The inflationary consequences of the broad money supply surge in 2020: a monetarist approach

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Abstract:

In the fourth quarter of 2021, the inflation rate in the US was 7.0%, measured with the implicit GDP deflator, a number above the Federal Reserve's 2% inflation target. The Fed and many leading economists could not foresee the growth in inflation that started in 2021 and blamed the inflation on transitory supply-chain problems. However, some economists who applied the quantity theory of money and considered the long and variable lags associated with broad money growth and inflation were able to predict the high levels of inflation in 2021. Cumulatively, the M2 measure of money increased by 40.52% between Q1 2019 and Q4 2021 due to the pandemic-related monetary policy actions. Currently, the Federal Reserve and many mainstream economists ignore monetary aggregates in their models, hence, risking not extracting any valuable information value provided by the money measures. Inflation erodes peoples' purchasing power, risks social unrest, postpones investment decisions, and misallocates resources when the price system becomes distorted. The poorest in society are hurt the most, since they lack such negotiation power and resources that those who are better off tend to have. Hence, a central bank needs to maintain price stability.

This thesis applies the P-star model, which has its origins in the quantity theory of money, to estimate the US price gap and, hence, estimate the average annual inflation rates for the next 3 to 4 years starting from 2022. The P-star model assumes that the current price level will move towards equilibrium. The main critique against the quantity theory of money relates to the instability of money velocity; hence, two alternative scenarios will be investigated to test the robustness of the main results. Additionally, this thesis will try to determine if the Federal Reserve should start to extract information from the monetary aggregates. Also, because the Federal Reserve and the mainstream economists view the economy through interest rates and not money, the original Taylor rule will be estimated to see where the federal funds rate should be when the inflation rates are high.

This thesis finds that the US price gap in Q4 2021 is 25.09%, implying an average annual growth rate of the implicit GDP deflator to be in the range of 6.27% to 8.36% for 3-4 years starting from 2022. The alternative scenarios, which are considered less likely, imply a price gap of 12.58% and 37.60% in a good and bad scenario, respectively. In the main scenario, it is assumed that the M2 equilibrium velocity is 1.41, compared to the actual level of 1.12, which is below the equilibrium value due to Covid-19 restrictions. In the good and the bad scenarios, the equilibrium velocity is assumed to be 1.27 and 1.55, respectively. It is also found that the monetary aggregates contain information value that the Federal Reserve should not ignore. The original Taylor rule implies that in Q4 2021, the federal funds rate should be 11.27% compared to the actual federal funds rate of 0.08%. This thesis recommends that the Federal Reserve slows the growth rate of money to a level consistent with the M2 golden growth rate of 5.24-5.99%, whereas the year-over-year growth rate in Q4 2021 was 13.07%. Slowing the growth rate of broad money is the only way to cure the inflation disease, and as a consequence of money growth slowing, a recession will follow. It is crucial that the Fed stays the course and does not endanger the healing process by accommodating more excessive broad money growth; otherwise, the inflation problem will worsen and last longer.

Keywords: inflation, monetarism, quantity theory of money, monetary aggregates, the P-star model, the Taylor rule.

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1. INTRODUCTION

Since the 1990s, inflation growth rates were relatively stable, especially in developed countries. However, inflation became a globally dominant theme in 2021 and has become more severe in 2022. Central banks and other mainstream macroeconomist forecasters failed to predict the surge in inflation (Powell, 2022). In December 2020, members of the Federal Reserve Board (2021a) estimated that the median personal consumption expenditure (PCE) measure of inflation for 2021 to be 1.8%, while the estimate had increased to 2.4% in March 2021. In June, it had risen to 3.4%, and in September 2021, it had risen to 4.2% (Federal Reserve, 2021b). Figure 1 illustrates the percent change from a year ago in some of the more commonly used inflation measures. Inflation measured in the headline CPI in December 2021 had increased by 7.1% over the last 12 months, and the core CPI that excludes more volatile energy and food prices had increased by 5.5% from the previous year. The headline PCE and the core PCE were 5.8% and 4.9%, respectively.

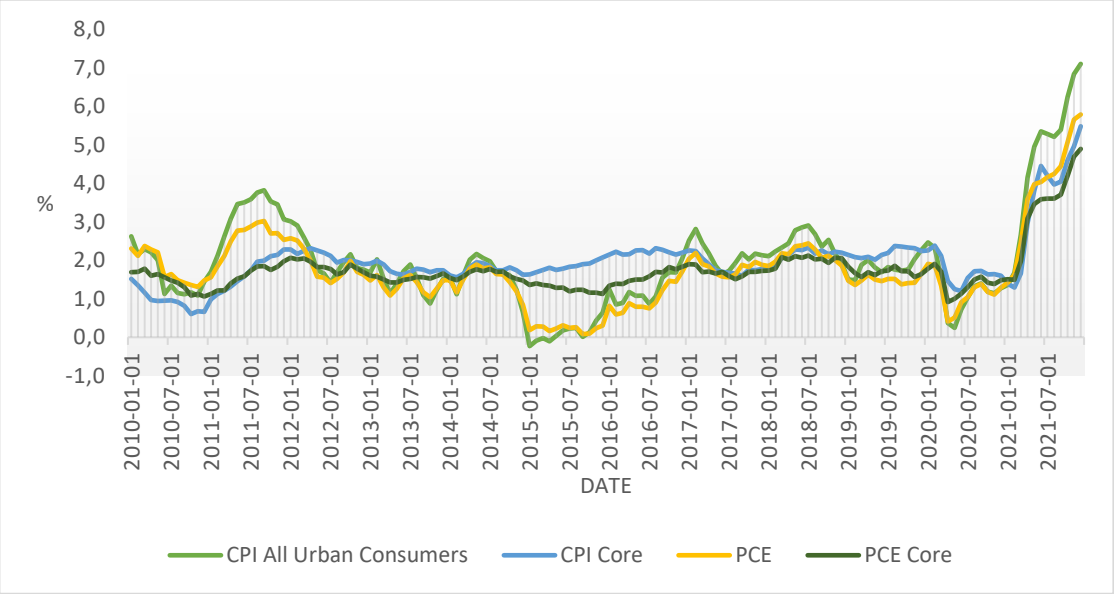

Figure 1: *Percent changes from a year ago, monthly, in different inflation measures 01/2019-12/2021, seasonally adjusted.*

Source*:* FRED Database (2022).

The inflation growth rates are well above the annual 2% PCE inflation target. A central bank attempts with the inflation target to keep the longer-term inflation expectations anchored (Board of Governors of the Federal Reserve System, 2012). According to Bullard (2016), inflation expectations are a significant determinant of actual inflation because firms and households consider the expected inflation when making economic decisions. Hence, central banks are interested in inflation expectations.

At first, the higher-than-expected inflation growth rates were described as transitory and related to supply chain problems by the mainstream view (Greenwood & Hanke, 2021). Certain central banks had started tightening their monetary policy to combat inflation as of November 2021, while the major Western central banks were still not ready to tame inflation (Burns & Schneider, 2021). The reason for not tightening monetary policy by the Federal Reserve (Fed), Bank of England (BOE), and the European Central Bank (ECB) was that they viewed the situation as being related to supply chain problems and thus not being in the realm of their toolbox. The Fed made similar statements during the 1970s inflationary period concerning the oil crises and wage push inflation (Eichengreen, 2018). The word transitory was buried by the Federal Reserve (Fed) chairman Jay Powell in December 2021, and the tone regarding inflation became more hawkish in 2022.

In 2019 the first reports of the coronavirus started to emerge. The Western world was not that alarmed at that point. In the early months of 2020, governments worldwide implemented lockdowns, which meant societies and travel shut down as the pandemic started to become alarmingly bad. Citizens around the globe stayed at home and avoided public places. First, companies responded with lay-offs and then scaled down on production. The governments quickly reacted with massive stimulus support to companies and households. The Fed reacted with many operations, resulting in lower interest and treasury yields (Bordo & Duca, 2021) and enormous growth in broad monetary aggregates. Asset prices started to recover quickly. Inflation was not yet a problem in 2020 during the early recovery phase, which can be explained by the lag time of the monetary stimulus to affect the economy. However, one could assume that many people started to

feel wealthier as asset prices soared. Friedman (1978) describes this phenomenon as an early good effect of inflation when people start to feel rich.

Figure 2 illustrates the percent change from a year ago in the M2 monetary aggregate and the GDP deflator from the first quarter of 1961 to the fourth quarter of 2021. M2 started growing in the second quarter of 2020 in response to the coronavirus lockdowns when the monetary authorities and fiscal authorities tried to keep the economy running to avoid an economic disaster. Another reason for the M2 spike was that corporations drew their revolving loans for additional cash during the crisis, whereas consumer credit declined due to record-high unemployment (Wang, 2021).

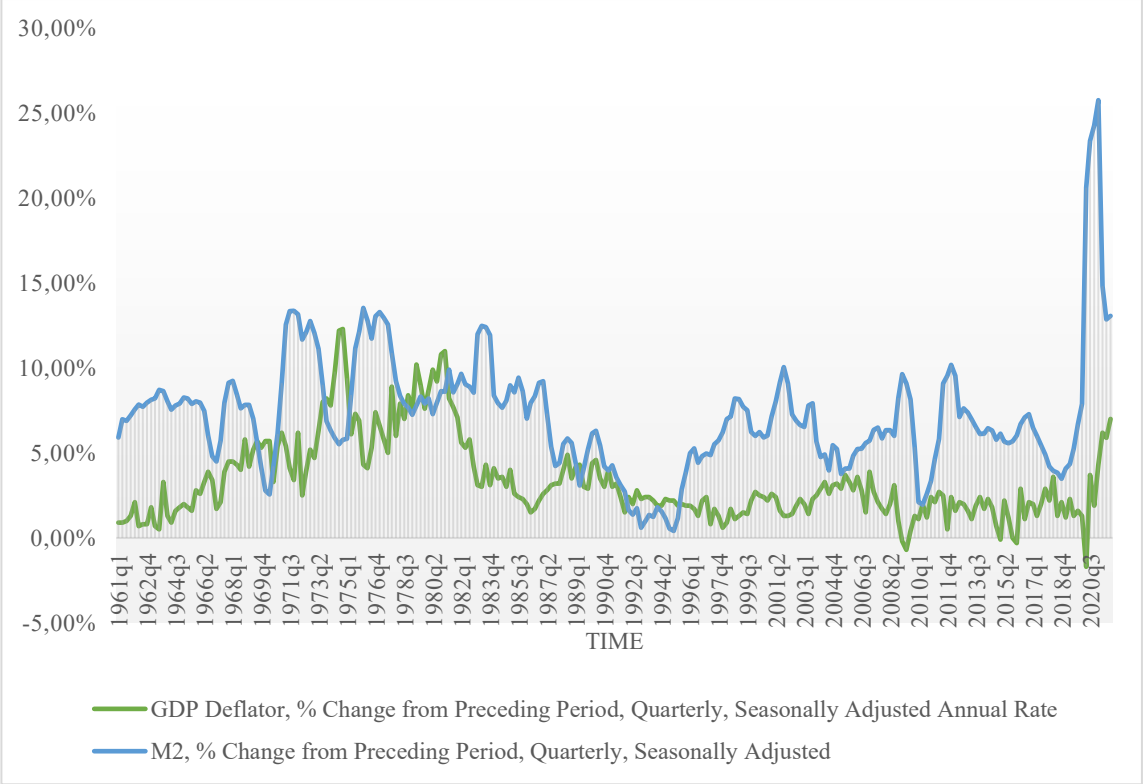

Figure 2: *Percent changes from the preceding period, quarterly, monetary aggregate M2 and GDP deflator Q1/1961- Q4/2021*

Source*:* FRED database (2022)

The average increase in M2 between 2010 and 2019 was 5.85%. It is worth noting that the M2 increase from a year ago was at its highest in Q1 2021, when M2 had grown 25.77%. A similar annual growth rate was recorded during the second world war when M2 grew at most at 27 % (Jones & Giorgianni, 2020). In Q2 2021, M2 growth had decreased to around 14.81% year-over-year. In Q4 2021, M2 had grown by 13.07% from the earlier year. The M2 growth is still elevated compared to the long-term historical averages presented in table 2. Cumulatively, M2 grew by 40.52% from Q4 2019 to Q4 2021, compared to the cumulative growth rate of 8.89% and 10.39% from Q4 2008 to Q4 2010 and Q4 2017 to Q4 2019, respectively.

Milton Friedman (1961) concluded that: "monetary actions affect economic conditions only after a lag that is both long and variable." Friedman (1972) identified that the lag of M2 to affect prices was 23 months. Bernanke et al. (1999) estimated a two-year lag for monetary policy actions to affect inflation. Batini & Nelson (2001) found evidence that monetary policy actions have the most effect on inflation after one year. According to Hanke (2021), money growth will: first lead to inflation in asset prices with a lag of 1-9 months, then 6-18 months after the money supply has increased, economic activity will be positively affected, and, lastly, after 12-24 months prices in goods and services will start to inflate. Darrat et al. (2003) found significant evidence that monetary base growth impacts inflation after an 18-month lag in the 1973-1998 period; they also found that the exchange rate affects CPI inflation with a two-month lag. Many economists agree that inflation is a monetary phenomenon in the long run (Tödter, 2002). Many empirical studies confirm this relationship throughout time and in different countries (see e.g., McCandless & Weber, 1995; King, 2002).

