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Monetary aggregates in the US since 2020 and post-COVID-19 inflation. Evidence from the equation of exchange.

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Abstract

Starting from Irving Fisher's equation of exchange ($M \times V = P \times Q$) at the basis of the quantity theory of money, we analyze from a theoretical macroeconomic-monetary perspective whether the increase of monetary aggregates M1 and M2 might have affected general prices. Moreover, we investigate why monetary aggregates have evolved differently for COVID-19 than in the global financial crisis (2007-2009). The article elaborates on data for the US from Q1/2020 to Q2/2022 and represents the first scientific contribution to the analysis of post-COVID-19 inflation by means of the equation of exchange. We find that money growth has contributed to inflation during the period of quantitative easing (2020-2021), but that inflation since 2022 seems to be driven also by non-monetary factors.

Keywords: COVID-19; inflation; Irving Fisher's equation of exchange; macroeconomics; velocity of money.

JEL Classification Codes: E13, E31, E51, E58.

1. Introduction

After experiencing several years of “low inflation environment” (Bandeira et al., 2018), the general price level is growing severely (+8.3% in August 2022 on a one-year basis (U.S. Bureau of Labor Statistics, 2022)). While this trend is likely to be due to several factors like reinforced customer demand after extraordinary events (Beretta, 2021), rigidities from the supply side (Shin, 2021) and current geopolitical uncertainties (Caldara et al., 2022), enabling firms with market power to increase their profits (Glover et al., 2023; Weber and Wasner, 2023), we explore whether the current inflation might be also caused by money growth. If so, this outcome would be in line with a relevant stream of contributions to the economic literature repeatedly finding a “cointegration between base growth and price inflation” (Crowder, 1998). Gillman and Nakov (2009) reconfirm that “inflation shifts are rooted in persistent changes in the growth

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rate of the money supply”, Benk and Gillman (2020) that “money supply growth Granger predicts inflation”, while Alquist et al. (2013) use US monetary aggregates to predict the nominal price of oil as a potential, additional source of inflation. Matthews and Ong (2022) find that “in the short run inflation expectations play a significant role. In the medium to long run it is the money supply”. An analysis of historical time series in industrial countries confirms “the longer-run relationships for money growth and inflation to be highly stable over time for all countries” (Haug and Dewald, 2011). In contrast, Gertler and Hoffmann (2016) and Teles et al. (2016) find that the money-inflation nexus has weakened over time and is weakest in advanced economies with low inflation. The Great Recession taught that “credit aggregates ought to be given greater attention in monetary analysis in order to better identify risks to financial stability and ultimately to long-run price stability” (Gertler and Hofmann, 2016). According to Stella et al. (2021), due to innovations in payment systems, the correlation between money growth and inflation is no longer stable.

The paper contributes to the literature by analysing the macroeconomic variables of the equation of exchange for the US in the post-COVID period (Q1/2020-Q2/2022) compared to the global financial crisis (2007-2009). We find that, from a purely arithmetical point of view, the high monetary growth during the pandemic has contributed to inflation. Being aware that no causal relationships can be derived from the quantity equation and that the quantity theory of money cannot be applied to short periods like the pandemic (Pinter, 2022), we discuss our findings in the light of the current debate on monetary versus non-monetary inflation drivers.

2. Methods

The starting point of our analysis is the equation of exchange of the quantity theory of money (Fisher, 1911, 1912):

$$M \times V = P \times Q \quad (1)$$

where M is money in circulation, V its velocity (i.e., “the frequency at which one unit of currency is used to purchase domestically-produced goods and services within a given time period” (Federal Reserve Bank of St. Louis, 2022g)), P the general price level and Q the real output of the economy. Furthermore, $P \times Q$ equals nominal GDP. Although V is not constant and the causality between M and inflation weakened (De Grauwe and Polan, 2005; Pinter, 2022), its status of tautological identity (Friedman, 1970) does not leave room for interpretation. For instance, “if velocity is increasing substantially there can be inflationary pressures even if the money supply is constant” (Colander, 2013). Monetizing a new production ($P \times Q$) involves issuing M and traditionally “in countries experiencing a secular rise in real income per capita the stock of money [...] rises [...] at a decidedly higher rate than does money income” (Friedman, 1959). Our research question is: was P also influenced by rapidly growing M (i.e., is post-COVID-19 inflation also an effect of money issue due to countercyclical policy measures)?

