The Fiscal Transmission Mechanism of Inflation

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ABSTRACT

The link between money creation and inflation has been theoretically demonstrated, but different inflation responses to Federal Reserve activity after the Great Recession and COVID recession showed the incomplete nature of the theory. We model a "fiscal transmission mechanism" whereby Federal Reserve purchases of Treasury securities lead to inflation as new dollars flow through fiscal deficits into the economy. In our model, other Federal Reserve activity generally lacks inflationary effects. Using a nonstructural vector autoregression approach, we test for the presence of this mechanism and offer near perfect predictions of the 2022 inflation rate using a time series extending back half a century. We explain the fiscal transmission mechanism and the reasons why other Federal Reserve activity lacks the same effects, and we propose an emphasis on controlling the money supply by limiting Federal Reserve purchases of Treasury securities as a better way to control inflation than setting an interest rate target.

KEY WORDS

Inflation, Money Supply, Monetary Policy, Budget Deficits

INTRODUCTION

Milton Friedman ([1963] 1968)[1] famously said that "inflation is always and every- where a monetary phenomenon." This was not always a widely held view, although it became more common in the years after he said it. Experiences in the United States and elsewhere seemed to corroborate Friedman's view. Four and a half decades after Friedman's remarks, the Federal Reserve cut interest rates nearly to zero and created trillions of new dollars, yet inflation remained low and steady. In 2021, Federal Reserve Chairman Jerome Powell testified to U.S. Senate Committee on Banking, Housing, and Urban Affairs about the need to unlearn that massive growth in monetary aggregates must cause inflation (Schneider, 2021).

Another episode of money creation during the COVID-19 pandemic was followed by an increase in inflation, unlike what happened during quantitative easing at the time of the Great Recession. Clearly, the simplified view that more new dollars necessarily lead to inflation was incomplete. Missing from both Friedman's and Powell's remarks was any mention of a transmission mechanism that links money creation to its use for economic exchange. When new dollars are created by the Federal Reserve's open market operation, they increase the reserves of its primary dealers. This increases the monetary base, which is the only measure that the Federal Reserve can directly affect, but bank reserves in the

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[1] This quote originated with a speech in 1963, but was formally published in Friedman's book in 1968.

monetary base are not the "too much money" that "chases too few goods." Before inflation can increase, something must happen to cause this money enter the economy and be captured in another measure of the money supply. This "something" is a transmission mechanism.

The nature of this transmission mechanism depends on whether banks lend are lending reserves to private borrowers (financial transmission mechanism) or to the government (fiscal transmission mechanism). In the case of a fiscal transmission mechanism, banks must have already lent money to the government, which the Federal Reserve subsequently converts into excess reserves. Borrowers, private sector or government, then spend the money, at which point inflation is a possibility. Our paper evaluates monetary expansion that is concurrent with government borrowing. The mechanism we highlight requires that both occur together, which is not addressed in existing literature.

By linking both monetary expansion to fiscal deficits, we make a unique contribution by showing that central bank purchases of government debt expand the money supply, not just the monetary base, when the government simultaneously runs a deficit, and this expanded money supply leads to inflation. This paper proceeds with a discussion of relevant literature on inflation and transmission mechanisms in the next section.

THEORY, HISTORY, AND LITERATURE

This section gives a theoretical framework, and links the prior literature on trans- mission mechanisms to a theory of both financial and fiscal transmission. It also provides the basis for our empirical approach.

First, we recognize the role that uncertainty plays in explaining the role of money. While this literature is tangential to the analysis, it points to the essential role that money plays in mitigating the impact of limited information on economic decision making. The transmission mechanisms that are the main focus of our paper, exist ultimately because of the role of uncertainty in economic decision making.

Secondly, we detail the two potential mechanisms of inflation transmission, financial and fiscal. From there, we explain the incentives and plausible processes that lead from money creation to inflation with each mechanism. We also discuss the role of central bank independence and policy targets in light of these mechanisms.

MONEY AND UNCERTAINTY

Any inquiry into the role of money in the economy is contingent upon the role of uncertainty in economic decisions. This role, in turn, is related to such axiomatic starting points as the nature of time: historical or logical. The latter is common in economic analysis, and often represented by the axiom of perfect foresight. There are instances where the two concepts of time are used concurrently (Kydland & Prescott, 1982). Perfect foresight logically excludes the need for liquidity in the economy. Therefore, it is reasonable to note, albeit briefly, that the role of uncertainty in economic decision making is not irrelevant to the analysis of economic policy. The role of uncertainty in affecting demand for money by consumers and businesses has long been a topic in the economics literature. Knight (1921) explains enterprise organization and monetary decisions in the context of varying levels of limited foresight. Keynes explains the ties between the liquidity preference and uncertainty (1936, ch. 13; see also Davidson (1978) and Moore (1988)). A later string of literature, exemplified by Okun (1981) and Larson (2002), has tied uncertainty and the liquidity preference to sticky wages and prices.

The demand for money under uncertainty inevitably affects the potency of monetary policy. When fiscal policy is tied to monetary policy through debt monetization, the role of money as a moderator of uncertainty assumes a central role for policy makers. Economic forecasting for the purposes of

policy making is often complicated by the ties between money and uncertainty (Burns, 1969; Cairncross, 1969; Holly & Veale, 1998). The following analysis is conducted with the understanding that uncertainty affects demand for money and therefore the potency of transmission mechanisms. However, the formal incorporation of uncertainty into the analysis would not add enough value to merit the increased complexity; the presence of un- certainty in economic decisions, including policy decisions, is implied but assumed constant.

TWO MECHANISMS: FINANCIAL AND FISCAL

Monetary expansion can be employed by government for at least two reasons: to improve liquidity in the financial system, and to finance government spending. The first relies on the financial transmission mechanism, and the second on the fiscal.

The first, or financial, mechanism is at work in the literature that was rewarded by the 2022 Nobel Memorial Prize in Economics given to Ben, Bernanke, Douglas Diamond and Philip Dybvig for their efforts to explain how bank runs initiate a real-sector crisis due to the restricted ability of depository institutions to recall their assets prematurely (Diamond & Dybvig, 1983). To prevent a bank run from escalating into an urgent financial crisis, Diamond and Dybvig propose a system of deposit insurance, preferably anchored in a government guarantee. This is essential because there are no market incentives for private insurers to provide this product. The solution would be a government-guaranteed system.

Bernanke got the prize for having explained the effects of "bank runs" on the balance sheets and credit policies of depository institutions (Bernanke, 1983). Large, abrupt withdrawals of bank deposits depleted liquidity reserves and forced banks to ration or even terminate new lending.

The solution that Diamond and Dybvig propose would also fit as a remedy to the Great Recession, as Bernanke explains it. In both cases, government intervention aims to keep the banking system liquid through a crisis; to secure sufficient liquidity, government would have to rely on expansionary monetary policy. Per Bernanke's explanation of the macroeconomic effects of liquidity shortage, such expansionary monetary policy would transmit into an improvement in real sector activity, compared to its absence.

The one problem that is absent in both the Nobel-awarded literature and the Nobel Prize Committee's motivation of the 2022 prize is the possible causal link from monetary expansion to inflation. This is a contested topic, primarily in economic- policy circles, but it is also not uncontroversial in the economics literature.

Standard concepts of the quantity theory of money says that a one-percent increase in money supply equals a one-percentage point increase in inflation. This type of symmetric, instantaneous inflation is impossible to find empirically, but at the same time it is imprudent to dismiss monetary inflation as a real phenomenon. The crisis in Weimar Germany in the 1920s is a classic example; a more recent one, Venezuela, has had encounters with inflation in excess of one million percent per year.

For a monetary expansion to cause inflation, the newly created liquidity needs a transmission mechanism from the monetary sector to the real sector. Broadly speaking, these mechanisms come in two forms: financial, or monetary, and fiscal. The former sends new money supply into the financial system while latter is a pipeline from the central bank into the government budget.

There is no literature on the fiscal transmission mechanism, while the financial one has been given a fair amount of attention (Bernanke & Gertler, 1995; Tobin, 1978, 1982). Some literature on monetary transmission mentions fiscal policy in a cursory manner, generally referring to government deficits as a cause of money entering the real economy. Government deficits indeed cause spending that would not otherwise occur, which can drive up demand for goods and services and raise their equilibrium prices. Without a corresponding increase in central bank financing, government deficits do not lead to

monetary inflation because the specific higher prices from increased demand are offset by financial crowding out that reduces spending in other sectors. A few prices may rise, but economy-wide or persistent monetary inflation will not result.