How was it possible that the guardians of price stability, the central banks, did not foresee the high growth in inflation after the Covid-19 monetary stimulus measures? One explanation is that the role of money started disappearing from the models used by mainstream economics in the 1980s (Greenwood & Hanke, 2021). The role continued declining throughout the years (King, 2002; Woodford, 2006) and culminated with the Fed chairman saying that there is no crucial connection between the 26% growth of monetary aggregate M2 and the economic outlook (U.S. Senate Committee on banking,

housing, and urban affairs, 2021). Furthermore, Powell continued: "We have had big growth of monetary aggregates at various times without inflation, so something we have to unlearn, I guess." (U.S. Senate Committee on banking, housing, and urban affairs, 2021, p. 24); this claim was questioned by Greenwood & Hanke (2021) and is in complete contrast to what Friedman taught (1973). Goodheart (2007) considered that the decline in using monetary aggregates had been overdone regarding inflation forecasting. King (2002) warned that the absence of money in economist models would cause problems in the future. According to Greenwood & Hanke (2021), BOE inflation report seized to mention the quantity of money after August 2018.

Another explanation is that the popular mainstream neo-Keynesian models use interest rates instead of money, with inflation expectations having an essential role in these models (Goodheart, 2007; Greenwood & Hanke, 2021). The basic neo-Keynesian model includes three equations. According to Goodheart (2007), these equations are: "…an IS-type aggregate expenditure function, a Phillips-curve type aggregate supply function, and a Taylor-type Central Bank reaction function, showing how Central Banks set interest rates". Goodheart (2007) highlighted that these models work only well during stable economic times. King (2022) pointed out that central bank models fail when something unexpected happens due to the assumption of stationarity. Also, Hendry & Mizon (2014) highlighted that when something unexpected happens, the commonly used dynamic stochastic general equilibrium models (DSGE), and the New-Keynesian Phillips curve that rely on expected future values, do not work as intended.

A third explanation to be considered is the expanding role of the central banks and the threat of central banks losing their independence. Central bank independence, together with a clear mandate, is vital for price stability (Issing, 2021b). The Fed has a mandate of maximum employment and price stability. There is also some responsibility for financial stability since the Fed is the lender of last resort (Reis & Mankiw, 2018). However, there has been discussion of central banks to address climate change and inequality (see e.g., Sumner, 2022). On the other hand, some economists, such as John B. Taylor and others, have been worried about the development of expanding the mandate of central banks (see e.g., Wynne, 2020; King, 2022; Issing, 2021a). Issing (2021a) argues that this

development threatens the credibility and independence of the central banks. Also, Hetzel (2020) warns that the Fed's independence is at stake as the central bank entered the private credit markets with many programs during the pandemic, hence entering the political arena.

According to Borjas (2015, pp.7-11), in economics, the importance of an economic model to isolate the necessary factors that affect a market is essential to make correct predictions. Even though an economic model would omit some variables that could explain what is happening in the real world, there is no problem if the model isolates the most important factors. A too complex model would be laborsome, and still, it would not guarantee that it could predict the future well. If the model was too realistic, it could explain the world in detail, but then a theory would not be needed and thus not help us understand how the world works. Based on the reasoning above, this thesis will implement a simple P-star model, based on the quantity theory of money, created by Halman et al. (1989, 1991) for the US to determine the price gap resulting from the surge in money supply in 2020. The aim is to see if monetary aggregates still matter and can provide better guidance to inflation forecasts than the mainstream neo-Keynesian models used by the Fed during these unusual times. Furthermore, since interest rates play a significant role in the models used by the Fed, an original Taylor rule will be calculated to estimate where interest rates should be with the higher inflation levels.

The previous P-star model literature has focused more on finding support for the P-star model than on using it to forecast the future inflation growth rates. In this thesis, the model is used to estimate the price gap between the current and equilibrium price levels. By using monetarist theory, estimates are made for the average inflation growth levels for the following 3-4 years. Unlike previous P-star literature, this thesis considers the robustness of the results by applying alternative scenarios for the equilibrium velocity, hence considering the critique presented that money velocity is unreliable in the US (see e.g., Estrella & Mishkin, 1997; Stock & Watson, 1999). However, the primary assumption in this thesis is that the equilibrium velocity is stable in the long run. This thesis also aims to provide more discussion and background to give a more comprehensive picture of

inflation, recent developments in forecasting inflation, and how mainstream economists view inflation.

This thesis will proceed in the following way. First, chapter 1.1 specifies the research question. After that, chapter 2 provides a brief history of monetary policy and monetarism. Chapter 3 discusses the previous literature and presents the discussion and research regarding inflation forecasts after the pandemic. In chapter 4, a presentation of the theoretical framework is provided. In chapter 5, there is a presentation of the method. Chapter 6 deals with the data material. In chapter 7, the results are analyzed. Lastly, chapter 8 summarizes the results, and conclusions are drawn based on the results.

1.1. RESEARCH QUESTION

The primary objective of this thesis attempts to answer the following research question: *how much inflation will result from the surge in broad monetary aggregate M2 due to the pandemic-related monetary policy actions*? This thesis will make use of the P-star model approach to give an estimate of the inflationary consequences. A secondary goal is to determine if monetary aggregates have some use in forecasting inflation even though the Fed is ignoring them at present. Also, since the Fed focuses on interest rates instead of monetary aggregates, an original Taylor Rule will be calculated to determine where the interest rates should be to tame inflation.

2. BACKGROUND

This section will give a brief discussion on inflation, the history of monetarism and the evolution of monetary policy. The definition of monetary policy is the actions taken by a central bank to affect both the monetary and fiscal side of the economy (Burda & Wyplosz, 2017).

2.1. INFLATION

So, *what is inflation*? A general definition of *inflation* is a sustained increase in goods and services prices for consumers measured in an index over time (Burda & Wyplosz, 2017). Friedman (1973, 1983) described inflation as a form of taxation that does not need legislative action; it is a hidden tax that no one is willing to pay for when requesting governments to expand their spending, with money printing. Often, when talking about inflation in the US, two measures are used: the consumer price index (CPI), which the Bureau of Labor Statistics produces, and the personal consumption expenditure index (PCE), which the Bureau of Economic Analysis produces (Bullard, 2013). A headline version of these indexes includes more volatile goods and services and has a higher number. When the more volatile parts of these indexes are removed, one gets core inflation that fluctuates less than the headline version.

Keynesians separate two sources of inflation: the cost-push or supply-chock view of inflation results from input prices affecting the prices of goods (Cronin, 2018), and the demand-pull view, where aggregate demand exceeds an economy's full employment or output level (Hearn, 2017). According to the cost-push view of inflation, costs for companies increase e.g., in the form of wages, energy costs, or a fall in a currency's exchange rate and thus increasing import prices; these costs are then pushing the price level up (Hearn, 2017). Friedman (1973) argued that: "What is called cost-push inflation is almost always the delayed effect of demand-pull inflation." By this Friedman (1973) meant that as increased spending led to higher prices (demand pull) the prices would catch up with a lag (cost-push).

The monetarist view is represented by inflation being always and everywhere a monetary phenomenon: that inflation is always and everywhere a more rapid increase in the quantity of money than output (Friedman (1973); Friedman, 1978). The monetarist definition of inflation views a price rise in a particular good or service, such as oil or lumber, as a relative price change. There would be no inflation in a barter economy, only relative price changes. The citizens in an economy cannot push up the aggregate price level without

more money enabling them to increase the price level. Hence, the Monetarists reject the cost-push view of inflation. They argue that this kind of inflation should be seen as relative price changes; these relative price changes cannot change the average price level without a monetary expansion that exceeds the economy's real growth rate (Hearn, 2017). In conclusion, inflation is not the rise in one price but the general rise in the price level at the same time.In this thesis, the focus is on the monetarist view, and hence only more money chasing the same amount of goods can result in more inflation.

There is also an inflation expectations view, which argues that inflation expectations matter for future inflation. There is an anchor for inflation in what people view the long-run value of inflation to be; when a central bank's target does not meet the expectation, the anchor is lost (Reis, 2021). When inflation expectations start to de-anchor, individuals start buying more goods, those who save abandon nominal assets, the labor force demands higher wages to keep their purchasing power, and firms hike prices; these effects then contribute to inflation, according to Reis (2021). Only a severe recession can lower inflation as inflation expectations rise (Reis, 2021). Hence, central banks focus on keeping the expectations near their target

What is the source of inflation? Milton Friedman pointed out that nowadays, governments create inflation, whereas earlier, it used to be gold rushes that would increase the money supply and cause inflation. Reasons for governments to create inflation can be to pay for government spending, and this happens because citizens of a country vote for governments to spend more money without taxing more. Governments typically receive tax revenue directly from their citizens. Because of inflation, governments also receive additional revenue through progressive taxation. Suppose prices increase by 10%, and the income of people, as a result, increases by 10%. In that case, an individual is not in the same situation as before since progressive taxation makes the individual pay more as a percentage of taxes with the pay increase. With inflation, a government can also reduce its debt levels with smaller debt levels as a percentage of GDP. (Friedman, 1978)

Why is inflation then bad and something that should try to be tamed? The unfortunate thing with inflation is that people lose their purchasing power. However, some individuals have real gains in an inflationary period. Individuals with more power and who are usually

better off tend to gain, whereas the weakest in society tend to lose (Hearn, 2017). In contrast, Nobel Laureate Paul Krugman (2021b) tried to question if inflation hurts the poor. Easterly & Fischer (2001) found that poor people describe inflation as a significant national concern more often than the wealthier and that inflation seemingly reduces poor people's relative incomes. According to Romer & Romer (1998), unanticipated inflation lowers unemployment in the short run, but this effect did not sustain over time. Furthermore, Romer & Romer (1998) found that lower inflation would make the situation for poor people better in the long run.

If the inflation rate is higher than nominal interest rates, then the real rates are negative, which is positive for those with debt but bad for creditors. In this way, a highly indebted government could inflate its debt away. Also, an economy experiencing inflation will see its exchange rate fall. During volatile and out-of-control inflation, economic growth is hurt, as price signals will no longer act efficiently to reallocate the scarce resources in an economy. Investment decisions might become postponed as companies do not trust that the economy is properly managed. There is also the risk of social and political disorder as people's living standards decrease when their purchasing power vanishes and economic growth is lower than expected, causing unemployment. (Hearn, 2017)

To complicate matters, the Federal Resrve (2020) introduced the new average inflation targeting (AIT; hence, the employment goal became less understandable. The AIT goal means that after periods when the inflation goal has underachieved the goal, there could be a period of moderately higher inflation. This approach was criticized by King (2022) because it can quickly become out of control.

2.2. HISTORY

The Fed was created in 1913 as a response to the banking panic of 1907. During the first decades until 1930, the transactions version of the equation of exchange (MV=PT) based on Irving Fisher's analysis was commonly accepted; the money velocity was regarded as

stable, the fluctuations in money would affect either prices or output, and economic fluctuations in the short term was due to changes in the money supply or credit availability (Friedman, 1970). Furthermore, it was considered that the primary tool that stabilized the economy was monetary policy, which operated either through discount rates or open market-market operations (Friedman, 1970).

According to Friedman (1970), the great depression that started in 1929 and lasted until 1933 changed the picture; the Keynesian revolution brought the thought that monetary policy was not effective against economic slumps. Friedman (1970) continued that this reasoning had to do with the Fed itself, stating that monetary policy was accommodative yet ineffective. Keynes assumed that money velocity was not stable but adjustable; if the money supply increased, velocity would go down, and there would be no effect on prices and economic activity (Friedman, 1970). Keynes considered the thing that mattered to be was government and business investment spending and not current income (Friedman, 1970). The result of the Keynesian counter-revolution was that the role of monetary policy was to keep interest rates low and that the tool for fighting recessions would be fiscal policy by changing government spending and taxation (Friedman, 1970).

A counter-revolution appeared, when the Keynesian doctrine resulted in inflation after the second world war (Friedman, 1970). Also, monetary history was analyzed from a new viewpoint. It turned out that it was the lack of monetary policy intervention that resulted in the great depression, as the central bank did not prevent bank runs and stop the downfall of government securities. This lack of intervention resulted in the downfall of banks that had government securities and that had to adjust the values of the government securities according to depressed market prices (Friedman, 1970). Interestingly, banks that had made bad loans without a secondary market to trade upon did not need to write down loans, but keep them at face value, hence, not failing (Friedman, 1970). There was also a growing number of empirical literature studying the effect of the quantity of money on incomes, prices, and interest rates.

Monetarism had its origins in the 1940s and started to gain traction in the 1950s with Milton Friedman as a front figure. According to Edward Nelson, before turning into a monetarist, Milton Friedman had Keynesian views as an economist, which was common

at the time (Beckworth, 2021). When Friedman started working with Anna Schwartz on money statistically, they realized what an impact monetary policy in the form of money had on business cycles. Especially in the 1930s depression era, which was in straight contradiction with the prevailing Keynesian view that money did not have much relationship with economic activity or the great depression (Beckworth, 2021). The money supply had decreased by a third between 1929 and 1933, which according to Freidman (1970) was the cause of the great depression. Friedman and Schwartz brought back to life the quantity equation of exchange. They brought with it the return of monetary neutrality. Monetary neutrality can be defined as the principle that real variables such as real output or unemployment are not affected by the money supply, which only affects the price level. (Burda & Wyplosz, 2017)

The equation in the heart of monetarists is the equation of exchange (MV = PY) that is based on the quantity theory of money. The theory holds that if the money supply growth exceeds the increase in real production, inflation will result (Cline, 2015). There is no consensus among economists on which measure of money should be used in the equation. Some prefer a narrow measure (M0, M1). In contrast, others prefer a broader measure (M2 to M4). Werner (1997) argues that the different monetary aggregates are used parallel depending on the author's purpose or which model has the best empirical fit.

