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Is the Fed's Quantitative Tightening entailing a new regime for asset classes?

How does it ultimately impact the global banking system and the real economy?

Clémence Louzier

Quentin Duflot

Under the supervision of Pierre Blanchet

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Introduction

The global financial landscape has experienced significant transformations in recent years, primarily driven by the actions of central banks in response to unprecedented economic challenges, including the Covid-19 crisis and the surge in geopolitical tensions. This thesis delves into the intricacies of monetary policies, particularly focusing on the Federal Reserve's approach, and explores the necessity of falling back on unconventional tools. Then, focusing on the recent enactment of the Fed's Quantitative Tightening plan, it aims at understanding the impacts of such unconventional monetary policy on various asset classes, the banking system, and the real economy. By examining the Quantitative Tightening (QT) phenomenon and its consequences on financial markets, this study aims to shed light on the potential anchoring of a new regime for asset classes. Is the Fed's Quantitative Tightening entailing a new lasting regime for asset classes and how does it ultimately impact the global banking system and the real economy?

Section 1 provides a comprehensive overview of central banks' monetary policy objectives, with a particular emphasis on the Federal Reserve. It explores the conventional and unconventional instruments employed by the Fed to manage monetary conditions and meet its mandated objectives. The section first elucidates the old "limited reserves framework" and the role of open market operations in controlling the Effective Federal Funds Rate (EFFR), and then discusses the emergence of an "ample reserves framework" using Interest on Reserves (IOR) and Reverse Repurchase Agreement (RRP) rates. Moreover, it examines the emergence and necessity of unconventional monetary policies, such as Quantitative Easing and Forward Guidance, as non-standard tools to navigate challenging economic circumstances.

In Section 2, we delve into today's unique challenges faced by the financial system and the global economy, laying the foundation for understanding the need for Quantitative Tightening. The roots of current inflation are explored, along with an analysis of the waves of Quantitative Easing and the growth of the Federal Reserve's balance sheet. Furthermore, the chapter investigates the definition of Quantitative Tightening, explores the rationale for shrinking the Fed's balance sheet and highlights its effects.

Section 3 focuses on tracking the impact of the Fed's Quantitative Tightening on various asset classes. We explore whether we are entering a new regime by examining the asset class returns, volatilities, and cross-correlations. The year 2022 appears as a pivotal period for the financial markets. We first outline the theories behind the repricing of fixed-income instruments due to hike rates. Then, our empirical research delves into the changes in valuation levels, performance, and volatilities of asset classes that followed the recent enactment of tightened monetary policy, with specific emphasis on equity and bonds. Additionally, changes in cross-correlations between asset classes are studied.

Section 4 investigates the implications of this new regime on the global banking system and the real economy. By examining specific recent affairs, including the failures of Silicon Valley Bank and Signature Bank, as well as the crisis of Credit Suisse, the thesis analyzes the underlying causes and consequences of these banking crises. The implementation of liquidity measures by the Federal Reserve to alleviate the banking crisis, including the Bank Term Funding Program, the Discount Window, and the Fed's swap lines, are explored. Furthermore, the chapter examines the reverberations of the banking turmoil throughout the markets, such as deposit flight, inflows in money market funds, and the tightening of banking conditions on the overall economy.

Ultimately, section 5 discusses the persistence of this new regime for asset classes in the short to medium term. Drawing upon the findings and analysis presented in the previous chapters, this section aims to provide insights into the potential durability of such high market volatility and unusual positive correlation between bond and stock markets.

In a nutshell, this thesis aims to offer a comprehensive examination of the recent Fed's choice to recourse to unconventional monetary policy to fight against unprecedented inflation amid concerns regarding economic outlook, unemployment, and financial stability. Our research work also tries to suggest some ways forward by outlining avenues for further reflection regarding the persistence of the current odd regime for asset classes and how it affects the banking system and the real economy.

1. Central Banks' Monetary Policy and Instruments

1.1. Central Banks' objectives: a focus on the Federal Reserve

The United States Congress established the mandates of the Federal Reserve in the Federal Reserve Act, which was passed in 1913 and subsequently amended several times. The Act lays out the objectives of the central bank, which consist of promoting stable prices, maximum employment, and moderate long-term interest rates. This set of objectives is often called the "dual mandate," as it requires the Fed to balance the goal of fostering employment and price stability. In addition to defining the Fed's objectives, the Act outlines the powers and structure of the central bank, which include conducting monetary policy, supervising and regulating banks, and acting as a lender of last resort during financial crisis. The objectives attributed to the central bank and their relative importance were topics of discussion among practitioners and academics.

Since the 1990s, the consensus shared among monetary authorities was that inflation belongs to the scope of central banks and is indeed the best lever on which monetary policies can play to participate in the social and economic prosperity of the state. Notably, it was largely agreed that price stability was the core objective of central banks. In practice, price stability is defined as low and stable inflation. The name of Inflation Targeting summarizes this objective.

One must understand the consequences of high and uncertain inflation to understand the rationale behind this objective of stable and, thus, predictable inflation. Firstly, an economy facing unpredictable and high inflation will have to deal with reduced purchasing power as inflation reduces the purchasing power of money, which can drive a decrease in the economy's standard of living. Then, inflation distorts price signals, which makes it more complex for investors to determine the actual value of goods and services and to make informed investment decisions. This increased uncertainty tends to reduce long-term investments from individuals and businesses as the future value of money is highly uncertain. This reluctance to invest also affects foreign investors, and it becomes clear that uncontrolled inflation can deeply harm the economy. High inflation can also hurt a country's economic competitiveness as it becomes more difficult for domestic producers to compete and align with foreign competitors who can offer similar products and services at lower prices. A

discrepancy in inflation between countries thus tends to reduce exports and increase imports for the country facing higher inflation, harming its economic activity. Finally, inflation also contributes to a redistribution of wealth as it tends to favor indebted agents (including governments) as their debt value decreases in real terms, whereas it is mainly detrimental to savers. Moreover, not all types of agents can protect themselves against inflation by having their income indexed. This wealth redistribution contributes to growing inequalities.

On the other hand, inflation can also profoundly affect financial stability. An uncertain and high inflation can erode the confidence in the value of a currency leading to a reduction in its demand. This leads to currency depreciation, further fueling imported inflation, creating a vicious circle destabilizing the financial system. High and unpredictable inflation can also induce a debt crisis where the value of fixed-income products tumbles, as market participants might expect increased interest rates to control inflation. Such a debt crisis can lead to defaults and bankruptcies, as we will discuss in part 4, which can further threaten the financial system's stability.

It is without saying that the negative consequences of uncontrolled and high inflation discussed above can trigger social and political unrest as the current political authority is seen as ineffective in managing the situation. This can expand outside the frontiers with a loss of international standing. Indeed, such a country can be considered unreliable and unstable, which damages its reputation and the willingness of other countries to engage in international trade and political agreements.

The reflection on the objectives of the central banks' monetary policy was enriched in 1993 by John Taylor, who presented his eponymous equation that first aimed at describing the interest rate policy of the central bank:

$$i_t = r^n + p_t + 0.5(y_t - y^*) + 0.5(p_t - p^*)$$

Where:

- i_t is the policy rate set by the central bank at time t
- r^n is the neutral rate (rate at which inflation is at target and the output gap is zero)
- y_t is the effective growth rate of the economy at time t and y^* is the potential growth rate of the economy, $y_t - y^*$ is mentioned as "the output gap"

- p_t is the inflation rate observed at time t and p^* is the target inflation rate

Several works showed that the Taylor equation provides a satisfactory account of the Fed's interest rate policy after 1987 and in the early 2000s, during the Great Moderation. The interest rate is positively correlated with the output gap and the deviation from the targeted level of inflation. In the initial formulations of the formula, the output gap and the deviation from the inflation target have the same weights, which supposes that the central bank cares equally about inflation and economic growth. Thus, it seems that a central bank's objectives, particularly those of the Fed, can be summarized as maintaining inflation and growth targets. A normative function later supplemented this descriptive use of the equation, the so-called "Taylor rule," which indicates the standard of interest rate-setting behavior that the central bank should adopt. Gradually, starting in the second half of the 1990s, central banks tended to adopt this rule to guide their interest rate decisions. The Taylor Rule has been praised for focusing the theory of monetary policy on a unique pillar which is setting the interest rate, in order to control inflation[1] and economic growth, which constitute the Fed's dual mandate.

Although these objectives were stated in 1977, their interpretation, relative importance, and the tools used to achieve them continue evolving based on the environment under which the monetary policy authority operates.

1.2. Instruments of conventional monetary policies

We define conventional monetary policies as the traditional tools central banks use to influence short-term interest rates and ultimately drive the economy towards the equilibrium state targeted by their respective mandates: price stability and economic growth as regards with the Fed. The primary conventional monetary tool is Open Market Operations. Other

[1] Ben Bernanke, the Fed's president in 2006, claimed that price stability is not an end but rather a means towards the other mandated objectives of the Fed, namely "sustainable employment and moderate long-term interest rates". Note that since 1977, the Fed has been operating under this dual mandate from the Congress through the Federal Reserve Act. It is important to mention that other central banks are not necessarily working towards these objectives. Namely, the primary objective of the ECB is to maintain price stability (EU 2007).

standard conventional monetary policies are reserve requirements and discount rates[2]. These monetary policies were the main tools of central banks before the Great Financial Crisis.

1.2.1. "Limited reserves framework": controlling the EFFR with open market operations

Before the Great Financial Crisis, the Fed operated in a framework where it implemented policies by supplying limited reserves to the banking system. For this reason, the Fed's main tool was Open Market Operations.

First, we can distinguish two types of reserves. Firstly, there are the Required reserves, which refer to the central bank money that a bank must hold in reserve as deposits at the Federal Reserve against stated customers' deposits. On the other hand, there are the Excess Reserves which refer to the funds held by the bank in their account at the Fed which exceed the required amount of reserves.

When a bank requires additional reserves to meet the Fed's regulatory requirement, it can borrow reserves in the Federal funds market, an interbank market. On the contrary, a bank with excess reserves can either deposit these funds in its Federal Reserve Bank account or lend them to other banks. The lenders in the Federal Funds market are considered suppliers of reserves, whereas the borrowers in this market are demanders of reserves. As in a classical supply-demand framework, the interaction between suppliers and demanders sets the Effective Federal Funds Rate. The EFFR is the interbank rate effective in the Federal Funds Market to lend and borrow reserves overnight. The calculation is a weighted average of all the overnight interbank transactions. The FOMC sets the Federal Funds Rate as the policy rate required to achieve its objectives of maximum sustainable employment and stable prices[3]. The Fed then uses different tools to move the EFFR, which is the market-determined rate, toward the target Federal Funds Rate (FFR). The EFFR can be depicted as follow:

[2] Forward Guidance is sometimes also considered conventional before the GFC. It refers to the central bank signaling its future monetary policies to financial markets to steer expectations and influence economic behavior.

[3] The FOMC meets eight times yearly to determine its target Fed Funds rate. This target depends on how the economy moves and compares to the dual mandate of sustainable employment and moderate inflation.

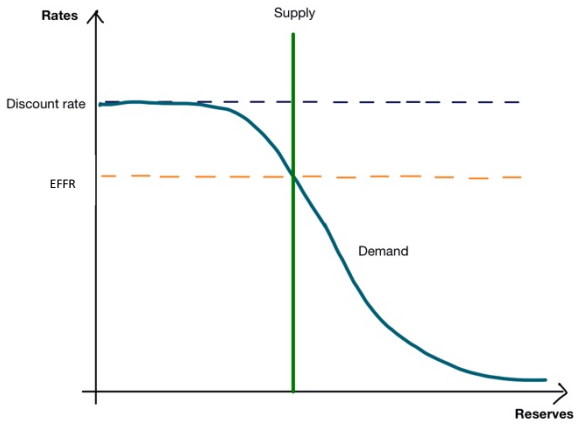


Figure 1. Setting the FFR in a Limited Reserves framework

The demand curve for reserves is downward sloping: as the cost of borrowing in the Federal Funds Market decreases, the demand for reserves increases. The Fed's discount rate[4] caps the demand curve. Indeed, banks are unwilling to borrow reserves at a rate higher than they can borrow from the Fed. In this model, the supply curve is vertical, as the Fed is the unique player which can increase (decrease) the total supply of reserves[5]. The intersection between the supply and the demand for reserves determines the Federal Funds Rate at which banks can borrow and lend reserves overnight to each other. This rate is the EFFR, a market-determined rate.

In a limited reserves framework, the supply curve intersects the downward-sloping part of the demand curve. Therefore, any relatively small change in the supply of reserves (e.g., a right (left) shift of the supply curve for an increase (decrease) in reserves) leads to a change in the Effective Federal Funds Rate equilibrium. The Fed thus can control the market-determined FFR (EFFR):

- To increase the Federal Fed Funds Rate, the Fed decreases the reserves supply, which shifts the supply curve to the left. It does so by selling securities in the Open Market[6].

- To decrease the Federal Fed Funds Rate, the Fed increases the reserves supply, which shifts the supply curve to the right. It does so by buying securities in the Open Market.

[4] The Discount Rate is the interest rate charged by the Federal Reserve to eligible depository institutions for loans obtained through the Fed's discount window. It is an administered rate.
[5] The money creation mechanism is discussed in Annexes.
[6] The mechanism of Open Market Operations is discussed in Annexes.

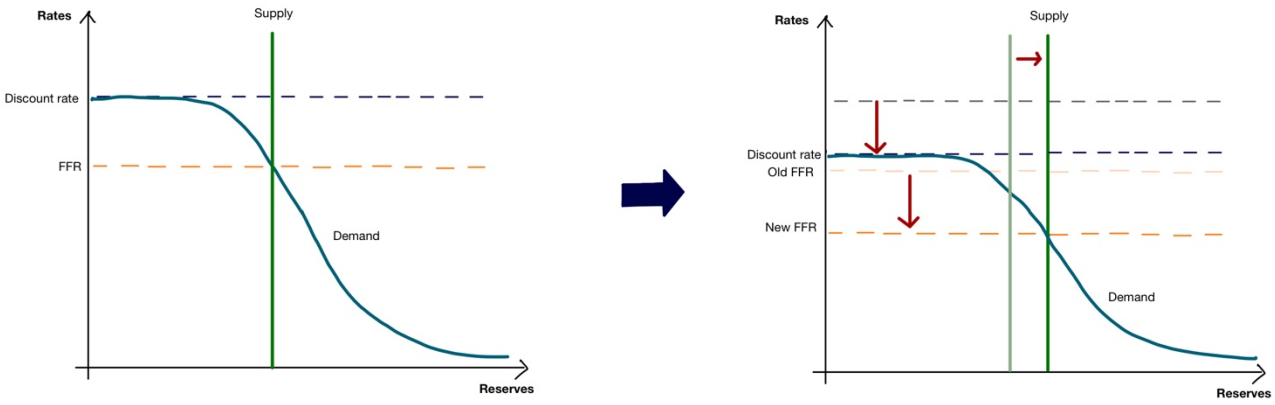


Figure 2. Expansionary policy of the Fed in a Limited Reserves framework

In the example above the Fed aims to decrease the FFR by increasing the supply of reserves. The supply curve shifts to the left, and the new intersection between supply and demand defines a new lower Federal Funds Rate.[7]

To sum up, Open Market Operations were the primary tool used by the Fed before 2008 to control the FFR and keep it close to the target set by the FOMC, i.e., at a level that ensures the economy can reach an equilibrium with maximum employment and stable prices. On top of that, the Fed could use other tools to control the demand for reserves. First, it can set the discount rate, acting as an upper bound for the Federal Funds Rate. Then the Fed can change the reserve requirements, determining the reserves banks must hold. This regulatory tool also drives the demand for reserves, particularly in a limited reserves framework[8].

However, this operational framework with limited reserves drastically changed after the GFC. As the economic conditions worsened, the FOMC decided to lower its FFR target close to zero. On top of that, it started to set a 25 basis points target range rather than a fixed FFR target. In this aim, the Fed engaged in unprecedented large-scale asset-purchase programs[9]. It purchased mainly long-term US Treasuries to lower long-term interest rates and anchor its willingness to keep low rates in the markets. These asset-purchase programs increased the Fed's balance sheet, from around $0.9 (2007) to over $2.7tn (by the end of

[7] Note that the Fed usually adjusts the discount rate in the same direction as the Federal Funds Rate.
[8] In a limited reserves framework, reserve requirements played a key role by ensuring a stable demand for reserves. Nevertheless, it is different in an ample reserves framework. As explained in the following paragraph, in an ample reserves framework, banks earn interest on excess reserves held in their Fed account which incentivize them to deposit more funds. In this sense, the Board of Governors of the Federal Reserve System announced in mid-March 2020 that it was reducing reserve requirements to zero.
[9] These programs are further explained in the part Quantitative Easing (section 1.3.2) of this report.

2014), and expanded the level of reserves in the Fed Funds Market. From this point on, the reserves were not "limited" anymore. This significant increase in the level of reserves in the banking system shifted the supply curve to the right, up to the horizontal section of the demand curve. In this situation, any slight supply curve shift would not move the equilibrium Effective Fed Funds Rate. In other words, expanding or contracting the reserves supply through Open Market Operations was no longer a sufficient tool in this new "ample reserves" framework.

1.2.2. "Ample reserves framework": controlling the EFFR through IOR and RRP (ON RRP) rates

The Fed had to implement new tools to control the overnight rate prevailing in the banking system while being on the flat portion of the demand curve. Holding the supply curve on the flat part of the demand curve is considered the "ample reserves" framework of the Fed.

In this new framework, the Fed mainly relied on two new monetary tools to adjust the overnight market rate. These tools consist of administered rates aiming to move the EFFR within the FOMC's target range.

- The Interest on Reserve rate (IOR rate)
- The Overnight Reverse Repurchase Agreement rate (ON RPP rate)

First, the Fed implemented interests on reserves (IOR)[10]. Before the GFC, reserves deposited at Federal Reserve Banks were not earning interest. Note that paying interest compensation on reserves increased banks' willingness to hold excess reserves, making reserve requirements less significant. The IOR rate appears as a safe overnight investment option for banks. Consequently, no bank will accept lending reserves at a lower rate. Hence, by setting the IOR rate, the Fed controls the level at which the demand curve flattens. However, as some financial institutions do not have access to the IOR rate, it is possible for the FFR to drop below the IOR rate without arbitragers – who borrow reserves in the Fed

[10] At first, the Fed distinguished Interests on Required Reserves (IORR) and Interests On Excess Reserves (IOER). Note that these two rates have been set to a unique rate by the end of 2008.

Funds market at the FFR and deposit their extra reserves at the Fed - being able to bring back the FFR to the IOR rate.

To prevent for this to happen, the Fed introduced the Overnight Reverse Repurchase Agreement (ON RPP) rate. This mechanism enables many financial institutions that cannot access the IOR facility, including some money market funds, to deposit reserves overnight at the Fed against some collateral. The following day, the transaction is closed, the Fed repurchases the collateral, and the counterparty receives the ON RPP rate on the amount deposited. This risk-free investment option determines a floor for the FFR rate. Indeed, if it were to fall below the ON RPP rate, this would create an arbitrage opportunity that institutions could benefit from, bringing back the FFR to the ON RPP rate. We obtain the following representation for the ample reserves framework:

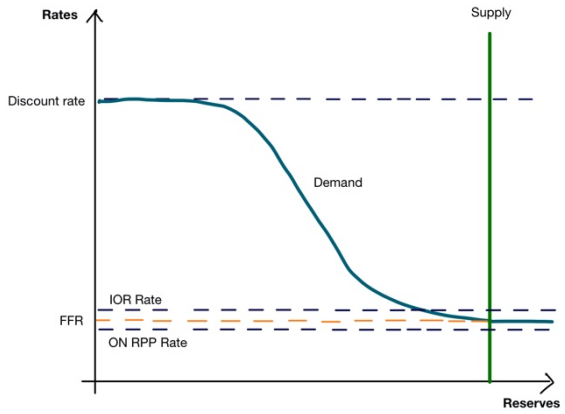


Figure 3. Setting the FFR in an Ample Reserves framework

Putting together these two administered rates, which control the horizontal part of the demand curve on the right-hand side, and the old discount rate, which still influences the top part of the demand curve, we can depict the new Fed's framework for controlling the FFR as follow:

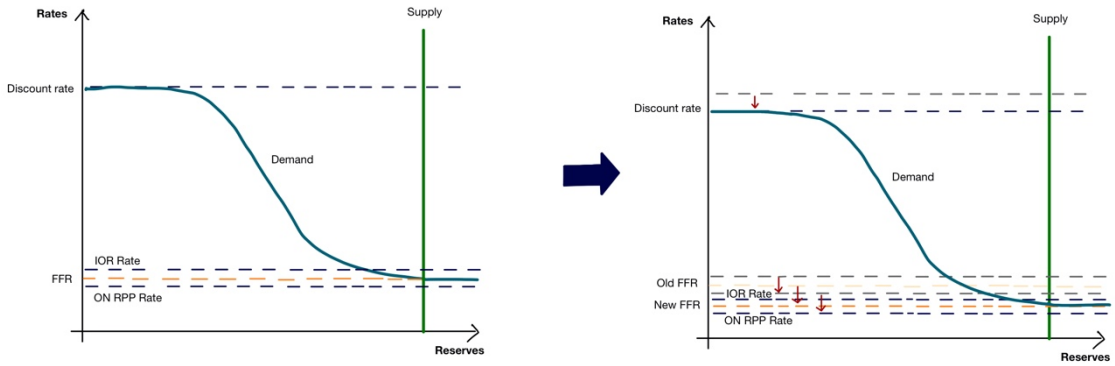


Figure 4. Expansionary policy of the Fed in an Ample Reserves framework

The example above represents an expansionary policy: the Fed aims to decrease the FFR by lowering its administered rates. The left-hand of the demand curve shifts down as the discount rate decreases, while the right-hand side of the demand curve shifts down as the IOR and ON RPP rates decrease. The new intersection between supply and demand determines a new lower Federal Funds Rate. Note that the Fed usually adjusts the discount rate in the same direction as the IOR and ON RPP rates. It is also worth mentioning that in this ample reserves framework, the Fed still uses OMO, no longer to control the level of FFR but rather to ensure that the level of reserves in the interbank market remains sufficiently ample.