Tobin's (1978) seminal paper on financial transmission was an alternative to Friedman's monetarism, and it focused on asset valuations and capital spending along with credit stability. Laidler (1978) wrote in a similar vein at about the same time. Shortly thereafter, Blanchard (1981) found that monetary expansion can cause asset bubbles, which he considered a surprise. Thorbecke (2012) found a similar result. Blanchard's work was prescient as asset bubbles accompanied periods of loose monetary policy during the housing boom and following the Great Recession. It should not, however, have been surprising because it reflects the logical search for returns. If interest rates fall, people look elsewhere. Our focus is on the real economy, not asset pricing, but Blanchard's and Thorbecke's work is very complementary to ours. As we explain in this section and subsequently demonstrate empirically, monetary expansion that is not targeted at government spending does not cause inflation in the real economy.

In 1995, the Journal of Economic Perspectives featured a symposium on the transmission mechanism, most of which focused on the financial transmission mechanism. Meltzer (1995) noted a difference between those who perceive a shock in the money supply as a one-time shock or the start of persistent inflation. Although Meltzer does not imply any sort of fiscal transmission mechanism, this potential difference in perceptions reflects such. If fiscal transmission is the link from money creation to inflation, then a one-time shock will lead to a temporary increase in inflation rates. If the transmission mechanism is financial, and fractional reserve banking causes money expansion to continue, inflation could persist, yet there is little empirical evidence for it. Also in this symposium, Bernanke and Gertler (1995) and Taylor (1995) focus on the mechanics of monetary transmission; mentions of fiscal policy center on the role of deficits in affecting total spending, but do not consider them simultaneously with central bank financing. There is no consensus on the effects of fiscal policy (Fontana, 2014). Our focus is not solely on fiscal policy, but on monetary policy flowing through fiscal deficits to the real economy, not fiscal policy alone, and our approach is not structural.

EXPLAINING THE THEORY

This imbalance of focus on the financial over the fiscal transmission mechanism is unfortunate, since a theoretical case can be made that the fiscal transmission mechanism is more inflationary in nature than the financial one, which we explain in this section. The reason has to do with the presence of free markets and price mechanisms along the transmission mechanism itself.

The financial transmission mechanism passes through a sequence of markets with price mechanisms: when a loan is issued by a bank, it prices the new credit with a rate of interest. It also considers the past market performance of potential borrowers, as exhibited in their credit ratings. When interest rates and credit ratings have been taken into account, the bank is left with a limited pool of first-tier borrowers. This pool will be restricted by market mechanisms, even if the bank has access to cheap liabilities in the form of central-bank credit. This explains the lack of inflation following the massive amounts of new money created during quantitative easing, most of which ended up as excess reserves.

Other price mechanisms put more limitations on how much money can be transmitted from the central bank to the real sector. Even first-tier borrowers have to consider how much of their current income they want to tie up in installment payments on a new loan. This decision is also subject to the free market: they weigh their ability to earn more money, determined by supply and demand for labor, against the cost of less leisure time.

These self-regulating price mechanisms that dampen the real sector effects of monetary expansion through the financial system are non-existent in the fiscal transmission mechanism. The treasury issues new securities which, depending on the permissibility of the legal framework, are purchased directly by the central bank, or indirectly through an intermediary, as in the United States, but always with newly created money in either case. The payments for the securities expand the treasury's cash at hand and can therefore be used directly for real-sector spending. Unlike commercial banks, the Federal Reserve gives no appearance of evaluating the federal government's ability to repay when purchasing its debt; increases in the federal debt beyond the growth rate of GDP attest to this.

There is another way to explain the difference that price mechanisms make. When a bank gets access to new money through financial transmission, its tentative client – debtor – has to earn the money that pays back the loan. In short, the debtor must put value into the economy that earns enough money to pay for the loan. While new loans under the financial transmission mechanism do increase debtor purchasing power, they are also backed by increased activity on the supply side of the economy. New supply meets new demand.

By contrast, under the fiscal transmission mechanism, there is no increase in supply needed in order to let the newly printed money expand the demand side of the economy. Plainly, this mechanism replaces a new bank loan with cash from government: the recipient's bank account is replenished without the need for reciprocal activity.

CENTRAL BANK BEHAVIOR AND INDEPENDENCE

Central bank independence is not integral to our paper, but it has a rich literature with some relevance. The independence of central banks from their governments varies from one country to another and has waxed and waned over time (Fischer, 1995). Inflation is generally lower if central banks are more independent, and this relationship is quite robust (Berger et al., 2001). Fernández-Albertos (2015) points out that central banks are unavoidably political and that crises, especially the global financial crisis that began the Great Recession, make them more political.

The COVID-19 pandemic exacerbated this politicization as the American federal government and Federal Reserve worked closely together to distribute money to the population. The federal government borrowed at low rates that were low only because the Federal Reserve purchased vast quantities of government bonds. Alesina and Summers (1993) point out that central banks can control price stability, but not economic performance, which post-COVID inflation confirms. Although rates had been low for years before COVID, the financial transmission mechanism was not causing inflation for reasons articulated above and empirically validated in the next section. Interest rate targets will lead to inflation if fiscal deficits increase to a point at which investors are not willing lend at the low rate without the central bank intervening to purchase bonds. On a related note, Kydland and Prescott (1977) point out that control theories exist against nature, but not against rational agents. The low-rate target thus worked without excessive financial transmission until government spending caused fiscal transmission because the Federal Reserve created new dollars to maintain the target.

This phenomenon of an interest rate target that does not cause inflation until fiscal deficits mount has precedent. Former Federal Reserve Board chairman Bill Martin clashed with President Lyndon Johnson and his rate hikes were not enough to stop inflation. He believed rates had to be higher to avoid inflation, yet felt that the Federal Reserve needed to work with the Treasury and Congress after setting the target. Higher rates displeased Johnson, yet the rates were not adjusted upward further in response to government borrowing to fund the Vietnam War and Great Society, thus causing fiscal transmission even while financial transmission was held at bay (Fessenden, 2016). Although Martin realized he failed to stop inflation, it is a mistake summarily to discredit him as fiscal transmission was not well understood, and he did increase rates when it was politically stressful. Had the Federal

Reserve kept rates at a somewhat higher level for the COVID stimulus, inflation still may resulted if the Federal Reserve had bought government debt to maintain a somewhat higher target.

A decade and a half after Martin clashed with Johnson, Paul Volcker took a different approach at the Federal Reserve and set a target for growth of the money supply, not interest rates. Ceteris paribus, the two are one and the same, and Volcker's approach looked like a rhetorical device to make an unappealing policy look more palatable. For our theory, controlling interest rates and controlling the money supply diverge when fiscal deficits require an increase in the money supply to maintain the interest rate, so Volcker's approach was fundamentally different from Martin's.

EMPIRICS

Fisher's equation of exchange, $MV = PY$ is the basis for the monetarist view that inflation is a monetary phenomenon. This equation describes the real sector, not the monetary sector. The theory we described above is presented in an intuitive, non- mathematical way that relies on incentives in the financial sector. These incentives and the mechanism through which they work is entirely inside one variable in Fisher's equation, *M*.

Our empirical approach is far more quantitative. We begin by defining the money supply and visually linking the theory to the data. Visual results from time series plots are consistent with our theory and offer a compelling story in their own right. To confirm appearances, we estimate vector autoregression (VAR) models to quantify visually apparent effects with impulse response functions (IRFs) and forecast error variance decompositions (FEVDs).

DATA OVERVIEW

This section first describes our data and its sources. From there, to build a case for our econometric approach, we present summary statistics in the form of time series plots that visually tell the story described in the theory section, which our econometric models corroborate. Our time series runs from the first quarter of 1971 through the first quarter of 2022.