In macroeconomics, two central schools of thought can be separated into Keynesians and monetarists. These schools have evolved somewhat over time and are nowadays represented by neo-Keynesians and neo-monetarists. According to Burda & Wyplosz (2017), the Keynesian view is that markets do not function well, therefore causing resources to be underutilized, which means that governments should intervene actively to limit the damage of recessions. Also, a Keynesian view is that money impacts the economy through interest rates (Congdon, 2021). However, monetarists argue that politics and bureaucracies make complicates matters and prefer to have markets to sort themselves out (Burda & Wyplosz, 2017). For monetarists, the money supply is the essential tool to analyze current GDP in the short run and inflation in the long run (Jahan & Papageorgiou, 2014). Thus, monetarists argued that the objective of monetary policy is best achieved by targeting the growth rate of a monetary aggregate. Keynes again emphasized that fiscal

policy was useful, whereas monetary policy was useless (Burda & Wyplosz, 2017). Ed Nelson highlighted that Friedman had also studied the labor market and concluded that the unions should not be seen as responsible for inflation and unemployment, resulting in Friedman defending unions against cost-push inflation. (Beckworth, 2021)

In the 1960s, the Fed tried to achieve unnaturally low unemployment as they used the Phillips Curve model and thought a tradeoff could be exploited between unemployment and inflation (Eichengreen, 2018). There was political pressure to strive for such policies. In the mid-1970, inflation started to be relatively high, and unemployment started rising as a phenomenon called stagflation occurred (Borjas & Wyplosz, 2017). In 1979 the CPI was 11,3%, and in 1981 Paul Volcker raised the federal funds rate above 20% to tackle the inflation problem (Eichengreen, 2018). During this time, monetary targeting became a policy that central banks strived for, and long-run monetary neutrality became a principle for monetary policy. During this time, monetarism was very influential.

Unfortunately, the cure for inflation involves an economic slowdown or a recession (Freidman, 1973; Friedman, 1983; Reis, 2021). The recession is caused by reducing monetary growth; reducing government spending is the most efficient way to achieve this. According to Friedman (1983, p. 50): "… the effects of cutting down inflation are not very pleasant; it tends to create unemployment and to produce a recession. Do not suppose there is a painless way to end inflation; there is no magic pill that will solve our ills without discomfort. But the alternative is more painful still. Experience over the past decade shows that as inflation rises, unemployment rises too."

Goodheart (1989) indicates that the stable relationship between money and prices and national income held until the 1970s. Velocity was assumed to be relatively constant. Therefore, the relationship between nominal GDP and money was dependent on a money demand function, which then was implemented to control nominal GDP with a monetary aggregate chosen by different countries at the end of the 1970s (Goodheart, 1989). This relationship became unstable around 1980, and because the money demand function was considered unstable, it became difficult to conduct monetary policy. Many economists argue that the link in the predictability of velocity resulted from financial innovation and banking regulations (Jahan & Papageorgiou, 2014). However, Bahmani-Oskooee &

Chomsisengphet. (2002) found that the money demand function for M2 was stable for the US and other countries during the period Q1 1971 to Q3 1998.

New Zealand was the first country to start inflation targeting as a policy regime and many other central banks soon followed (Clinton et.al, 2015). In the 1980s, inflation was moderate, and in the 1990s, inflation levels stabilized. Numerical inflation targets emerged and clarified the objectives of monetary policy. Worldwide, Central banks' communication improved as central banks understood that the more effective their policies became if their policies were understood. King (2022) points out that as we live in an uncertain world, we cannot rely upon a central bank to behave so that it reaches the target. Due to the uncertainty, an expectations policy is not a reliable anchor for inflation.

Clinton et al. (2015) argue that transparency in communication is one of the most important principles of a central bank. Transparency means how a central bank aims to reach its inflation targets once it deviates from the target. The authors also emphasize that the inflation forecast targeting needs to communicate how their interest rate policy will be affected to achieve their goals. This influences the medium-term inflation and interest rate expectations which results in real rates moving to assist the central bank’s objective. Also, both quantitative and qualitative explanations of keeping inflation intact give confidence in the inflation goal and make the nominal anchor solid. The authors highlight the importance of a central bank's credibility to achieve the inflation targeting goal.

Despite the long stable inflation levels since the 1990s, Milton Friedman was not too optimistic that a period of low inflation would continue too long (Roberts, 2006). Friedman thought that one day in the future, the government could not resist the urge to print too much money, mainly because people have been accustomed to low levels of inflation, and to extrapolate the most out of creating inflation, it has to be unanticipated.

As interest rates hit the zero bound, unconventional large-scale asset purchases, known as quantitative easing (QE), were implemented as a monetary policy tool by the Western central banks in the aftermath of the financial crisis of 2007-2008. Many commentators feared inflation since they thought that expanding central banks' balance sheets would significantly expand the money supply (Cline, 2015). These predictions did not come true since the money was not channeled out into the economy as thought due to regulations

and stricter bank lending standards (Hanke, 2017) and interest paid on excess reserves (Wang, 2021). Just a minor share of high-powered money created by QE got extended as loans by the banking sector because of the banks' preferring liquidity and the newly imposed regulations, which caused the money multiplier to fall (Jones & Giorgianni, 2020). On the other hand, asset prices have gone up since QE (Moosa & Al-Nakeeb, 2020).

3. PREVIOUS LITERATURE

In this chapter, the P-star literature will be discussed. First, the literature on the P-star model will be presented, and after that, inflation forecasts and discussions during the pandemic will be given.

3.1. THE P-STAR LITERATURE

Overall, many studies have been conducted for the P-star model, and often with good performance compared to other models (see e.g., Moosa, 1998; Scheide & Trabandt, 2000; Gerlach & Svensson, 2003). Different versions of the P-star model have been developed throughout the years. Czudaj (2010) tested three different P-star models; one derived from the quantity equation, the second price gap was derived from a money demand function, and the third was a real money gap used by Gerlach & Svensson (2003). Czudaj (2010) found support for all the models in forecasting inflation in the euro area. Often a dynamic least-square regression is used when the P-star model is studied empirically; in contrast, Cronin (2008) used a vector-autoregression (VAR).

Hallman et al. (1991) used the M2 monetary aggregate as the money supply. The authors had the M2 velocity be a mean-reverting process and found a long-run relationship

between money and prices in the US. The authors also compared the P-star model's forecasting power with Phillips curve-based models. The finding was that the P-star model was better than the other models.

Hoeller & Poret (1991) used the GDP deflator as the price level and real GDP as the output variable in 20 OECD countries. The monetary aggregates used for the OECD countries varied from M2 to M4 based on the aggregates targeted or monitored by the central banks of the respective OECD country. Their results showed that for many countries, except for USA and Germany, the P-star model had less suitable forecasting performance when compared to the OECD:s auto-regressive models. Kool & Tatom (1994) noted that the P-star model worked better for larger than smaller countries and pointed out that this might have to do with fixed exchange rate regimes and the tendency for smaller countries to import inflation. By considering this, the forecasting results improved.

Scheide & Trabandt (2000) consider other factors than the price gap in their version of the P-star model such as raw material price and unit labor costs, which also have explanatory power for the euro area. They also found significant evidence that the price gap helps predict inflation in the subsequent period.

Özdemir & Saygılı (2009) utilize the P-star model to explain Turkish inflation dynamics and find supporting evidence that the price gap can explain the inflation dynamics in Turkey. The authors also made an empirical comparison with the New Classical Phillips curve, which favored the P-star model. İslatince & Şıklar (2015) used monthly Turkish data from 2002 to 2014 and found results that supported the P-star model, and their results showed that the money gap affects inflation both in the short and long term. Atta-Mensah (1996) concluded that the P-star model could be used as an early warning tool for where inflation is heading. Tawadros (2007) modeled output and velocity with stochastic trends in Middle Eastern countries and found support for the P-Star model.

Frait et al. (2000) implemented a P-star model specifically designed for the Czech Republic from 1991 to 1999. The empirical method used was OLS. Since the original P-star model is designed for a relatively closed economy with a floating exchange rate, the authors considered the exchange rate peg with Germany, which helped form the equilibrium price level. Instead of using the gross domestic product (GDP), they used

domestic aggregate expenditures. Because of this update, the model can also consider imports in the short run when the money supply increases. The study by Frait et al. (2000) concludes that inflation dynamics in the Czech Republic follow the P-star model, which suggests that the prevailing inflation tends to close price gaps and that the foreign price gap seems to be of more importance to the Czech Republic. Results also confirmed that the link between money and domestic expenditures for the Czech Republic is greater than the link between money and the nominal product. Several institutions were predicting intense inflation pressures for the economy of the Czech Republic in 1998, but the P-star model indicated a decline in inflation pressures during the next quarters. It turned out that actual inflation decreased as the model estimates suggested

Qayuum & Bilquees (2005) searched for the leading inflation indicator in Pakistan by comparing the P-star model with a simple autoregressive model and an M2 growth augmented model. The results favored the P-star model.

Cronin (2018) incorporated oil price inflation into the VAR estimation to compare cost-push factors against monetary variables. Thus, helping to determine if the velocity gap or output gap has a large proportion of the inflation forecast's error variance. Results showed that shocks in velocity and output gaps explain a big part of the United States GDP implicit deflator throughout the analyzed period. E.g., In the 1970-the 1980s, oil price changes had a less explanatory power on the inflation levels than the monetary variables; therefore, Cronin found support for the P-star explanation of inflation. Monetary aggregates used were M2 and MZM. Also, in general, the velocity gap had more explanatory power over inflation and output developments. Cronin (2018) also found that the different money stocks have importance regarding the link between money and inflation during different periods

The P-star model's forecast performance was favorable compared to two output gap models and a simple univariate autoregressive model in a study by Kiptui (2013). Furthermore, the author found significant results that the 1% increase in the domestic price gap resulted in a 0,5 % increase in Kenyan CPI in a later period, whereas the foreign price gap studied was not significant.

Moosa & Al-Nakeeb (2020) used an augmented P-star model to explain the low inflation levels in the United States between 2000 and 2018. They found that declining velocity and accumulation of reserves by banks explained the low inflation. Additionally, the authors found that cost-push factors that lowered import prices also contributed to the low inflation.

3.2. INFLATION FORECASTS POST-PANDEMIC

Powell (2022) admitted that Fed got their inflation forecasts wrong and highlighted that most other macroeconomist inflation forecasts were wrong too. Castañeda & Congdon (2020) predicted already in the summer of 2020 that an inflationary boom is coming as a result of the money supply growth; they also highlighted that the crisis has shown that in a fiat monetary system, there are almost no constraints for money creation. Castañeda & Congdon (2020) explained that speculative precautionary demands to hold money can explain the fall in M3 velocity and that the velocity of money will revert to a mean value. Assuming that the pandemic would end in 2021 and the monetary growth rates would normalize, they saw an inflation rate of over 10% as plausible in 2021.

Jones & Giorganni (2020) discussed the possibility of the M2 growth and the risk of fiscal dominance leading to higher inflation as happened at the end of the 1930s and the 1940s when the the Fed kept interest rates low and monetized debt from the Treasury long after the economic recovery.

Based on a US 1985-2019 Phillips curve estimate, Ball et al. (2021) estimated that the PCE inflation could rise to 2.3-2.8 % by 2023; they assumed fiscal stimulus would achieve an unemployment rate of 1.5-3.5%. Additionally, they expected the fiscal expansion to be only temporary and that monetary policy would be credible so that inflation expectations do not become un-anchored and risk inflation. Ball et al. (2021) did not see the pandemic stimulus as causing inflation: “Overall, we see little risk that the current temporary

government spending for pandemic relief causes an inflationary spiral. We expect instead a rise in inflation that is modest and temporary."

Christensen (2021) presented his simulation of the P-star model to argue that there was a possibility for double-digit inflation due to the price gap resulting from the US pandemic. Christensen (2021) used M3 for M and CBO data for the output gap; the results indicated a price gap of 15% in April 2020, which, according to his simulation, could lead to 12% inflation already in the end of 2021. He simulated that the price gap would be closed over five years, and it should be closed as frontloaded. Another assumption was that money growth should end in January 2022.

Reis (2021) studied inflation expectations data retrieved from three sources: market prices, professional surveys, and cross-sectional distribution of household surveys. This data set enabled the author to see that the inflation expectations anchor might have drifted away in 2021. However, Reis (2021) considered that because the anchor had drifted recently that with good fortune or good policies, inflation expectations could become anchored once again.

Greenwood & Hanke (2021) used the monetarist Cambridge approach to forecast inflation; they estimated that the price level in the US will increase by 28% due to the excess increase in broad money, measured with M2. Furthermore, they considered that inflation will last through 2023 and 2024. They received their results by subtracting two years of typical real GDP growth and the measured annual growth rate of velocity from the cumulative broad money growth. The remaining residual is the excess money that needs to work through the economy. Considering that real GDP growth cannot be impacted much and there is long-run stability in the public's demand to increase their money holdings, inflation is the only way for the excess money to work through the economy.

Larry Summers (2021) has also been fearing inflation, but his standpoint results from a fiscal view of inflation where he was worried about the significant government deficits. In contrast, Krugman (2021a) has not been worried about inflation and wrote: "…those paying attention to the flow of new information, inflation panic, is, you know, so last week. Seriously, both recent data and recent statements from the Federal Reserve have,

well, deflated the case for a sustained outbreak of inflation." In May 2020, Blanchard (2020) saw deflation as a bigger threat than inflation. Later, Blanchard (2021) did not see troubling inflation signs with the Phillips curve calculations that included many assumptions, which were that inflation expectations are anchored, and every one percentage point decrease in unemployment would increase inflation by either 0.2 or 0.5 percent. However, Blanchard (2021) considered the US output gap at the end of 2020 to be $900 billion against a total stimulus of $2.8 trillion proposed, depending on the size of the multipliers that are hard to measure accurately might result in the de-anchoring of inflation expectations; hence leading to higher inflation. Clarida (2020), in May 2020, considered the Covid-19 shock to be disinflationary for the following few years.