In summary, the Federal Reserve's responsibility is to maintain maximum employment and price stability as mandated by Congress. For many years, the Fed has controlled market interest rates, offered to households and businesses, by controlling the Federal Funds Rate (FFR), a *short-term rate* for banks that ultimately influences all market rates. Therefore, spending and investment decisions by households and businesses are affected and should align with the Fed's dual mandate. However, the approach to controlling interest rates has shifted from using Open Market Operations to using the administered rate of Interest on Reserves (IOR). This means that if the economy slows down, the FOMC will lower the target range for the FFR, and the Fed will subsequently lower administered rates, including IOR. This prompts market interest rates to decrease.

1.3. Instruments of unconventional monetary policies

Unconventional monetary policies are non-traditional tools that central banks use when conventional policies are insufficient or have reached their limits. These policies were first

used extensively during the global financial crisis of 2008 and have since become more widely accepted as tools for central banks. Unconventional monetary policies include quantitative easing, credit easing, forward guidance on asset purchases, and negative interest rates.

The key differences between conventional and unconventional monetary policies are their purpose, scope, and scale. On the one hand, conventional monetary policies aim to influence *short-term interest rates* and money supply (by controlling the reserves supply and the money multiplier effect). Central banks use these instruments on a regular basis, and their implementation scale is limited so that it does not trigger a change in the operational framework of the central bank. On the other hand, unconventional policies are designed to address specific economic issues, including inflation-related or growth-related challenges. They were introduced as one-off policies, and their implementation usually involves much larger transactions that impact *long-term expectations of interest rates*, asset prices, and the global economic environment.

For conventional monetary policies to be effective, central banks' decisions to steer interbank short-term interest rates must be transmitted efficiently to the interest rates offered to the global economy (individual customers and companies). However, the Great Financial Crisis initiated a new economic reality where the banking system's functioning degraded, and conventional policies were not conveyed effectively to commercial banks' customers. Central banks required new instruments to restore financial stability and curtail the economic downturn.

1.3.1. The Emergence and the Necessity of unconventional monetary policies

During the GFC, as the financial tumult spread into a global economic panic, the central banks significantly lowered their administered rates in an attempt to transmit these lower rates to the economy and boost economic activity. However, at some point, Open Markets operations are not efficient anymore in a low-rate environment. Recall that Open Market Operations influence the short-term interbank lending rate by changing the reserves available in the interbank market. However, when the interbank lending rate is very low, the opportunity cost of holding excess reserves might be perceived as too low compared to the risk of lending these reserves in the Federal Funds Market. In this situation, any central bank's decision to increase or decrease banks' excess reserves does not affect the short-term interbank rate. Also, when the interest rates are very low, banks might be reluctant to entirely

pass the interest rate cuts to customers in order to keep deposits. This constrains banks' intermediation margin and thus reduces their lending. Overall, in a very low-rate environment, the interbank market progressively freezes, which curbs banks' lending to customers and potentially creates liquidity issues for banks facing large withdrawals.

Additionally, as central banks decreased the short-term interest rates to expand economic activity, one must recall that nominal interests are subject to the zero lower bound. Indeed, there is an effective lower bound for nominal interest rates since negative interest rates motivate individuals to keep their money in cash rather than putting it in the bank. Without deposits or with costly deposits, banks can not lend to customers. In such a situation of very low-interest rates, decreasing further interest rates ends up further freezing the banking system and, by transmission, the economy. This situation of very low-interest rates and low effectiveness of conventional monetary policies is called Liquidity Trap.

The above describes what happened during the Great Financial Crisis. The US Federal Reserve lowered the federal funds rate from 5.25% in 2007 to near zero by December 2008. Even with Federal Fed Funds rate at the effective lower bound, the economy was still sluggish, with inflation lower than the Fed's target and negative output gap. Note that the equilibrium interest rate determined by the Taylor rule dropped below the zero lower bound, therefore unattainable with conventional monetary policies. That is why central banks had to resort to new "non-standard' instruments to bolster the economy. The Federal Reserve then maintained the federal funds rate at a target range of 0% to 0.25% from December 2008 until December 2015.

1.3.2. Quantitative Easing: a new "non-standard" tool

Quantitative Easing is a policy that aims to foster economic activity by adjusting long-term interest rates. QE involves large-scale asset purchases of Treasury securities and other long-term financial instruments (incl. government bonds and mortgage-backed securities). This increases demand for those securities, which raises their prices, decreasing their yields. As long-term interests decrease, financing costs for businesses and households decrease, stimulating long-term investments. On top of that, QE involves central banks purchasing securities from banks and other financial institutions by creating new bank reserves. These reserves are then deposited in their central bank accounts, increasing their ability to extend

customer loans. Overall, the mechanics of QE boost banks' customer lending, drive investment and consumption, and thus boost employment rate and output.

It is critical to differentiate QE from conventional Open Market Operations discussed previously. First, their objectives differ. On the one hand, OMO is designed to steer short-term interest rates in the interbank market, feeding the rates offered in the economy. Alternatively, Quantitative Easting aims to influence long-term interest rates to solve specific economic issues directly. Then, their scale is different. QE involves buying substantially more assets than OMO, significantly affecting central banks' balance sheets. Then, as part of QE, the central bank can target specific markets depending on its specific objectives: to foster the housing market, the central bank might choose to purchase mortgage-backed securities. Finally, Quantitative Easing involves long-term transactions and long-term holding of assets, while OMO are typically short-term buying and selling of assets.

Starting in November 2008, the Fed initiated its first round of QE with the primary objective of increasing credit availability in private markets[11]. Mainly, the aim was to revive mortgage lending and support the housing market. To achieve this goal, the Fed invested $1.25 trillion in mortgage-backed securities and $200 billion in federal agency debt, bonds issued by Fannie Mae, Freddie Mac, and Ginnie Mae[12] to finance mortgage loans. Additionally, the Fed purchased $300 billion in long-term Treasury securities to lower interest rates and bolster the private credit market. Subsequent rounds of QE, in 2010, 2012 and later in 2020, further expanded the Fed's balance sheet. We will discuss the adverse effects of such policies in deeper detail in section 2.

1.3.3. Forward Guidance: a tool shaping market expectations

The second main category of unconventional measures is "forward guidance". Forward guidance consists of a central bank issuing public statements about the path of its monetary policies in the foreseeable future. For instance, it includes the central bank making

[11] This specific type of Quantitative easing is commonly named "Credit Easing". It refers to all decisions the central bank makes to ease credit granting from banks to the economy. For instance, it includes the decision of the central bank to sell short-term securities and buy more long-term securities. This changes the structure of the central bank's balance sheet and lowers long-term interests, encouraging investments. The Fed "Twist" policy, deployed in 2011, is an example of such credit easing. Another method for credit easing is the central bank accepting lower quality collaterals, which in turn enhance the quality of the banks' balance sheets and should favor lending activities.

[12] Government-sponsored mortgage companies.

a public commitment regarding the future evolution of policy rates or regarding its asset-purchase programs. The forward guidance mechanism aims to affect long-term interest rates and broader economic conditions by adjusting market expectations. For instance, by announcing that administered rates will remain low for a given period, a central bank can lower markets' expectations of future short-term rates and decrease uncertainty. This would improve households' and businesses' confidence regarding the future economic environment and encourage investments. The Reserve Bank of New Zealand and the Bank of Japan were the first to use Forward Guidance in 1997 and 1999, respectively. At this time, the Bank of Japan's policy rates were nearly zero. Following the Great Financial Crisis, the Fed started using this tool regularly in 2008[13]. Different forms of Forward Guidance exist: Open-ended forward guidance is a qualitative statement regarding the monetary policy. Data-based forward guidance describes the future path of the central bank's policy conditional on specific economic outcomes. Finally, calendar-based forward guidance depicts the path for future monetary policy within a given timeline.

It is essential to highlight that Forward Guidance's effectiveness as a monetary policy tool relies extensively on a central bank's transparency and credibility. Risks of using such a tool include markets not fully acknowledging and understanding the announced guidance or a central bank being required to change its forward guidance too often to adjust to a volatile economic environment. In such cases, markets tend to disregard the guidance, which would not reflect in long-term interest rates.

[13] Note that the FOMC shifted toward more transparent communication in the early 2000s by releasing public statements after its meetings, explaining its current policy decisions, and including indications of the economic environment risks in the near future. These post-meeting statements can be considered a form of Forward Guidance.

2. The Current Situation and the Fed's Unconventional Monetary Policy Response

2.1. Unprecedented Times: The unique challenges faced by the financial system and the global economy

2.1.1. Understanding the roots of current inflation

Recall that inflation is the cumulative increase in the general price level. We commonly measure inflation as the rate of change in the general price level from one period to another. The primary price level measure is the Consumer Price Index (CPI)[14]. This is a fixed-weight price index with weights being the quantities purchased by the average customer in a chosen base year for each item in a basket of goods and services.

Different types of inflation can occur. Demand-driven inflation is when the aggregate demand for goods at any specific price level increases more quickly than the aggregate supply of goods available at that specific price. This can happen due to insufficient raw materials or inputs or inadequate production facilities. As a result, producers cannot satisfy the demand, leading to an increase in prices. Another cause of price increase is inflation through costs, happening when the costs of production rise, including higher wages, increased cost of imported products, or any general rise in the price of intermediate consumption. Finally, inflation can occur when there is an increase in the quantity of money that exceeds demand. With more money in the economy and easier access to credit, households and businesses tend to increase their investments. As the supply of goods and services might not adjust instantaneously, this increased demand will drive prices upward. Finally, we should mention that inflation tends to become self-reinforcing. In a context of inflationary expectations, workers might bargain to increase their wages, and businesses will raise prices further to face these higher wages: this is a “wage-prices” spiral.

The past year and a half have been characterized by unprecedented high inflation caused by multiple underlying factors, both from the supply and demand side. Back in 2020, when the Covid-19 pandemic hit economies worldwide, supply chains were disrupted, from plant shutdowns to shipping disruptions and labor shortages. This caused huge supply

[14] As the CPI includes volatile food and oil prices, we often use Core CPI which excludes these items.

bottlenecks, preventing factories to produce enough to meet demand. Then starting in February 2022, the Ukraine conflict increased energy and food prices worldwide as both Ukraine and Russia stand as critical exporters of these resources. This conflict further increased the price of various goods. On the demand side, as the Covid crisis adversely affected households and companies with lockdowns and job losses, governments and central banks undertook significant expansionary fiscal and monetary policies. These policies led to an increase of the money available in the economy, which boosted the demand for goods and services. Overall, many different economies faced uncommon inflation in 2022, even more for countries relying heavily on imports. In particular, the United States faced a record-breaking CPI inflation in 2022 with a 9.1% peak in June.

Figure 5. Annual Inflation Rate in the United States based on CPI

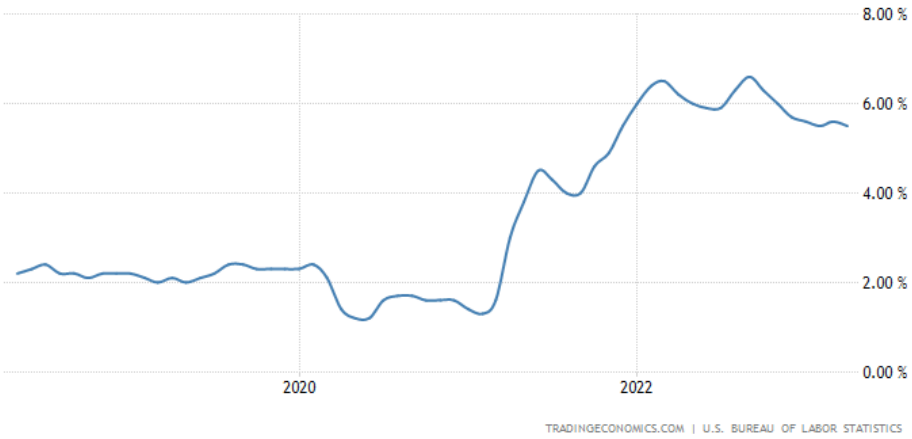


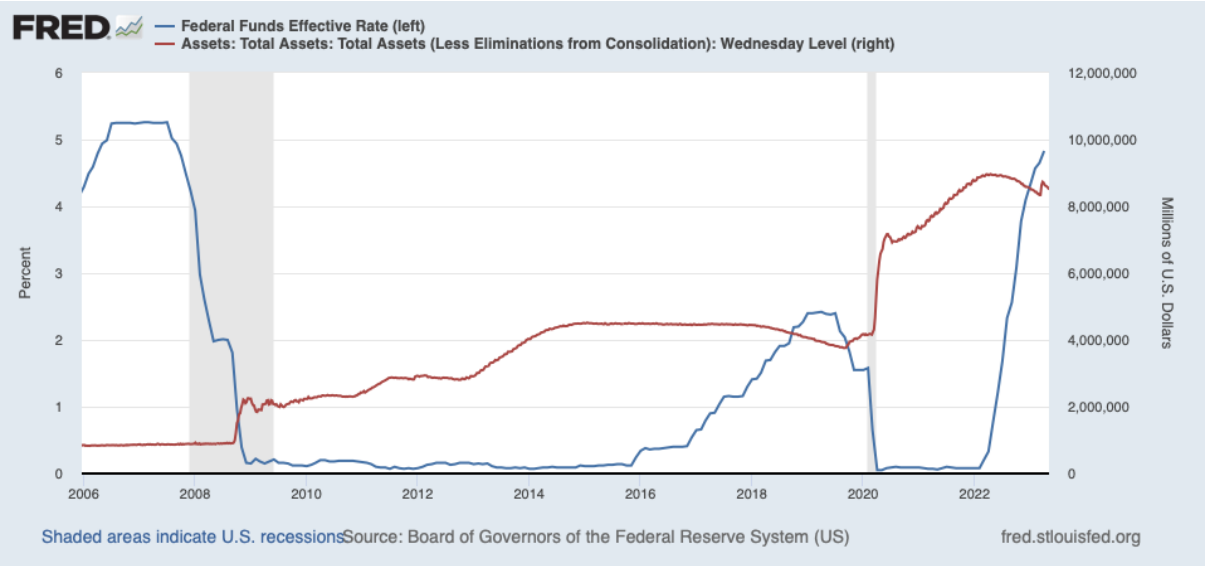
Figure 6. Annual Inflation Rate in the United States based on Core CPI (excluding food and energy)

2.1.2. From QE to Fed's balance sheet: Exploring the waves of Quantitative Easing and the Fed's growing balance sheet

As mentioned earlier, the Fed engaged in QE following the Great Recession and Covid-19 to stimulate the economy as conventional tools reached their limits. Usually, the Fed would use tools to steer short-term interest rates down, decreasing the cost of financing and fostering economic activity. Nevertheless, as short-term interest rates got closer to zero during the Great Recession and the Covid crisis, these traditional tools were no longer efficient. The Fed had to switch its focus to long-term interest rates and use new unconventional tools such as quantitative easing.

Following four consecutive waves of quantitative easing operations since the Great Financial Crisis, the size of the Fed's balance sheet has grown significantly to historic levels. As explained earlier, the first three waves of QE in 2008, 2010, and 2012 created an environment of "ample reserves". Between 2007 and 2017, the Fed's assets underwent a substantial increase from $882 billion to $4.473 trillion. Then, as can be seen in the graph below, the post-Covid quantitative easing has brought the size of the Fed's balance sheet to staggering levels. The Fed has grown its assets above $8.5 trillion.

Interestingly, the use of QE following the COVID-19 crisis to limit the economic fallout seemed to be more of a routine decision than in 2008, when QE was fully considered an exceptional, unconventional monetary instrument.



While the Fed has evolved in an ample reserves framework since 2008, the level of reserves reached since the Covid crisis is far above what is considered ample. Observing this and having discussed the consequences of QE on the economy and how it can trigger inflation, one could suspect that the Fed would stop Quantitative Easing.

In December 2021, after months of increasing inflation with U.S. officials arguing that it was a transitory phenomenon, Jerome Powell – Federal Reserve Chair - admitted that inflation was here to stay. Markets viewed this announcement as a shift towards hawkish monetary policy and an increased probability of early and fast rate rise. The Fed Chairman indeed communicated his willingness to accelerate the bond-buying taper. This period marks the beginning of a new monetary policy era, with the primary objective of fighting the deeply anchored and increasing inflation. Two main tools will be used: conventional monetary policy with policy rates and unconventional monetary policy with Quantitative Tightening.

2.2. Understanding the need for implementing Quantitative Tightening

2.2.1. Definition of Quantitative Tightening

Quantitative Tightening (QT) is a contractionary monetary policy that consists of reducing the balance sheet of a central bank. On the one side, we distinguish passive tightening, when the central bank decides to let its bonds mature without reinvesting the proceeds, progressively shrinking the size of its assets. Conversely, there is active tightening when the central bank actively sells its bond holdings. Choosing between passive or active tightening affects QT's effects on financial markets and the economy. As the central bank decides to engage in QT, demand for long-term Treasuries (and other long-term securities bought by the central bank during previous QE waves) decreases. This has the effect of anchoring long-term rates at a higher level. If the central bank chooses active tightening and sells such assets, it can temporarily increase volatility in these abandoned markets as private investors must adjust to absorb the increased supply. The effects of Quantitative Tightening are further discussed in the following paragraph.

2.2.2. Effects of Quantitative Tightening and rationale for shrinking the Fed's balance sheet

Unlike QE, there are much fewer QT episodes to study. The Fed only attempted QT once before 2022, from October 2017 to September 2019[15], making understanding and estimating QT effects more complex and uncertain. A study realized in June 2022 projected that decreasing the size of the balance sheet by approximately $2.5 trillion over the following years would have roughly equivalent effects to raising the policy rate by 50 basis points. The study stresses the high uncertainty of these estimates.

One might be tempted to believe that quantitative tightening (QT) effects would only be the reverse of quantitative easing (QE) effects, but there are some crucial differences.

First, the signaling effect of QE is sought to be greater than QT. Quantitative Easing is indeed a positive surprise for the markets. During a crisis, the Fed rapidly communicates its decision to engage in QE to calm markets. However, QT signals much worse news regarding the future economic environment. The Fed, therefore, wants to avoid surprising the markets with its Quantitative Tightening decisions, thus announcing its plans well in advance. In that respect, the Fed communicated its QT plans in January 2022, then detailed the schedule for roll-off in May, and finally started deploying the plan in June. Also, it took all the care to communicate about a progressive schedule for shrinking the balance sheet with progressive reinvestment caps. This careful communication aimed to reassure markets and avoid the significant market reaction that happened when Ben Bernanke unexpectedly announced the possibility that the Fed would unwind QE soon in 2013[16].

Second, the effects of QE and QT on market liquidity seem to differ. A study by Andrew Lee Smith and Victor Valcarcel estimated the liquidity effects of QT to be twice those of QE. Indeed, as the Fed balance sheet's asset side shrinks, the liability side, primarily composed of reserves used to purchase its assets during QE, decreases by the same amount. On top of that, as the Fed no longer purchases long-term assets, private markets must deal with the considerably larger amount of assets available. Ultimately it might increase markets' volatility.

[15] This past unsuccessful QT attempt also differs from the 2022 Quantitative Tightening by its size, as its plans were much less aggressive than today's.
[16] This episod is the 2013 « taper tantrum".