DESCRIPTION AND SOURCES

Our measure of the money supply is M2[2] less the monetary base[3], and we explain the reason for this choice because it is an unconventional measure. The Federal Reserve can directly affect only the monetary base, which includes currency in circulation and bank reserves. M2 includes the monetary base as well as transaction deposits, savings deposits, small time deposits, and money market funds. Money creation from fractional reserve banking causes M2 to increase beyond the monetary base. Money created by the central bank can only affect prices when it enters the economy, which occurs when the federal government spends it or when banks lend it. By excluding the monetary base from our measure, we evaluate expansions of the money supply that have the capability to cause inflation. This measure has shown a long-term exponential growth trend without a sharp jump during the quantitative easing that characterized both M2 and the monetary base. This measure of the money supply is linked to the equation of exchange because it reflects only money used in exchange, and it is plotted in figure 1.

[2] FRED Series M2SL
[3] FRED Series BOGMBASE

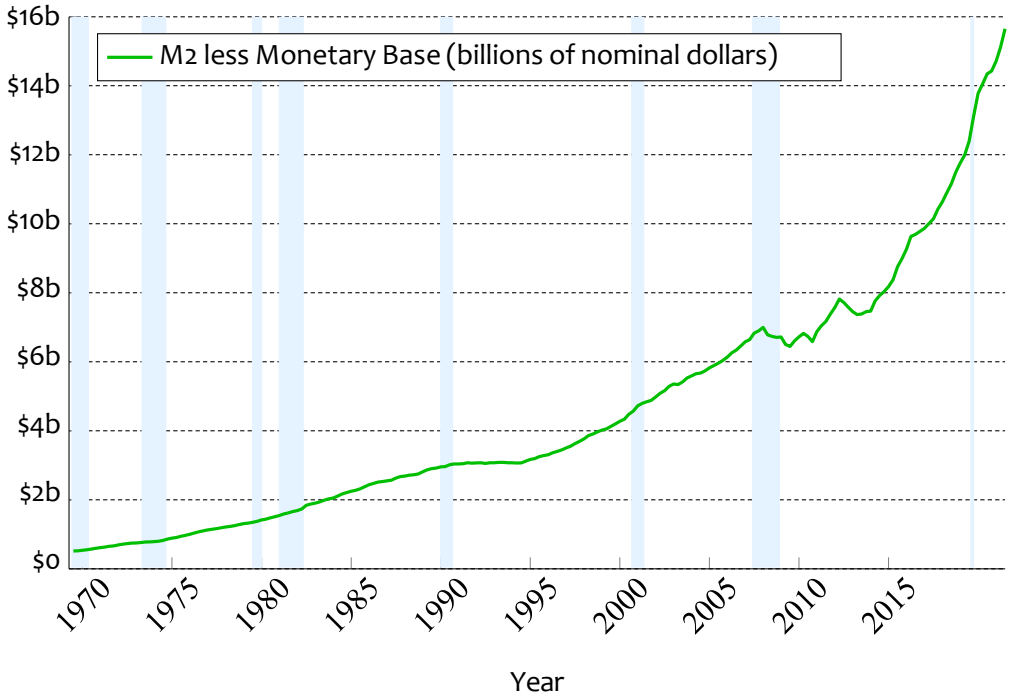

Figure 1. Measure of the Money Supply in Levels – M2 Less the Monetary Base

We use two measures of inflation, the consumer price index for all items for urban consumers[4] and the GDP deflator,[5] but only one of them enters any given model. These two measures are highly correlated, but they have an important distinction. Because it includes imports, a current account deficit may offset inflationary pressures when inflation is measured by the CPI, and this possibility is magnified by the U.S. dollar's status as the world's reserve and transactional currency. The GDP deflator is less susceptible to trade-related effects. Like the money supply, we measure inflation as its year-over-year percentage change or is quarter-over-quarter percentage change.

Federal Reserve purchases of Treasury securities[6] are our first measure of central bank activity to create money, and it pertains directly to monetary policy. We seasonally adjust this quarterly measure using X-13 ARIMA. We also use Federal Reserve purchases of other securities, which we obtain by subtracting this measure of Treasury security purchases from purchases of total debt securities.[7] These series represent transactions which we express in billions of nominal dollars, so they require no additional first differencing. In contrast to our measures of the money supply and inflation, we do not express these numbers as growth rates. Growth rates are based on changes in levels which change when securities mature as well as when they are bought and sold. By expressing these purchases in dollar terms, we restrict our analysis to changes in the balance sheet that are accompanied by changes in the monetary base.

For the federal deficit or surplus, we take the difference of federal government expenditures[8] and current tax receipts.[9] This is an important control because government borrowing should not cause inflation if new money is not created. Additionally, Federal Reserve purchases of Treasury securities

[4] FRED Series CPIAUCSL
[5] FRED Series GDPDEF
[6] Federal Reserve Board of Governors FU713061103.Q
[7] Federal Reserve Board of Governors FA714022005.Q
[8] FRED Series FGEXPND
[9] FRED Series W006RC1Q027SBEA

have a stronger intuitive link to the money supply when they coincide with large deficits. Like Federal Reserve purchases of securities, we also express the federal deficit in billions of nominal dollars and we do not difference it because it is analogous to a transaction. We likewise include the balance on the current account in billions of nominal dollars. Because they are nonstationary time series, summary statistics are best understood visually from graphs in the figures in this section and the next.

THE STORY THE NUMBERS TELL VISUALLY

Using the measures above, this section presents an intuitive and visual explanation in support of our theory, beginning first with the growth of the money supply. Figure 2 plots the year-over-year growth rates of this measure of the money supply alongside year-over-year growth in the CPI and real GDP that was deflated by the CPI. Econometric models in this paper use the percentage growth rate to normalize the exponential growth visible in figure 1.

Historically, this measure of the money supply has not markedly increased during recessions. Up until the mid-1980s, inflation followed increases in the money supply that preceded a downturn in real GDP. There is an intuitive link between inflation and increases in the money supply that are not matched by sustained increases in output. The COVID recession was the first recession during which this measure of the money supply dramatically increased, and this was followed by a sharp burst of inflation.

