner, 2005; Rosa, 2011; Yin et Yang, 2013). Table 3 shows the empirical findings testing the relationship between the federal funds rate and the Dow Jones U.S. bank index, which is used as a proxy for U.S. bank stocks. Noteworthy, the years 2004–2007 and 2015–2019 are selected to be examined first jointly, because they represent U.S. monetary policy during the interest rate targeting periods without significant economic turmoil, such as Covid19-crisis taking place in 2020. Column (1) of Table 3 reports that considering the interest rate targeting periods between 2004–2007 and 2015–2019 combined, 1-basis-point unexpected change in the policy interest rate

shifts bank stock prices by 0,10 % in the opposite direction statistically at 5 % significant level. These findings mean that a hypothetical 25-basis-point unexpected increase in the federal funds rate decreases daily bank stock returns by 2,50 % and vice versa. This makes sense as higher interest rates decrease expected future cash flows and increase the used discount rate according to asset valuation models. As Yin et al. (2010, p. 293) state, these effects apply also to bank industry due to higher noninterest expenses, lower noninterest income, declined asset values, and decreased loan demand. These overall effects are suggested to explain why bank stock returns correlate negatively with interest rates.

Table 3. U.S. bank stocks response to changes in interest rates between 2004–2019.

Time period	2004–2007 & 2015–2019	2004–2007 & 2015–2019
Regressor	(1)	(2)
Intercept	0.076 (0.669)	0.076 (0.672)
Expected	-0.002 (0.831)	-0.002 (0.873)
Unexpected	-0.100** (0.030)	-0.107 (0.501)
Unexpected X Year Dummy		0.008 (0.963)
N	67	67
R^2	0.077	0.077
Residual Std. Error	1.326	1.337
F Statistic	2.678*	1.758

Note: The table 3 documents how expected and unexpected adjustments in the federal funds rate impact on one-day holding period returns of the value-weighted Dow Jones U.S. Banks Index. P-values are presented in parentheses. Regression (1) measures the overall effects during normal market conditions in the selected interest rate targeting periods between 2004–2007 and 2015–2019 combined. Regression (2) examines the asymmetrical effects between these individual periods. The dummy variable is set to 1 if the FOMC announcement occurs during 2004–2007 and 0 if 2015–2019. Regression model in column (1) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$ and column (2) $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \theta_y \cdot D_y \cdot \Delta r_t^u + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Column (1) of Table 3 do not reveal any statistically significant evidence that U.S. bank stock returns react to expected interest rate decisions. These findings are consistent with the efficient market hypothesis and the previous studies like Bernanke and Kuttner (2005), Yin et al. (2010), and Yin and Yang (2013a) as stock prices react inversely only to unexpected interest rate announcements between 2004–2019 during the selected interest rate targeting periods. These results provide supporting evidence for the proposed H1, which states that U.S bank stock prices correlate negatively (positively) to increase (decrease) in the federal funds rate around FOMC announcements. The magnitude of the effects -0,10 % appears to be stronger compared to the earlier studies as Yin et al. (2010, p. 307) documents -0,04 % and Yin and Yang (2013a, p. 1762) -0,014 % change in U.S. bank stock returns in response to surprise adjustments in the federal funds rate. Basically, the evidence in the existing literature means that a hypothetical 25-basis-point change in the policy interest rate shifts bank stock prices to the inverse direction by 1 % and 0,35 % respectively.

H2 proposes that the negative relationship between interest rates and bank stock returns is more pronounced in the pre-financial crisis period than after it. Second regression model is used to test empirically the hypothesis giving value 1 for the dummy variable if the interest rate announcement occurs between 2004–2007 and zero if 2015–2019. Hence, the expected more pronounced effects between 2004–2007 can be observed if θ_y is significantly less than zero. That is because the prior literature such as Smales and Apergis (2017, p. 172) say that the U.S. central bank has increased its transparency and predictability in monetary policy practices during the recent years that may lower the informational importance of the actual interest rate decisions around the FOMC statement. In fact, the previously seen descriptive statistics of Table 2 show that the mean surprise change was 0,294 between 2004–2007 and 0,061 between 2015–2019. Therefore, the surprises are higher on average during the pre-financial crisis period.