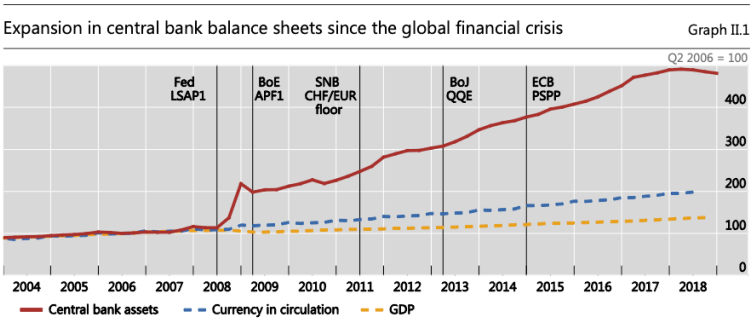
However, these effects are mainly uncertain. Given these uncertainties, one may wonder why the Fed decided to use QT and decrease the size of its balance sheet. Indeed, the Fed could increase its administered rates as there is no upper bound for interest rates, unlike the lower bound when lowering rates. Three primary reasons come to light.

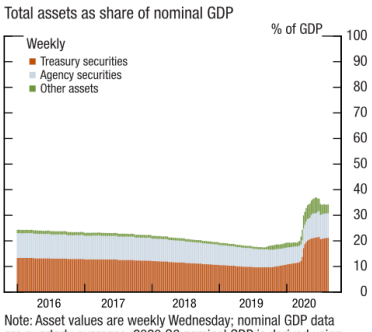
The first explanation relates to the increased interest rate risk faced by the Fed. To understand where this risk comes from, one should return to the series of Quantitative Easing policies since the GFC and their consequences on the Fed's operational framework and policymaking. Indeed, we have previously discussed the consequences of QE on interest rates and how it can spur the economy, but QE also affects the structure of the Fed's Balance Sheet. As the Fed bought long-term securities (mainly Treasuries and MBS), it fixed the interest it would earn until these securities would mature. However, the interests paid on the liability side of its balance sheet depend on its monetary policy. As the Fed began to change its monetary policy and raise interest rates to fight inflation before shrinking its balance sheet, it exposed itself to the risk of paying more on its liabilities than its earnings on its long-term assets. Indeed, its liability side is currently composed mainly of Reserves and Reverse Repos, on which it must pay interests. This was not the case before 2008 when currency was its primary liability. Even though the Fed cannot default in case of significant losses, it could require support from the Treasury which would alter its independence. Hence the Fed prefers to avoid such a situation and cares about limiting its exposure to such losses by decreasing the size of its balance sheets. This situation happened in March 2022 when the Fed enacted its first interest rate hike to fight against inflation which started running well above its inflation target. Therefore, to limit losses, the Fed decided to end its QE policy in March 2022 and then to shrink its balance sheet starting June 2022. First, the ceasing of QE refers to only reinvesting maturing securities to maintain the size of its balance sheet. The second step, Quantitative Tightening, refers to progressively stopping reinvestments of these maturing securities. The Fed did so by setting monthly caps that limit reinvestments. As proceeds from mature securities are not reinvested, the size of the Fed Balance sheet shrinks.

The second reason justifying Quantitative Tightening is the need to align short-term and long-term tools in order to convey its policies efficiently. Indeed the policy rates that the Fed administers are overnight rates. These short-term policy rates shape the left-hand side of the yield curve, and the ultimate objective for the Fed is to feed long-term rate expectations

with these short-term rates: policy transmission. Indeed, long-term rates are those affecting households' and businesses' investments and spending decisions. However, suppose the Fed continues to purchase long-term Treasuries or any long-term securities. In that case, it will exert downward pressure on long-term rates, despite its willingness to increase interest rates to slow down the economy and fight against inflation. This would undermine the effectiveness of its rate policy.

The third explanation for the Fed's decision to decrease its balance sheet is that its current size seems inadequate with regard to the current GDP. Since the GFC, the Fed's balance sheet growth outpaced the growth of U.S. GDP (see the graph below). This can participate in inflationary pressure as the supply of reserves increases more rapidly than the rate at which the economy absorbs it. In its fight against inflation, shrinking its balance sheet could help lower these inflationary sources.





Finally, another possible reason for shrinking the balance sheet relates to the Fed's balance sheet structure. The Fed's assets are mainly Treasuries and MBS (above graph). However, by holding non-treasury assets such as MBS, the Fed chooses to directly support specific markets, although some argue that this is not the role of the Fed. By changing the composition of the Fed's assets to only Treasuries, the Fed would return to a more neutral position.

Having mentioned these macroeconomic effects of QT, our objective is to analyze the Fed's 2022 Quantitative Tightening effects empirically. Ultimately, our goal will be to discuss whether these changes are subject to last. First, we will analyze the impacts of Quantitative Tightening on different asset classes. Then we will explore how QT impacts the global banking system and, as a fallout from that, the real economy.

3. Tracking the impact of Quantitative Tightening on asset classes: the great repricing, volatilities, correlations: are we entering a new regime?

3.1. The year 2022 in the financial markets

It would be an understatement to say that 2022 was a turbulent year. As investors reacted to increasing inflation and Russia's invasion of Ukraine, equity markets - which had peaked in January - fell sharply in less than two months following these events. The tightening of monetary policy was subsequently triggered by soaring inflation. Bond prices dropped by record levels as a result of central bank policy rates and interest rates across maturities rising at the fastest pace in decades. Furthermore, once the Nord Stream 2 project was halted and additional energy export restrictions were placed on Russia, the price of oil and natural gas fluctuated heavily. Growing geopolitical tensions throughout the world following the invasion of Ukraine as well as China's aggressive posture, notably toward Taiwan, caused further turmoil in the financial markets. All in all, it goes without saying that 2022 was a year of high volatility in all asset classes, characterized by negative performances except for the energy sector.

US equities, as measured by the S&P 500, recorded a maximum drawdown of 25% and a final total return of -18.1% for the year. With a maximum cumulative drawdown of 44%, the FANGMANT stock basket (Facebook/Meta, Apple, Netflix, Google/Alphabet, Microsoft, Amazon, Nvidia, and Tesla) was among the worst-performing ones in the S&P 500. Tesla and Facebook/Meta performed extremely poorly, with maximum drawdowns exceeding 70%. European stocks, excluding the UK, declined by 12.2% over 2022 as shown on the Table below of World stock market returns. Nevertheless, stock markets had a strong start to the year 2023 so far with European stocks gaining back 8.1% as of January 2023 and the S&P 500 rising by 4.7% over the same period. Overall, developed markets equities, measured by the MSCI World Index, declined by 17.7% over 2022, and Growth equities, measured by the MSCI World Growth Index fell sharply by 29.1%. Value stocks, measured by the MSCI World Value Index, experienced the smallest decline with only -5.8% returns due to their defensive status among equities.

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Jan '23
MSCI Asia ex-Japan 19.9%	US S&P 500 2.1%	MSCI Asia ex-Japan 22.7%	Japan TOPIX 54.4%	US S&P 500 13.7%	Japan TOPIX 12.1%	UK FTSE All-Share 16.8%	MSCI Asia ex-Japan 42.1%	US S&P 500 -4.4%	US S&P 500 31.5%	MSCI Asia ex-Japan 25.4%	US S&P 500 28.7%	UK FTSE All-Share 0.3%	MSCI Asia ex-Japan 9.8%
MSCI EM 19.2%	UK FTSE All-Share -3.5%	Japan TOPIX 20.9%	US S&P 500 32.4%	Japan TOPIX 10.3%	MSCI Europe ex-UK 9.1%	US S&P 500 12.0%	MSCI EM 37.8%	UK FTSE All-Share -9.5%	MSCI Europe ex-UK 27.5%	MSCI EM 18.7%	MSCI Europe ex-UK 24.4%	Japan TOPIX -2.5%	MSCI EM 9.2%
US S&P 500 15.1%	MSCI Europe ex-UK -12.1%	MSCI Europe ex-UK 20.0%	MSCI Europe ex-UK 24.2%	MSCI Europe ex-UK 7.4%	US S&P 500 1.4%	MSCI EM 11.6%	Japan TOPIX 22.2%	MSCI Europe ex-UK -10.6%	UK FTSE All-Share 19.2%	US S&P 500 18.4%	UK FTSE All-Share 18.3%	MSCI Europe ex-UK -12.2%	MSCI Europe ex-UK 8.1%
UK FTSE All-Share 14.5%	Japan TOPIX -17.0%	MSCI EM 18.6%	UK FTSE All-Share 20.8%	MSCI Asia ex-Japan 5.1%	UK FTSE All-Share 1.0%	MSCI Asia ex-Japan 5.8%	US S&P 500 21.8%	MSCI Asia ex-Japan -14.1%	MSCI EM 18.9%	Japan TOPIX 7.4%	Japan TOPIX 12.7%	US S&P 500 -18.1%	Japan TOPIX 4.8%
MSCI Europe ex-UK 5.1%	MSCI Asia ex-Japan -17.1%	US S&P 500 16.0%	MSCI Asia ex-Japan 3.3%	UK FTSE All-Share 1.2%	MSCI Asia ex-Japan -8.9%	MSCI Europe ex-UK 3.2%	MSCI Europe ex-UK 14.5%	MSCI EM -14.2%	MSCI Asia ex-Japan 18.5%	MSCI Europe ex-UK 2.1%	MSCI EM -2.2%	MSCI Asia ex-Japan -19.4%	US S&P 500 4.7%
Japan TOPIX 1.0%	MSCI EM -18.2%	UK FTSE All-Share 12.3%	MSCI EM -2.3%	MSCI EM -1.8%	MSCI EM -14.6%	Japan TOPIX 0.3%	UK FTSE All-Share 13.1%	Japan TOPIX -16.0%	Japan TOPIX 18.1%	UK FTSE All-Share -9.8%	MSCI Asia ex-Japan -4.5%	MSCI EM -19.7%	UK FTSE All-Share 4.7%

Source: FTSE, MSCI, Refinitiv Datastream, Standard & Poor's, TOPIX, J.P. Morgan Asset Management. All indices are total return in local currency, except for MSCI Asia ex-Japan and MSCI EM, which are in US dollars. Past performance is not a reliable indicator of current and future results. Data as of 31 January 2023.

Figure 7. World stock market returns (*Source: JP Morgan AM*)

In 2022, bonds experienced a sharp decline in response to increasing inflation and interest rates in advanced economies. Bonds are typically used to protect portfolios against equity drawdowns, but their value dropped significantly. The maximum drawdown for 10-year US Treasuries was 22%, which is unusual given their lower volatility compared to US equities. Similarly, the maximum drawdown for 10-year German bunds was 21% and for 10-year UK gilts, it was 26%. Although shorter-term bond benchmarks also declined, they experienced a smaller maximum drop, with 1- to 10-year US Treasuries falling 11%, 1- to 10-year German bunds declining 12%, and UK gilts decreasing by 15%.

The table below, which represents fixed-income government bonds returns using the Bloomberg Barclays benchmarks, shows that US Treasuries had returns of -12.5%, while the UK bonds (Gilts) suffered the biggest decline: -25.1%.

2014	2015	2016	2017	2018	2019	2020	2021	2022	Jan '23
Spain 15.9%	Italy 4.8%	UK 10.7%	Global 7.5%	Spain 2.5%	Italy 10.6%	Global 9.7%	Japan -0.2%	Japan -5.4%	Global 3.1%
Italy 15.2%	Spain 1.7%	Spain 4.1%	US 2.3%	Germany 1.9%	Spain 8.3%	UK 8.9%	US -2.3%	US -12.5%	UK 3.0%
UK 14.6%	Japan 1.2%	Germany 3.4%	UK 2.0%	Japan 1.0%	UK 7.1%	US 8.0%	Germany -2.9%	Global -16.8%	Italy 2.8%
Germany 9.0%	US 0.8%	Japan 3.2%	Spain 1.1%	US 0.9%	US 6.9%	Italy 7.9%	Italy -3.0%	Italy -17.2%	US 2.1%
US 5.1%	UK 0.5%	Global 1.7%	Italy 0.8%	UK 0.5%	Global 5.6%	Spain 4.3%	Spain -3.0%	Germany -17.4%	Spain 2.0%
Japan 4.5%	Germany 0.4%	US 1.0%	Japan 0.2%	Global -0.7%	Germany 3.1%	Germany 3.0%	UK -5.3%	Spain -17.5%	Germany 1.9%
Global -1.0%	Global -3.7%	Italy 0.8%	Germany -1.0%	Italy -1.3%	Japan 1.7%	Japan -0.8%	Global -5.8%	UK -25.1%	Japan -0.1%

Source: Bloomberg Barclays, Refinitiv Datatsream, J.P. Morgan Asset Management. All indices are Bloomberg Barclays benchmark government indices. All indices are total return in local currency, except for global, which is in US dollars. Past performance is not a reliable indicator of current and future results. Data as of 31 January 2023.

Figure 8. Fixed income government bonds returns (*Source: JP Morgan AM*)

The invasion of Ukraine caused a great deal of upheaval in the oil and natural gas markets, bringing energy security concerns to the forefront once again after a period of relative stability. WTI oil prices experienced significant fluctuations, rising by 62% between January and June 2022 before falling by 42% to a low point in early December. Overall, WTI oil prices increased by 7% for the year. Brent oil prices followed a similar pattern, rising by 59% before falling by 38% and ultimately ending the year up 10%. Natural gas prices were particularly volatile, especially in Europe, where they increased by nearly five times by August before experiencing a significant decline. Overall, commodities were the only asset class experiencing positive returns (measured by the Bloomberg Commodity Index), with 16.1% increase over the year.

Before looking more precisely at how these asset classes were repriced (returns, volatilities, cross-correlations), let us discuss the different mechanisms at play in their valuations.

3.2. Theories of repricing of fixed-income instruments due to rates hikes

Quantitative tightening can lead to higher interest rates and a reduction in the money supply, which can impact fixed income securities such as bonds. When the Fed stops purchasing bonds or sells bonds back into the market, it reduces the demand for bonds, leading to a decline in bond prices and an increase in yields. This means that borrowers will

need to pay higher interest rates to borrow money, and existing bondholders may experience capital losses if they sell their bonds before maturity.

3.2.1. The mark-to-market mechanism

The mark-to-market (MTM) is an essential mechanism in finance as it is used to determine the current market value of an asset, such as a fixed-income instrument, based on the prevailing market conditions. In the context of fixed-income instruments (bonds, notes, and other debt securities), MTM refers to the process of valuing these instruments based on current interest rates and yield curves, credit ratings, and other market conditions as their value can fluctuate significantly based on variations of these parameters.

The MTM can then be used to calculate the hypothetical returns or losses on the investment if the position is closed. More precisely, the MTM process for fixed-income instruments involves comparing the current market price of the instrument to its original cost or book value. If the current market price is higher than the book value, the instrument is said to have a positive MTM, which means that the investment has appreciated in value. Conversely, if the current market price is lower than the book value, the instrument is said to have a negative MTM, which means that the investment has depreciated in value.

When interest rates rise, it can harm the value of financial assets such as fixed-income securities. This is explained by how we value these financial instruments: by doing the sum of their discounted cash flows.

Let us recall that the Yield to Maturity is the internal rate of return (IRR) of the project corresponding to investing in the bond at the current (dirty ask) price and holding it to maturity. For a zero-coupon bond, the yield to maturity is easily derived. Indeed, on a zero-coupon bond that pays in j years, the (annually compounded) yield to maturity is the discount rate y_j such that:

$$Bond\ Price = \frac{Bond\ Face\ Value}{(1 + y_j)^j}$$

The yield to maturities y_t for zero coupon bonds of different maturities t gives the zero-coupon yield curve. Therefore, if we note C the coupon rate, N the nominal, T the maturity, P the dirty ask price, and t_i the coupon payment dates, we get for annual coupons and annually compounded yield y_a:

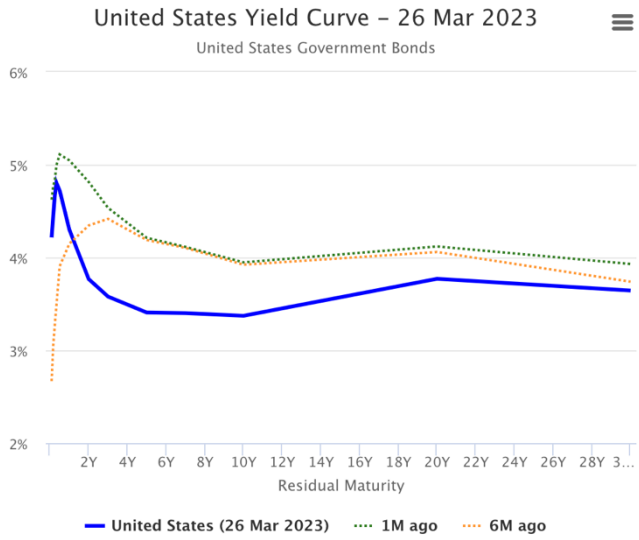
$$P = \sum_{i=1}^{n} \frac{C \times N}{(1 + y_a)^{t_i}} + \frac{N}{(1 + y_a)^{T}}$$

When the yield curve is shifted upwards, for example following a rate hike (e.g., by 25bps at the Fed meeting in March 2023), the discount factor is increased and therefore, the bond's market price is reduced. Consequently, if the Fed continues its monetary policy of hiking rates to curb inflation, every Fed meeting will be accompanied by an instant negative mark-to-market for holders of fixed-income securities. Obviously, this repricing is in fact not 'instant' as investors constantly use their expectations of rate hikes, yield curve etc to price fixed-income instruments.

Another way, perhaps more intuitive, to understand this is because fixed-income securities are issued with a stated interest rate, typically fixed for the life of the security. If interest rates rise, newly issued bonds will have a higher interest rate, which makes the previously issued bonds less attractive to investors. To compensate for this, the bond's market price will decrease so that its yield aligns with the current market interest rate. For example, suppose an investor holds a 10-year bond with a 2% interest rate. If market interest rates rise to 3%, new bonds will be issued with a 3% interest rate. The investor's bond with a 2% interest rate will be less attractive, and the bond's market value will fall until the yield matches the current market interest rate of 3%. This decrease in market value is a capital loss.

3.2.2. Inverted yield curve and negative roll-down returns

An inverted yield curve refers to a situation wherein yields on long-term maturities are lower than yields on short-term maturities for bonds of the same credit quality. This is an unusual situation because, under normal circumstances, investors demand a higher yield for longer-term investments to compensate for the additional risk and uncertainty associated with holding the bond for a longer period. A downward-sloping yield curve depicts investors anticipation of higher interest rates in the short term, and their belief that these higher rates will eventually harm the economy and force the Fed to loosen monetary policy at some point in the future. Below is the yield curve of US Governments Bonds as of March 26, 2023:



An important notion when considering fixed-income securities is the roll-down effect. Let us take a practical example in an inverted yield curve environment to grasp this concept. When an investor buys a 10-year Treasury it does not stay a 10-year bond forever. After three years, for all practical purposes, it is a seven-year bond, and after a further two it is a five-year bond. In an inverted yield curve environment, if rates have not changed, the yield on the now five-year bond should be higher because it is a shorter-term bond. And because bond prices and interest rates move in opposite directions, the higher interest rate of this shorter-maturity bond means the bond should decrease in price as time passes. Basically, the investor is losing money by rolling down the yield curve, which occurs over time as bond cash flows' due dates move along the yield curve.

3.3. Empirical dive into 2022's asset class valuation levels, returns, and volatilities

In order to conduct our empirical analysis, we used daily time series from Bloomberg. In particular, we used the *XCMP Index*, the NASDAQ Composite Total Return[17], the *SPTR500N Index*, the S&P 500 Total Return Index, where index level changes reflect both movements in stock prices and the reinvestment of dividend income, and *RUTTR Index*, the Russell 2000 Total Return Index. Regarding fixed-income markets, we used the *LBUSTRUU Index*, a Total Return index measuring the investment grade, US dollar-denominated, fixed-rate taxable bond market[18], to represent the global U.S. bond market. Additionally, we analyzed the

[17] The index reinvests cash dividends on the ex-date.
[18] It includes treasuries, government-related and corporate securities, mortgage-backed securities (agency fixed-rate and hybrid ARM pass-throughs), ABS and collateralized mortgage-backed securities (agency and nonagency).

LUATTRUU Index (Total Return USD Unhedged), which measures US dollar-denominated, fixed-rate, nominal debt issued by the US Treasury, and the *LUACTRUU Index*, a Total Return index measuring the performance of the investment grade U.S. corporate bond market. Concerning the FX markets, we studied the *EURUSD currency*, the *U.S. Dollar Index (DXY)*, measuring the value of the United States dollar relative to a basket of foreign currencies, and the *USDJPY currency*. We will only focus on bonds and equities within the main document body. Other asset classes are mentioned in the Appendix.

As mentioned in section 3.1., 2022 was a very singular year for financial markets during which all asset classes performed poorly. As we can observe on the graph below, it is highly uncommon to see both bonds and equities have negative performance over the same year.