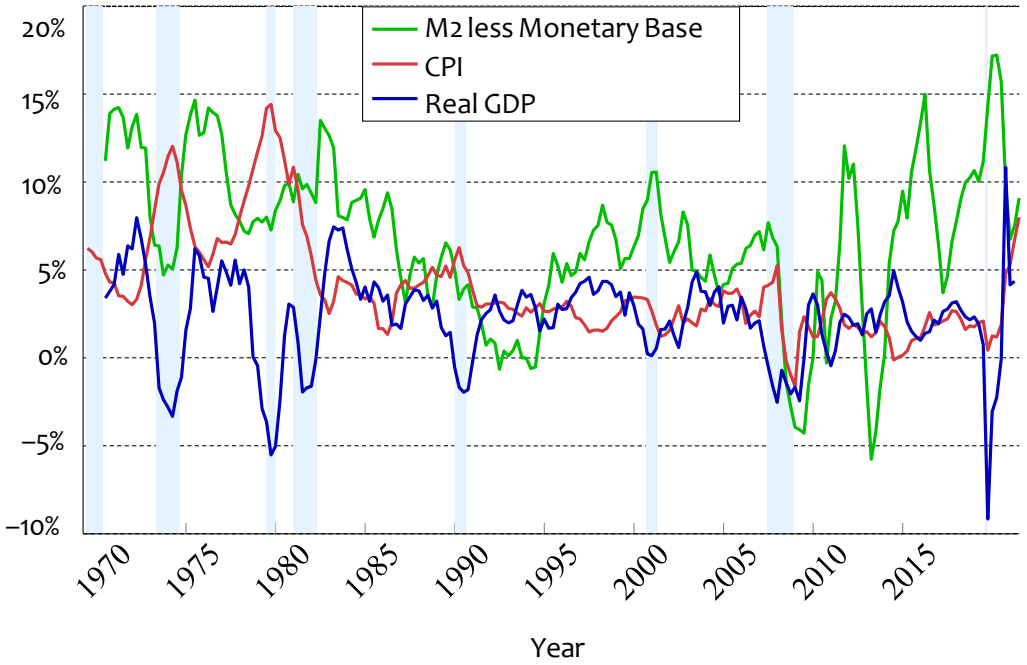

Figure 2. Measure of the Money Supply (Growth Rate) – M2 Less the Monetary Base

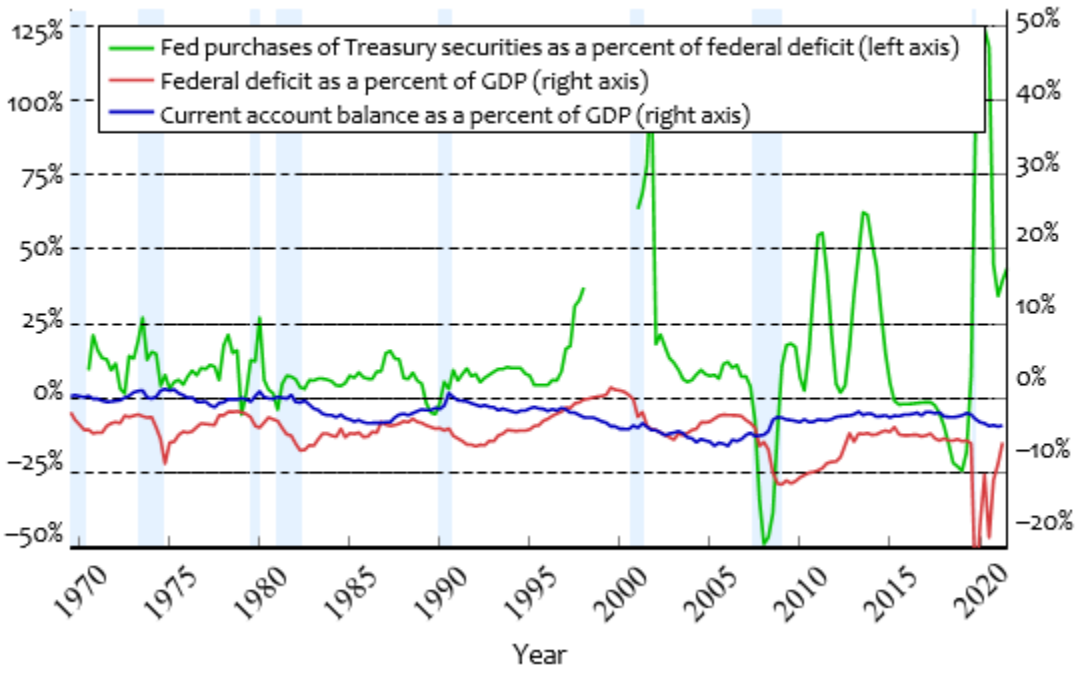

Figure 3. Percent of the Federal Deficit Financed by Federal Reserve Purchases of Treasury Securities, Federal Deficit as a Percent Of GDP, and Current Account Balance as a Percent of GDP

The link between the money supply, real GDP, and inflation breaks down later in the time series, coinciding with increases in the current account deficit. Because the consumer price index includes imports, there is a distinct possibility that increases in imports prevent a rise in inflation when inflationary pressures exist.

Before exploring this possibility, we return to the theory that the money supply expands because of central bank financing of government budget deficits. Because the deficit has fluctuated over time, it is important to compare the percentage of the deficit financed by the Federal Reserve to the deficit as a percent of GDP. A small deficit that is financed by the Federal Reserve may have a negligible effect on the money supply. Figure 3 shows the percent of the federal deficit that is financed by the Federal Reserve, the federal deficit as a percent of GDP, and the current account balance as a percent of the GDP. By showing inflationary pressures, this figure complements figure 2 which shows the results of these pressures.

Inflation was highest in the mid-1970s and the early 1980s. During this time, deficits were large and funded to a substantial degree by the Federal Reserve, thereby injecting large amounts of money into the economy. The current account deficit was either small or in surplus, offering little in the way of foreign goods to mitigate these pressures. Although the money supply increased in the early 1980s, albeit at a slower rate, inflationary pressures were offset by a widening current account deficit and a shrinking federal deficit that remained fairly large. By the mid-1990s, monetary policy was quite loose by historical standards, but the federal deficit was small and briefly was in surplus and the current account deficit expanded sharply. Fairly small deficits and limited Federal Reserve funding tempered inflationary pressures through the early 2000s. Massive federal deficits that began with the Great Recession were not excessively funded by the Federal Reserve. As equities and real estate fell, investors looked to the safety of Treasury securities, enabling the federal government to borrow on the open market. Setting aside any long-term fiscal sustainability issues, there was no sharp growth in the money supply at this time, although M2 and the monetary base both skyrocketed due to increasing

reserves because of quantitative easing. Following the Great Recession, real GDP grew and deficits shrank even as the Federal Reserve funded an increasing proportion, which coincided with some increases in inflation. This inflation was not excessive in part because there was no clear deviation from the long run exponential trend in the money supply which had decreased during the preceding recession.

During the COVID recession, a confluence of factors contributed to a sharp burst of inflation. By shutting down much economic activity, governments forced a decline in real GDP. The current account deficit was still substantial, but shutdowns abroad reduced supply and affected prices for imports as well. The federal deficit ballooned in part due to stimulus programs which offered cash payments to individuals and firms. The Federal Reserve cut its already-low rates nearly to zero, and to maintain the low rates, it had to purchase massive quantities of Treasury securities. Unlike in the Great Recession, a bull market in equities and sharply appreciating real estate prices reduced private sector demand for Treasurys. The burst of inflation following the COVID recession is a near-perfect example of the fiscal transmission mechanism. To complement figure 3, we provide these same three variables, Federal Reserve purchases of Treasury securities, the federal deficit, and the current account balance, as a percent of the money supply, shown in figure 4.

Financing a large proportion of the federal deficit through the central bank should only cause material expansion of the money supply if that deficit is large. These measures, expressed as a percent of the money supply, show competing pressures on the money supply. Federal Reserve purchases of Treasury securities show the expansion of the money supply, and the size of the federal deficit shows the amount of these purchases that are funding new spending. The current account deficit reflects borrowing from abroad, which can offset inflationary pressures.

During the 1970s and early 1980s, the Federal Reserve's purchases of Treasury securities did not constitute a large percentage change in our measure of the money supply. To an extent, our measure masks some underlying effects. The rationale for measuring the money supply as the difference between M2 and the monetary base is the sharp increase in bank reserves that accompanied quantitative easing during the Great Recession. Excess reserves were minuscule during the 1970s. From 1971 to 1983, the monetary base increased from approximately $81 billion to $189 billion, which is about 233%, or 6.7% per year over 13 years. M2 increased from about $650 billion to $2,124 billion, a 327% increase, which annualizes to 9.5%. During this interval, Federal Reserve purchases of Treasury securities totaled about $87 billion, or 81% of the increase in the monetary base, implying that a fiscal transmission mechanism was at work. Comparatively low values of Federal Reserve purchases of Treasury securities as a percent of our measure of the money supply in the 1970s and 1980s are more of a reflection on the comparatively larger values of the money multiplier. No single measure of the money supply is perfect, and we address this issue in the next section.

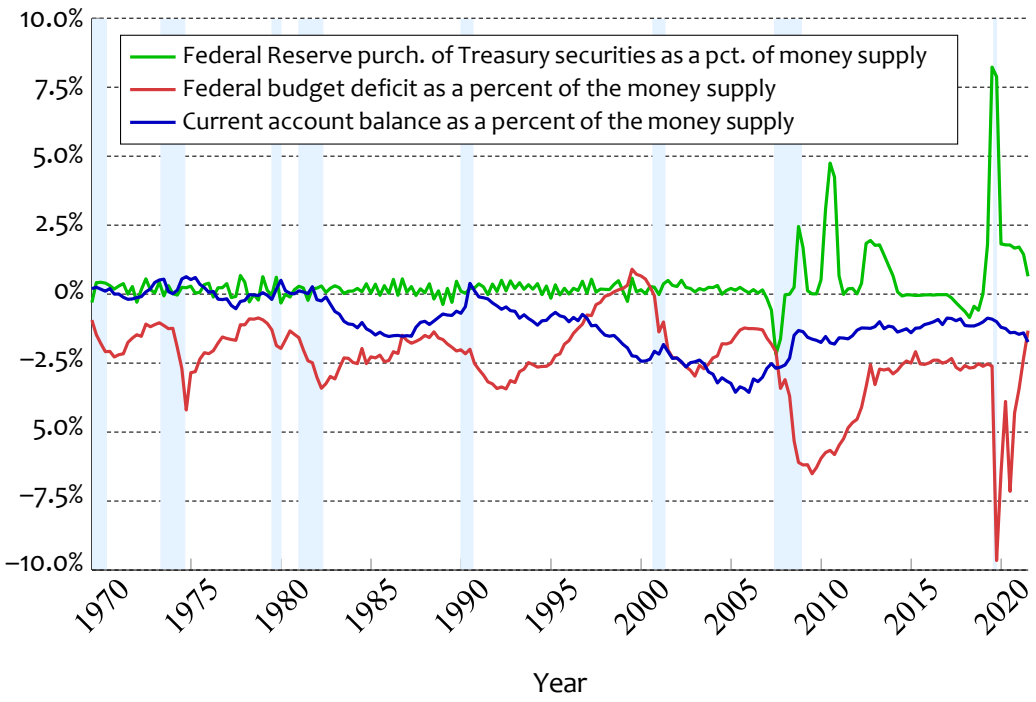

Figure 4. Federal Reserve Purchases of Treasury Securities, Current Account Balance, and Federal Budget Deficit, All as a Percent of the Money Supply

VECTOR AUTOREGRESSION STRATEGY

An explanation of the fiscal transmission mechanism must have a complete set of variables to conclusively explain the high inflation of the late 1970s and early 1980s, the subsequent drop and low inflation of the 1990s, the near-zero rate policies that accompanied low inflation before 2021, and the burst of high inflation that followed the COVID recession. The summary statistics reflect the usefulness of our data in substantiating the theory in this paper.