3. Data and results

First, we analyze each term of the equation of exchange separately while comparing their evolution during COVID-19 with the global financial crisis or Great Recession (2007-2009). Then we verify the whole equation of exchange for the COVID-19 period.

3.1. The left term of the equation of exchange ($M \times V$)¹

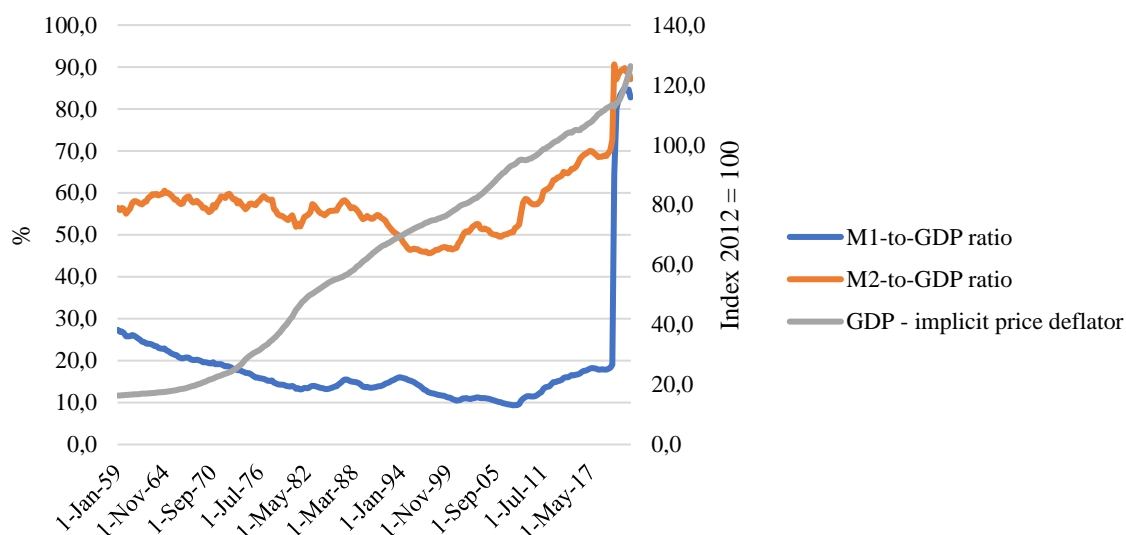
3.1.1. Money in circulation (M)

Since 1959, M never grew more than during COVID-19. During the global financial crisis, M1 and M2 soared by respectively +19.3% and +15.4% (Gharehgozli and Lee, 2022). Monetary aggregates do not contain any information about fiscal stimuli in parallel to the monetary ones.

¹ All numerical data in Sections 3.1.-3.3. are taken from the Federal Reserve Bank of St. Louis (2022a, 2022b, 2022c, 2022d, 2022e, 2022g, 2022h).

Therefore, the monetary and fiscal effort against COVID-19 was numerically speaking extraordinary. While M1² jumped from \$4,086.1bn. to \$20,593.7bn. (+404.0%) from Q1/2020 to Q2/2022 also because “trillions of dollars in savings accounts were reclassified as checking accounts” (Housel, 2021) and moved from M2 to M1 from May 2020, this is just a side of the “big picture” as the analysis of the M1- and M2-to-GDP ratio combined with the rapid increase of the GDP: implicit price deflator suggests (Figure 1).

Figure 1. M1- and M2-to-GDP ratio as compared to the GDP: implicit price deflator (1959-2022).