Castaneda & Congdon (2021) uses for velocity a ratio of nominal GDP and GNP to broad with M2 until 1959 and M3 after that; doing so gives them a relatively stable velocity over time. Moreover, what they see from their data is tha the change in US velocity reverts to a mean and is a stationary process, especially after the 1950s, and declines by 0.8% per year on a 93-year period to Q1 2019, and if Q1 2021 is included -1.1%. For the decade prior to 2019, money velocity was relatively stable, and Castandera (2021) suggests that one reason for this could be the Dodd-Frank regulation of 2010.

By examining the prices of inflation options data, Hilscher et al. (2022) found evidence that in 2021 the risk for persistent high inflation was rising steadily, and there was also a quick rise in the inflation risk for the eurozone in 2022.

In conclusion, those using the information value of monetary aggregates could foresee the upcoming inflation earlier and more accurately than those relying on other methods such as inflation expectations and the Phillips curve models. However, it cannot be ruled out that at least some of the other more prominent economics commentators might have understood what was possibly coming but were instead trying to steer inflation expectations and hoping for good luck. Because of the immediate effect of forward guidance on the market pricing of assets (Wang, 2021), it might be disastrous for the Fed chairman to say in the early recovery phase that there is a risk of persistent inflation in the coming years. Hanke considered that central banks refer to supply chain and other ad hoc explanations of inflation because the inflation problem is political; no politicians nor the

Fed want to take responsibility for the inflation that is a result of the excess money produced (Friedberg Economics Institute, 2021).

4. THEORETICAL FRAMEWORK

This chapter presents the relevant theory for the thesis. First, the quantity equation of exchange will be presented, and then monetary aggregates, money creation, and the Taylor rule will be covered. Since there is much confusion about money creation, that chapter will be more in-depth.

4.1. THE QUANTITY EQUATION OF EXCHANGE

The quantity equation of exchange can be described with the following equation:

$$MV = PY \tag{1}$$

where M represents money supply, V is velocity, and is often assumed to be a constant, P represents the current price level, and Y represents real GDP. With the assumption of money neutrality, an expansion in the money supply will generate a proportional rise in the general price level if velocity is constant (Burda & Wyplosz, 2017). The P-star model used in this thesis will

4.2. MONEY SUPPLY AND MONETARY AGGREGATES

The money supply can be viewed as the total amount of money in circulation in an economy, and the various monetary aggregates represent statistical measures of the money supply. In the 1930s, the Fed started to give more attention to monetary aggregates (Bernanke, 2006). Previously, prior to the 1930s, the Fed had been focusing on monetary data.

In the 1970s, five monetary aggregates were published, varying from M1 to M5. In the 1980s, due to defining the monetary aggregates in a new way M4 and M5 were canceled (Bernanke, 2006), and in 2006 The Fed stopped publishing M3 (Federal Reserve Statistical Release, 2006).

In table 1, the monetary base (M0) and the most commonly used monetary aggregates (M1-M3) are described. The composition of the different aggregates varies country wise (Burda & Wyplosz, 2017), and there can be, at times, updates to the composition regarding what is included and what is not. In April 2020, due to regulation D, the savings accounts became more liquid when limitations on transfers vanished (The FRED Blog, 2021). Hence, savings accounts were added to the M1 monetary aggregate, which means that in May 2020, the old M1 would have been 5 trillion, whereas the new M1 was 16 trillion. Hence, with the new definition, M1 can be considered a broad measure of the money supply.

The greater the number of the monetary aggregate after the M, the less liquid components are included in the monetary aggregate in question. These less liquid components require more time and cost to be converted into cash and bank deposits. Sight deposits can be thought of as deposits that are easily converted to cash, or they can be transferred easily to other banks and have an interest rate that is zero or very close to zero. Savings deposits (or time deposits) include longer-term deposits that are possibly restricted for use and deposits that non-bank institutions hold. Also, if money from a savings account is transferred to a sight deposit account, it will increase M1, but M2 will stay the same since it includes M1. Thus, it is better to use a broader measure of a monetary aggregate to avoid such fluctuations in a more narrowly defined monetary aggregate.

Table 1: Monetary aggregates and their composition

	Composition	Type
M0	Reserve deposits and currency	Narrow
M1	Currency + sight deposits	Narrow*
M2	M1 + savings deposits at banks with unrestricted access	Broad
M3	M2 + larger, fixed term deposits + accounts at non-bank institutions	Broad
*From April 2020 onwards, the M1 measure includes savings deposits due regulation D. As a result, M1 can be defined as a broad money measure.		

Source: Burda & Wyplosz (2017, p. 223)

Figure 3 is a simple illustration of how to easily think about the different monetary aggregates.

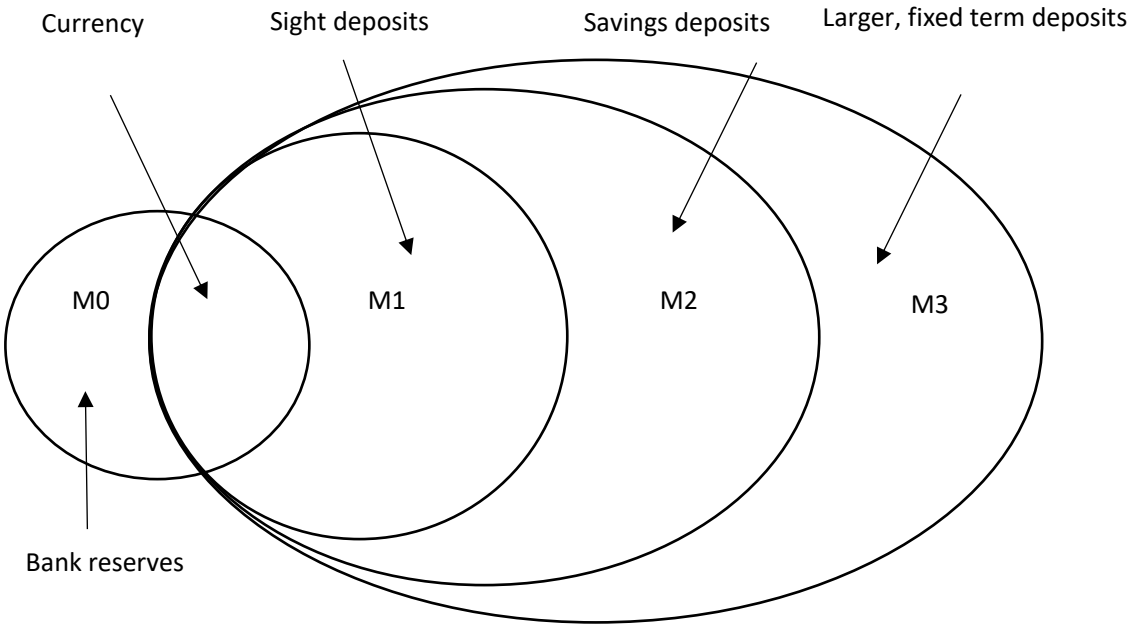

Figure 3: *Illustration of the monetary aggregates*

Source: Marginal Revolution University (2017); BURDA & Wyplosz (2017)

4.3. MONEY CREATION

The central banks create two sorts of money, and they can only create money that belongs to M0. The first kind of money is currency, i.e., coins and banknotes, and this can be created by the central bank separately or together with some other monetary authority. The other type of money a central bank can create is bank reserves. Bank reserves are sometimes called high-powered, state, or central bank money. These are funds that a commercial bank holds with the central bank, and these reserves are not circulating outside commercial banks. However, they are highly substitutable for currency and, thus, can be used immediately. (Burda & Wyplosz, 2017)

Banks create money when they grant loans to their customers. According to theory, there is a money multiplier process where a new deposit in a bank increases the money supply and leads to new loans. The amount of the new loans extended depends on the fraction from the new deposit that a bank is obliged or otherwise holds aside (Burda & Wyplos, 2017). One of the tools to restrict or increase the money multiplier is the reserve ratio that a central bank requires a bank to hold; during the Covid-19 crisis, the Fed lowered the reserve requirement to zero, meaning that, in theory, the money multiplier has no limit (Jones & Giorgianni, 2020). Also, the profitability motives of a bank reduce the number of loans that a bank extends to its customers (Wang, 2021). Banks also need reserves to settle transactions with other banks and to be able to convert reserves to currency; hence a bank would not automatically use all its reserves to extend too many loans. Regulation can also discourage or make it harder to extend bank lending (Hanke, 2017).

Before the financial crisis in 2007-2008, the Fed used to target the federal funds rate (FFR) with open market operations (OMO) in the market called the federal funds market. FFR is an overnight lending rate between banks. If a bank had too few reserves to meet the requirements, it could borrow reserves from other banks with excess reserves. The interest rate that emerges from the interbank transaction is called FFR. With OMO, the Fed can buy and sell government securities, usually treasury bills, and trade with the banks. If the Fed wants to lower (raise) the FFR, they buy (sell) the securities from a bank in exchange for reserves, and with these reserves, the bank can create new loans. This works in the

way that the Fed chairman announces the new target and signals that Fed will buy and sell securities to achieve that specific goal. With open market operations, Fed can directly impact the monetary base, and a bank, with its actions, could impact the monetary aggregates from M1 upwards by extending a new loan. Banks continuously repay short-term loans to a central bank, so with a contractionary OMO, the easiest way to make reserves scarce is not to renew maturing loans or only renew them partially. (Burda & Wyplosz 2017; Wang 2021)

Reserves increased enormously after the financial crisis from around 20 billion USD to trillions, resulting in FFR no longer being controllable with changing the amount of reserves (Wang, 2021). As a result, new tools were introduced QE, interest on reserves and repurchase (repo) and reverse repurchase agreements, and the use of forward guidance. QE works in the way that Fed buys longer-term assets with bank reserves, and if they buy it from a non-bank entity, the non-bank entity's commercial bank will receive the reserves, while the non-bank entity will receive commercial bank deposits in exchange for the asset sold to the Fed (Wang, 2021). With QE, interest rates are lowered (Burda & Wyplosz, 2017). According to Wang (2021), usually, it is wealthy entities selling treasuries to Fed via QE, and treasuries are money that is not likely to be spent in the real economy. As a result of this QE process, this money allocates itself to riskier equities and corporate debt, making asset prices increase. According to Hanke, if a central bank buys with QE assets from banks, it only increases bank reserves, as was the case in the Eurozone and Japan; the US and the UK bought with QE from the non-bank sector, which increased the money supply (Friedberg Economics Institute, 2021).

Repo and The Overnight Reverse Repo Facility (ON RRP) and interest on reserve balances (IORB) was introduced to control the federal funds rate (New York Fed, 2021). In a repo, the Fed buys securities from a counterparty, which increases the amount of reserves. In a reverse repo, Fed sells securities to a counterparty, which temporarily reduces the amount of reserves. RRP gives a broader group of counterparties the possibility of lending to Fed at the RRP offering rate to avoid the repo rate being lower than IORB. RRP and IORB create a floor on the amount of return the participants will accept from the private sector. The security in a repo transaction is collateral in case of

the lender's bankruptcy. The Fed created a Standing Repo Facility (SFR) in 2021, which aims to calm down the upward pressure in repo market rates (New York Fed, 2021). Figure 4 is a simple illustration that attempts to summarize the above-described money-creating process more easily.

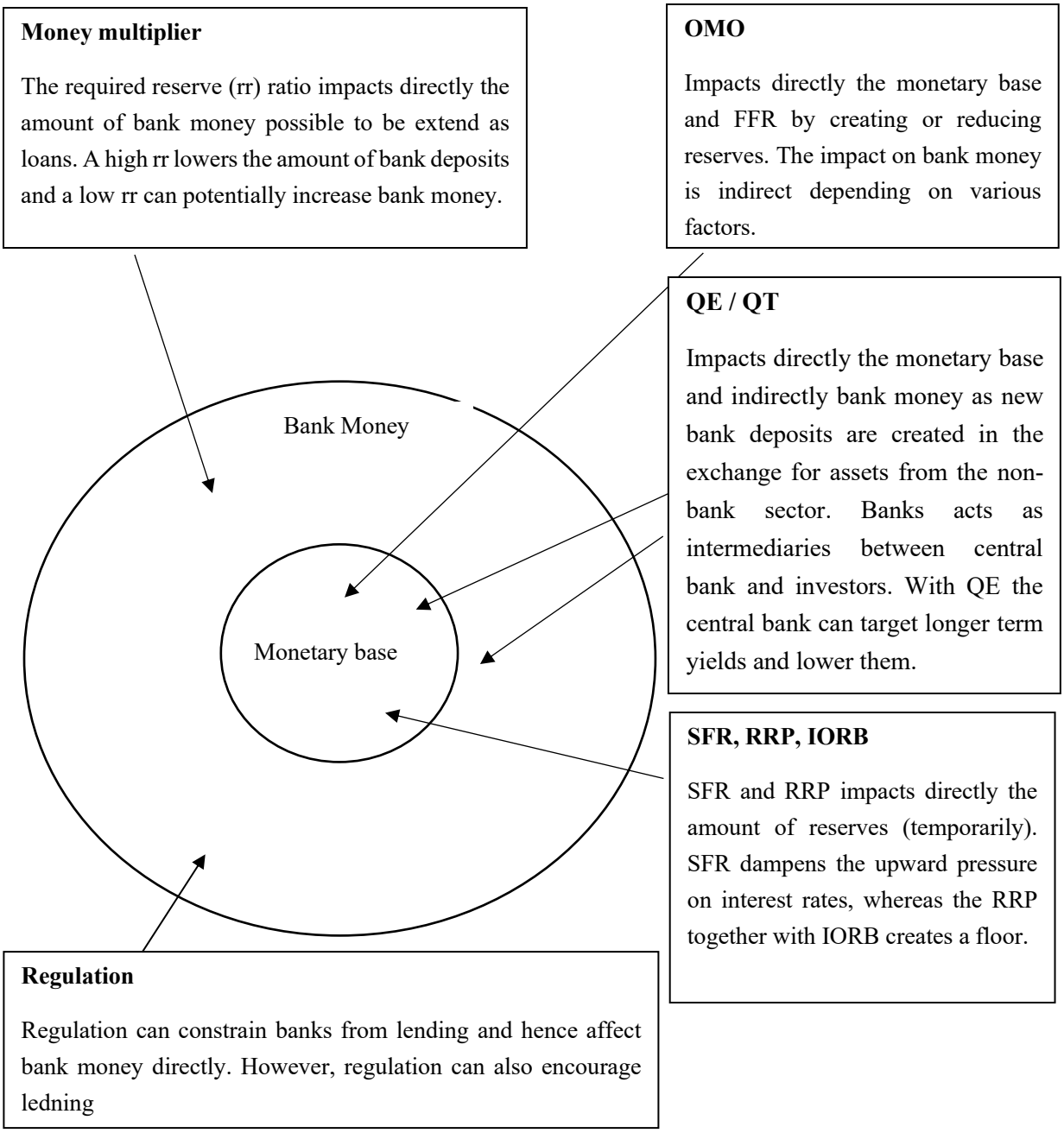

Figure 4: *The money creation process*

Sources: Burda & Wyplosz, 2017; Hearn 2017; Wang, 2021; New York Fed, 2021; Hanke, 2017