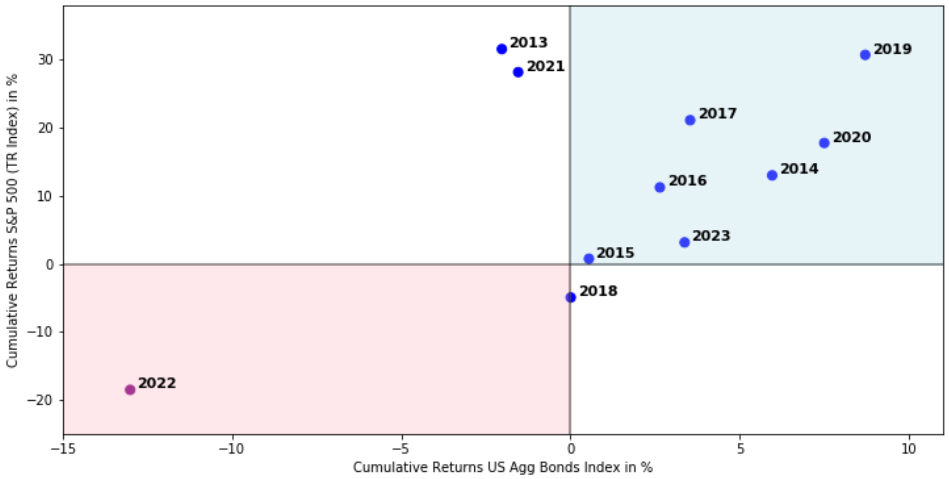


Figure 9. Comparing the U.S. bond market and the U.S. stock market performances[19]

Interestingly, we observe in Figure 10. that the year 2022 has been less volatile for U.S. equities than the year 2020 when Covid-19 surged (based on the S&P500 Total Return Index difference between maximum drawdown and maximum return). Also, we can observe that, unlike U.S. bonds and U.S. equities, the U.S. currency has performed well in 2022. The United States dollar appreciated against nearly all significant currencies to levels that have not been observed for years as the Fed increased interest rates aggressively in an attempt to address inflation. The relative resilience of the U.S. economy, its relatively high. interest rates

[19] We used the LBUSTRUU Index to represent the global U.S. bond market and the S&P 500 Total Return Index to represent the U.S. equity market.

compared to other economies, and its historical safe-haven status participated to this bullish trend. However, as signs of disinflation manifested at the end of 2022, we should expect the Fed's pace of rate hikes to slow down and central banks' monetary policies to become more aligned starting from 2023. Therefore we should slowly observe a decline in the U.S. dollar strength throughout 2023.

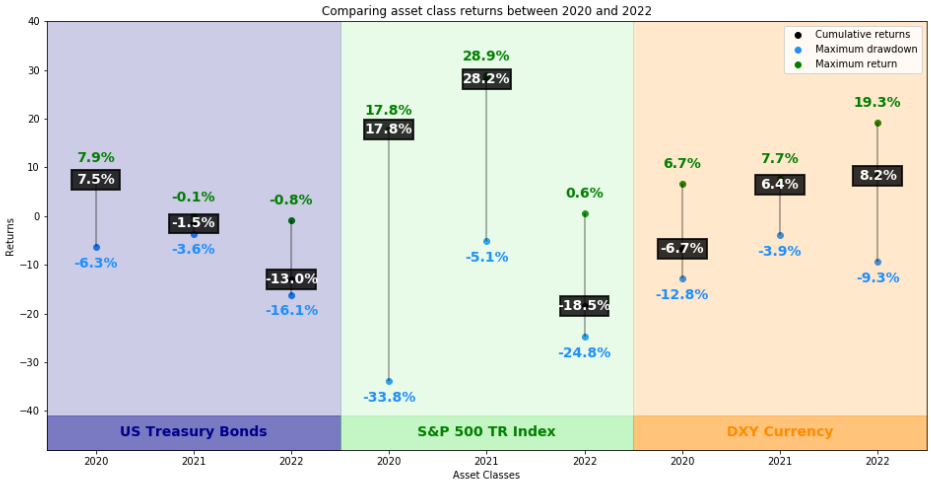
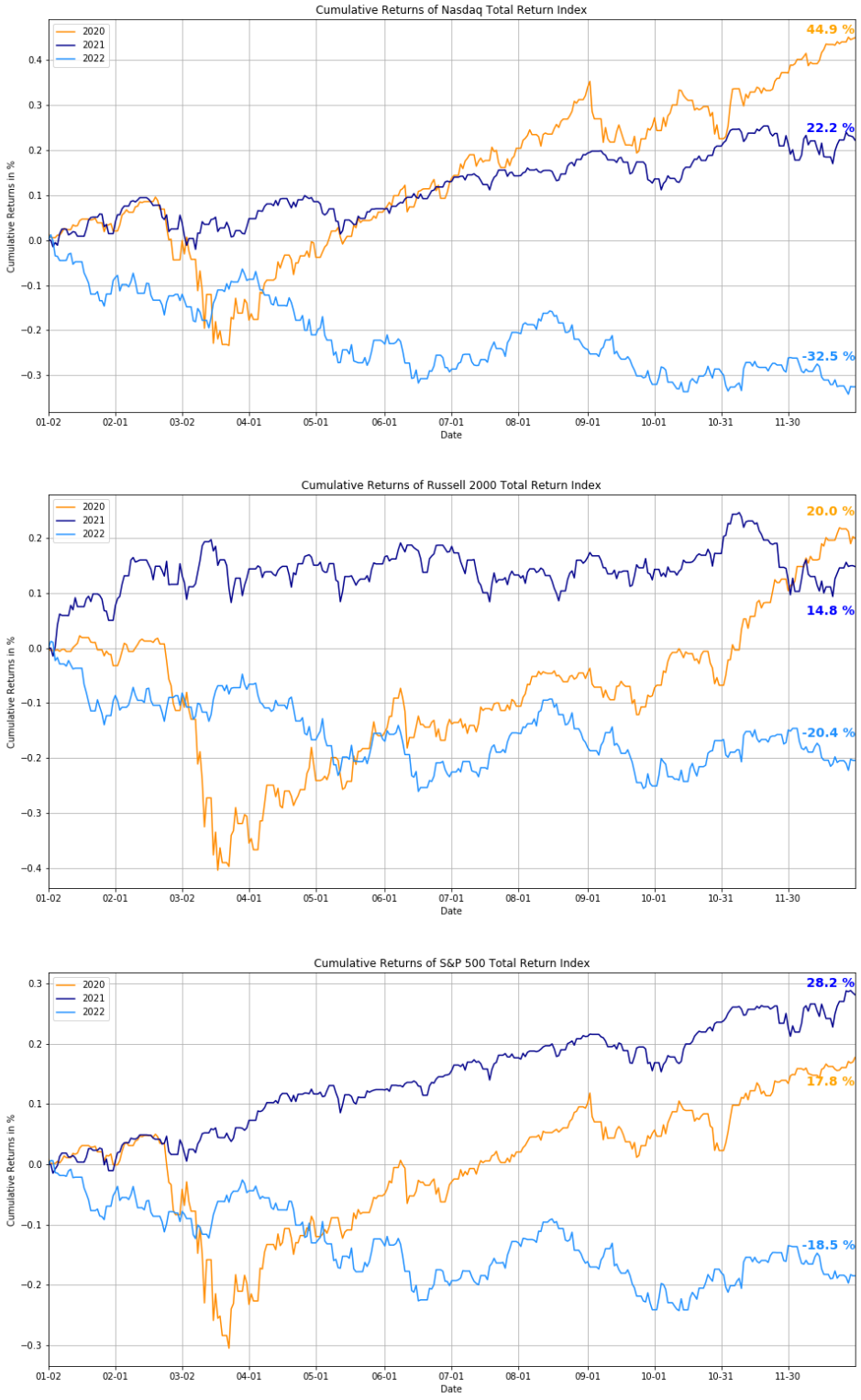


Figure 10. Comparing asset class returns between 2020 and 2022[20]

In the following sections we will dig deeper into the realized performance and volatilities of U.S. equities and U.S. bonds in 2022. We will discuss how the progressive Fed's announcements regarding the severity of inflation, the end of Quantitative Easing and the following incremental downsizing of the balance sheet with Quantitative Tightening, and the simultaneously increases in policy rates, have affected the market.

[20] We computed the Maximum Drawdown as the percentage decline from its peak value to its lowest point during a specific period. We computed the Maximum Return as the maximum cumulative return over the year.

3.3.1. Focus on equity



Figures 11. Cumulative Returns of different U.S. stock market indices from 2020 to 2022

We can observe from the graphs above that U.S. stocks performed poorly in 2022. The sharp increase in interest rates in 2022, increased the discount factor used to discount future

cashflows from stocks and future expected earnings. On top of that, higher market volatility and the high uncertainty regarding future Fed rate hikes decreased investors' risk appetite. This increased the equity risk premium as investors asked for higher compensation for risk. Additionally, as Fed's monetary policy became more and more hawkish and Jerome Powell showed his willingness to curb inflation, no matter the effects on economic growth, investors became concerned about a possible economic recession. Consequently, expectations for future earnings and dividends growth decreased significantly. Overall, all these effects pushed companies' market values downward.

We can note that the worst performance in 2022 has been for the Nasdaq Total Return Index with a -32.5% cumulative return, then the Russell 2000 Total Return Index exhibited a -20.4% cumulative return, and ultimately, the more resilient Index was the S&P Total Return Index with a -18.4% cumulative return. This highlights that tech companies – which tend to be the most expensive stocks, trading at very high multiples - had the most acute effects of increased rates. It can also depict that the tech sector was the most affected by the change in monetary policy and future economic growth expectations. Apple and Meta are great examples of harsh market value declines in 2022. Then the Russell 2000 Total Return Index performance provides evidence of the higher sensitivity of the small-cap stock market to changes in the economic outlook. Indeed, small companies usually exhibit higher market risks and have greater volatility.

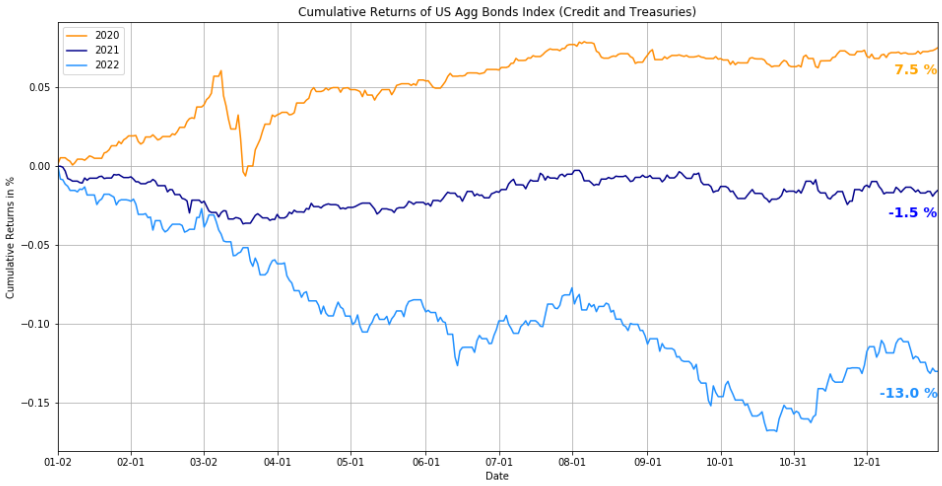
Concerning stock market volatility, we observe in Figures 12. an apparent increase in realized volatility starting from November 2021. This coincides perfectly with Jerome Powell's speech on the 29th of November 2021, claiming that "transitory" was not suitable anymore to define inflation. Interestingly, the FOMC's enactment of the first rate hike on the 16th of March 2022, also marking the end of its large-asset purchase program of 'QE', did not appear as such a pivotal date, even though it let volatility on its increasing trend. Thanks to the communication of the transparent communication of the Fed and the upstream announcements of the Fed's officials acknowledging sticking inflation and the need for balance sheet normalization by the end of 2021, markets had time to digest and incorporate this news into their market expectations straight away. By the end of 2022, an evident decline in equity volatility can be observed, which reflects the emerging signs of declining inflation (Figures 5. and 6.)

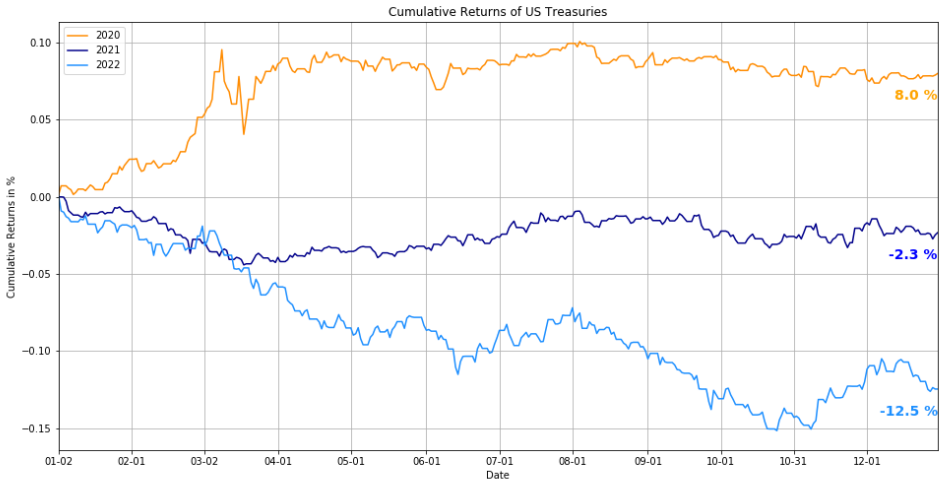
Figure 12. Realized volatility (annualized) of different U.S. stock market indices

3.3.2. Focus on bonds

As we can observe in the graphs below, the global U.S. bond market followed very different paths between 2020 and 2022. In 2020, the U.S. bond market faced substantial

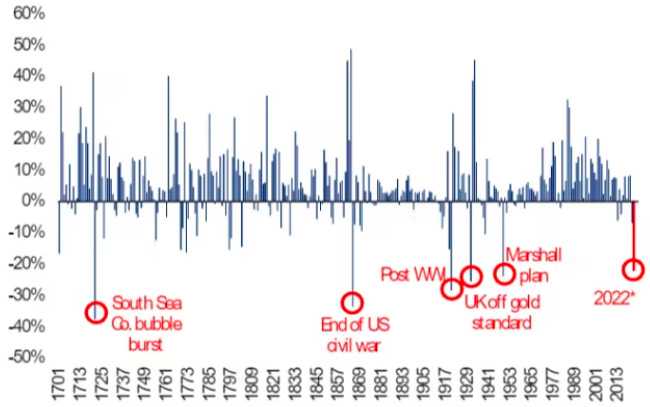
growth as Covid-19 hit sharply and investors ran onto safe-haven assets, leading yields to plunge to historic low levels. This drop in U.S. Treasury yields was stimulated by the unprecedented Fed's support through QE. Then, from 2021, yields slowly began to increase amid rising concerns about inflation and expectations that the Fed will start to ease its monetary policy and decline its rate of bond purchases. U.S. bonds experienced negative returns in 2021, with approximately -2.3% cumulative returns for U.S. Treasuries. Finally, 2022 stands as one of the worst-ever years for the U.S. bond market. We clearly observe a sharp decline in the cumulative returns curve at the beginning of March 2022, which coincides with the first Fed's hike rate. Then by the end of July 2022, another shock seemed to drive bond prices down. This corresponds to the U.S. Consumer Price Index release for the 12-month period ending in June 2022. The CPI rose by 9.1% from 2021, well above expectations, reaching the fastest increase since 1981. From November 2022 onwards, bond prices rallied as the CPI increase started to slow down, and markets anticipated that the Fed might reduce the speed of monetary tightening, resulting in a decrease in yields.





Figures 13. Cumulative Returns of different U.S. bond market indices from 2020 to 2022

As shown on the graph below, government bonds experienced in 2022 the 6th worst annual return since 1700, as measured by the world government bonds index annual total returns (GDP-weighted, %).



Source: BofA Global Investment Strategy, GFD Finaeon. *Annualized return for 2022 as of October.

Figure 14. Annual world government bonds returns (*Source: BofA Global Research*)

If we look more closely at the realized volatility in the bond market, we observe similar patterns as those for equities. Indeed the volatility of the U.S. Aggregate Bond Index started to increase abruptly by the end of 2021, when Fed officials finally recognized the persistence of inflation. Since then, annualized volatility in the bond market has remained well above historical levels and beyond the level reached during the Covid crisis. Volatility only began to show weak signs of decline at the end of 2022, as news regarding inflation became more optimistic.

Figure 15. Realized volatility (annualized) of different U.S. bond market indices

The ICE Bank of America Move index of bond market volatility confirms these observations. It increased continuously throughout 2022. More recently, in March 2023, the index jumped far above its early 2020 coronavirus pandemic peak to hit its highest level since the 2008 financial crisis. This is due to the turmoil affecting the banking system after the failures of SVB and Signature Bank.

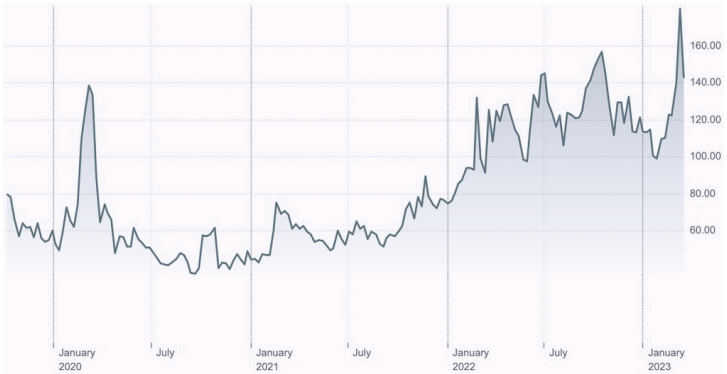


Figure 16. ICE BofA MOVE Index (*Source: FT*)

Overall, we can make two observations regarding the period the Fed developed its Quantitative Tightening plan.

First, this period has been characterized by robust negative performance and soaring volatility for both U.S. equities and bonds. The unrivaled rate hikes to fight the persistent and unprecedented high inflation largely explain the significant negative repricing of these two asset classes as they cause a significant increase in the discount rate used for discounting future cash flows from bond and stock holding. The unusual uncertainty about the future economic outlook and the responding Fed's monetary policy, and the subsequent heightened market volatility, also decreased investors' risk appetite, increasing the equity and bond risk premia. It further reinforces the negative discount effect on future cash flows. The persistence of inflation despite the hawkish Fed monetary policy, amid the increasing worldwide political instability, raises concerns regarding the necessity to tighten policies even stronger and for longer. This contributes to anchoring market volatility, which is continuously affected by any release of the CPI or other measures of economic activity release.

Second, we must highlight that it is not the enactment of Quantitative Tightening itself that affects volatility and cumulative returns but rather any early warning signs of the Fed reinforcing its hawkish monetary policy. To reflect that point, it seems that the effective change in regime for volatility and performance happened at the end of 2021, when the Fed conceded that inflation was not "transitory" and that it should take corrective measures, but did not happen in March 2022 nor in June 2022 when the Fed respectively stopped QE and started implemented its QT plan.

3.4. Cross-correlations between asset classes under scrutiny

The correlations between asset classes are critical inputs to asset allocation decisions. Nevertheless, they can be subject to drastic shifts depending on the macroeconomic environment. In this part, we will focus on the stock-bond correlation. Since the early 2000s, the negative correlation benefited multi-asset investors as bonds could protect portfolios in case of equity distress. Nevertheless, the surge in inflation, which started in 2021 and reinforced throughout 2022, came with a change in correlation sign. This observation raised questions on whether this new regime for asset class correlation was transitory or not. Indeed although such changes toward negative correlation have occurred multiple times throughout

history, the length of each episode varied greatly and is a crucial parameter for investors' behaviors. The duration of this current regime of negative correlation is all the more unpredictable as 2022's macroeconomic environment of high and sticky inflation and fast interest rate hikes, accompanied by worldwide political instability, is unprecedented and uncertain.

3.4.1. Understanding the stock-bond correlation

To understand what explains shifts in the correlation between stocks and bonds, we must understand the drivers of their correlation. Several studies have tried to understand these drivers, their significance, and their relative importance through diverse regressions. Their conclusions often disagree as they rely on different periods with specific macroeconomic environments. However, two main drivers come to light: inflation and growth. Let us recall the pricing formulas for bonds and equities:

$$Bond\ Price = \sum_{t=1}^{T} \frac{Coupon}{(1 + r_t + i_t + BRP_t)} + \frac{Face\ Value}{(1 + r_T + i_T + BRP_T)}$$

$$Stock\ Price = \sum_{t=1}^{T} \frac{Div_{t-1}(1 + g_t)}{(1 + r_t + i_t + ERP_t)}$$

Where r_t is the short-term real interest rate, i_t is the annual inflation in period t, g_t is the growth rate of dividends in period t, BRP_t and ERP_t are respectively the bond and equity risk premium to represent risk preferences and compensate the cashflows uncertainty. $Coupon$ is usually fixed, whereas dividends payments can vary depending on the growth rate of earnings.