Source: own elaboration based on Federal Reserve Bank of St. Louis (2022a, 2022c, 2022d).

Although the Federal Reserve Bank of St. Louis (2022f) has pointed out that “the resulting acceleration in the supply of M1 can be understood largely as banks accommodating an increase in people’s demand for money”, it should not be forgotten that M2 also contains M1. Therefore, the above-mentioned shift of items from M2 to M1 becomes a not sufficiently satisfying explanation as soon as we analyze M2 which also grew by \$6,103.8bn. (+39.1%) from Q1/2020 to Q2/2022.

Table 1 shows how significant the increase of the M2-to-GDP ratio was for COVID-19 (+18.7%) compared to the global financial crisis (+8.4%), which was even characterized “by unconventional monetary policy [including] quantitative easing by expansion of central banks’ balance sheets” (Kinatader and Wagner, 2017).

We have to take into account that *M* is “far more endogenous than it was assumed by the classical Quantity Theory” (Munro, 2022), but this mostly applies to normal times of positive interest rates without quantitative easing” (Bank of England, 2014). The Federal Reserve’s Policy Normalization, raising the federal funds rate and reducing its securities holdings, lasted from 2014 until 2019. “As a response to the COVID-19 pandemic, in addition to lowering the target range for the federal funds rate to near zero and establishing emergency credit and lending facilities, the Federal Reserve began purchasing very sizable quantities of Treasury securities and agency mortgage-backed securities [...]. Thereafter, asset purchases continued at a more moderate pace to help foster accommodative financial conditions and smooth market functioning” (Board of Governors of the Federal Reserve System, 2022). Since 2022, the Fed aims at significantly reducing the size of its balance sheet. We conclude that, during 2020-2021, the increase in the quantity of money can be regarded as mainly exogenous in support of the

² M1 is commonly defined as “narrow money [including] currency i.e. banknotes and coins, plus overnight deposits” (Organisation for Economic Co-operation and Development, 2022).

quantity theory while since 2022 this is no longer the case. In the first two quarters of 2022, M2 and the M2-to-GDP both declined by 0.1%.

Table 1. Percentage change of M1- and M2-to-GDP ratio from previous year.

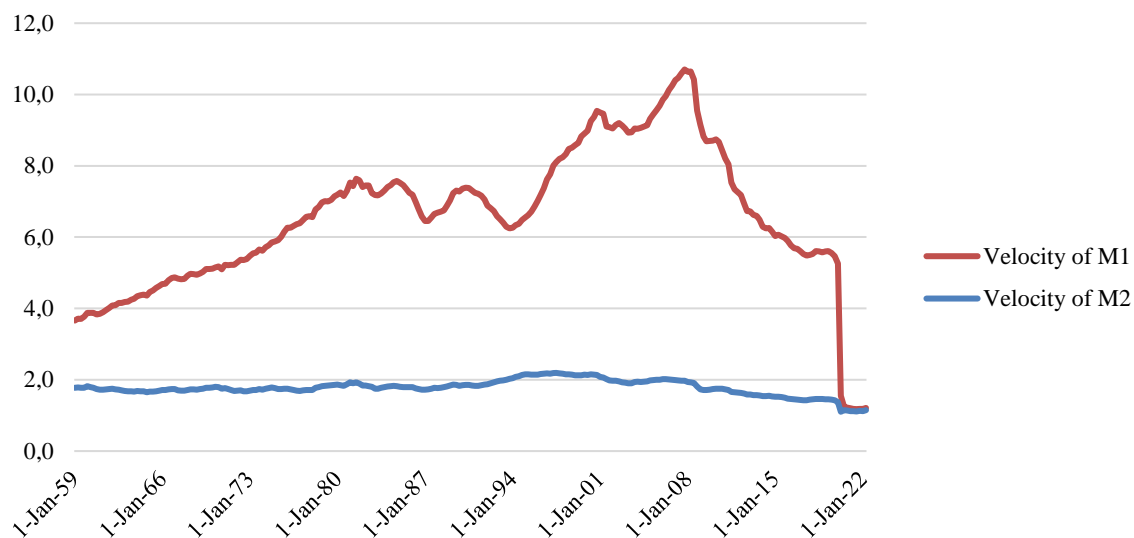
(% change)	Global financial crisis			COVID-19		Q1/2022	Q2/2022
	2007	2008	2009	2020	2021		
M1-to-GDP ratio	-0.5	+0.2	+1.6	+43.2	+23.0	-0.1	
M2-to-GDP ratio	+0.7	+2.3	+5.4	+15.1	+4.7	-1.1	
M1-to-GDP ratio (total)	+1.3			+66.1			
M2-to-GDP ratio (total)	+8.4			+18.7			