4.4. GOLDEN GROWTH RATE OF MONEY

Hanke (2021) defines the formula for the golden growth rate of money as the *inflation target + average real GDP growth – average percentage change in velocity.* Hanke's estimate for the golden growth rate for the monetary aggregate M4 was 6,3% using data from 2010 to 2020. The golden growth rate for monetary aggregate M2 calculated by the data used in this thesis provides a golden growth rate of 5,98% to achieve a target of 2% inflation (based on 2010-2019 data to avoid the fluctuations in 2020). The golden growth rate of the M2 money supply is between the interval of 5,24% to 5,99% when calculated during different time intervals, as seen in table 2 below.

Table 2: Golden growth rate of M2

	1960-2019	**1990-2019**	**2000-2019**	**2010-2019**
Inflation target	2,00%	2,00%	2,00%	2,00%
Average real GDP growth	3,06%	2,47%	2,09%	2,25%
Average percentage change in M2 velocity	-0,31%	-0,77%	-1,89%	-1,74%
Golden growth rate (GGR)	**5,37%**	**5,24%**	**5,98%**	**5,99%**
Average percentage change in M2	7,21%	6,21%	6,14%	5,85%
M2 growth rate deviation from GGR	*1,83%*	*0,97%*	*0,16%*	*-0,14%*

4.5. THE TAYLOR RULE

Monetary policy can be discretionary or based on a rule. A discretionary monetary policy means that a central bank does not systematically or in a reliable way react to changes in the economy. Often, when monetary policy was unconstrained without the gold standard or pegged exchange rates during the Bretton woods arrangement, the discretionary monetary policy resulted in inflation; however, a rule cannot always work; hence some discretion is required (King, 1999). In practice, no rule could describe how a central bank should act in every outcome possible. For example, a rule can be the Taylor rule where the central bank sets the interest rate at a level so that the inflation is kept in check or a

money growth rule as monetarists recommended. According to Mankiw & Reis (2018), almost all central banks have continued using discretion to affect the economy and react to shocks.

The Taylor Rule was introduced in 1993 after economist John Taylor observed a rule that seemed to monitor central bank behavior quite accurately. The original policy rule was described with:

$$r = p + 0{,}5y + 0{,}5(p - 2) + 2 \qquad (2)$$

where r represents FFR, p is the year-over-year inflation, and y (100*(Y-Y*)/Y*) is the percent deviation of real GDP from its potential or target level (Taylor, 1993). The Taylor rule summarizes how a central bank deals with its inflation and output objectives. When calculating the Taylor rule, it is also common to use the unemployment gap instead of the output gap. The parameters 0,5 in equation 2 are proposed by Taylor and describe how much importance the central bank sets on each objective. The number 2 represents the target inflation rate; if the inflation gap and output gap are on target, the FFR would be 4% (2% in real terms). (Taylor, 1993)

5. METHOD

In this section the method P-star model will be discussed in detail. In this thesis, the method to answer the research question is to apply the P-star model in the following way to estimate the future price gap; first, the data is converted to their logarithm form as in equation 7; lastly, the values are calculated and the results visualized. The v^* is estimated with a Hodrick-Prescott (HP) filter until Q4 2019. From Q4 2019, it is assumed that there will be a downward trend of -0.77% per annum, the same trend that prevailed between 1990 and 2019. Furthermore, it is assumed that M2 money growth will stabilize to a growth rate in line with the golden growth rate of M2. The alternative scenarios deviate 10% in both directions from the main scenario to test the robustness of the results.

5.1. THE P-STAR MODEL

The P-star model originates from the quantity theory of money and, in the model, the money stock affects the equilibrium path of the price level. The actual price level will follow until it has adjusted to the new equilibrium level. At the end of the 1980s, the Fed introduced the dynamic P-star forecasting model (Humphrey, 1989). The P-star forecasting model was used for some time by the Fed, but in 2000 FOMC ceased to have target ranges for monetary aggregates (Cline, 2015). This is because financial innovations collapsed the stable economic relationships based on M2. Bernanke (2006, p. 3) described why the P-star model and monetary aggregates were no longer used in the following way: "Unfortunately, over the years the stability of the economic relationships based on the M2 monetary aggregate has also come into question. One such episode occurred in the early 1990s, when M2 grew much more slowly than the models predicted. Indeed, the discrepancy between actual and predicted money growth was sufficiently large that the P* model, if not subjected to judgmental adjustments, would have predicted deflation for 1991 and 1992. Experiences like this one led the FOMC to discontinue setting target ranges for M2 and other aggregates after the statutory requirement for reporting such ranges lapsed in 2000. " In this thesis, the growth rate of the monetary aggregates is not predicted; it is assumed that the Fed lowers the growth rate of the M2 to a level consistent with the golden growth rate of M2.

The model's name originates from P^* being the equilibrium level to which actual prices P adjusts. In short, when subtracting P from P^*, a gap is generated that helps predict future direction of inflation. If there is no gap, prices will remain unchanged. The P-star equation does not grasp the short-run factors influencing the price level, such as indirect tax changes or energy shocks, but the price level when these short-term factors have been sorted (Hoeller, 1991). Hence, the P-star model provides a measure of where the price level will move once these transitory factors have worked themselves out.

From equation (1), we receive the price level by the following:

$$P = \frac{MV}{Y} \tag{3}$$

The equilibrium price level is received by setting asterisks to represent the equilibrium values. Then we receive the following equation:

$$P^* = \frac{MV^*}{Y^*} \tag{4}$$

where the money supply, *M*, represents a current measure of money, e.g., a monetary aggregate that is multiplied by the long-run equilibrium value for velocity, *V**. This variable is not directly observed and can deviate from the current velocity level and vary over time. E.g., Hallman et al. (1991) used, based on their data sample, the sample mean velocity of 1.65. *Y** is the real potential output, which can also vary over time and deviate from the observed current real level. This thesis will proxy *Y** with the data for potential real GDP produced by the congressional budget office (CBO).

The next step is to transform the equations (3) and (4) into natural logarithms (identified by lower case variables):

$$p = m + v - y \tag{5}$$

$$p^* = m + v^* - y^* \tag{6}$$

After this, we combine (5) and (6) to receive the following equation:

$$(p^* - p) = (v^* - v) + (y - y^*) \tag{7}$$

where the LHS in equation 7 is the price gap, and the RHS has the liquidity gap, $v^* - v$, and the output gap, $y - y^*$. The output gap explains inflation in traditional standard inflation

models; the P-star model differs by accounting for deviation in velocity from its equilibrium level (liquidity gap), which also affects inflation (Hoeller, 1991)

The model assumes that the price level, in the long run, is affected by the change in the money supply. Inflation will increase (decrease) according to equation (7) if the current price level p is below (above) the equilibrium price level p^*. If y were above its equilibrium value y^*, the price gap would not increase since v would increase with the same amount due to the relationship shown in equation (5) that velocity has with output (Czudaj, 2011).

Figure 5 illustrates the model and how a price gap works in the model. The green-colored dash line is a hypothetical time path for equilibrium prices, whereas the solid blue line represents a possible time path for current prices. Until time *t0* actual and equilibrium prices are the same. However, a monetary expansion raises the equilibrium rate of inflation; this results in a gap between the equilibrium and actual prices. There is a lag before the current prices start to rise. For current prices to reach their equilibrium level, they must grow in excess above the equilibrium inflation rate (CD > BE) before stabilizing at the new equilibrium rate. Between *t1* and *t2*, the current prices are adjusting, and the inflation rate rises above the equilibrium level and the initial rate (slope AC). (Humphrey, 1989)

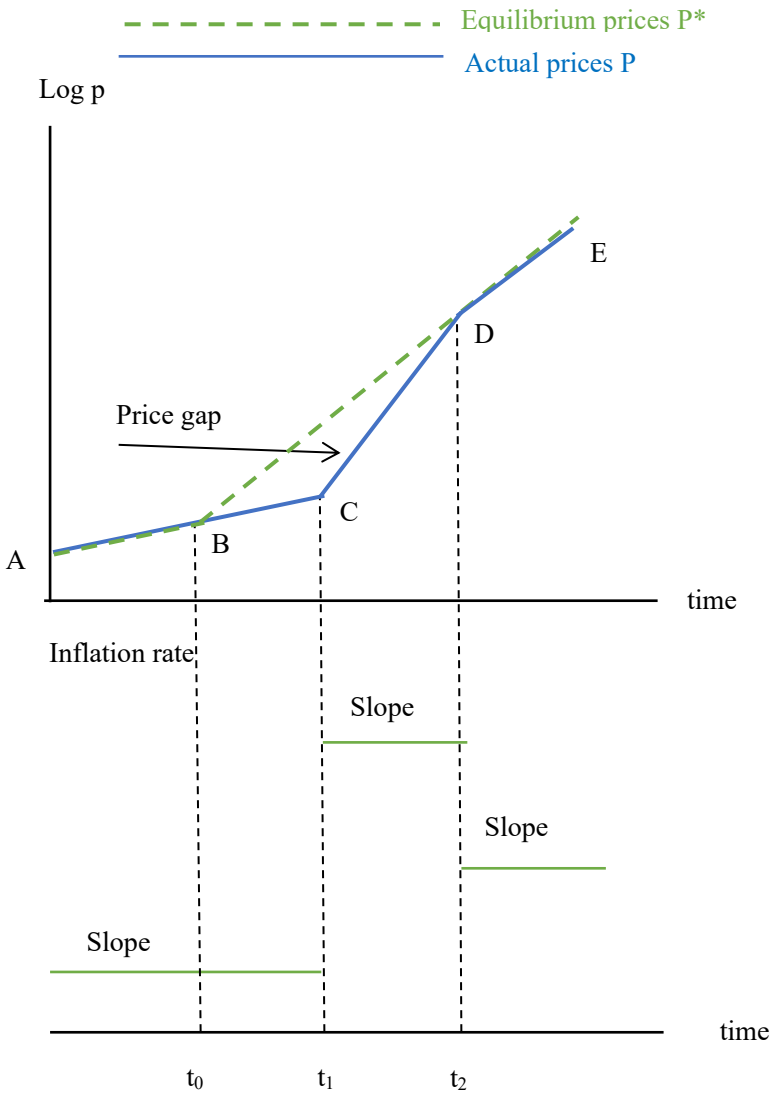

Figure 5: *P-Star Diagrammed (Humphrey, 1989)*

6. DATA

This chapter presents the data for this thesis, which is downloaded from the Federal Reserve Bank of St. Louis (FRED) database. Quarterly data from the first quarter of 1960

to the fourth quarter of 2021 is used, except for the monthly data used in figure 1 and 8. The monetary aggregate (*M*) chosen for this thesis is the simple sum M2; other data used is the nominal GDP in $ billions, the velocity of the M2 money stock, and real- and potential real output originating from CBO. Also, the federal funds rate, University of Michigan inflation expectations, and the 5- and 10-year breakeven data are used. From econpapers.repec.org, an HP filter add-in is downloaded to estimate the equilibrium velocity.

6.1. DISCUSSION OF DATA

A problem occurring is that there is no data available for the equilibrium velocity V^*. The literature offers different approaches to model V^*; to implement a Hodrick-Prescott (HP) filter as Cronin (2018), constant as Hallman et al. (1991), or some form of a trendline.

Figure 6 illustrates the liquidity gap between Q1 1960 to Q4 2021; examining the M2 velocity behavior during the sample period suggests that a constant for equilibrium would not seem suitable. Therefore, an HP filter is applied to create values for V^*, with a lambda value of 1600 that Cronin (2018) used. The HP filter is a way to detrend macro data. Because there is an endpoint problem associated with the HP filter (see e.g., Pedersen, 2001), the HP values after Q1 2017 have been dropped. From Q2 2017 onwards, this thesis assumes that the average annual percentage change of -0,77 % in M2 velocity between 1990 and 2019 (table 2) is a reasonable estimate of the downward trend in equilibrium velocity, which is the blue line in figure 6.