First, inflation has a same-sign effect on both bonds and equities. Regarding equities, the effect of inflation is quite equivocal as two opposing effects come into play. First, as inflation increases, companies' future nominal earnings are expected to increase (g_t), which should increase their stock prices. However, a negative discount effect adds up: markets might discount these higher future cash flows at a higher rate as they are worth less due to inflation. The net effect of inflation is, therefore, uncertain. A study from Schroders estimates that when inflation is above 3% per year for five years, the negative discount effect is more important. When it comes to bonds, the effect of inflation is more indisputable. As bonds

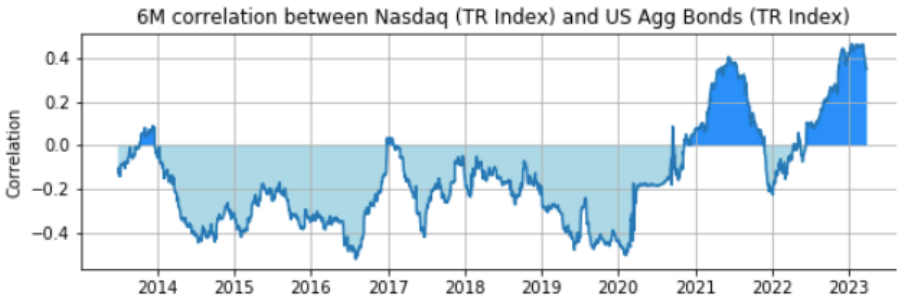
commonly have fixed nominal coupon payments, their value decreases as inflation rises since the given future payments will be worth less in real terms at the payment date. This pushes their prices down and their yields higher.

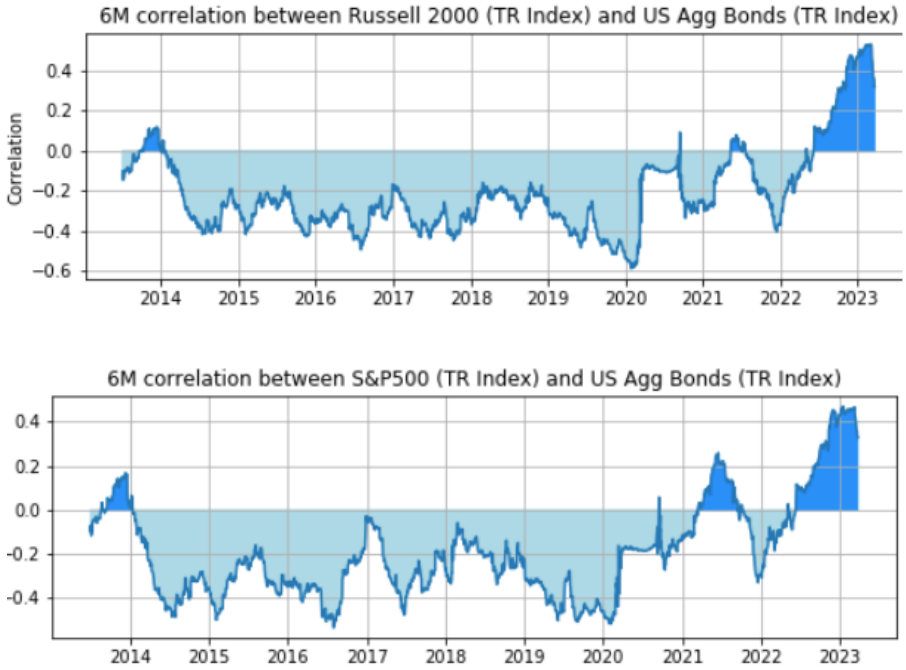
Second, growth has opposite signs effects on bond products and stocks. As growth expectation does not change cashflows received from bonds but increases expected dividends from stocks, a high growth environment tends to push equity prices upward and bond prices downward. These dynamics favor a negative stock-bond correlation.

We should also mention that changes in the correlation of risk premia affect the stock-bond correlation. Usually, when investors have a low-risk appetite, they tend to sell stocks to buy bonds, considered safe investments in a stable rate environment. Conversely, when risk appetite increases, stocks are favored compared to bonds. Hence bond and equity risk premia change in the opposite direction, which drives a negative stock-bond correlation. However, it can happen that both ERP and BRP move in the same direction. Imagine a situation where investors are concerned about sluggish growth (low g_t) and high inflation. Then both equities and bonds would be avoided for holding cash instead. This would translate into ERP and BRP increase and drive a positive correlation between stocks and bonds prices. This situation happened during the Great Inflation period in the 1970s and seems to fit the 2022 situation.

Ultimately, depending on which factor dominates and drives the markets, correlations between stocks and bonds can be positive or negative. In particular, when markets are driven by inflation, the stock-bond tends to be positive. This happens when inflation is high and very volatile. Conversely, when markets are driven by growth, it tends to be negative. This happens when inflation is stable and close to the Fed's target.

3.4.2. The new correlation regime in 2022





Figures 17. 6-months correlation[21] between U.S. stock indices and U.S. Bonds

As we clearly observe on the graphs above, the correlation between stocks and bonds has switched to negative in 2022. This negative correlation seemingly coincides with the Quantitative Tightening announcement, back in March 2022. Referring to our previous discussion regarding drivers of stocks bonds correlations, we can explain this shift by the growing uncertainty around inflation and interest rate hikes present at this time. Indeed starting from early 2022, inflation started to be on an unprecedented growth trend, and there was no clear sign of where it would stop. In the meantime, to constrain inflation, Fed embarked on a series of rate hikes starting on March 2022. It was the first rate hike since 2018 and the first of ten consecutive rate hikes until May 3rd, 2023. The Fed Funds Rate range went from 0.00%-0.25%, beginning of 2022, to 5.00%-5.25% in May 2023. All along 2022, there was a huge uncertainty around the terminal rate of the Fed, the rate at which it would stop raising its policy rate. This stop was conditioned on observing clear signs of a decrease in inflation. However, markets continued to believe that inflation was not back on its right track toward the Fed's 2% target. Therefore, they expected that inflation would continue to drive policy rates and, thus, markets. This uncertainty around inflation and the resulting monetary policy

[21] Graphs for 12-month and 18-month correlations can be found in Appendix.

of the Fed dominated other market drivers in 2022. This explains the switch towards a negative correlation between assets and stocks.

We must note that the correlations between the U.S. Aggregate Bonds Index and the S&P 500 Index, and with the Nasdaq Index, have turned positive temporarily in 2021. We believe that it reflected the transient concerns about the possible upcoming inflation as the Fed stepped in massively with QE measures to limit the economic downturn since the Covid-19 crisis.

In part 5, we will share our views on the possible persistence of this new regime for stocks and bonds, characterized by positive stock-bond correlation and high volatility.

4. What impacts could this new regime have on the global banking system and the real economy?

Ever since central banks around the world began rapidly raising interest rates in 2022 to curb rising inflation, investors, analysts, and economists have been on the lookout for signs that something in the market's plumbing was breaking.

Cracks began to emerge in September 2022 when U.K. markets were slammed after the government said it would push through surprise tax cuts. That led to a meltdown in complex financial instruments held by pension funds called liability-driven investments, which forced the Bank of England to launch an emergency intervention to prevent broader damage and the U.K. government to cancel the tax cuts.

The first signs of broader trouble came with the Silicon Valley Bank (SVB) and the successive events following its collapse as described in the following section. Investors quickly fled other lenders that had some of the same characteristics as SVB that led to its collapse: a dependence on uninsured deposits, or those above the FDIC's $250,000 cap, and a large portfolio of government bonds and other debt securities that had fallen in value as the Fed began to raise interest rates. Now, the odds of recession have increased considerably.

4.1. Silicon Valley Bank and Signature Bank, two regional bank failures

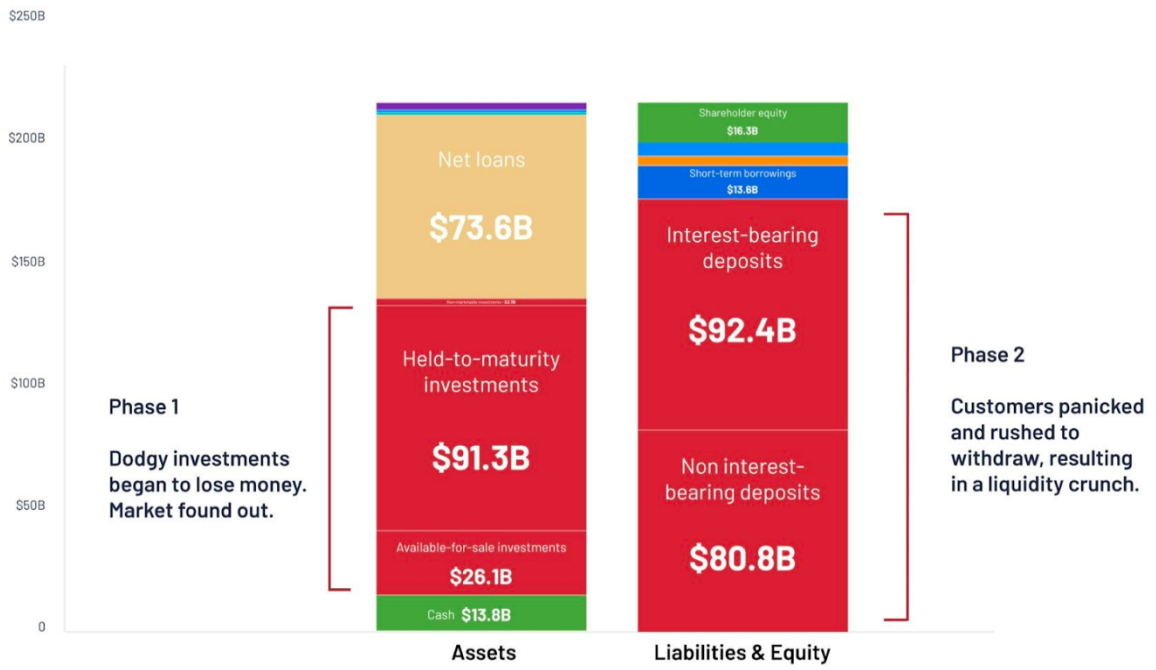
4.1.1. A timeline of the events

Silicon Valley Bank (SVB) was a crucial bank for early-stage businesses. It was the banking partner for nearly 50% of U.S. venture-backed tech and healthcare companies that were listed on US stock markets in 2022.

As the Fed began raising rates last year, venture capital dried up, leading startups to burn cash. Indeed, with the rise in interest rates, the cost of refinancing for these startups increased, forcing them to withdraw cash from their bank deposits. To meet accelerating withdrawals, SVB was forced to sell off some of its government bonds at steep losses as yields on new bonds were much higher. In fact, two mechanisms are at play here: the marked-to-market mechanism and the negative roll-down returns due to an inverted yield curve as explained in the previous section (cf. 3.2.). This led to a bank run because of which these early-stage companies could not get their money out. This money is a critical source of liquidity for them and often the difference between success and failure. Here's a timeline of the events so far:

March 8: SVB announced it would book a $1.8 billion loss after selling some of its investments to cover increasing withdrawals: unrealized losses became realized losses. According to SVB, client cash burn has remained elevated, and increased further in February, leaving its deposits at the end of that month lower than it expected.

SVB's exposure far exceeded their peers at possibly the worst time. SVB had over $160 billion in deposits. It had over $120 billions of investment securities in US Treasuries and mortgage-backed securities (MBSs) which included its $91.3 billion MBS portfolio, far exceeding its $73.6 billion of total loans, as we can see on the simplified Balance Sheet below.



Source: Silicon Valley Bank 2022 December balance sheet

March 9: SVB's stock crashes when the market opens. Shares of the four biggest U.S. banks slide amid fears other banks could be forced to take losses to raise cash. The declines wipe out a combined $52 billion in the market value of JPMorgan Chase, Bank of America, Wells Fargo and Citigroup. As the panic spreads, venture-capital firms begin pulling their money out of SVB and urge their portfolio companies to do the same.

March 10: Shares of SVB are halted Friday morning after a pre-market selloff. Soon after, federal regulators announce they have taken control of the bank before it can open. The FDIC says customers' insured deposits would be available on Monday but doesn't say when uninsured depositors will get their money back.

March 12: As worries of bank runs spread to other banks, federal regulators unveil emergency measures to stem the fallout from SVB's failure on Sunday. They announce they took control of a second bank, Signature Bank, making it the third-largest failure in U.S. history. Regulators say customers of both banks will get all their money back. They also announced a new lending program for banks.

March 15: Credit Suisse Group sees its shares hit a new low as worries about the financial system spread across the Atlantic. Other European bank stocks take hits, including France's

Société Générale and BNP Paribas and Germany's Deutsche Bank. U.S. regional bank shares slide again.

March 16: Shares of Credit Suisse jump, snapping an eight-session losing streak, after the bank's loan announcement. First Republic shares also turned positive after the Journal reported that the biggest banks in the U.S. are discussing a joint rescue to shore up the lender's liquidity. Federal regulators later announce that 11 banks have deposited $30 billion in First Republic.

4.1.2. Key takeaways

This provides evidence of the risks of interest rates going to 5.5%-6% coupled with Quantitative Tightening and the reduction of the Fed's Balance Sheet, as over 95% of SVB's deposits were not insured by the FDIC (due to being over the $250,000 limit), which represents over $160 billion in uninsured customer deposits. This is terrible for early-stage companies that were simply just looking for somewhere to hold their cash for operations. Yet, in that case, SVB failed to manage their interest-rate risk by simply not hedging their exposure at all. SVB's lack of diversification and exposure to early-stage tech companies led to their failure. But this event still exposes companies and business models that looked liquid and solvent when rates were zero. It also epitomizes the potential effects of the Fed's QT on the real economy, more specifically on U.S. venture-backed tech and healthcare companies here. This could be the sign of a wider credit crunch to come and a tightening of the financial conditions.

This is a massive warning to central banks like the Fed, the BoE and the ECB, who have collectively embarked on the most aggressive interest-rate tightening cycle since the 1970s when Paul Volcker jacked up rates to 20%.

That has triggered signals like an inverted yield curve which puts huge pressure on banks margins. For instance, there was an inversion of -100bps early March in the U.S. An inverted yield curve can put pressure on banks' margins because it makes it more difficult for banks to generate profits from their lending activities. Banks make money by borrowing at short-term rates and lending at long-term rates, so when the yield curve inverts, the difference between the interest income that banks earn from their loans and the interest expense that they pay

on their deposits and other sources of funding narrows. An inverted yield curve can impact banks' balance sheets in several ways:

- **Asset Quality:** Banks' balance sheets are heavily weighted towards assets such as loans and securities. When interest rates rise, the value of these assets can decline, which can negatively impact banks' balance sheets. This can be a particular problem for banks that hold long-term assets, such as mortgages, when the yield curve inverts, as the value of these assets can decline faster than short-term assets.
- **Funding Costs**: When the yield curve inverts, banks' funding costs can increase. This is because short-term funding costs, such as deposit rates, can rise more quickly than long-term funding costs. This can put pressure on banks' balance sheets, as they may need to pay more to fund their lending activities, which can reduce their profitability.

In addition, by reducing market liquidity through QT, the Fed may put banks at risk due to liquidity issues on their balance sheet, as for SVB. A problem of liquidity on a bank's balance sheet refers to the bank's inability to meet its short-term financial obligations as they come due. This can happen when a bank does not have sufficient liquid assets or funding sources to cover its liabilities, such as deposits, loans, or other financial obligations, which must be paid within a relatively short period of time, usually less than one year.

When a bank faces a liquidity problem, it may need to borrow funds at a higher cost, which can reduce its profitability, or it may be forced to sell assets quickly, potentially at a loss to meets its obligations, as this was the case for SVB. In extreme cases, a liquidity problem can lead to a bank's failure if it cannot meet its financial obligations, resulting in losses for depositors and creditors.

However, it is highly unlikely that the banking turmoil caused by SVB will spread to the biggest banks, SVB collapsed because they had the highest-risk deposit base among U.S. banking peers. Nevertheless, the Fed may have started tightening too late in the cycle and not in 2021 when inflationary pressures were building. Now, they are trying to stabilize the banking industry while also fighting rising prices: US consumer prices rose 6% in March at a tricky time for the Fed amid SVB and Signature Bank fallout.

4.2. Credit Suisse, a global bank to fall

4.2.1. What caused the crisis at Credit Suisse and why did UBS agree to buy it?

Following the SVB collapse, investors have been closely watching for signs of contagion. As a result, shares of banks across the world, including Credit Suisse, were sold off. The Saudi National Bank stating that it was not considering increasing its investment in Credit Suisse owing to regulatory requirements amplified the concerns about the bank's ability to make money and raised the prospect that it might have to tap shareholders again for funds.

Therefore, UBS was pushed into the deal by regulators who were eager to curb further panic about the stability of the banking system. Indeed, Credit Suisse suffered a sharp decline in confidence, sending its stock and bond prices tumbling, and customers rushing to pull their money from the bank. The bank faced as much as $10 billion in customer outflows a day in March 2023. Regulators feared that the bank would become insolvent if not dealt with. Therefore, UBS became a state-backed solution for Credit Suisse. Finma, Switzerland's financial regulator, said it was necessary for authorities to take action in order to prevent damage to the Swiss and global financial markets.

<u>What were the terms of the deal?</u>

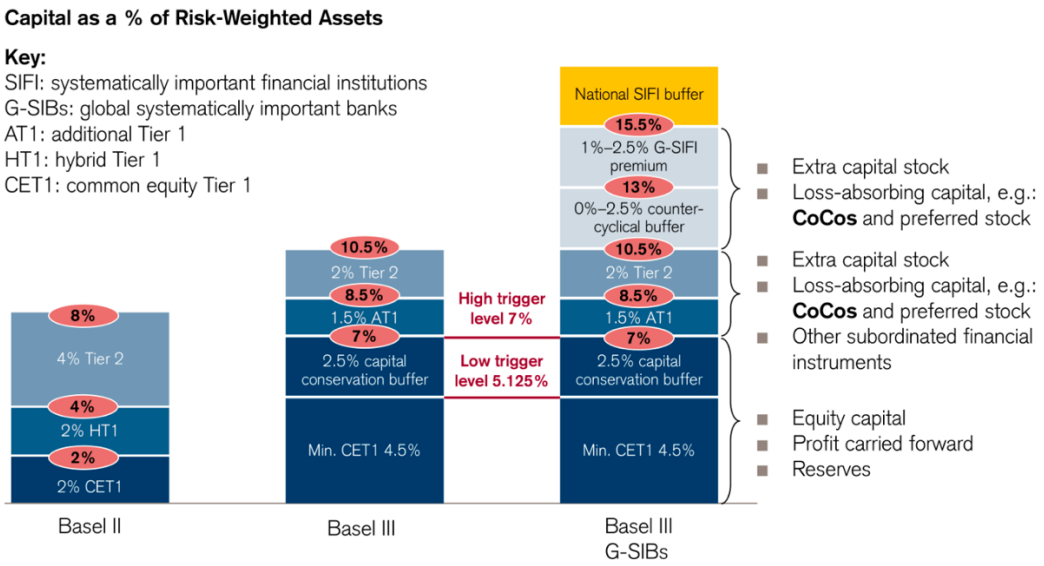
UBS agreed to pay Credit Suisse shareholders 3 billion Swiss francs, or around $3.1 billion, in the all-share deal. The Swiss government also agreed to backstop 9 billion francs of potential losses from Credit Suisse's assets and allowed UBS to wipe out about $17 billions of Credit Suisse AT1 bonds.

4.2.2. AT1 bonds and the $17bn wipeout

Contingent Convertible bonds (or CoCos) are a type of fixed-income instrument created following the 2008 financial crisis. At the time, governments worldwide used taxpayer money to rescue financial institutions. To prevent that from happening again, CoCos were invented to absorb losses in the event of bank stress. With the arrival of these instruments, we moved from "bail-out" type of scenarios to "bail-in". In other words, investors in this type of bank instruments (such as CoCo bondholders) would take the losses rather than the taxpayers. Thus, hundreds of billions of dollars' worth of AT1 bonds were issued after the 2008 financial crisis as part of an international regulatory move to transfer the risk of bank

failure to investors in bonds exposed to write downs in a crisis. Indeed, AT1 bonds are debt securities issued by banks that don't need to be paid back if a bank gets in trouble.

They had been very attractive to both European banks and investors: Regulators require banks to hold a certain amount of capital, which, loosely defined, is its assets minus its liabilities. AT1s are a form of liability, but because of their special vanishing feature, they don't have to be counted in that formula. That makes capital bigger. But buyers of these bonds were always risking the chance that the instruments would become worthless or written down to a fraction of their value. For banks, issuing AT1s is a cheaper way to increase capital than selling fresh shares. For investors, AT1s carry higher interest payments than normal bonds.



<u>The controversy</u>

$17 billions of AT1 Credit Suisse bonds have been written off as decided by the Swiss authorities. However, the restructuring will leave shareholders with some recovery value (CHF 3 billion in an all-share merger), effectively subordinating AT1 bondholders to shareholders. This violates the standard corporate finance pecking order because, in theory, shareholders are the first to take the hit in the event of losses. Why were bondholders wiped out when shareholders weren't?