To econometrically validate our theory, we adopt a vector autoregression (VAR) approach. The VAR approach produces impulse response functions (IRFs) to show visually show the effect of an impulse variable on a response variable, holding all others constant. We use IRFs to show the effect of increasing Federal Reserve purchases of Treasury securities on inflation. By evaluating other impulse variables, such as the current account deficit, we gain an idea of factors that exacerbate or mitigate these inflationary pressures. Forecast error variance decompositions (FEVDs) show the amount of variation in one variable that is attributable to changes in each other variable over time, and we use FEVDs to complement IRFs.

The vector error correction model (VECM) refinement of a VAR is less suitable for this problem for two reasons. First, the quantity of detectable cointegrating relationships among the variables is large, often at least three. Given the figures above, there is little visual link to explain cointegrating relationships that are consistent throughout the entire time series which spans half a century. Moreover, several variables are choice variables – all Federal Reserve actions and the federal surplus or deficit – and there is little intuitive meaning to cointegrating relationships involving these choices. Second, the usefulness of a VECM over a VAR is in the corrections of a deviation from the cointegrating relationships, and these are less pertinent to this paper. When choice variables change, others must respond, and we use VARs to show these adjustments in a way that does not involve cointegrating

relationships and that does show responses reverting to zero in the absence of a persistent shock. Variables that enter our VARs are shown in table 1.

Many of our variables are expressed as a percent of the money supply, reflecting what we depict in figure 4. Some variables, like growth rates of inflation and the money supply, are very small, but others like Federal Reserve purchases of Treasury securities, are quite large. Expressing them as a percent of the money supply avoids computational difficulties that arise from sharply different scales. It also normalizes away exponential growth and the accompanying heteroskedasticity. All of these variables are either a growth rate or are analogous to a difference, such the current account balance, the federal surplus or deficit, or Federal Reserve purchases of Treasury securities. No variables enter as levels (i.e., cumulative totals of Federal Reserve purchases of Treasury securities instead of current quarter purchases).

Table 1. Variables

Name/Description	Unit	Source	Mean	Std. Dev.
Variables That Enter VAR Models				
Federal Reserve Purchases of Treasury Securities	*% of money supply*	*Federal Reserve Board of Governors FU713061103.Q*	*0.0036*	*0.0103*
Federal Reserve Purchases of Other Assets	*% of money supply*	*Federal Reserve Board of Governors FA714022005.Q*	*0.0019*	*0.0117*
Federal Surplus/ Deficit as a % of Money Supply	*% of money supply*	*see below*	*–0.0234*	*0.0147*
Current Account Balance as a % of Money Supply	*% of money supply*	*FRED NETFI*	*–0.0108*	*0.0097*
Real GDP Growth Rate, Deflated By CPI	*annual percent change*	*FRED GDP and FRED CPIAUCSL*	*0.0214*	*0.0253*
Real GDP Growth Rate, Deflated by GDP Deflator	*annual percent change*	*FRED GDPDEF*	*0.0262*	*0.0235*
Money Supply Growth Rate	*annual percent change*	*see below*	*0.0684*	*0.0436*
CPI Inflation Rate	*annual percent change*	*FRED CPIAUCSL*	*0.0398*	*0.0293*
GDP Deflator Inflation Rate	*annual percent change*	*FRED GDPDEF*	*0.0325*	*0.0217*
Variables Used to Calculate Above Variables				
Money Supply (M2 Less Monetary Base)	*billions of $*	*FRED M2SL and FRED BOGMBASE*	*See note 3*	
Current Federal Revenues	*billions of $*	*FRED W006RC1Q027SBEA*	*See note 3*	
Current Federal Expenditures	*billions of $*	*FRED FGEXPND*	*See note 3*	

Notes:

1. All variables are quarterly
2. Time series is from 1971 Q1 through 2021 Q4
3. Variable displays exponential growth

Table 2. Bivariate VAR Specifications

	Specification 1	Specification 2
Endogenous	*Money supply growth rate*	*Money supply growth*
Variables	*CPI inflation rate*	*GDP deflator inflation rate*
Lag Length	*13*	*18*
Criteria for Lag Length	*Minimize AIC*	*Minimize AIC*
Portmanteau	*157.59 (46 d.f.),*	*125.456 (46 d.f.),*
(Ljung-Box) Q-stat	*p = 0.1470*	*p = 0.1815*

Note: The order of the variables is the Cholesky ordering for orthogonal IRFs and FEVDs

We first estimate two VARs to link our measure of the money supply to the inflation rate. The first consists of the annualized growth rate of the money supply (M2 less the monetary base) and the annualized CPI inflation rate, and has thirteen lags to minimize the Akaike Information Criterion (AIC). The second uses this same measure of the money supply and the annualized percentage change in the GDP deflator, and has eighteen lags, which minimizes the AIC. Both VARs are stable (all inverse roots outside the unit circle) and both have no significant autocorrelation in the residuals, shown by insignificant Ljung-Box Q-statistics. Overviews of these VARS are shown in table 2.

After establishing the link between the money supply and the inflation rate, we estimate two multivariate VAR models to show the effects of interest and isolate the fiscal transmission mechanism. Table 3 shows these specifications. Both specifications contain nine lags, which is more than twice the annual frequency (quarterly). The AIC is minimized at eleven lags, but including ten or more resulted in instability. The Hannan-Quin and Schwarz-Bayesian criteria are minimized with fewer, but fewer lags resulted in a significant Q-statistic. To maintain stability and stationarity while using as many lags (as much information) as possible, we use nine lags.

RESULTS AND IMPLICATIONS

IRFs and FEVDs rely on identifying assumptions, and we orthogonalize the shocks using the Cholesky decomposition method. This requires an ordering of variables from most exogenous to least, and the order given in tables 2 and 3 is the order we use. Each IRF represents the response the named response variable to a shock of one standard deviation in the impulse variable.

Table 3. Multivariate VAR Specifications

	Specification 1	Specification 2
Endogenous Variables	*Federal Reserve purchases of Treasury securities* *Federal Reserve purchases of other assets* *Federal surplus/deficit as a % of money supply* *Current account balance as a % of money supply* *Real GDP growth rate, deflated by CPI* *Money supply growth rate* *CPI inflation rate*	*Federal Reserve purchases of Treasury securities* *Federal Reserve purchases of other assets* *Federal surplus/deficit as a % of money supply* *Current account balance as a % of money supply* *Real GDP growth rate, deflated by GDP deflator* *Money supply growth rate* *GDP deflator inflation rate*
Lag Length	*9*	*9*
Criteria for Lag Length	*Max. possible for stability and stationary error term*	*Max. possible for stability and stationary error term*
Portmanteau (Ljung-Box) Q-stat	*1987.10 (48 d.f.), p = 0.1981.38*	*1978.32 (47 d.f.), p = 0.1281*

Note: The order of the variables is the Cholesky ordering for orthogonal IRFs and FEVDs

BIVARIATE LINK BETWEEN MONEY SUPPLY AND INFLATION

Figures 5 and 6 show the response of the inflation rate to a one standard deviation shock in the growth rate of the money supply, which is 0.0436, or 4.36 percentage points. CPI inflation peaks sooner than GDP deflator inflation, but both peak at approximately 0.4%, and both are significant at the 5% level. This means that if the annualized money supply growth rate increases by 4.36 percentage points for just one quarter, inflation should increase by 0.4 percentage points, but this effect is delayed. These bivariate specifications do not account for any confounding variables. The shock is a one-period shock and does not persist, so a sustained increase in the money supply growth rate should cause even more inflation. The key result from these bivariate models is that this measure of the money supply, M2 less the monetary base, is positively linked to inflation.