As figure 6 shows, the M2 velocity was relatively stable with some fluctuations from the 1960s until the early 1990s. Peak M2 velocity was 2.19 in Q3 1997. After that, a downward trend started, which was relatively steep after the financial crisis. M2 velocity hit record low levels after the imposed corona lockdowns, and it has not yet started to pick up in Q4 2021. This thesis assumes that once the economy starts to reopen again, the M2

velocity will move from the current value of 1.12 toward the estimated equilibrium value of 1.41 in Q4 2021.

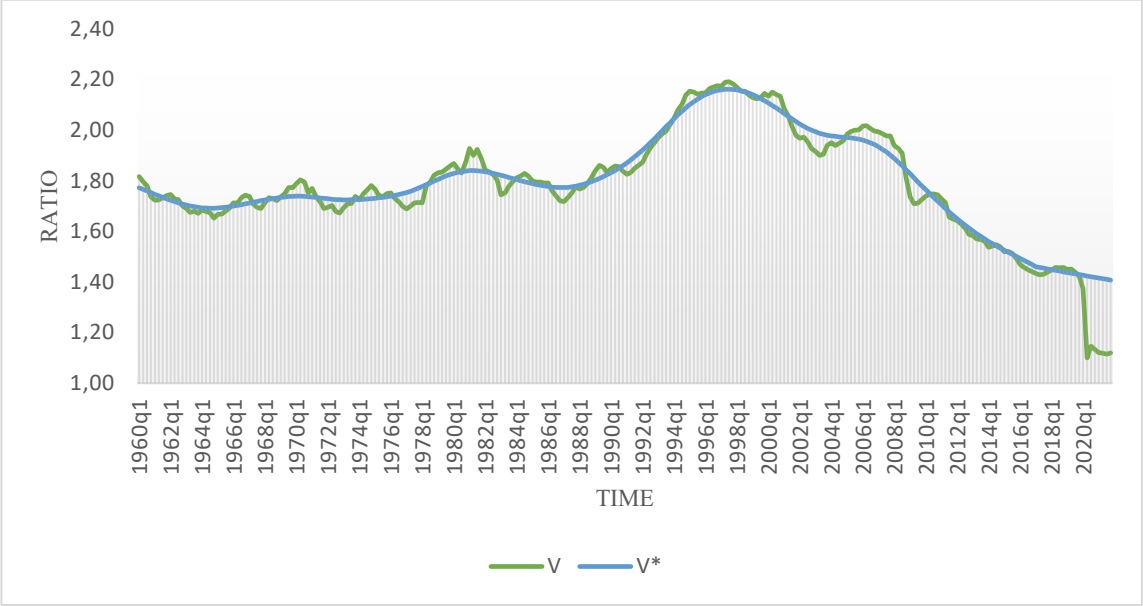

Figure 6: *Quarterly M2 velocity from Q1 1960 to Q4 2021*
Source: FRED database

An output gap emerged after the corona lockdown, where real GDP fell below its potential, as seen in figure 7. The output gap was almost closed in Q4 2021. Also, figure 7 shows that real GDP grows slowly but surely over time.

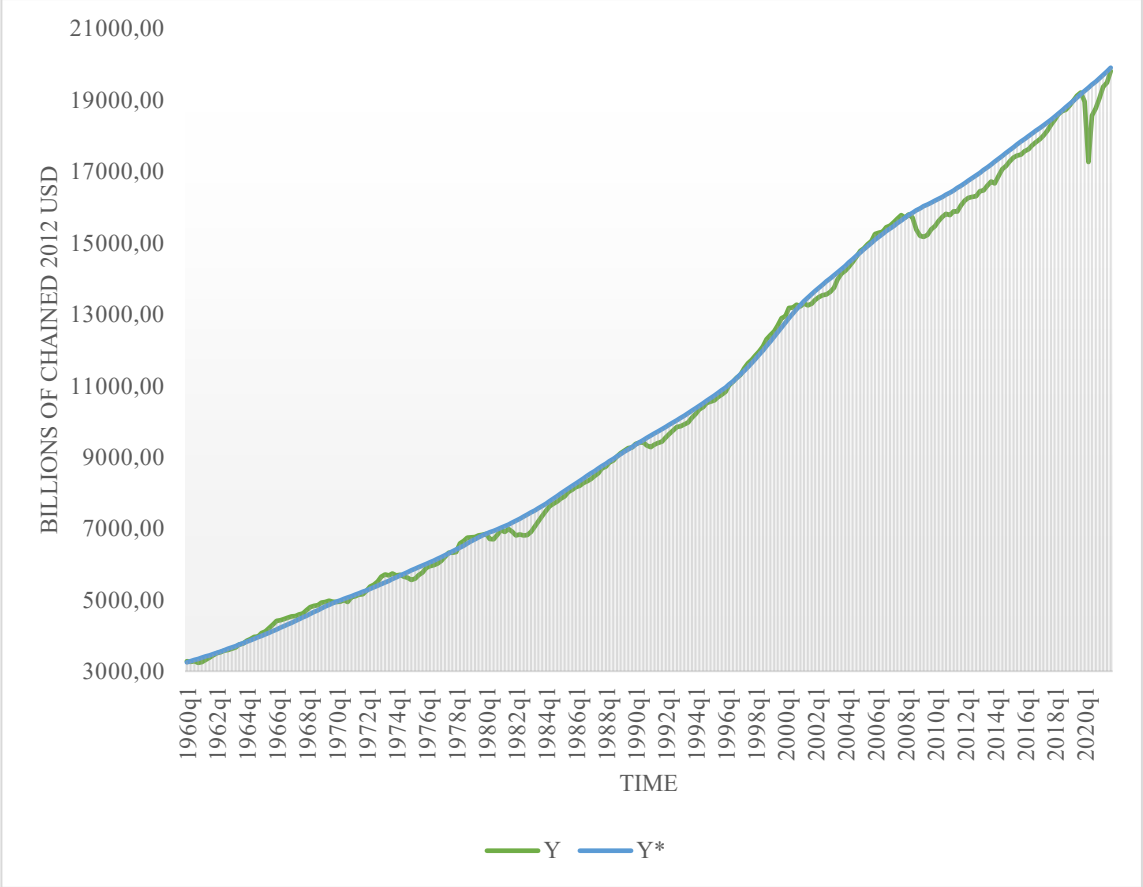

Figure 7: *Quarterly real GDP & real potential GDP 1960 -2021*
Source: CBO

Some economists and central banks regard inflation expectations as to how actual inflation will evolve since inflation expectations affect the economic decisions of households. Figure 8 illustrates some commonly used inflation expectation measures that economists often refer to; these expectations did not have predictive power to foresee the inflationary pressures experienced in the US economy since the measures were still anchored at the end of 2020. The blue line describes the University of Michigan's survey for consumers, which describes the median expected price change next 12 months, which in December 2021 was 4.8. The 5- and 10-year breakeven inflation expectations are derived from the 5- and 10-year treasuries, respectively. The latest values on these imply that market participants expect inflation to be, on average, for the next 5 and 10 years, 2.75% and 2.46%, respectively.

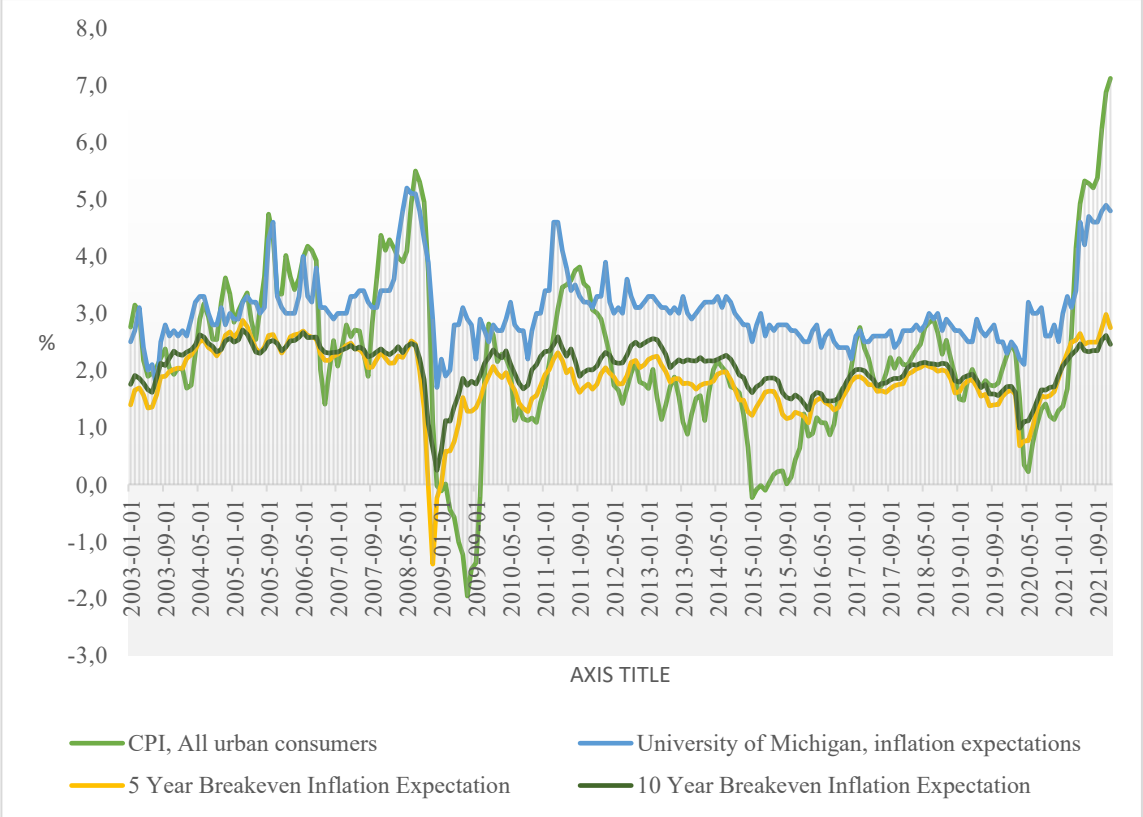

Figure 8 *Monthly inflation expectations 01/2003-12/2021*
Sources: University of Michigan and FRED database

7. RESULTS

In this chapter, the results are presented and discussed. First, the main results from the P-star model will be presented After that, the alternative scenarios will be discussed. Then the results from the Taylor rule will discussed. Lastly, the results from the main scenario and the alternative scenarios will be summarized.

7.1. MAIN RESULTS

The main results are visible in figure 9. The logged values of p (green line) and p^* (blue line) are on the LHS of the Y-axis. The yellow area visualizes the price gap, and the values are on the RHS of the Y-axis. To improve the accuracy of the percent changes, exponentiating transformation of the logged values was done; this is because log% is not a good approximation for significant percent changes.

As figure 9 shows, since the beginning of the 1990s, p and p^* have not deviated too much from each other. However, in Q2 2020, as the M2 money supply surged by over 20.62% year-over-year, the price gap immediately exploded to 15.51%, which is close to the price gap estimated by Christensen (2021) in the same period. In addition, the price gap continued to increase during the next quarters to 25.09% in Q4 2021. This price gap could be closed in three different ways; Firstly, $^*V$ could drop to the same level as V, secondly the additional money in the system could be reduced by the Fed to a pre-crisis level, and lastly, the gap could be closed by inflation. The first option could happen, if the US public would not be able to spend their excess money due to new lockdowns or some form of restrictions on the usage of money. However, this is not considered a too likely scenario in this thesis because the US can be considered a relatively free-market economy; also, it is difficult to imagine the American public supporting such policies. The second option is also a possibility but considering that the Fed fears deflations and economic depressions, this scenario is neither considered very likely. The likeliest scenario considered in this thesis is the third option, where the price level will reach the equilibrium price level, which is also considered to be the way that Greenwood & Hanke (2021) and Christensen (2021) assume the excess money and price gap to close.

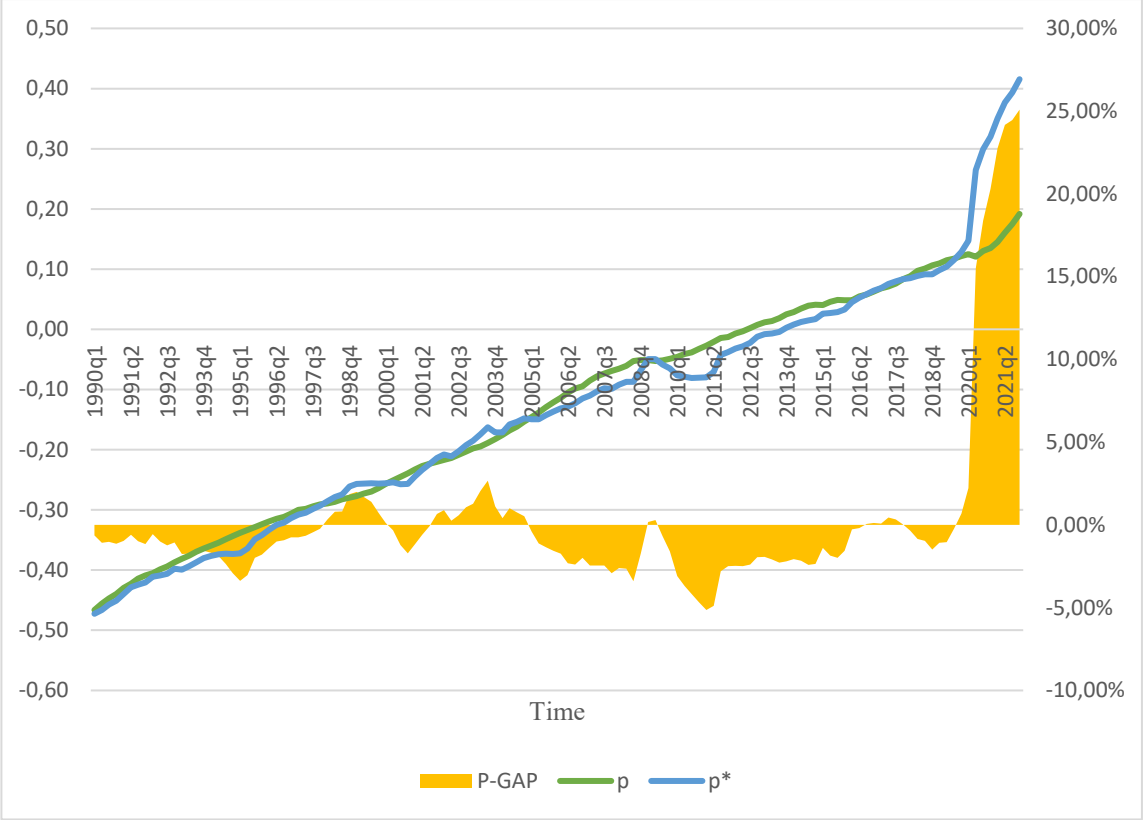

Figure 9 *Main results*

Hanke suggests that the excess money will work its way through prices in 3-4 years when looking at a historical context (Friedberg Economics Institute, 2021). According to this time spread, the annual inflation rate measured with the GDP deflator would be from 2022 the following 3-4 years on average between 6.27% and 8.36% p.a. The impressive thing with the model is how quickly the inflation pressures are visible in the economy compared to the inflation expectations in figure 8, or to the neo-Keynesian models that did not foresee the current inflation problem.