Column (2) of Table 3 shows the empirical magnitude difference in price response between 2004–2007 and 2015–2019. The model fails to capture any significant evidence for the proposed H2 as the dummy coefficient is more than zero and it remains statistically insignificant. This means that the impact of unexpected interest rate changes on U.S. bank stock returns is not significantly stronger in the interest targeting periods between 2004–2007 before the financial crisis than after it between 2015–2019. Therefore, the proposed H2 must be rejected. Respectively, Table 4 shows the empirical results for the separated interest rate targeting periods when the U.S. central bank practiced conventional monetary policy between 2004–2022. When the interest rate targeting periods 2004–2007 and 2015–2019 are examined separately, column (1) of Table 4 shows that surprise adjustments cause significant effects on U.S. bank stock returns only between 2004–2007 at 10 % statically level. In turn, column (2) of Table 4 does not reveal any statistically significant results. However, when comparing the periods, the response is not more pronounced at statistically significant level before the financial crisis as previously reported.

Table 4. U.S. bank stocks response in the separated interest rate targeting periods between 2004–2022.

Time period	2004–2007 (1)	2015–2019 (2)	2020–2022 (3)	Full Sample (4)
Regressor				
Intercept	0.429 (0.184)	-0.240 (0.163)	-0.104 (0.897)	-0.202 (0.423)
Expected	-0.006 (0.727)	-0.005 (0.653)	0.034 (0.105)	0.025** (0.020)
Unexpected	-0.101* (0.085)	-0.084 (0.454)	0.245** (0.040)	0.088* (0.092)
N	34	33	25	92
R^2	0.105	0.033	0.340	0.111
Residual Std. Error	1.607	0.919	3.402	2.256
F Statistic	1.820	0.509	5.671**	5.540***

Note: The table shows comparison results how expected and unexpected adjustments in the federal funds rate impact on one-day holding period returns of the value-weighted Dow Jones U.S. Banks index during the different interest rate targeting periods. P-values

are presented in parentheses. Regression model in columns (1-4) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Contrary to the previous observations, column (3) of Table 4 shows statistically significant positive relationship for interest rate surprises and U.S. bank stock prices between 2020–2022. This same applies also in column (4) of Table 4, which examines the effects considering the full sample. Moreover, it shows that bank stock prices reacted also to expected interest rate decisions during the full sample period. In summarized, column (4) of Table 4 shows that stock prices reacted positively on average 0,025 % to expected 1-basis-point change at 5 % significant level and 0,088 % to surprise 1-basis-point change at 10 % significant level. According to Jarocinski and Karadi (2020, p. 2), the positive co-move indicates that the FOMC statement causes information shock rather than monetary shock. Basically, it could mean the Chair's communication about the future path of monetary policy deviates from market expectations, causing a price reaction despite the predicted interest rate decision.

On the other hand, the results in columns (3) and (4) of Table 4 can be potentially explained by the Covid19 outbreak in March 2020 when the Federal Reserve decreased the federal funds rate by 50 and 100-basis-points to minimize uncertainty in the financial markets and stimulate the U.S. economy. Due to the global economic concerns caused by the Covid19-crisis, the S&P 500 index declined around 12,5 % in March 2020. For example, on 16 of March in 2020, when the FOMC decided to decrease its policy rate by 100 basis-points, the one-day holding return of S&P 500 index was -11,98 % and the Dow Jones U.S. Bank Stocks Index was -15,24 % respectively. Correspondingly, the correlation of the daily returns between these indexes were 0,78 between the years 2004-2022 and 0,97 during March 2020. This means that the overall market turbulence in March 2020 may explain the results why bank stock prices decreased heavily and show positive relationship in column (3) of Table 4 despite the interest rates cuts.

These findings are contrary to the prior findings of Bernanke and Kuttner (2005), Yin et al. (2010), and Yin and Yang (2013a) who do not find any statistically significant results

that bank stock prices react to expected interest rate decisions. On the other hand, these results match to the documentation of Rosa (2011) and Jarocinski and Karadi (2020) who state that stock prices may react also to the expected interest announcements based on the information shocks. Therefore, columns (3) and (4) of Table 4 do not support the suggested H1, so it must be rejected considering the full sample. This evidence raises a question whether the relationship between interest rates and stock prices is pleasant to examine over strong economic turbulence or should the turmoil periods be excluded from this treatment to avoid biases and get more accurate results about the real effects of monetary policy transmission through financial markets in normal market conditions. For example, Yin et al. (2010) do not exclude the Dot Com bubble from their analysis during the early 2000s, which may potentially disturb the results because the bursting of the technology bubble significantly decreased the whole S&P 500 index in the early 2000s. For example, column (4) of Table 4 indicates that this is potentially the case in terms of the Covid19-crisis.