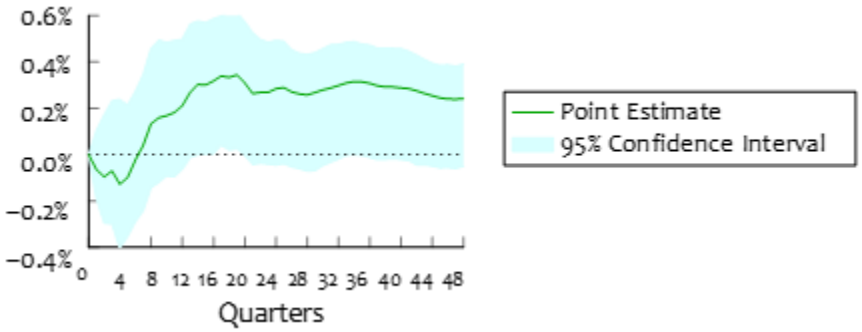

Figure 5. Bivariate VAR Specification 1 – Response of CPI inflation to Money Supply Growth Rate

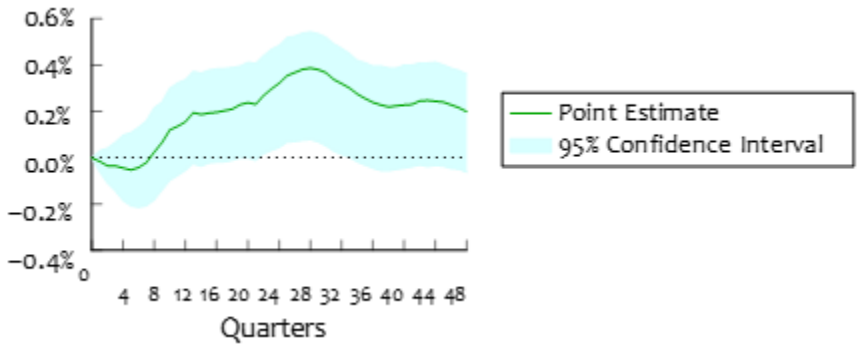

Figure 6. Bivariate VAR Specification 2 – Response of GDP Deflator Inflation to Money Supply Growth Rate

MULTIVARIATE MODELS

The multivariate models described in table 3 confirm the results from the bivariate models and highlight the fiscal transmission mechanism. Figures 7 and 8 show the effect of a shock to Federal Reserve purchases of Treasury securities on inflation.

One standard deviation of this impulse variable is 0.0103, and it is linked to approximately a 0.6 percentage point increase in the CPI or 0.4 in the GDP deflator, and the effect is delayed about two or three years. In the first quarter of 2020, the Federal Reserve purchased Treasury securities in the amount of 0.0855% of the money supply, and its purchases amounted to 0.0794% the following quarter. When combined, these consecutive shocks are about sixteen standard deviations, and should cause approximately a 9.6 percentage point increase in CPI inflation or 6.4 percentage points in the GDP deflator. Although our time series ends at the end of 2021, before the inflation rate was known but after the massive Treasury security purchases occurred, this is very close to what subsequently happened. In the second quarter of 2020, GDP deflator inflation was 0.72% annually, and CPI inflation was 0.44%. By the second quarter of 2022, these numbers had jumped to 7.62% and 8.58%. These results are very poignant because they are informed by 50 years of data that preceded the current burst of inflation, which began shortly after our time series ends.

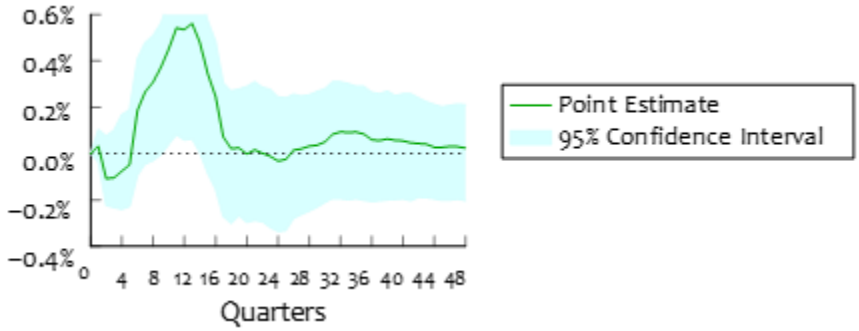

Figure 7. Multivariate VAR Specification 1 – Response of CPI Inflation to Federal Reserve Purchases of Treasury Securities

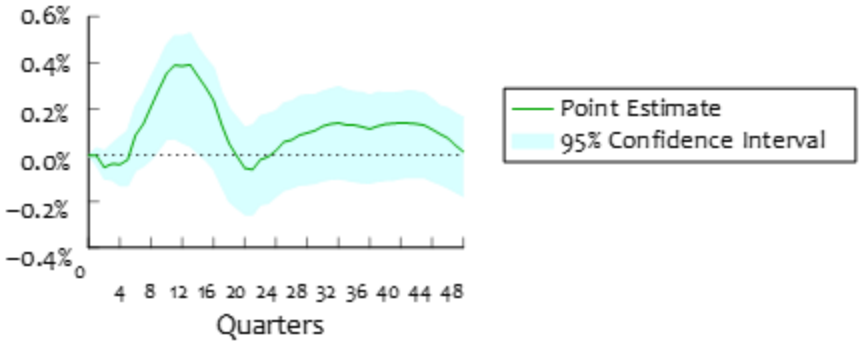

Figure 8. Multivariate VAR Specification 2 – Response of GDP Deflator Inflation to Federal Reserve Purchases of Treasury Securities

Figures 9 and 10 show the effect of Treasury security purchases on the money supply growth rate, and figures 11 and 12 show the effect of the money supply growth rate on the inflation rate. These IRFs show the fiscal transmission mechanism at work. The money supply growth rate did not increase rapidly like Federal Reserve purchases; it increased from 9.98% in the first quarter of 2020 to 15.71% in the first quarter of 2021, before dropping below 10% again. Figures 9 and 10 imply that the Federal Reserve's activity would have caused the money supply growth to increase between eight and twelve percentage points, which is less than we observe for a point estimate, but it is within the 95% confidence interval. Figures 11 and 12 highlight effects of the money supply on inflation that are not explained by Federal Reserve purchases, but because of the Cholesky ordering, they do account for the fact that the money supply is increased by Federal Reserve activity. The change in the money supply growth rate was less than two standard deviations and it was spread across an entire year, so this should not have contributed more than a percentage point to the inflation rate at most.

Figures 13 and 14 explain why large-scale Federal Reserve activity did not cause inflation right during and after the Great Recession. Most of that activity was purchases of other assets, and the result was increases in bank reserves. The effect on our measure of the money supply was negligible, implying that the monetary transmission mechanism was not very active, and thus there was no reason to expect inflation. For CPI inflation, the effect of Federal Reserve purchases of other assets is negative and significant.