In the main results, the average annual velocity decline for 1990-2019 of -0.77% was converted to a quarterly figure of -0.43% when calculating V^*. However, the price gap is extremely sensitive to changes in the equilibrium velocity, and the fluctuations in the velocity are something that critics of the quantity theory of money often refer to. Therefore, considering the presented critique two other scenarios will be tested to see how those different equilibrium values would affect the price gap.

7.2. ALTERNATIVE SCENARIOS

In a good scenario, it is assumed that the equilibrium velocity would be 10% lower than in the main scenario and be 1.27 in Q4 2021. It is reasonable to assume that the equilibrium velocity is higher than the current velocity of 1.12 in Q4 2021; since the economy has not gone to a completely normal situation at the end of 2021, and inflation is still rising at the beginning of 2022. Therefore, in the good scenario, it is assumed, that V^* is moving in the same direction as the V^* from the main result until Q4 2019. After that, due to possible future lockdowns or some regulations that restrict spending in the future, v^* will remain below the main scenario. In this case, the price gap would be only 12.58%; this would imply, on average, an inflation rate of 3.15% to 4.19% p.a. in the next 3-4 years. The results are illustrated in Figure 10.

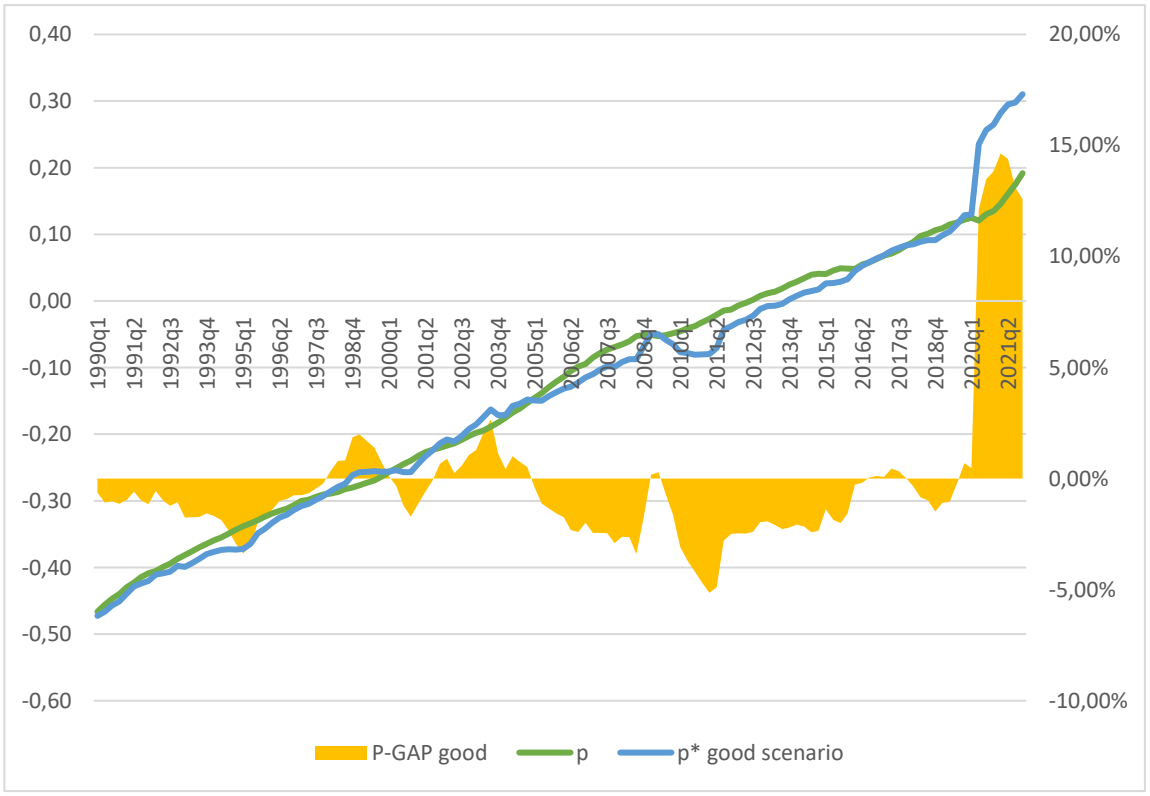

Figure 10 *Results in a good scenario*

In a bad scenario, it is assumed that the equilibrium velocity would be 1.55 or 10% higher in Q4 2021 than in the main scenario. This could be due to interest rates going up. There is a positive relationship between V and interest rates, which has to do with the money demand function (Burda & Wyplosz, pp. 233-235). The original Taylor rule implies that the FFR should be 11.27% and considering the price pressure to last for 3-4 years, it could be argued that V^* should be higher than in the main scenario. When there is a high cost of holding money, people work hard to have less of it. Similarly, when the cost of money is low, people do not mind holding more of it. As interest rates start to rise, V would start to rise, and therefore, one could argue there the V^* should rise; if assumed that the interest rates will be higher than they have recently been for a more extended period.

Figure 11 below shows the relationship between the 5-year US treasury yield and M2 velocity from Q1 1992 to Q4 2021. As the 5-year US treasury yield has gone down also, money velocity has been downward sloping, so the assumption that money velocity could go higher when interest rates go up seems plausible.

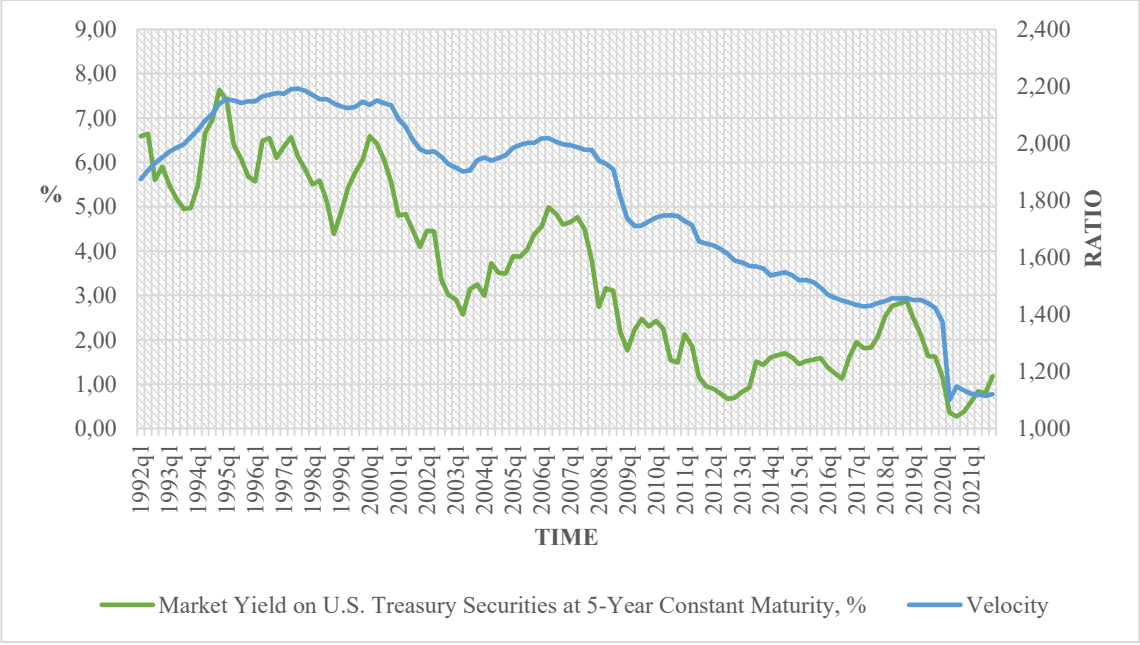

Figure 11 *Relationship between interest rates and velocity*

Figure 12 illustrates the bad scenario; the price gap is estimated to be 37.60%. From 2022 onwards, the average annual inflation would be the following 3-4 years between 9.40% to 12.53%.

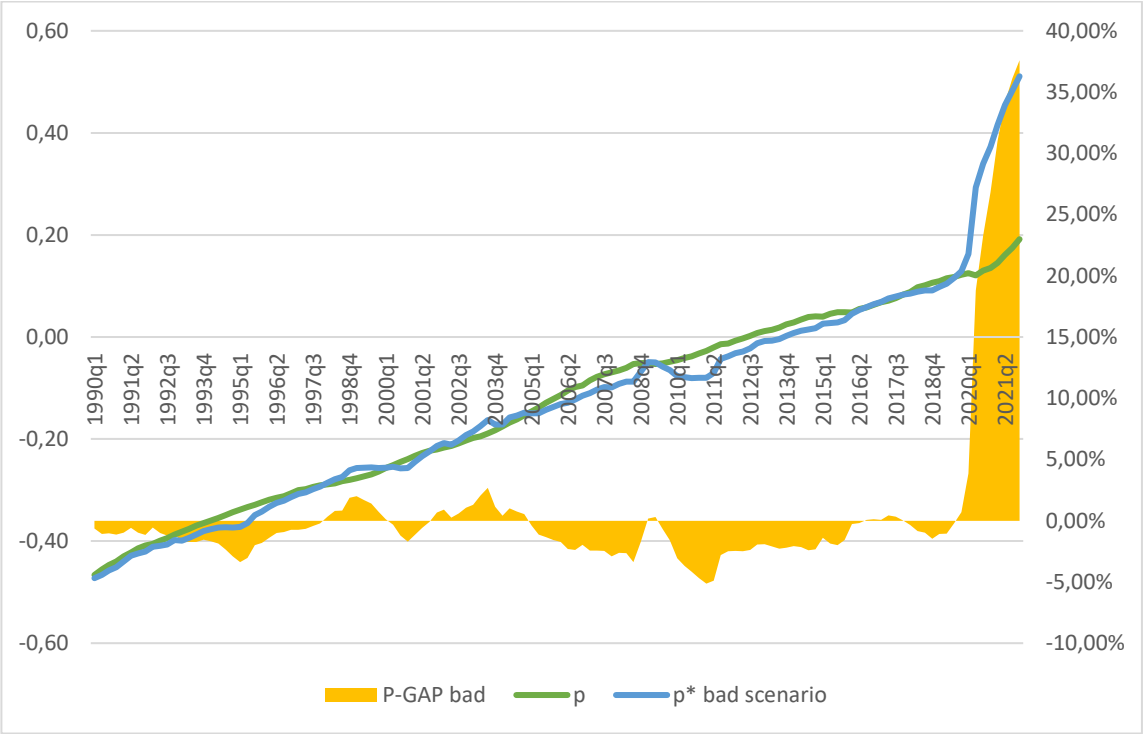

Figure 12 *Results in a bad scenario*

7.3. THE TAYLOR RULE

Figure 13 illustrates where the federal funds rate should be according to the Taylor rule. Using the GDP deflator as the measure for inflation together with the proposed coefficients of 0.5 for both the policy rules as initially used by Taylor (1993); suggests that the federal funds rate should have been at 11.27% in Q4 2021, while the federal funds rate at the same time was 0.08%. Different versions of the Taylor rule can give different results, but the direction is clear: the FFR should be much higher than now if a central bank steers the economy with interest rates.