Including economic crises or significant economic turmoil to the research periods may increase the possibility that the measured magnitude and direction of monetary policy transmission through asset prices is biased compared to normal market conditions. This is because asset prices may react more strongly to the overall market performance than follow interest rate adjustments during that time. For example, investors may not interpret hypothetical 100-basis-point rate cut as good news for asset valuations but rather as indications of economic concerns. Due to this, stock prices may co-move positively with interest rates. Hence, central bank cannot potentially influence the transmission of monetary policy through financial markets during heavy economic turmoil because stock prices do not follow the traditional formula of asset pricing models. Moreover, having accurate information how stock prices react to changes in the policy interest rate is crucial, because the wealth and balance sheet channels transmit monetary policy into economic behavior. When setting monetary policy, it is important to find the right balance in the adjustments and remember that the effects are seen in the real economy with a delay. There is a risk that monetary policy is tightened too much,

which causes stress to financial stability. For example, to the health of banks if the effects are estimated to remain smaller.

On the other hand, Rosa (2011, p. 916) remarks that new information incorporates to asset prices roundly within 1 hour. Therefore, investigating the effects by using the one-day holding period may likely include also other market events besides the actual interest rate announcement and is therefore an imperfect measurement to capture how changes in interest rates impact on stock prices around the FOMC announcement. For example, R^2 in column (1) of Table 3 documents that interest rate decisions explain stock returns only by 7,7 % around FOMC meeting days. This is consistent with the study of Chuliá et al. (2010, p. 836) who reports that the R^2 of their model decreases from 25 % to 7 % when the stock returns are examined daily instead of 5-min scope. This shows that high-frequency data could be recommended to capture the rawer effects and giving more accurate picture for portfolio managers and central bankers how changes in the policy interest rate affect immediately on stock returns.

6.1.2 S&P 500 Index

Column (1) of Table 5 shows that the negative relationship between unexpected interest rate decisions and regular stock prices, that are represented by the S&P 500 index, applies similarly as bank stocks. The column reports that 1-basis-point surprise adjustment in the federal funds rate increases (decreases) the broad stock market index by 0,058 % in the opposite direction when investigating the interest rate targeting periods between 2004–2007 and 2015–2019 jointly. These results are statistically significant at 5 % level unlike the price response to expected interest rate changes, which do not reveal any significant evidence. In other words, a hypothetical 25-basis-point surprise hike in the policy rate decreases the S&P 500 index on average 1,45 % and vice versa. Comparing the price response of S&P 500 index to the previously shown Dow Jones U.S. Banks index, the empirical results indicate supporting evidence consistent with the prior literature that bank stock prices are more sensitive to unexpected

adjustments in interest rates than regular stocks. Respectively, the model cannot find any significant evidence about the asymmetrical effects between 2004–2007 and 2015–2019 as seen in column (2) of Table 5.

Table 5. S&P 500 response to changes in interest rates between 2004–2019.

Time period	2004–2007 & 2015–2019	2004–2007 & 2015–2019
Regressor	(1)	(2)
Intercept	0.097 (0.389)	0.097 (0.392)
Expected	-0.001 (0.907)	-0.001 (0.902)
Unexpected	-0.058** (0.045)	-0.051 (0.609)
Unexpected X Year Dummy		-0.007 (0.944)
N	67	67
R^2	0.065	0.065
Residual Std. Error	0.837	0.843
F Statistic	2.224	1.461

Note: The table documents how expected and unexpected adjustments in the federal funds rate impact on one-day holding period returns of the S&P 500 Index, which is used as a proxy for the general stock market in the U.S. P-values are presented in parentheses. Regression (1) measures the overall effects during the selected interest rate targeting periods between 2004–2007 and 2015–2019 combined. Regression (2) examines the asymmetrical effects between these periods. The dummy variable is set to 1 if the FOMC announcement occurs during 2004–2007 and 0 if 2015–2019. Regression model in column (1) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$ and column (2) $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \theta_y \cdot D_y \cdot \Delta r_t^u + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 6 shows again contrary evidence to what asset pricing models suggests about the negative relationship between interest rates and asset prices. This is visible in columns (3) and (4) of Table 6, which shows that the S&P 500 index reacts positively to both expected and unexpected interest rate announcements at 10 % significant level. The positive relationship does not apply during 2004–2019 when no crises occur. These results strengthen the previously discussed evidence that crisis periods may disturb the relationship between interest rates and stock prices and therefore biases the results.