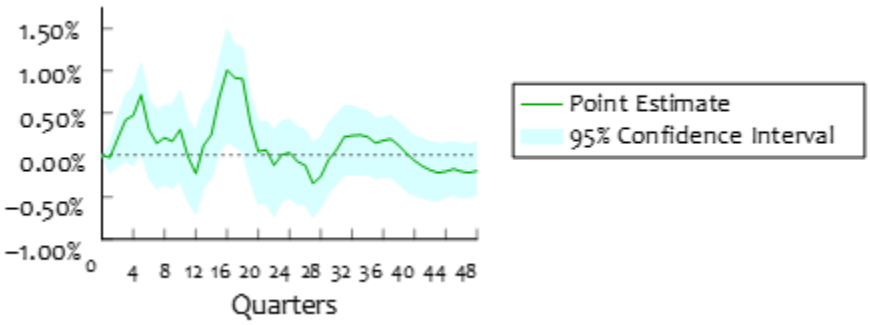

Figure 9. Multivariate VAR Specification 1 – Response of Money Supply Growth to Federal Reserve Purchases of Treasury Securities

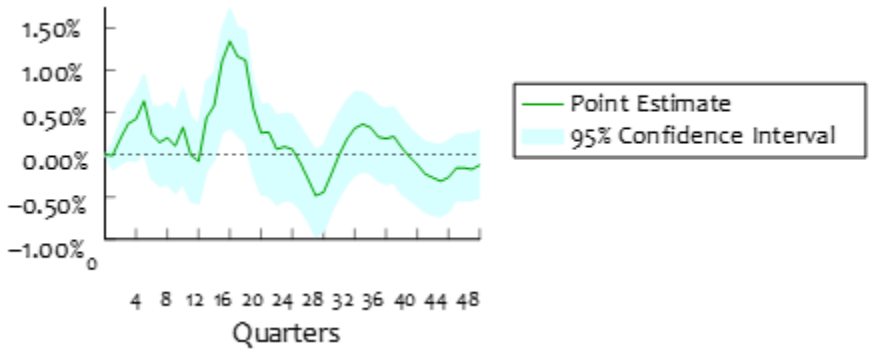

Figure 10. Multivariate VAR Specification 2 – Response of Money Supply Growth to Federal Reserve Purchases of Treasury Securities

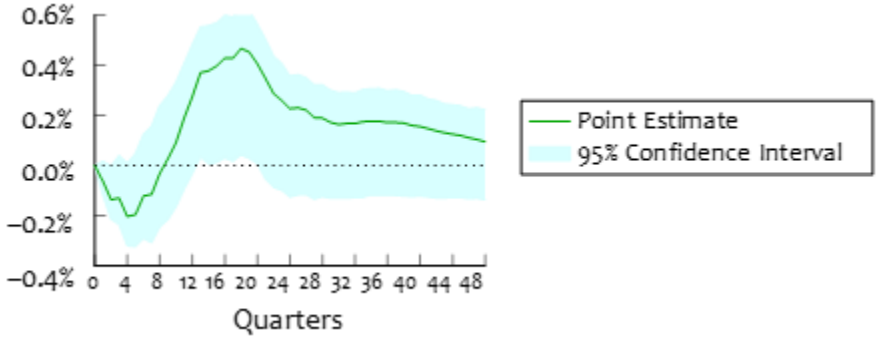

Figure 11. Multivariate VAR Specification 1 – Response of CPI Inflation to Money Supply Growth

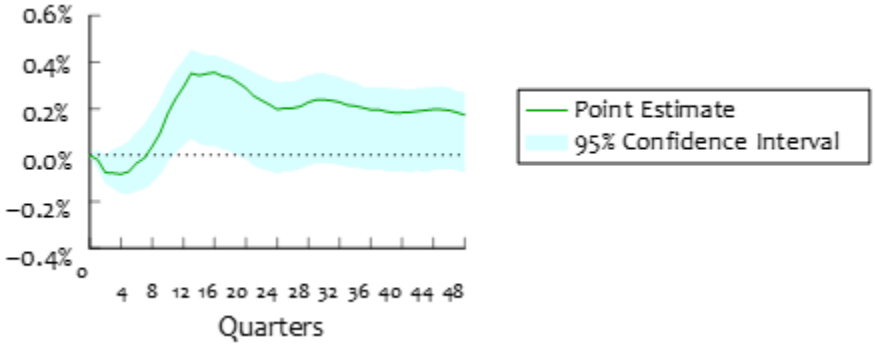

Figure 12. Multivariate VAR Specification 2 – Response of GDP Deflator Inflation to Money Supply Growth

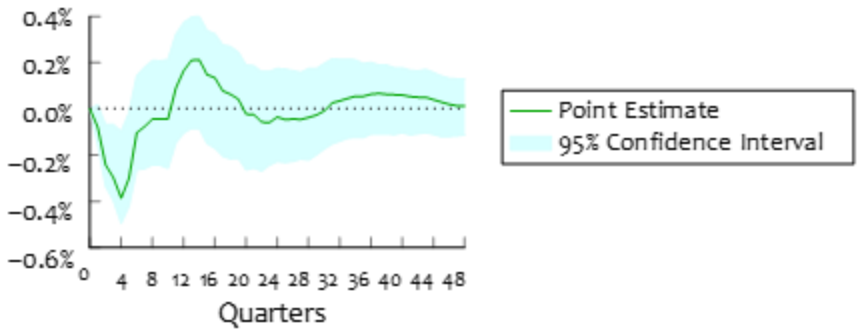

Figure 13. Multivariate VAR Specification 1 – Response of CPI Inflation to Federal Reserve Purchases of Other Assets

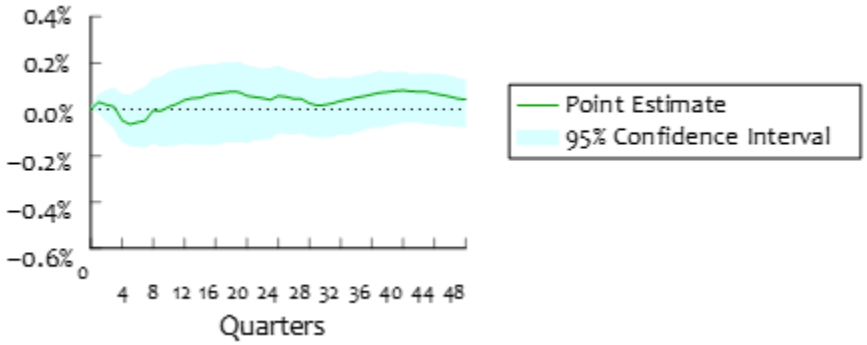

Figure 14. Multivariate VAR Specification 2 – Response of GDP Deflator Inflation to Federal Reserve Purchases of Other Assets

The current account balance has a positive and significant but brief effect on CPI inflation shown in figures 15 and 16, meaning that trade surpluses are linked to inflation increases, and trade deficits to decreases. This is consistent with the time series plots in section, "The Story the Numbers Tell Visually" and it is intuitive because the CPI includes imports. The GDP deflator does not include imports, so it is not surprising that it has no significant response to the current account.

The effect of the federal budget surplus on inflation, shown in figures 17 and 18 is positive, meaning that deficits are linked to reductions in inflation. It is critical to remember that IRFs are analogous to partial derivatives, so the effect of a budget deficit holds constant Federal Reserve activity and money supply growth. Intuitively, this should cause a decrease in inflation because the deficit takes money away from other uses, thus depressing demand. Unsurprisingly, this effect is larger for CPI inflation than GDP deflator inflation.

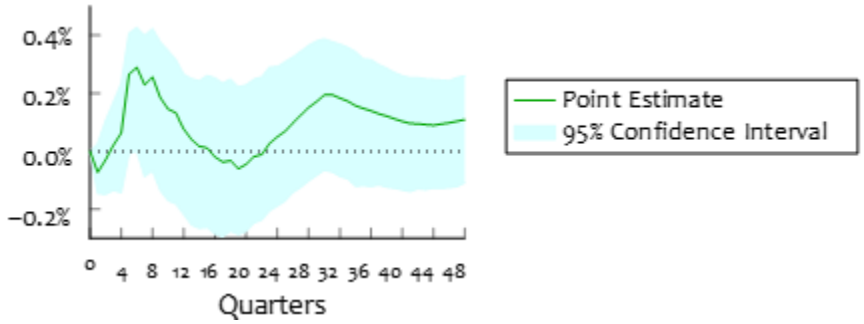

Figure 15. Multivariate VAR Specification 1 – Response of CPI Inflation to Current Account Balance

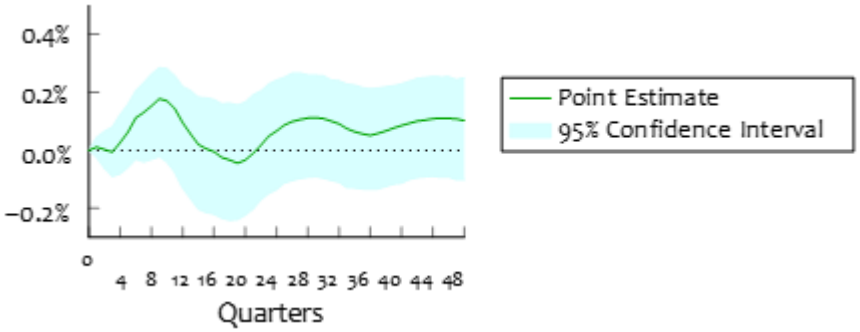

Figure 16. Multivariate VAR Specification 2 – Response of GDP Deflator Inflation to Current Account Balance