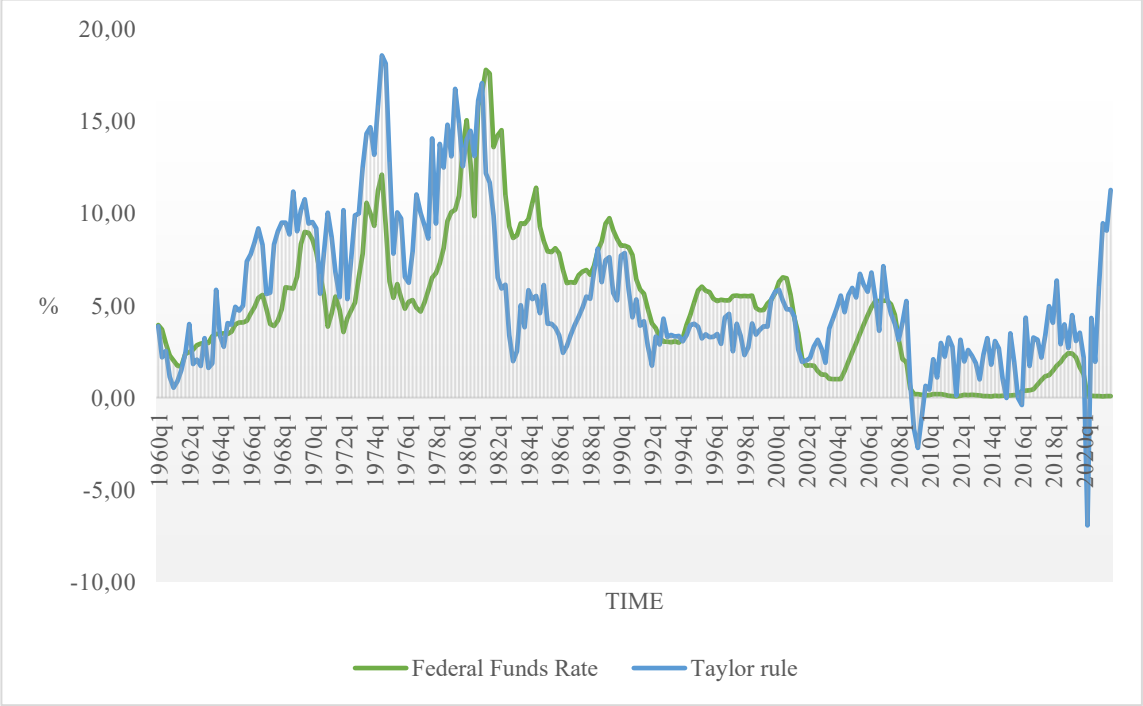

Figure 13: *Taylor rule and Federal Funds Rate*
Source: FRED database

7.4. SUMMARY OF RESULTS

Table 3 below summarizes the results of the annual average inflation rates estimated by the model and the different equilibrium velocity assumptions from good to bad. The spread in which the price will be closed is impossible to forecast; it could be one year or five years. From a historical context, 3-4 years is the most likely spread. The alternative scenarios showed that the results are sensitive to the equilibrium velocity level.

Table 3: Summary of results

Scenario	Good	Main	Bad
P-gap	12.58 %	25.09 %	37.60 %
Years			
1	12.58 %	25.09 %	37.60 %
2	6.29 %	12.55 %	18.80 %
3	4.19 %	8.36 %	12.53 %
4	3.15 %	6.27 %	9.40 %
5	2.52 %	5.02 %	7.52 %

8. CONCLUSION

"*A steady rate of monetary growth at a moderate level can provide a framework under which a country can have little inflation and much growth. It will not produce perfect stability; it will not produce heaven on earth; but it can make an important contribution to a stable economic society*."

(Friedman, 1970, p. 14)

The primary goal of this thesis was to estimate how much inflation will result from the enormous creation of the broad monetary aggregate M2, which expanded cumulatively 40.52% from Q4 2019 to Q4 2021. The growth in M2 was related to monetary policy actions during the Covid-19 pandemic. In the main scenario, there is a price gap of 25.09% in Q4 2021. Assuming the current price level p adjusts towards the equilibrium price level p^*, and that the broad money growth will return to more normal levels of 5.24% to 5.99%. With these assumptions, the current price level will have to increase by 25.09% to

reach its equilibrium level; this will result in average annual inflation rates of 6.27% to 8.36% over the next 3-4 years starting from 2022.

However, the model is sensitive to what the equilibrium velocity level v^* is estimated to be; also, the critique of the quantity theory is usually related to the instability of the money velocity. Hence, two alternative scenarios are considered where v^* would be 10% lower and 10% higher in a good and bad scenario, respectively. In a good scenario, the average annual inflation rate would be 3.1%5-4.19%, and in the bad scenario, it would be 9.40%-12.53% starting from 2022 and for the following 3-4 years.

A secondary goal of this thesis was to see if the monetary aggregates are of any use, even though they are not used in modern economic models used by the Fed. Those who used monetary aggregates in their models and recognized the lags of money growth on inflation were able to foresee the inflation problem that started to take place in 2021 (see e.g., Castañeda & Congdon, 2021). The visualization of the P-star model in figure 10 shows how the price gap explodes in Q2 2020, creating a price gap of 15.51%, hence working as an early warning indicator of what is to come, as Atta-Mensah (1996) concluded in his research. In addition, the broad monetary aggregates have been able to explain why the first rounds of QE was not inflationary, even though many feared hyperinflation; QE resulted in just enough broad money growth to offset the impact of restrictions on bank lending after the great financial crisis. Thus, it can be concluded that the broad monetary aggregates still hold significant information value and should not be ignored by central banks; else, there is a risk of policy mistakes such as inflationary periods from a central bank.

Moreover, instead of expanding the central bank mandate to issues such as climate change and inequality, the central bank's resources should develop more accurate estimates of the monetary aggregates and improve the way they forecast inflation. Also, changing the definitions of already existing monetary aggregates should be avoided, since it becomes difficult to make historical comparisons. For example, in April 2020, savings accounts were added to the monetary aggregate M1, which from then onwards can be considered as a broad money measure instead of a narrow one.

Because the Fed focuses on interest rates instead of monetary aggregates, an original Taylor rule was implemented to estimate where inflation should be to achieve the inflation problem under control. The results showed that in Q4 2021, the federal funds rate should have been 11.27 compared to the actual FFR of 0.08. There are different versions of the Taylor rule, and not all of them are as elevated as the one calculated in this thesis. However, they are showing higher numbers than the current FFR as well. The FFR would be unlikely to be raised to 11.27; the consequences would be harsh on those who must renew their loans, and asset values would be repriced to the downside, risking a financial crisis and creating a severe recession. However, Friedman (1973) said that the only cure for inflation is to slow the growth rate of many, which as a side effect, causes a recession. Hence, the soft landing that the Fed tries to achieve regarding inflation and the economy seems very unlikely to materialize.

Other issues discussed in this thesis are that the central banks' independence and credibility are threatened when their mandate expands, which is harmful to price stability. Due to the negative effects of inflation, such as the loss of peoples' purchasing power, possible social unrest, postponed investment decisions, and the misallocation of resources when the price signal becomes distorted, are all important reasons to maintain price stability. Additionally, the commonly used inflation expectations were presented in figure 8. On Friday 29th of April, the 5-year breakeven inflation rate was 3.30%, which is way above the Fed target of 2% inflation. Hence, it can be argued that inflation expectations are no longer anchored.

Even though many of the Fed's actions during the pandemic were correct for the crisis, the continuation of the measures when the economy continued to improve and the ignoring of the speculative asset boom that followed when committing to forward guidance has worsened the inflation crisis. The Fed and other central banks in countries that experience inflation must start extracting information from broadly measured monetary aggregates and ensure that the growth rates are in a range consistent with the golden growth rate of money. Currently, the Fed has started tightening monetary policy, and Congdon & Petley (2022) calculated that the annualized growth rate M3 in Q1 2022 was 6.1%. Once the broad monetary aggregate growth rates slow, it is vital that the Fed does not risk the

healing process when a recession occurs; else, the risk for persistent inflation throughout the rest of the decade increases.

SUMMARY IN SWEDISH – SVENSK SAMMANFATTNING

De inflatoriska konsekvenserna av ökningen av breda penningaggregat 2020: ett monetaristiskt tillvägagångssätt för att prognostisera inflation

Under 2021 började den allmänna prisnivån stiga i många länder. På årsbasis var inflationen mätt med BNP-deflator 7,0 % under fjärde kvartalet i USA. Även kärninflationen för de olika inflationsmåtten har stigit från 4,9 % till 5,5 % på årsbasis, jämfört med inflationsmålet på 2 %. Centralbankerna och en stor del av nationalekonomerna fick fel i sina estimeringar över inflationen. Därutöver ansåg de att de stigande inflationsnivåerna i 2021 var övergående och relaterade till störningar i leveranskedjor. Framför allt i väst var centralbankerna sena med att reagera på de stigande inflationsnivåerna. Då covid-19-pandemin bröt ut stimulerades ekonomin, framför allt i USA massivt där det breda penningaggregatet M2 expanderades. Kumulativt ökade M2 med 40,52% mellan fjärde kvartalen från 2019 till 2021 jämfört med tillväxten i M2 mellan fjärde kvartalen 2017 och 2019 då den kumulativa tillväxten var 10,39 %.

De modeller som centralbankerna använder för inflationsprognoser inkluderar inflationsförväntningar och räntor, medan dessa modeller exkluderar penningmängden. Detta i motsats till att de flesta nationalekonomer anser att en ökning i penningmängden resulterar i inflation på lång sikt. Under våren 2021 konstaterades att penningmängdstillväxten efter covid-19 inte har någon större inverkan på de ekonomiska utsikterna. Enligt monetaristisk teori och empiri tar det mellan 12 och 24 månader för penningmängdstillväxten att resultera i inflation. De modeller som används av centralbankerna har även kritiserats för att de inte fungerar bra då något oförväntat händer och då inflationsförväntningarna blir oförankrade. Dessutom har det börjat diskuteras ifall centralbankernas mandat borde expanderas från sysselsättning och prisstabilitet till att bekämpa ojämlikhet och klimatförändring. Detta har kritiserats av många för att det

riskerar centralbankernas självständighet och gör det svårare att uppnå prisstabilitet och full sysselsättning.

I den här avhandlingen estimeras de genomsnittliga inflationsnivåerna för USA från 2022 och därpå följande åren genom att utnyttja P-star-modellen som är baserad på kvantitetsteorin. Denna modell producerar ett prisgap som visar åt vilken riktning den nuvarande prisnivån ska gå för att nå jämviktsnivån på sikt. I modellen består prisgapet både av ett likviditetsgap och av ett produktionsgap, som även används i traditionella inflationsmodeller. Jämviktsprisnivån ändras enbart då det sker förändringar i penningmängden och jämviktsnivån rör sig mot samma riktning som penningmängden. I litteraturen finns det stöd för P-star modellen och den skapades och användes av USA:s centralbank på 1990-talet. USA:s centralbank slutade använda modellen då de hade svårigheter att prognostisera hur penningmängden utvecklas. Kritiken mot som diskuteras i litteraturen gällande kvantitetsteorin berör penningmängdens omloppshastighet. Den anses av somliga vara ostabil och därför är kvantitetsteorin enligt kritikerna inte användbart. För att bemöta denna kritik skapar avhandlingen ett robusthetstest med alternativa scenarier för penningmängdens omloppshastighet med olika jämvikt, något som inte gjorts tidigare i P-star litteraturen. Tidigare litteratur har fokuserat främst på att testa prognoser för sampelperioden, medan denna avhandling fokuserar på framtida värden.

Utöver detta estimeras även var styrräntan borde ligga utgående från den ursprungliga Taylorregeln. Detta för at se var styrräntan borde vara för att få inflationen i styr, eftersom centralbankerna fokuserar på räntor och inte penningmängd. Dessutom redovisar avhandlingen för bakgrunden till hur centralbanker och ekonomisk teori sett på inflation och hur utvecklingen skett de senaste decennierna.

Metoden för att estimera prisgapet är att utnyttja datamaterialet för att beräkna de värden som modellerna behöver för att producera prisgapet och Taylorregeln. De alternativa scenarierna för jämviktsnivån för penningmängdens omloppshastighet skapar ett robusthetstest för resultaten. Antagandet för prognoserna är att penningmängdstillväxten normaliserar sig till en takt mellan 5,24% och 5,99 % på årsbasis, som är kravet för en inflationsnivå på 2 %. Allt datamaterial i avhandlingen har hämtats från USA:s

centralbanks hemsida. Resultaten visualiseras i en omfattande figur som visar var den nuvarande prisnivån och jämviktsnivån skiljer sig åt och storleken på prisgapet.

I basscenariot för resultaten antas att jämviktsnivån för penningmängdens omloppshastighet fortsätter neråt på årsbasis med en trend på -0,77 %. Prisgapet i fjärde kvartalet 2021 var 25,09 %, vilket indikerar att de genomsnittliga inflationsnivåerna från 2022 och därpå följande 3-4 år kommer vara mellan 6,27 % till 8,36 %. De två övriga scenarierna anses inte vara lika sannolika som basscenariot. I det goda scenariot antas jämviktsnivån för penningmängdens omloppshastighet sjunka 10% lägre och resulterar i att prisgapet blir 12,58 %. Detta skulle resultera i en genomsnittlig inflationsnivå på 3,15 % till 4,19 % från 2022 framåt. I det dåliga scenariot är jämviktsnivån av penningmängdens omloppshastighet 10% högre än i basscenariot. Resultaten visar att i det dåliga scenariot är prisgapet 37,60 %, vilket skulle innebära en genomsnittlig inflation mellan 9,40 % och 12,53% för 2022 och därpå följande 3-4 år. Den ursprungliga Taylorregeln indikerar att styrräntan borde vara 11,27 % i fjärde kvartalet 2021, jämfört med nivån på den verkliga styrräntan på 0,08.

Sammanfattningsvis tyder resultaten på att det finns stora obalanser i ekonomin efter stimulansåtgärderna under pandemin, vilket inte är konstigt med tanke på att de breda penningaggregaten växte för mycket på kort tid. De få som utnyttjat kvantitetsteorin har lyckats förutse den inflation som pågår. Därför är det viktigt att centralbankerna börjar se på penningaggregat igen för att få det informationsvärde som de behåller. Inflation är skadligt för samhällen, den skapar social oro då människor förlorar sin köpkraft och företagen vågar inte investera i framtiden då priserna fluktuerar kraftigt. Centralbankerna har riskerat prisstabiliteten med att blunda för penningmängden och de måste agera snabbt för att kunna normalisera situationen. En normalisering av situationen över tid kräver att penningmängden når en lägre tillväxttakt.

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