This means that the magnitude of the interest rate announcement to stock prices may weaken when treating all type of financial conditions as jointly. This can be seen in column (4) of Table 6 as it shows positive relationship for interest rate surprises against the results in column (1) of Table 5.

Table 6. S&P 500 response in the separated interest rate targeting periods between 2004–2022.

Time period	2004–2007 (1)	2015–2019 (2)	2020–2022 (3)	Full Sample (4)
Regressor				
Intercept	0.276 (0.157)	-0.058 (0.647)	-0.208 (0.712)	-0.144 (0.419)
Expected	-0.005 (0.624)	0.002 (0.855)	0.030* (0.053)	0.021*** (0.005)
Unexpected	-0.058 (0.102)	-0.050 (0.550)	0.164* (0.055)	0.067* (0.066)
N	34	33	25	92
R^2	0.102	0.012	0.362	0.145
Residual Std. Error	0.968	0.689	2.450	1.569
F Statistic	1.760	0.183	6.230***	7.546***

Note: The table shows comparison results how expected and unexpected adjustments in the federal funds rate impact on one-day holding period returns of the S&P 500 Index during the different interest rate targeting periods. P-values are presented in parentheses. The used regression model in columns (1-4) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

6.2 Spillover effects to Euro Area bank stocks

Table 7 captures the spillover effects of U.S. monetary policy on Euro Area bank stock returns during the interest rate targeting periods between 2004–2019. The prior literature, like Yin and Yang (2013b, p. 25), suggest that unexpected interest rates announcements cause cross-border effects to Euro Area bank stocks despite the European Central Bank is the authority that determines the interest rate level in the Euro Area. However, Wongswan (2009, p. 360) states that the magnitude of price response is more pronounced in domestic than in the foreign financial markets. Considering column

(1) of Table 7, Euro Stoxx Banks index reacts only to unexpected interest rate adjustments around FOMC announcement statistically at 5 % significant level. This means that an unexpected 1-basis-point interest rate announcements shifts Eurozone bank stock returns by 0,022 % in the opposite direction. Based on this evidence, the proposed H3 can be accepted.

Column (2) of Table 7 reports that the response is more pronounced between 2015–2019 than 2004–2007 as the dummy coefficient is positive 0,080 at 5 % significant level. Hence, the suggested increased transparency of U.S. monetary policy does not cause effects which would indicate that the price response is lower after the periods of the financial crisis. In overall, these results support empirically the prior literature which says that foreign bank stock prices react negatively to surprises in interest rate changes. Moreover, it seems that the effects remain lower than the domestic, but the results between U.S and Euro Area bank stocks may not be perfectly comparable because the one-day holding period return is used for U.S. bank stocks and overnight holding period return for Eurozone bank stocks. Hence, the speculated more pronounced price reaction between the countries is not empirically tested in this regard.

Table 7. Euro Area bank stocks response to changes in interest rates between 2004–2019.

Time period	2004–2007 & 2015–2019	2004–2007 & 2015–2019
Regressor	(1)	(2)
Intercept	0.112*** (0.008)	0.111*** (0.007)
Expected	-0.004 (0.116)	-0.003 (0.165)
Unexpected	-0.022** (0.041)	-0.095*** (0.009)
Unexpected X Year Dummy		0.080** (0.032)
N	67	67
R ²	0.116	0.179
Residual Std. Error	0.305	0.297
F Statistic	4.210**	4.575***