A strong precedent has been set for CoCo holders and the AT1 market ($275 billion). Investors now wonder if AT1s will be the first target to recapitalize failing banks instead of shares (ignoring market convention along the way). But the Credit Suisse bonds were outliers

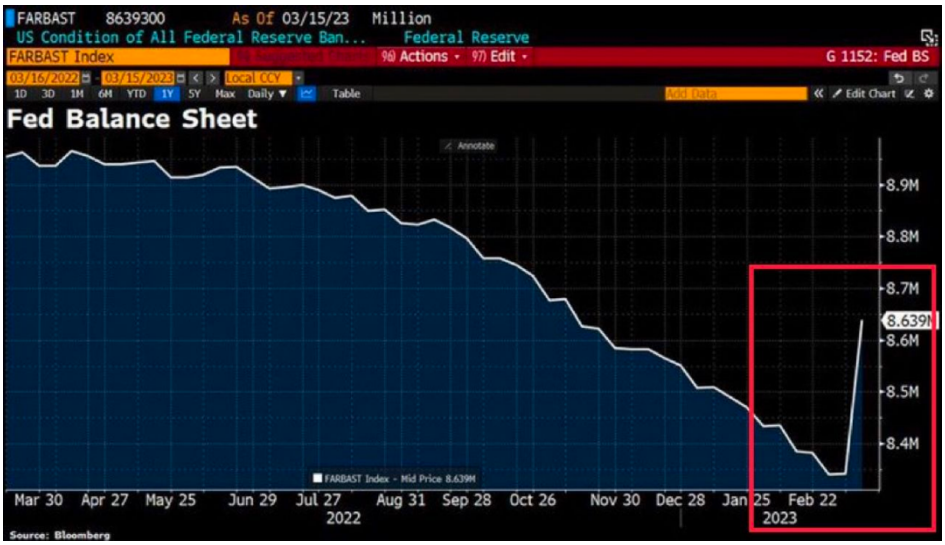
from other European banks because they provided for a case where regulators could write them down without wiping out equity holders. In addition, regulators in the eurozone, which doesn't include Switzerland, clarified that difference with investors: "Common equity instruments are the first ones to absorb losses, and only after their full use would Additional Tier 1 be required to be written down," said a statement from the European Central Bank's banking supervision arm, the Single Resolution Board and the European Banking Authority.

Nevertheless, the complete write-off by Credit Suisse, one of the largest issuers in the AT1 market, will likely hurt investor appetite for the bonds. It will also squeeze lending by banks. Ultimately, AT1 bonds will become more expensive for banks to issue, reducing their ability to make new loans. That means banks will likely have to run smaller balance sheets.

QT has therefore put pressure on bank margins due to, for example, an inversion of the yield curve: rate hikes have impacted the short-end of the yield curve faster than QT has impacted the long-end on the curve. Furthermore, the QT has removed liquidity from the markets, which may create liquidity issues related to the balance sheets of banks holding assets with long maturities. All these elements will reduce lending in the economy and tighten financial conditions.

4.3. Implementation by the Fed of liquidity measures to ease the banking crisis

To restore confidence in the financial system and provide liquidity in financial markets, U.S. regulators (e.g. the FDIC) announced emergency measures on March 12: they would guarantee all of SVB's deposits and would make more funds available to support other banks should they face a similar run on their deposits. To do so, the Fed lent $300 billion in emergency funds to banks who were short on liquidity. Banks borrowed the funds to raise cash likely to pay off depositors who tried to withdraw their money. An additional $153 billion in borrowing from the Fed came through a longstanding program called the "discount window"; it amounted to a record level for that program. Typically, in a given week, only about $4 billion to $5 billion is borrowed through this program.



4.3.1. The Bank Term Funding Program

The Fed unveiled on March 12 a new facility: the Bank Term Funding Program (BTFP), which enables financial institutions to post bonds as collateral and borrow against them, rather than having to sell them. This program is organized as follows:

Step 1: BTFP participants, needing to raise cash, swap a security they don't want to sell outright to avoid unrealized losses with cash from the Fed. They send the (fully digitalized) security to the Fed via the Fedwire service, which custodies the asset during the loan.

Step 2: to obtain the cash, the BTFP participant pays the going overnight indexed swap rate plus a 10bp spread. They can borrow cash for up to one year and can pay back the full amount early with no penalty. Only securities owned on March 12th, 2023, can be pledged by the BTFP participant.

Step 3: Unlike other Fed programs, no "haircut" is applied to the BTFP participant's collateral, meaning they receive the security's full initial (par) value in cash, rather than its market value. Moreover, they don't have to sell the security thereby preventing a realized loss. If a bank run prompts them to sell a large number of assets, doing so may wipe out a bank's equity. The BTFP program mitigates this.

As of March 22, following the implementation of Bank Term Funding Program, the Fed's balance sheet increased by $94.5 billion to $8.734 trillion from $8.639 trillion which in turn was a $297 billion increase from the previous week when the bank crisis started. In total, the Fed's balance sheet has increased by $393 billion in the two weeks following the SVB

collapse and is fast approaching its all-time high of $8.95 trillion one year ago, when QT kicked in and shrank the Fed's assets by $600 billion.

Why does the Fed's rescue package for US banks differ from 2008 bailouts?

Lenders will be able to use the Fed's lending facilities for up to a year by putting government bonds for instance as collateral, which will be valued at face value. This avoids the marked-to-market problem associated with rising interest rates that we mentioned in the section 3.2. This program is justified by the fact that the value of the bond does not vary if it is held until maturity, which is why the Fed buys at par. But what problems are regulators trying to solve?

Many banks have large depositors whose balances exceed the $250,000 cap beyond which deposits are not covered by the FDIC insurance mechanism. If they flee, more lenders will face the same pressure, as SVB for instance, to sell assets at a loss. Therefore, the Fed's offer to lend against high-quality bonds at par is aimed at helping other banks to meet withdrawals without selling securities at a loss. Depositors at other banks can now be more confident about avoiding being caught up in a similar panic. Through this mechanism, regulators' goal is to prevent more bank runs because customers will be protected even if another bank fails.

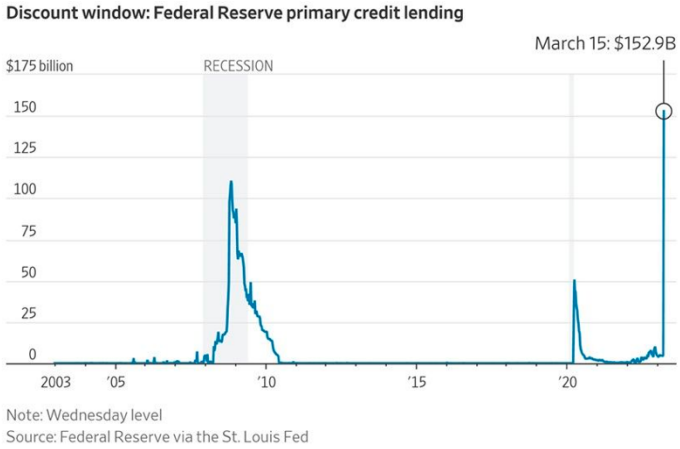
However, the emergency lending facility's decision to accept securities at par also reduces the pressure on banks to be prudent with their investments and liquidity management, which runs counter to decades of efforts to make banks safer.

4.3.2. The Discount window

Lending from the Federal Reserve to depository institutions (known as the "discount window") is crucial to maintaining the stability and liquidity of the banking system as well as ensuring the effective execution of monetary policy. The discount window enables depository institutions to efficiently manage their liquidity risks and prevent acts that have a detrimental impact on their clients, such as withdrawing credit during tense market conditions. As a result, the discount window facilitates the efficient flow of credit to individuals and businesses. One of the initial goals of the Fed and other central banks across the world was to provide liquidity in this manner.

Depository Institutions have access to primary credit, secondary credit, and seasonal credit, each with its own interest rate ("discount rate"), through their regional Federal Reserve Bank, as will be explained in more detail below. The board of directors of each Reserve Bank sets rates, which are then reviewed and approved by the Board of Governors of the Federal Reserve System. All Reserve Banks have the same interest rates for the three lending programs.

- Primary credit is a lending program that serves as the principal safety valve for ensuring adequate liquidity in the banking system. It is available to depository institutions that are in generally sound financial condition, and there are no restrictions on the use of funds borrowed under primary credit. Primary credit is priced relative to the Federal Open Market Committee's (FOMC) target range for the federal funds rate. The bank tumult has caused strains in key markets around the globe such as huge illiquidity in the corporate bond market. Therefore, the Fed, through its primary credit lending facility, has injected billions of dollars of liquidity in financial markets, even if it is for temporarily horizon. The need to tighten monetary policy to reduce high inflation appears to be conflicting with concerns about financial stability here.



- Secondary credit is a lending program that is available to depository institutions that are not eligible for primary credit. It is provided at a rate that is higher than the primary credit rate on a very short-term basis, usually overnight. The use of secondary credit extensions is constrained in comparison to primary credit. When used in a manner that is consistent with the borrower's rapid return to reliance on market sources of funding or the orderly resolution of a problematic institution,

secondary credit is available to address backup liquidity needs. The borrower may not use secondary credit to finance the increase of their asset base. Furthermore, compared to the primary credit program, the secondary credit program requires a higher level of Reserve Bank oversight and management. Reserve Banks typically apply higher haircuts on collateral pledged to secure secondary credit.

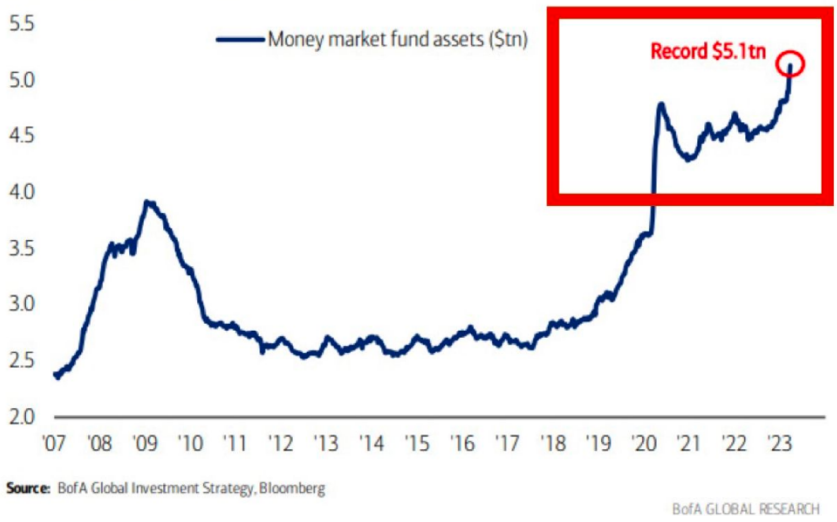
4.3.3. The Fed's swap lines

Additionally, the Fed's swap lines network, which was first established in 2007, has served as an important funding safety net for international banks during times of extreme market stress. By pledging collateral at their respective central banks, lenders outside of the US can use the swap lines to access dollars in exchange for their home currencies. As a result, the network of swap lines between these central banks acts as a crucial liquidity backstop to reduce pressures in the global financing markets, thereby reducing the impact of such pressures on the availability of credit for households and businesses. The daily swap lines between the Fed and the European Central Bank, the Bank of England, the Swiss National Bank, the Bank of Canada, and the Bank of Japan would run at least until the end of April, the officials said.

4.4. The banking crisis quickly reverberated throughout markets

4.4.1. Deposit flight and accelerating inflows in money market funds

Money market funds, which primarily invest in safe assets such as government debt with short-term maturities, have seen significant returns due to the Fed's rapid increase in borrowing costs over the past year. It is a consequence of the QT. This has resulted in a significant disparity between the interest rates paid to depositors by banks on their standard bank accounts (approximately 0.5%) and the high returns offered by money market funds (approximately 4%). However, it was not until the recent banking crisis triggered by the collapse of SVB that investors began to flock towards money market funds, leading to inflows of more than $350bn since March. The graph below represents the money market fund assets (in $ trillion) over time.



Experts have expressed concern that the shift towards money market funds poses a risk to the stability of the banking sector, particularly for smaller regional lenders who may struggle to increase their interest rates for account holders. If more depositors choose to invest in money market funds, it could create additional pressure on smaller lenders. Ironically, the Fed, which aims to support and protect the banking system, may be contributing to this problem by offering a standing facility that becomes the weak point in this chain of events. Notably, a significant portion of the cash in money market funds is outside of the banking system, as these funds often use a Fed facility that provides attractive interest rates for overnight cash deposits. The use of this "reverse repo" facility has increased in recent weeks, with daily levels reaching around $2.3tn. More precisely, the reverse repo facility is used to drain excess cash from the financial system and reduce downward pressure on short-term interest rates. By borrowing cash from money market funds and other counterparties, the Fed can effectively remove liquidity from the financial system and provide an additional means of tightening monetary policy.

Thus, money market funds are not deposit-taking institutions, and if their assets were not held in the Fed facility, they would still be within the banking system. However, their use of the reverse repo facility reduces the collective deposits held by banks, potentially reducing their incentive to lend. Concerns about an economic downturn may also lead banks to become more cautious about lending. Although the shift towards money market funds typically occurs during every cycle of Fed interest rate increases, this trend could continue even after the central bank ends its monetary tightening and starts lowering borrowing costs.

Banks are experiencing a "two-stage shift," with the first wave of outflows driven by savers concerned about the stability of their banks, resulting in record-high assets in government money market funds. Overall bank deposits in the US decreased by $161bn in the first two weeks of March, driven by outflows from smaller banks. The second wave is just beginning as "sleepy depositors" become aware of the significant disparity between yields on bank deposits and those available elsewhere.

The recent disruptions in the US banking sector mean that even if banks raise their deposit interest rates to compete with money market funds, savers may still be deterred by perceived risks in the banking system. Although money market funds invest in short-term government debt that is highly sensitive to changes in Fed borrowing costs, their yields may still decrease with lower interest rates. However, this may not lead to fund outflows since deposit rates are unlikely to increase. The flood of cash flowing into US money market funds is unlikely to slow down, and this trend has the potential to further strain the banking system.

4.4.2. Fallout from the banking turmoil on the economy: tightening of banking conditions

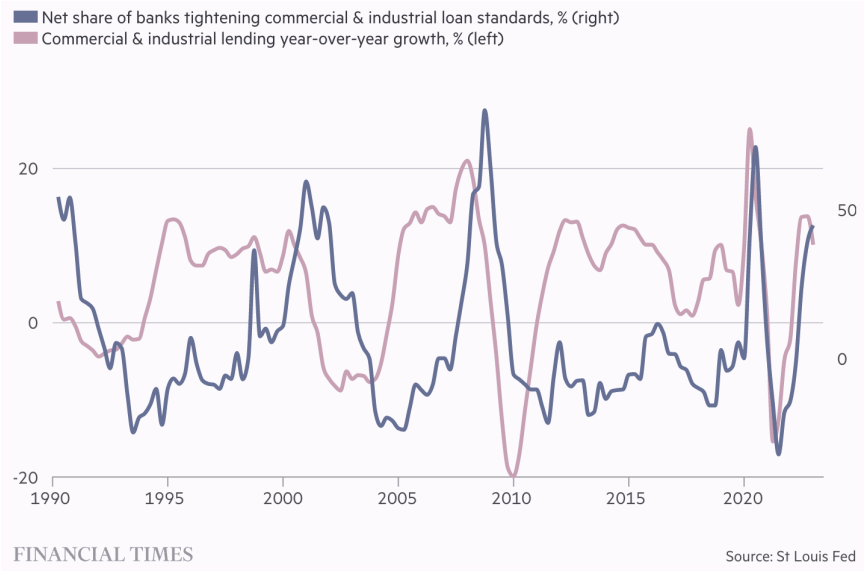
To decrease the size of its balance sheet due to its Quantitative Tightening policy, the Fed has been removing reserves from the financial system therefore contributing to a shortage of liquidity. Additionally, the rapid increase in interest rates has raised the yields on money-market funds and short-term Treasuries, causing the remaining liquidity to flow away from bank accounts as we saw previously.

Consequently, there is a genuine risk of a broad credit crunch. The increased interest rates have already reduced lending to the actual economy, and the recent events may cause banks to raise their lending standards even higher. A downward spiral of falling prices and defaults could occur if banking conditions tighten significantly: property lending seems to be vulnerable for instance. In the US, most of the commercial real estate lending comes from smaller lenders who are currently under pressure, and those who need to refinance their loans may face difficulties. Mortgage-backed securities (MBS) owned by banks are already taking a hit, putting a self-reinforcing cycle at risk.

Indeed, MBS spreads, which are the additional yield that investors require to hold mortgage debt over risk-free US Treasuries, rose significantly. Over the past year, these

spreads have increased from 1.1% to 1.6%. This, in turn, led to higher mortgage rates and a decline in new home purchase applications in February, reaching their lowest level in over 20 years. As housing, including investments, rents, and other services, accounts for about one-sixth of the US economy, this has had a significant impact on the real economy.

Moreover, the pink line below shows the year-over-year increase in banks' overall volumes of commercial and industrial (C&I) loans, which has stayed at a high level but has begun to decline. However, what's concerning is the blue line representing the Federal Reserve's loan officer survey for C&I loans. Nearly half of the banks reported that they are tightening their standards, and none are reporting any loosening. Historically, this level of tightening has usually resulted in a decrease in lending volumes.



Despite the unlikelihood of a crisis as severe as that of 2008, there is a clear possibility of a credit squeeze, although the extent of its severity is still unclear. The recent chaos that began in the relatively unregulated regional US banking sector may indicate other potential vulnerabilities. Rather than a minor hiccup, this event may serve as a warning of what is to come. Although banks have stronger capital and failures have been mostly attributed to specific risks and mismanagement, with authorities taking proactive measures to provide aid, lending criteria have improved but uncertainty persists.

5. Discussions on the Persistence of This New Regime in the Short/Medium Term

As we have seen, this period of quantitative tightening by the Fed, which is still ongoing, has been characterized by a regime of high volatility and positive correlation between equities and bonds. Indeed, because of 2022's inflationary shock, the discount rates for all securities have been repriced in the same direction. This negative discount effect was the main driver of asset class valuation throughout the year. From then on, there is no longer a safe-haven asset class. As discussed in part 3.4.1., this correlation between stocks and bonds relates to how inflation and growth drivers' respective importance compare.

- If inflation remains high and unstable, and if it remains more important than the expected growth of the economy, then it is likely that the correlation between asset classes will remain positive. Indeed, high and volatile inflation heavily impacts the denominator of the pricing formulas for the two asset classes, by increasing the nominal discount rate. On top of that, this high, sticky and uncertain inflation can push markets to believe that the Fed will continue its hawkish monetary policy and will have to accept an economic recession to wipe inflation out. This participates to a decrease in risk appetite for both equities and bonds: i.e., a positive correlation of bond and equity risk premia (cf. section 3.4.1.). These two effects push the discount factors for both asset classes' valuation in the same direction. As long as there is no clear sign of inflation's convergence towards the 2% target, markets will continue to focus on the inflation outlook rather than growth perspectives, and the positive correlation will remain.

- On the other hand, when markets start to get reassured about the inflation path and the effectiveness of current monetary policy to reach the Fed's inflation target, they will concentrate on future growth expectations. We will be back to markets being driven by growth perspectives. The correlation between bonds and stocks should start to increase and return to its historical positive equilibrium, and overall volatility will decrease.

By the end of 2022 and the beginning of 2023, we observed an apparent decrease in inflation (Figures 5. And 6.). We may thus expect markets to refocus on the growth outlook, and thus, the stock-bond correlation should return to negative. Nevertheless, we also observe signs that inflation remains sticky and much higher than the Fed's target. We could thus argue that markets might not be confident about the Fed's current ability to push inflation towards its target. The positive correlation and high market volatility could remain longer in this case.

As we observed that markets react more strongly to Fed's monetary policy decisions than to the effective enactment of these decisions, we should expect that investors will have an attentive look at future announcements regarding the Fed's QT plan, especially concerning its tighter caps for reinvesting mature securities. In particular, as many analysts estimated that QT should end by the end of 2024, or early 2025, any expected extension of this schedule should significantly increase market volatility and further depress equity and bond market values. Conversely, if signs of recessions were to appear, potentially harming the Fed's plan and forcing the Fed to end QT sooner, markets should rally, although volatility might remain high.

Conclusion

The Fed kept financial conditions excessively loose for an extended period, and ultimately applied sudden and strong brakes to its easing monetary policy after wrongly categorizing inflation as transitory for months, causing prolonged harm. The Fed now faces an intensified trilemma: how to simultaneously reduce inflation, maintain financial stability, and minimize the damage to growth and jobs.

The markets are probably going to have a calmer year in 2023. Already, inflation is on the decline. It is anticipated that central banks will continue to tighten their policies, but not to the same degree as in 2022. As a result, bonds should be less pressured. Prices for gas and oil

are less likely to fluctuate as international trade should return to normal thanks to decreasing in political instability.