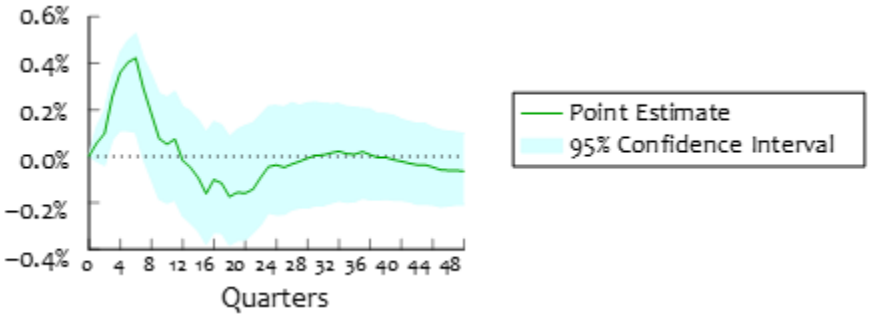

Figure 17. Multivariate VAR Specification 1 – Response of CPI Inflation to Federal Budget Surplus

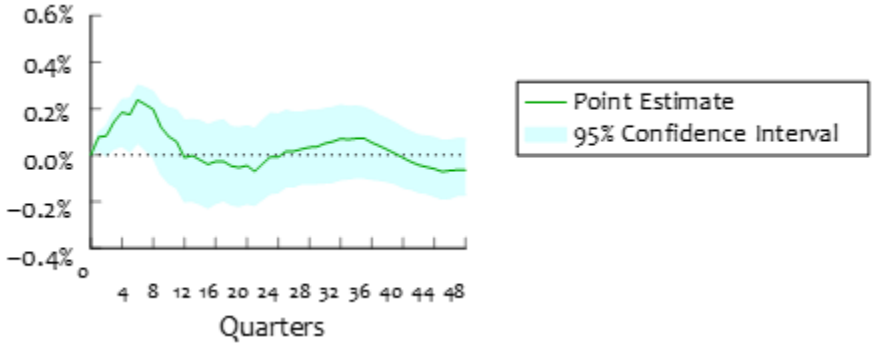

Figure 18. Multivariate VAR Specification 2 – Response of GDP Deflator Inflation to Federal Budget Surplus

Our IRFs imply that effects may be more delayed than has been the case most recently. This may be explained by the fact that prior events in our time series were of much smaller magnitude than those contemporaneous with the COVID-19 pandemic, and they were more persistent, allowing for effects to compound over time, like happened in the 1970s and 1980s. The magnitude of our results matches recent observations even though the timeline is somewhat accelerated.

We present FEVDs for CPI and GDP deflator inflation in figures 19 and 20 to show the amount of variation in inflation that is attributable to exogenous shocks in other variables. For both measures, prior values of the inflation rate initially explains the most variation. The federal deficit explains a noticeable amount within a few quarters, and within three years, Federal Reserve purchases of Treasury securities explain the most. These soon give way to the growth rate of the money supply as the single largest predictor. These FEVDs are consistent with the IRFs and depict a logical flow of inflationary pressures.

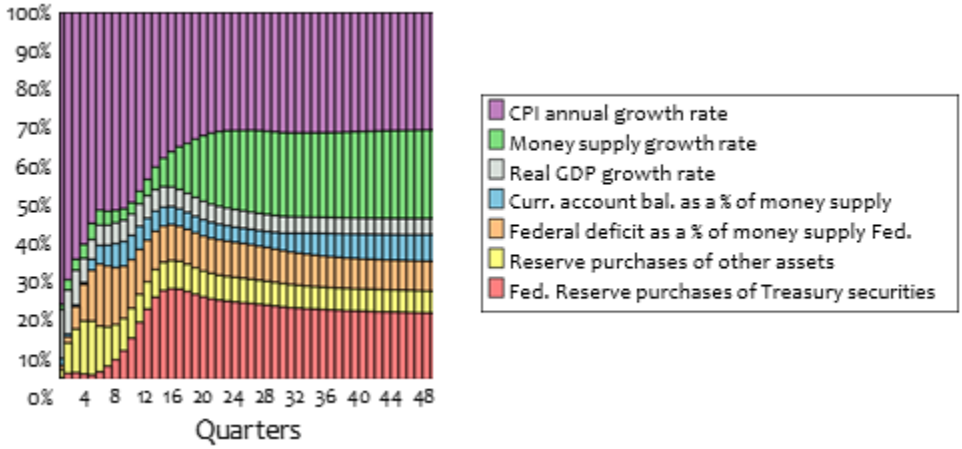

Figure 19. Multivariate VAR Specification 1 – Forecast Error Variance Decomposition of CPI Inflation

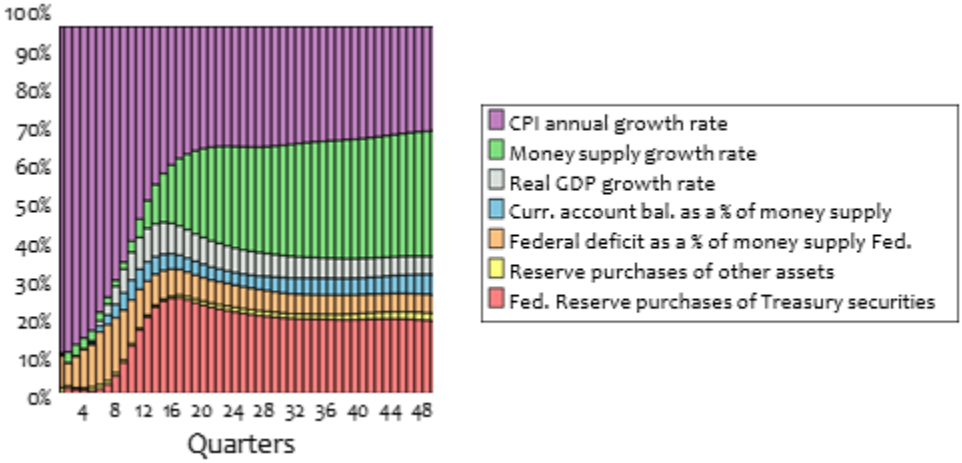

Figure 20. Multivariate VAR Specification 2 – Forecast Error Variance Decomposition of GDP Deflator Inflation

CONCLUSION

From Friedman's assertion that inflation is a monetary phenomenon to Jerome Powell's assessment of the need to unlearn that creating new money must cause inflation, the link between the money supply and inflation has not been well understood. Although the Federal Reserve can create new money, its influence over subsequent uses of money is limited, necessitating greater understanding of the "transmission mechanism" that leads from new money to inflation. We highlight a fiscal transmission mechanism in which government deficits lead to inflation when they are financed by newly created money. Our measure of the money supply, M2 less the monetary base, excludes excess reserves to focus solely on money that is used in exchange.

With a nonstructural vector autoregression approach that relies on 50 years of data, we find that purchases of Treasury securities by the Federal Reserve on the secondary market is linked to future inflation and offers a near-perfect explanation of the inflation experienced in 2022 when measured both by the consumer price index and the GDP deflator. To complement these findings, we show that Federal Reserve purchases of other assets are not linked to inflation, nor are fiscal deficits linked to inflation when they are not financed by Federal Reserve purchases of Treasury securities, casting doubt on the importance of a financial, non-fiscal transmission mechanism. These complementary findings show why unprecedented Federal Reserve activity during the Great Recession did not cause inflation, in contrast to its activity during the COVID recession.

As an important policy implication, we point out that maintaining targets for growth of the money supply and limiting purchases of Treasury securities is a better path to maintaining price stability than an interest rate target. Maintaining an interest rate target, even if noticeably above zero, can lead to inflation if the Federal Reserve must finance a government deficit to maintain it without crowding out causing interest rate increases. Our most important result is that the fiscal transmission mechanism is the predominant cause of inflation when new money is created, and our most important recommendation is to limit central bank purchases of government debt, even on the secondary market, and focus on growth of the money supply as opposed to interest rates when aiming for price stability.

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