Note: The table reports how expected and unexpected adjustments in the federal funds rate impact on overnight holding period returns of the value-weighted Euro Stoxx Banks Index. P-values are presented in parentheses. Regression (1) measures the overall effects during the selected periods 2004–2007 and 2015–2019 combined. Regression (2) examines the suggested asymmetrical effects between these periods. The dummy variable is set to 1 if the FOMC announcement occurs during 2004–2007 and 0 if 2015–2019. Regression model in Column (1) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$ and column (2) $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \theta_y \cdot D_y \cdot \Delta r_t^u + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

R^2 in column (1) of Table 8 equals to 0,322 meaning that 32,2% of the Eurozone banks stock returns are explained by the interest rate adjustments made around the FOMC meeting days during 2004–2007. Eurozone bank stock returns response to 1-basis-point expected interest rate adjustments by -0,006 % at 1 % significant level and -0,014 % at 5 % significant level during 2004–2007. These results related to expected interest rate changes are not necessarily against the efficient market hypothesis because new information about the economic outlook may have occurred in the FOMC statement. On the other hand, they may indicate that international monetary policy act differently compared to domestic. As Kim et al. (2013, p. 25) state, German bank stocks are more sensitive to U.S monetary policy during good economic phases but less sensitive during bad economic phases. Respectively, the author shows that U.S. bank stocks works inversely in this regard. Column (3) of Table 8 support these findings as the model cannot capture any significant evidence that Eurozone bank stock returns react to surprise changes during 2020–2022, which was not the case in terms of the Dow Jones U.S. Banks Index and the S&P 500 index. Respectively, the column shows that Eurozone bank stocks react positively by 0,005 % to 1-basis-points expected interest rate decisions at 10 % significant level. Nevertheless, column (4) of Table 8 cannot find any statistical evidence about international spillover effects, so the proposed H3 must be rejected when the full sample including the Covid19-crisis is examined. During that period, the value 0,008 of R^2 shows that returns around FOMC meeting days are explained by only 0,8 % interest rate decisions.

Table 8. Euro Area bank stocks response in the separated interest rate targeting periods between 2004–2022.

Time period	2004–2007 (1)	2015–2019 (2)	2020–2022 (3)	Full Sample (4)
Regressor				
Intercept	0.134*** (0.001)	0.093 (0.188)	-0.133 (0.188)	0.024 (0.551)
Expected	-0.006*** (0.009)	-0.0001 (0.982)	0.005* (0.075)	0.001 (0.432)
Unexpected	-0.014** (0.044)	-0.103** (0.032)	0.001 (0.964)	-0.004 (0.599)
N	34	33	25	92
R^2	0.322	0.153	0.154	0.008
Residual Std. Error	0.192	0.378	0.418	0.362
F Statistic	7.356***	2.704*	1.998	0.374

Note: The table show comparison results how expected and unexpected adjustments in the federal funds rate impact on overnight holding period returns of the Euro Stoxx Banks Index during the different interest rate targeting periods. P-values are presented in parentheses. Regression model in columns (1-4) is $R_t = \alpha + \gamma_u \cdot \Delta r_t^u + \gamma_e \cdot \Delta r_t^e + \varepsilon_t$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

6.3 Summary of the empirical results and hypotheses

Table 9 below summarizes the empirical results. H1 suggests that U.S bank stock prices are negatively correlated with increases (decreases) in the federal funds rate. Considering the interest rate targeting periods without crises in financial markets between 2004–2007 and 2015–2019, the hypothesis can be accepted. This is consistent with the efficient market hypothesis and asset valuation models. However, the hypothesis is rejected when the full sample is examined. This is because bank stock prices co-move in the same direction with interest rate changes. The full sample period includes the Covid19-crisis in 2020 which potentially causes the positive relationship as the entire stock market fell significantly between February and March 2020 affecting the full sample.

H2 suggests that the negative relationship is more pronounced in the interest rate targeting periods before than after the financial crisis. This is due to the increased focus of central banks on preventing asset price bubbles and maintaining financial stability through the more transparent and predictable monetary policy (Joyce et al., 2012; Smales and Apergis, 2017a). However, the model cannot capture any significant results about the more pronounced effects during 2004–2007 compared to 2015–2019. Hence, the hypothesis is rejected.

Finally, H3 suggests that Euro Area bank stock returns react negatively to surprise adjustments in the federal funds rate. The empirical results show that U.S. monetary policy causes negative international spillover effects to Euro Area bank stock returns, so the hypothesis can be accepted considering the interest rates targeting periods between 2004–2019. However, these effects do not apply when the period of Covid19-crisis is included, so the hypothesis is rejected when the full sample is examined.