Overall, we concluded from our empirical study that the Fed's announcement and implementation of quantitative tightening was progressive and smooth. First, the Fed announced in late 2021 its plan for tightening its monetary policy, due to persistent and increasing inflation, then it started to stop its large asset purchase programs, and finally, it progressively stopped reinvesting proceeds from maturing securities with increasingly stringent caps. The objective of carrying such transparent communication and slowly tightening policy was to avoid too strong adverse market reactions. Indeed, it is only the second attempt of the Fed to conduct quantitative tightening and the most aggressive by far, which makes it very complex to estimate the market reactions and effects on asset classes of this unconventional monetary policy. Nevertheless, we have been able to distinguish three sustained effects on asset classes since the announcement of the Fed's tightening. First we observed a significant drop in bond and equity market prices. Second, this simultaneous drop reflects a switch towards a positive correlation between bond and stock returns. Finally, we observed a global increase in volatility in bond and stock markets. We claimed that these effects were largely caused by soaring and uncertain inflation, as markets demonstrated high sensitivity to CPI and other indicators of economic activity releases. Ultimately, we discussed whether this new regime for asset classes, which was reinforced throughout 2022, was transitory or here to stay. We think the Fed's quantitative tightening should gradually decrease liquidity in the financial markets and consequently decrease credit issuance. This will participate to decrease households' and businesses' investments and, in the end, decrease inflation. This should reassure markets about the capability of the Fed to control inflation back toward its target. Once inflation stops driving market expectations, we should come back to a normal regime with lower volatility and negative correlation between bonds and stocks.

The Fed has pointed out the Core PCE Services Ex-housing as one of the key metrics for the monetary policy outlook and for "understanding the future evolution of core inflation". In particular, it is the main driver of the core PCE[22] inflation. As increases in Core PCE Services

[22] While the PCE includes both urban and rural direct consumers' expenditures as well as expenses made on their behalf by third parties, the CPI only looks at expenses made directly by urban consumers.

Ex-housing are largely driven by wage growth, it turns out that wage increases are a key determinant of inflation. We should thus expect the Fed to cut rates when the labor market starts showing signs of weakening. However, the last release presented a higher-than-expected wage growth in the U.S. for the month of April 2023, leading Fed officials to worry that it will take longer to cool inflation. This brings us to an old debate regarding the 2% inflation target of the Fed. As we observe that it will require much more to return to this level of inflation, we may wonder if the consequent impacts on economic growth, unemployement and financial stability are worth it compared to the true costs of inflation. Recently, Jerome Powell rejected the idea of changing the inflation target. *"We think it's really important that we do stick to a 2% inflation target and not consider changing it,"* he said to the U.S. Senate Banking Committee, claiming that doing so would alter the credibility of the central bank to use monetary policies effectively to reach their objectives and not relaxing their objectives to temporary difficulties. However, if the sustainable rate of inflation has definitively moved away from this 2% objective, the Fed's attempts to temper inflation back to its target will remain unsuccessful and the current regime of high market volatility and positive stock-bond correlation could anchor itself for longer.

Appendix

1. The Federal Reserve's balance sheet and the money supply process

The money supply refers to the total amount of currency and other liquid financial products (e.g. deposits at commercial banks) in a country's economy at a particular time. There are various definitions of money supply depending on whether we consider non-cash items like credit and loans. For instance, the monetary base, also called M0, includes hard currency (physical papers and coins) circulating in the public, plus the currency that is physically held in the vaults of the commercial banks, as well as the reserve balances held by commercial banks and other depository institutions in their accounts at the Federal Reserve (the Fed), which constitutes the Fed's main liabilities. Indeed, depository institutions in the US are required to maintain reserves at their district Federal Reserve Bank, called federal funds. There is also the M1 money supply, also called "narrow" money, which includes all M0 plus the remaining demand deposits.

Money supply plays a significant role in the economy as it can affect interest rates, exchange rates, inflation and an economy's output of goods and services. Central banks, and in particular the Fed in the US, are responsible for managing the size of the money supply to influence these different parameters. When an economy is growing too slowly, increasing the money supply can stimulate it and generate growth. On the contrary, decreasing the money supply can slow down an economy which is growing too quickly, therefore preventing inflation. This management of the money supply is called monetary policy.

What are the factors that determine the money supply? How can a central bank increase or decrease the amount of money in circulation?

1.1. The monetary base

The monetary base and the money supply are linked according to the following formula, which applies to the monetary aggregate, M1, that we defined previously:

$$Monetary\ base \times Money\ multiplier = Money\ supply$$

This formula highlights 3 actors that are playing a key role in determining the money supply:

- **The Fed**, which is responsible for controlling the money supply by increasing or decreasing the monetary base and regulating the banking system by setting up the reserve requirement ratio. This ratio refers to the percentage of checkable deposits that commercial banks must hold as reserves at the Fed. It impacts the money multiplier that we will study in more details later.
- **The banking system**, which creates checking accounts. Checking accounts are very liquid and can be accessed through different methods (checks, ATMs, debit cards).
- **The nonbank public**, i.e. all households and firms, can hold money in different forms: as currency or as checking account balances for instance.

We can note that these 3 actors are related to the Money multiplier components of the model. However, if the Money multiplier remains stable, the Fed can control the money supply by adjusting the monetary base, as it is the only actor determining this parameter. Thus, the process starts with the monetary base, which is equal to the amount of currency in circulation plus the reserves of the banking system:

$$Monetary\ base = Currency\ in\ circulation + Reserves$$

The Monetary base and the Fed's balance sheet are interlinked. The Fed's balance sheet is a listing of the Fed's assets and liabilities. To put it simply, it is composed of 4 entries that are very important in allowing the Fed to increase or decrease the monetary base: US Government securities plus mortgage- and asset-backed securities, discount loans to banks, currency in circulation and reserves. For instance, during the financial crisis of 2007-2009, the Fed purchased large amounts of mortgage-backed securities and asset-backed securities (securitized loans backed by assets other than property) to provide liquidity to the markets.

Reserves, which are equal to the bank deposits at the Fed plus the vault cash, are assets for banks, but they are liabilities for the Fed because banks can request that the Fed repay the deposits on demand with Federal Reserve Notes. To be more precise, here we call "reserves" the total amount of reserves, which is made of the required reserves, the amount that the Fed compels banks to hold using the reserve requirement ratio, and the excess reserves, the extra amounts that banks hold over the required reserves:

$$Reserves = Required\ reserves + Excess\ reserves$$

1.2. How does the Fed change the monetary base?

1.2.1. Open market operations

The Fed changes the monetary base by changing the levels of its assets through open market operations or by making discount loans to banks. Open market operations is the most direct method used by the Fed to control the monetary base. It involves buying or selling large amounts of securities like US Treasury bonds and mortgage-backed securities (MBS) to inject reserves into the banking system. Let's use an example to illustrate this mechanism.

Suppose the Fed buys $1 million worth of Treasury bills from JP Morgan. JP Morgan will electronically transfer ownership of the bills to the Fed, and the Fed will pay for them by transferring $1 million in JP Morgan's reserve account at the Fed. To show the effect of this open market purchase on a balance sheet we can use a T-account. In this example, the Fed purchases the Treasury bills from only one bank, but in practice the Fed does so with many banks simultaneously. Therefore, we will consider a T-account for the whole banking system (we add the assets and liabilities of all the commercial banks in the US). The banking system's balance sheet shows on the assets side a decrease in security holdings of $1 million while reserves increase in the same amount.

Banking system Balance Sheet

Assets		Liabilities
Securities	-$1 million	
Reserves	+$1 million	

On the other hand, the Fed's balance sheet shows an increase of security holdings of $1 million on the asset side, while on the liability side the bank reserves increase by $1 million as well. The Fed's liability can take the form of a reverse repurchase agreement.

Federal Reserve Balance Sheet

Assets		Liabilities	
Securities	+$1 million	Reserves	+$1 million

Thus, the open market operation carried out by the Fed leads to a $1 million increase in bank reserves, and, therefore a $1 million increase in the monetary base. We can see a 1 for 1 relation in dollar amount between the monetary base and open market operations. The Central Bank has created electronic reserve money out of nowhere.

The opposite works as well: by selling Treasury securities to a commercial bank (open market sale), the Fed can reduce the monetary base. For example, as opposed to the previous transaction, let's assume the Fed sells $1 million worth of Treasury securities to JP Morgan. The Fed transfers the securities to JP Morgan, and JP Morgan pays with funds in its reserve account. As a result, the banking system's reserves will fall by $1 million, as shown in the following T-account:

Banking system

Assets		Liabilities
Securities	+$1 million	
Reserves	-$1 million	

Federal Reserve

Assets		Liabilities	
Securities	-$1 million	Reserves	-$1 million

We can see that the reserves have fallen by $1 million, and, therefore, so has the monetary base.

In addition, it is interesting to note that the nonbank public (households and firms) does not affect the monetary base by deciding how much currency it wishes to hold relative to deposits. To illustrate this point, let's consider a $1 million withdrawal from their checking accounts:

Nonbank Public

Assets		Liabilities	
Checkable deposits	-$1 million		
Currency	+$1 million		

Banking system

Assets		Liabilities	
Reserves	-$1 million	Checkable deposits	-$1 million

Federal Reserve

Assets		Liabilities	
		Currency	+$1 million
		Reserves	-$1 million

The item “currency”, a component of the monetary base, has risen by $1 million, while at the same time the reserves (the other component of the monetary base) have fallen by $1 million. The Fed has converted reserves into paper money. Therefore, the monetary base is unaffected which is an important result because it means that the Fed can change the monetary base through open market operations without the changes being affected by the public’s decisions.

1.2.2. Discount loans

Although the Fed typically uses open market operations in managing the monetary base, it can also adjust reserves by making discount loans to commercial banks, therefore influencing the monetary base.

Let's say the banks want an additional $1 million in discount loans from the Fed. By expanding the banks' reserve accounts, the Fed provides the funds to the banks. The new discount loans increase the Fed's assets by $1 million, while the additional bank reserves increase its liabilities by that same amount. Therefore, the Fed's balance sheet on both sides is impacted by the increase of discount loans:

Fed Balance Sheet

Assets		Liabilities	
Discount loans	+$1 million	Reserves	+$1 million

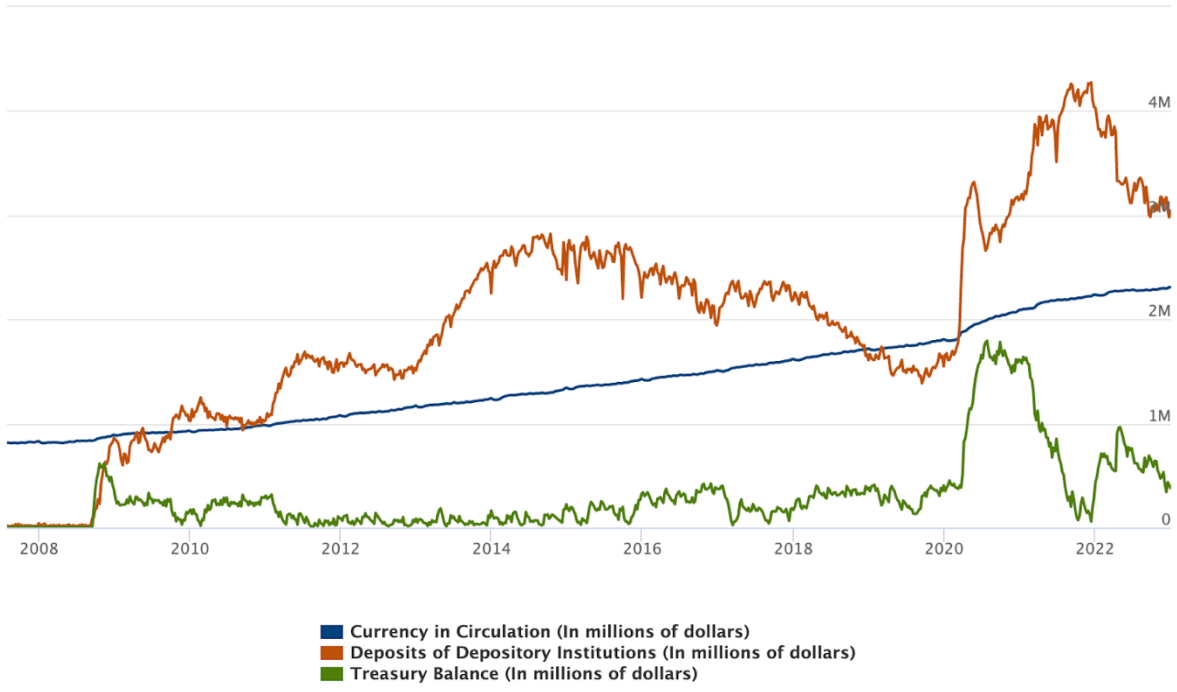
Likewise, the balance sheet of the banking system is impacted on both sides. Banks raise their liabilities by $1 million in the form of discount loans payable to the Fed while increasing their assets by $1 million in the form of reserves:

Banking System Balance Sheet

Assets		Liabilities	
Reserves	+$1 million	Discount loans	+$1 million

Thus, bank reserves and the monetary base increased by $1 million as a result of the Fed making $1 million in discount loans. The aforementioned activities are reversed if banks repay $1 million in discount loans to the Fed, lowering the overall amount of discount loans. The amount of discount loans, reserves, and the monetary base all decrease by $1 million.

All in all, it appears that discount loans and open market operations both change the monetary base, but open market operations are more under the Fed's control. Because it places orders with the primary dealers through its trading desk at the New York Fed, the Fed completely controls the volume of open market operations. To properly conduct its open market operations, the Fed is prepared to purchase and sell securities at any price. Moreover, because banks decide whether to borrow from the Fed, the Fed's control over discount lending is significantly less effective than its control over open market operations. Because it determines the discount rate—the interest rate the Fed charges on discount loans—the Fed still has some control over these loans. In fact, it is different from most interest rates because it is set by the Fed, as opposed to most interest rates, which are decided by supply and demand on financial markets. Finally, the monetary base increases each time the Fed buys assets of any kind.



1.3. The money multiplier and the deposit expansion

1.3.1. The reserve requirement ratio

The reserve requirement ratio is the percentage of deposits that commercial banks are required to hold in reserve either in their own vaults or on deposit with the central bank of their country. It is an important tool used by central banks to regulate the money supply in the economy and to maintain financial stability.

The reserve requirement is the amount of funds that a bank must keep in reserve to meet the potential withdrawal demands of its depositors. One reason for its implementation is to ensure that banks have enough funds to meet the demands of their depositors. If a bank is unable to meet the withdrawal demands of its depositors, it may face a run on the bank, which can lead to financial instability. This requirement is determined by the central bank and is usually expressed as a percentage of a bank's total deposits. For example, if the reserve requirement ratio is set at 10%, a bank with $1 million in deposits would be required to hold $100,000 in reserves.

Another reason why a central bank may use a reserve requirement ratio is to regulate the money supply in the economy. When banks have more reserves, they have less money to lend out, which can reduce the amount of money in circulation. Conversely, when banks have fewer reserves, they have more money to lend out, which can increase the amount of money in circulation. Therefore, if the central bank wants to increase the money supply, it can lower the reserve requirement ratio, which allows banks to lend out more money. This, in turn, can increase spending and stimulate economic growth. Conversely, if the central bank wants to decrease the money supply, it can raise the reserve requirement ratio, which limits the amount of money that banks can lend out. This can help to reduce inflation and promote financial stability. In some countries, the reserve requirement ratio is used in conjunction with other monetary policy tools, such as open market operations and interest rate adjustments. By using a combination of tools, central banks can fine-tune the economy and maintain financial stability.

1.3.2. Loan creation and deposit expansion

What happens to the money supply when the Fed increases bank reserves through an open market purchase? We first analyze the changes that occur at a single bank and then look at the changes for the whole banking system.

How a single bank responds to an increase in reserves:

Suppose that the Fed purchases $100,000 in Treasury bills from Bank of America.

Bank of America

Assets		Liabilities
Securities	-$100,000	
Reserves	+$100,000	

The Fed's purchase of T-bills from Bank of America increases the bank's excess reserves but not its required reserves. The reason is that required reserves are determined as a percentage of the bank's checkable deposits. Because this transaction has no effect on Bank of America's checkable deposits, it doesn't change the amount of reserves that the bank is required to hold. Bank of America earns only a low interest rate from the Fed on the additional reserves obtained from the T-bill sale and therefore has an incentive to loan out or invest these funds.

Suppose that Bank of America loans $100,000 to Mr A. We will assume that Bank of America extends the loan by creating a checking account for Mr A and depositing the $100,000 principal of the loan in it.

Bank of America

Assets		Liabilities	
Securities	-$100,000	Checkable deposits	+$100,000
Reserves	+$100,000		
Loans	+$100,000		

Recall that the money supply - using the M1 definition - equals currency in circulation plus checkable deposits. By lending money to Mr A, Bank of America creates checkable deposits and, therefore, increases the money supply. Suppose that Mr A then spends the loan

proceeds by writing a check for $100,000 to Mr B. Mr B deposits the check in its account with BNP Paribas. Once the check has cleared and BNP Paribas has collected the funds from Bank of America, Bank of America will have lost $100,000 of reserves and checkable deposits:

Bank of America

Assets		Liabilities	
Securities	-$100,000	Checkable deposits	$0
Loans	+$100,000		
Reserves	$0		

Bank of America is now satisfied because it has exchanged some of its low-interest Treasury bill holdings for a higher-interest loan.

How the banking system responds to an increase in reserves:

We can trace the further impact of the open market operation by considering the situation of BNP Paribas after it has received the check for $100,000 from Mr B.

BNP Paribas

Assets		Liabilities	
Reserves	+$100,000	Checkable deposits	+$100,000

For simplicity, let's assume that when it received Mr B's deposit, BNP Paribas had no excess reserves. If the required reserve ratio is 10%, BNP Paribas must hold $10,000 against its increase of $100,000. The other $90,000 of the reserves it has gained are excess reserves. BNP Paribas knows that it will lose reserves equal to the amount of any loan it grants because the amount of the loan will be spent, and the funds will be deposited in another bank. So, BNP Paribas can only safely lend out an amount equal to its excess reserves. Suppose that BNP Paribas makes a $90,000 loan to Mr C. BNP Paribas's assets (loans) and liabilities (checkable deposits) rise by $90,000 but only temporarily as Mr C will spend the loan proceeds by writing a $90,000 check that will be deposited in Société Générale. The reserves decrease by 90,000 to make the loan to Mr C.

BNP Paribas

Assets	Liabilities

Reserves +$10,000 Loans +$90,000	Checkable deposits +$100,000

Société Générale

Assets	Liabilities
Reserves +$90,000	Checkable deposits +$90,000

To this point, checkable deposits in the banking system have risen by $190,000 as a result of the Fed's $100,000 open market purchase.

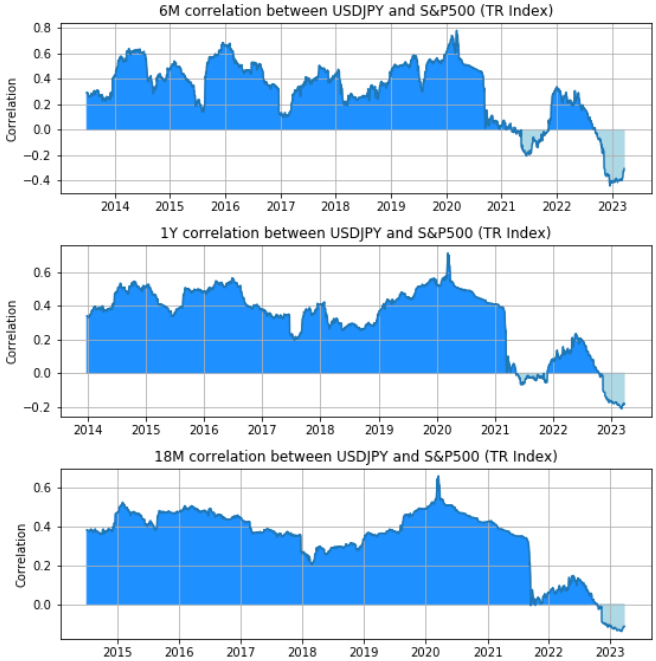
Société Générale faces the same decisions that confronted Bank of America and BNP Paribas. Société Générale wants to use the increase in reserves to expand its loans, but it can safely lend only the increase in excess reserves. With a required reserve ratio of 10%, Société Générale must add $90,000*0.10 = $9,000 to its required reserves and can lend only $81,000.

SunTrust Bank

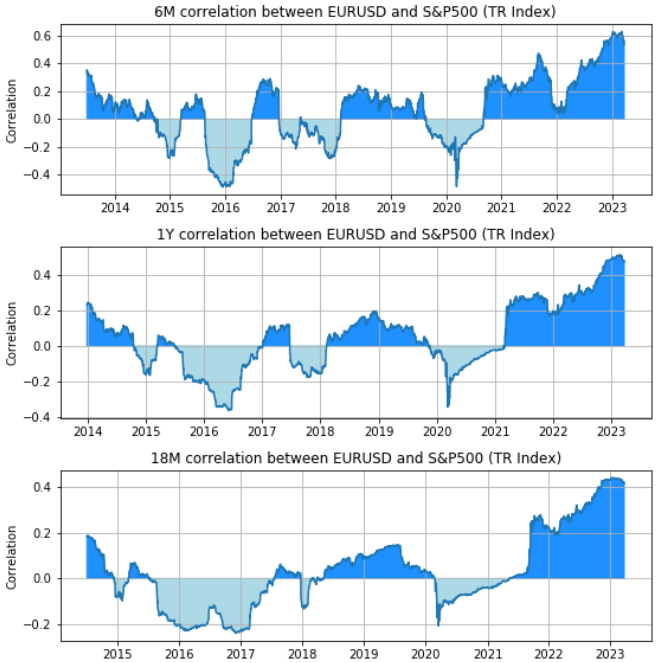
Assets	Liabilities
Reserves +$9,000 Loans +$81,000	Checkable deposits +$90,000

To this point, the $100,000 increase in reserves supplied by the Fed had increased the level of checkable deposits by $100,000 + $90,000 + $81,000 = $271,000. This process is called multiple deposit creation. The money supply is growing with each loan. The initial increase in bank reserves and in the monetary base is resulting in a multiple change in the money supply. The process continues as the recipient of the $81,000 check from Mr C will deposit it, and checkable deposits at some other bank will expand. The process continues to ripple through the banking system and the economy, and this is how the money supply increases in the economy.

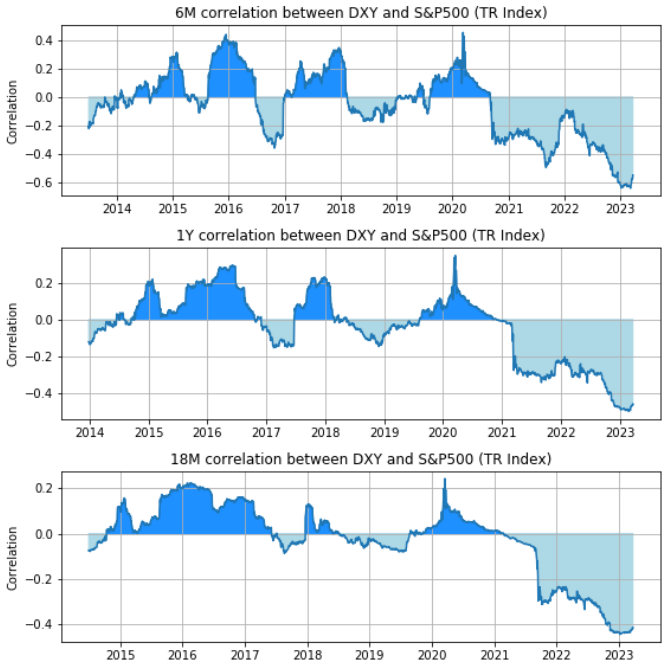
2. Further empirical analysis of asset class returns, volatilities, and cross-correlations



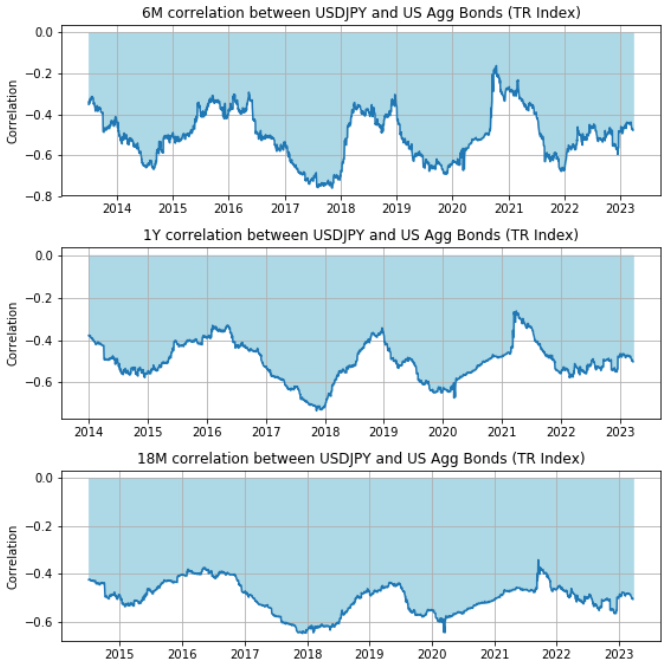
Graphical representations of correlations between the USDPY and the S&P500 Index



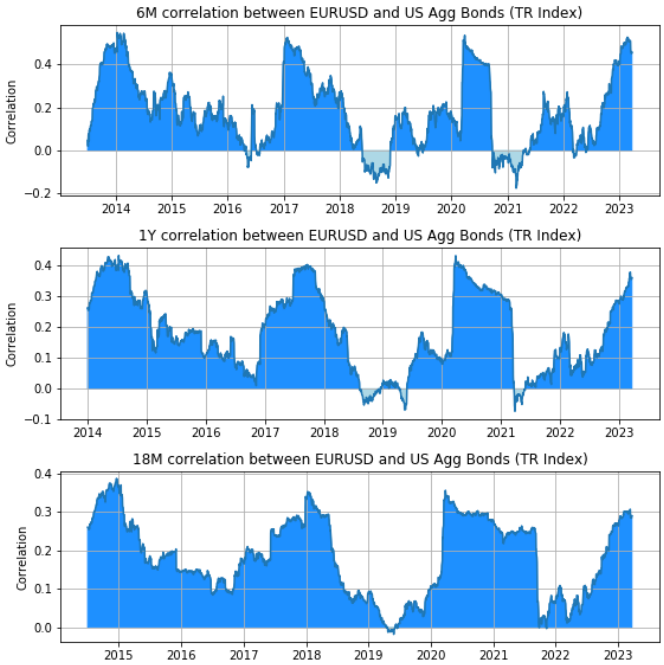
Graphical representations of correlations between the EURUSD and the S&P500 Index



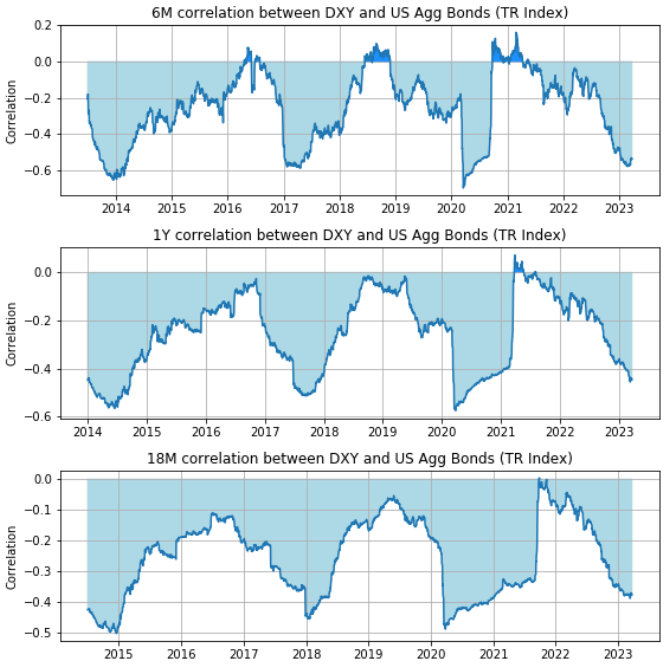
Graphical representations of correlations between the DXY and the S&P500 Index



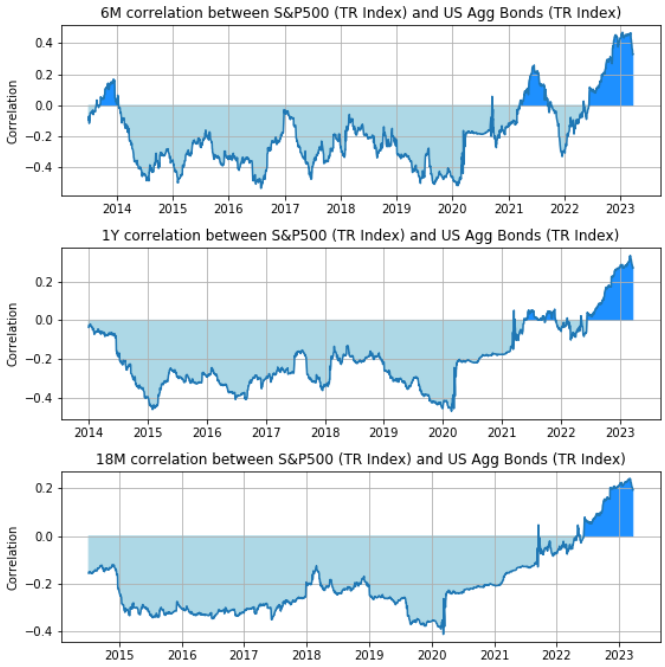
Graphical representations of correlations between the USDJPY and the LBUSTRUU Index



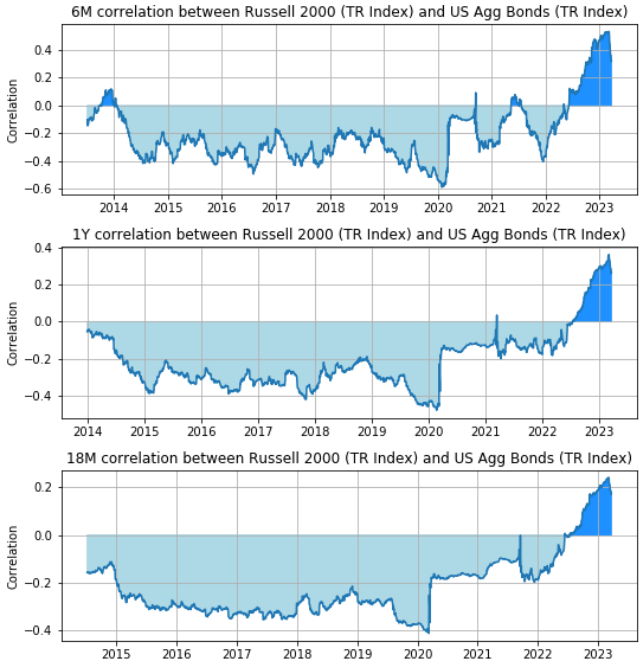
Graphical representations of correlations between the EURUSD and the LBUSTRUU Index



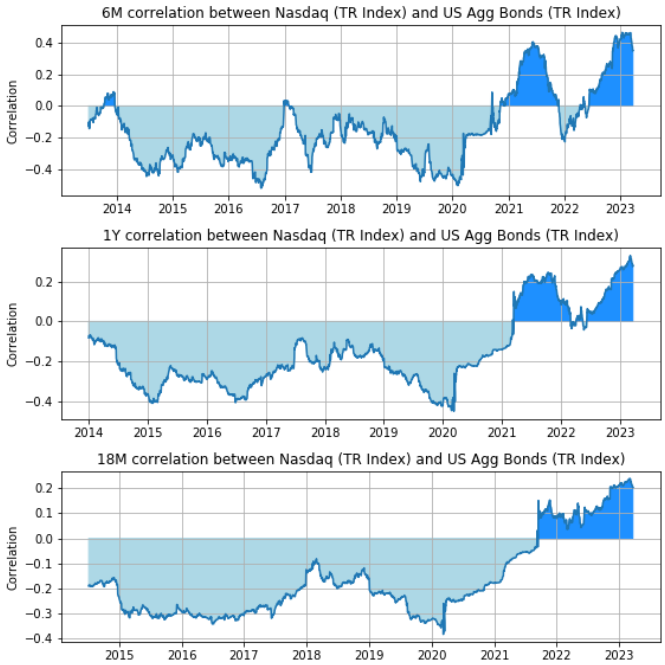
Graphical representations of correlations between the DXY and the LBUSTRUU Index



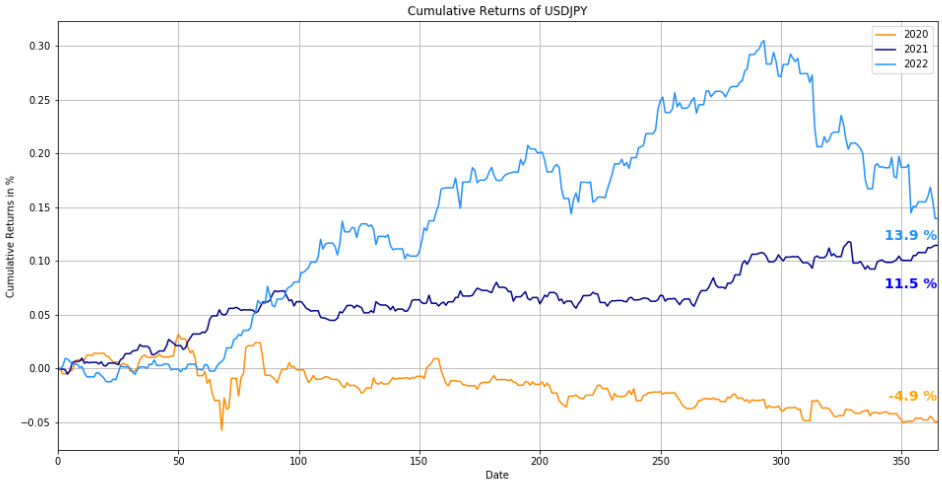
Graphical representations of correlations between the S&P 500 Index and the LBUSTRUU Index

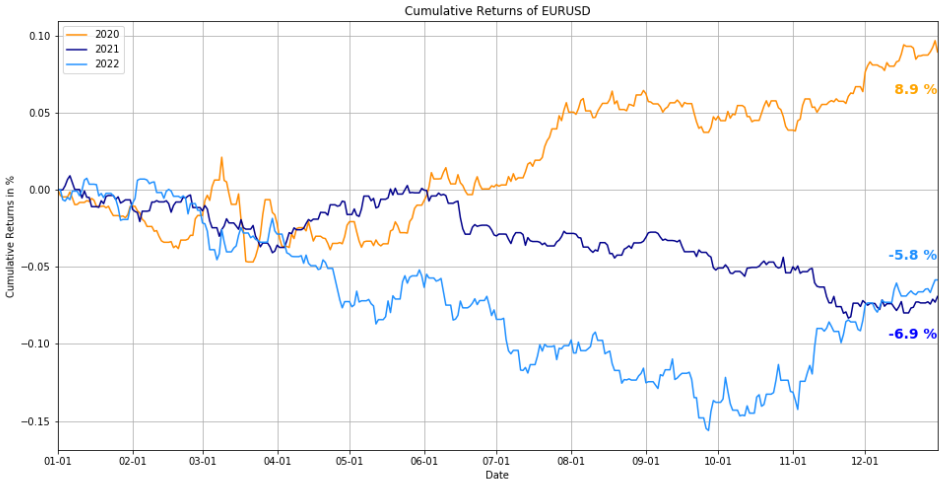


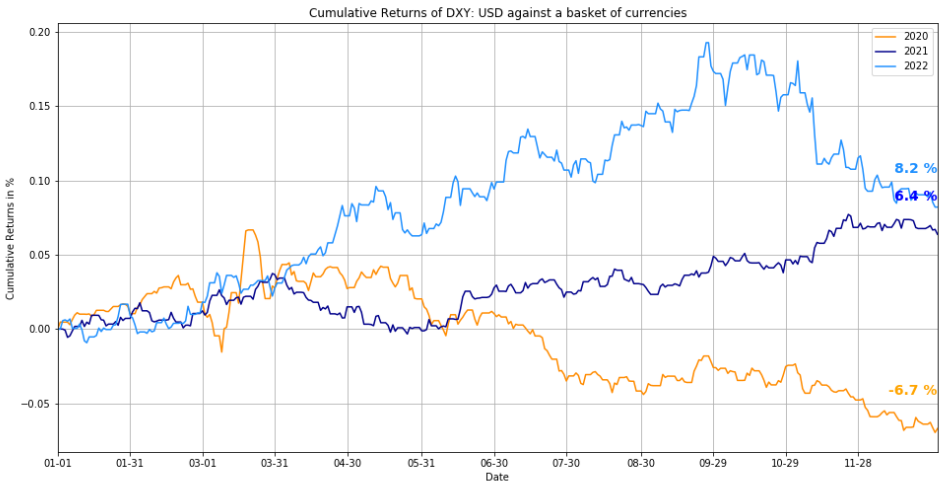
Graphical representations of correlations between the Russell 2000 Index and the LBUSTRUU Index



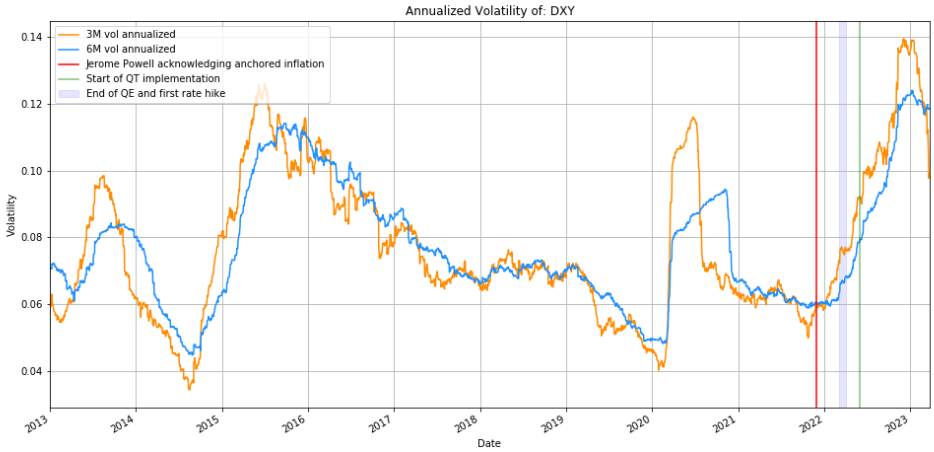
Graphical representations of correlations between the Nasdaq Index and the LBUSTRUU Index

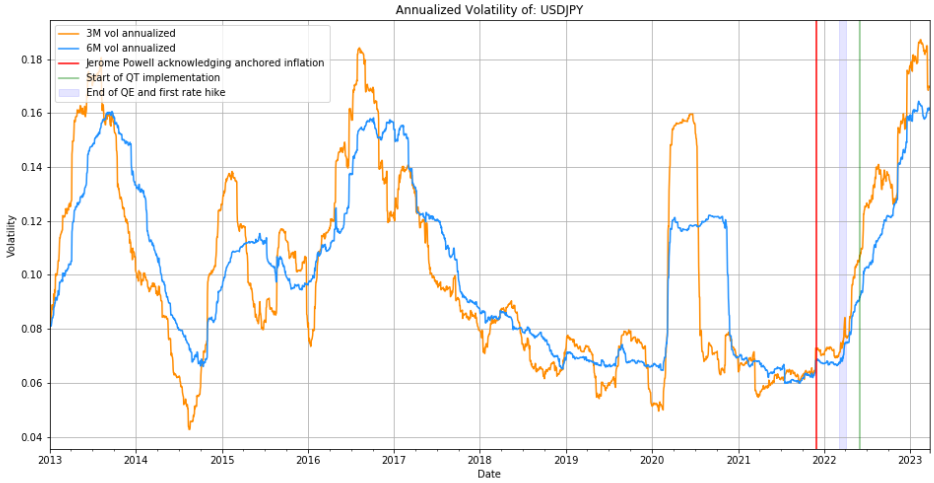


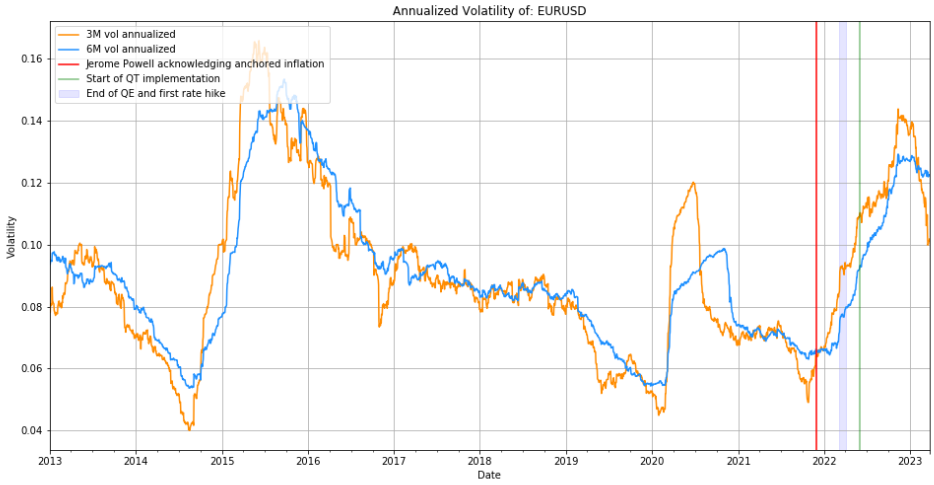




Graphical representations of cumulative returns of different currencies between 2020 and 2022







Graphical representations of the realized volatility of different currencies

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