Table 9. The empirical results and hypotheses summarized.

Period		2004–2019		Full sample	
Environment		Normal		Covid19-crisis included	
Hypothesis	Dependent variable	Results	Accepted	Results	Accepted
H1: $\gamma_u < 0$	U.S bank stock returns	-0.100** (0.030)	Yes	0.088* (0.092)	No
H2: $\theta_y < 0$	U.S bank stock returns	0.008 (0.963)	No		
H3: $\gamma_u < 0$	Euro Area bank stock returns	-0.022** (0.041)	Yes	-0.004 (0.599)	No

Note: The table summarizes the empirical results and shows whether the proposed hypotheses are accepted based on them. P-values are presented in parentheses. Noteworthy, this thesis covers the examination of suggested asymmetrical effects only for the years 2004–2007 and 2015–2019 considering H2. Moreover, the one-day holding period is used for the U.S. bank stocks and overnight holding period for the Eurozone bank stocks due to time differences and the opening hours of stock exchanges.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

7 Conclusions

This thesis examines how changes in the federal funds rate impact on U.S. and Euro Area bank stock returns around FOMC announcements. The empirical results show that the relationship between interest rates and bank stock returns is statistically negative during the FOMC interest rate targeting periods between 2004–2019. This applies to both domestic and international spillover effects and is consistent with asset valuation models. According to Yin et al. (2010, p. 293), higher interest rates reduce bank earnings due to lower noninterest income, higher noninterest expenses, lower asset values, and reduced loan demand. This causes bank stock returns to be negatively correlated with interest rates. The empirical results show that bank stock returns react only to surprise adjustments in the federal funds rate during the selected interest rate targeting periods between 2004–2019. This evidence supports the efficient market hypothesis and the previous evidence of Bernanke and Kuttner (2005), Rosa (2011), and Yin and Yang (2013) to name a few. However, the empirical results do not capture the proposed more pronounced effects during the interest rate targeting period of 2004–2007 compared to 2015–2019 despite the increased transparency and predictability of U.S. monetary policy after financial crisis that is suggested by the prior literature such as Smales and Apergis (2017a).

Alternatively, this thesis studies also the effects including the interest rate targeting period of 2020–2022 covering the Covid19-crisis. This gives new insight into the effects of monetary policy on financial markets in different economic environments. The empirical results show that U.S. bank stock returns co-move in the same direction with expected and unexpected interest rate changes during the full sample period from 2004 to 2022. Respectively, any evidence cannot find about significant spillover effects on Euro Area bank stock returns when the interest rate targeting period 2020–2022 is included to the full sample. These results are most likely explained by the strong market turmoil between February and March in 2020 due to Covid19-crisis when the broad stock market declined despite the FOMC decreased the federal funds rate to zero. These results contradict asset valuation models and the previous studies mentioned above.

However, these results support the evidence of Jarociński and Karadi (2020, p. 2) who say that the relationship between interest rates and stock returns may not be unambiguous as stock prices can co-move positively with interest rates due to information shocks over monetary policy shocks. Even though bank stock prices response to expected interest rate adjustments, these results may not be against the efficient market hypothesis if the price reaction occurs due to new information in the press release.

This thesis adds to the existing literature by providing additional evidence on the relationship between interest rates and bank stock returns, especially in the post-financial crisis period. Moreover, it examines the FOMC interest rate targeting periods separated to normal market environment and the full sample including Covid19-crisis. These results contribute the existing literature by emphasizing that periods of market turmoil can alter the effects of interest rate changes on stock prices. For example, Yin et al. (2010) do not separate the Dot Com bubble from their treatment of the effects. Noteworthy, the empirical results of this thesis find that the magnitude of the effects in the U.S. are stronger than documented in the prior literature when significant market turmoil or crisis periods are not included. Hence, jointing crisis or turmoil periods in the full sample may not give a pure picture about the effects of interest rates on bank stock prices. This creates challenges for policymakers to implement the right monetary policy measures to adjust macroeconomic variables for supporting the central bank's goals. Furthermore, these results provide a better understanding for investors how bank stock prices react on fluctuations in interest rates.

However, it must be remark that the used one-day holding period may be an imperfect measurement capturing the effects how interest rate adjustments impact on stock prices around the FOMC announcement. High-frequency data and a narrower event window could be recommended to minimize other news affecting stock prices and capture purer effects as Chuliá et al. (2010) and Rosa (2011) suggest. Moreover, Yin and Yang (2013a) show that interest rates sensitivity of banks depends on different characteristics like size

or funding source. Due to these observations, the future research could examine banking industry at the individual stock level with intraday data in the post-financial crisis period. This may provide a better understanding what type of banks may be the most sensitive particularly for higher interest rates and stressed by the increased cost of capital in economy. For example, how better current ratio or the quick ratio impact on sensitivity of bank stocks as representing the better ability to tackle financial obligations or liquidity issues. A better understanding of these linkages emphasizes the fact that the role of central banks is also to ensure financial stability, to which the banking system is strongly connected.

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Appendices

Appendix 1. The FOMC meetings and interest rate change components

Event date	Actual	Expected	Surprise	Event date	Actual	Expected	Surprise
28.1.2004	0	0	0	27.4.2016	0	0	0
16.3.2004	0	0	0	15.6.2016	0	0	0
4.5.2004	0	1	-1	27.7.2016	0	0	0
30.6.2004	25	26	-1	21.9.2016	0	4	-4
10.8.2004	25	23	2	2.11.2016	0	1	-1
21.9.2004	25	23	2	14.12.2016	25	25	0
10.11.2004	25	25	0	1.2.2017	0	-1	1
14.12.2004	25	25	0	15.3.2017	25	25	0
2.2.2005	25	25	0	3.5.2017	0	0	0
22.3.2005	25	25	0	14.6.2017	25	24	1
3.5.2005	25	25	0	26.7.2017	0	0	0
30.6.2005	25	25	0	20.9.2017	0	0	0
9.8.2005	25	25	0	1.11.2017	0	0	0
20.9.2005	25	24	1	13.12.2017	25	25	0
1.11.2005	25	1	24	31.1.2018	0	0	0
13.12.2005	25	25	0	21.3.2018	25	24	1
31.1.2006	25	25	0	2.5.2018	0	0	0
28.3.2006	25	25	0	13.6.2018	25	25	0
10.5.2006	25	26	-1	1.8.2018	0	-1	1
29.6.2006	25	24	1	26.9.2018	25	25	0
8.8.2006	0	4	-4	8.11.2018	0	0	0
20.9.2006	0	0	0	19.12.2018	25	22	3
25.10.2006	0	0	0	30.1.2019	0	0	0
12.12.2006	0	0	0	20.3.2019	0	-1	1
31.1.2007	0	0	0	1.5.2019	0	3	-3
21.3.2007	0	0	0	19.6.2019	0	-4	4
9.5.2007	0	0	0	31.7.2019	-25	-25	0
28.6.2007	0	0	0	18.9.2019	-25	-22	-3
7.8.2007	0	-3	3	30.10.2019	-25	-25	0
10.8.2007	0	0	0	11.12.2019	0	0	0
16.8.2007	0	2	-2	29.1.2020	0	0	0
18.9.2007	-50	-35	-15	3.3.2020	-50	-20	-30
31.10.2007	-25	-25	0	16.3.2020	-100	-87	-13
11.12.2007	-25	-26	1	29.4.2020	0	-1	1
16.12.2015	25	23	2	10.6.2020	0	0	0
27.1.2016	0	0	0	29.7.2020	0	0	0
16.3.2016	0	1	-1	16.9.2020	0	0	0

Event date	Actual	Expected	Surprise	Event date	Actual	Expected	Surprise
5.11.2020	0	0	0				
16.12.2020	0	1	-1				
27.1.2021	0	0	0				
17.3.2021	0	1	-1				
28.4.2021	0	4	-4				
16.6.2021	0	-3	3				
28.7.2021	0	0	0				
22.9.2021	0	0	0				
3.11.2021	0	-1	1				
15.12.2021	0	0	0				
26.1.2022	0	2	-2				
16.3.2022	25	28	-3				
4.5.2022	50	51	-1				
15.6.2022	75	72	3				
27.7.2022	75	79	-4				
21.9.2022	75	79	-4				
2.11.2022	75	75	0				
14.12.2022	50	50	0				