Source: own elaboration based on Federal Reserve Bank of St. Louis (2022a, 2022c, 2022d).

3.1.2. Velocity of money (V)

V dropped like never before (respectively, by -77.0% for M1 and -16.6% for M2) while reaching the lowest level since the beginning of the data series in 1959 (Figure 2). In this regard, Benk et al. (2010) show “how a significant proportion of the volatility of [...] velocity can be explained with [money, credit and goods productivity] shocks, in both business cycle and long run frequencies”.

Figure 2. Velocity of M1 and M2 (1959-2022).



Source: own elaboration based on Federal Reserve Bank of St. Louis (2022g, 2022h).

This result is no coincidence and counterbalances the massive increase of M . During the Great Recession, V shrank only by -16.1% for M1 and -13.3% for M2.

3.2. The right term of the equation of exchange ($P \times Q$)

3.2.1. General price level (P)

Whether calculated by means of the Consumer Price Index (+14.8%) (U.S. Inflation Calculator, 2022) or of the Gross Domestic Product: implicit price deflator (index 2012=100) (+11.5%) used for $M \times V = P \times Q$ in Tables 2 and 3, P soared from Q1/2020 to Q2/2022 while from 2007 to 2009 it remained somehow stable (+2.6%).

3.2.2. Real output (Q)

Q rose from Q1/2020 to Q2/2022 by +3.9% compensating for its decrease by -3.4% in 2020, which in turn outreached the negative result (-2.6%) in 2009.

3.3. Results from the whole equation of exchange during COVID-19

Tables 2 and 3 calculate $M \times V = P \times Q$ by using M1, respectively M2.

Table 2. Verification of the equation of exchange for the US with M1 (Q1/2020-Q2/2022)³.

	<i>M</i> (bn. \$)	<i>V</i>	<i>M</i> × <i>V</i> (bn. \$)	<i>P</i>	<i>Q</i> (bn. \$)	<i>P</i> × <i>Q</i> (bn. \$)	Statistical correspond- ence between <i>M</i> × <i>V</i> and <i>P</i> × <i>Q</i> (%)
Q2/2022	20,593.7	1.208	24,877.2	1.263	19,699.4	24,880.3	100
Q1/2020	4,086.1	5.257	21,480.6	1.133	18,952.0	21,472.6	100
(% change)	+404.0	-77.0	+15.8	+11.5	+3.9	+15.9	-

Source: own elaboration based on Federal Reserve Bank of St. Louis (2022b, 2022c, 2022e, 2022g).

Table 3. Verification of the equation of exchange for the US with M2 (Q1/2020-Q2/2022)⁴.

	<i>M</i> (bn. \$)	<i>V</i>	<i>M</i> × <i>V</i> (bn. \$)	<i>P</i>	<i>Q</i> (bn. \$)	<i>P</i> × <i>Q</i> (bn. \$)	Statistical correspond- ence between <i>M</i> × <i>V</i> and <i>P</i> × <i>Q</i> (%)
Q2/2022	21,706.9	1.148	24,919.5	1.263	19,699.4	24,880.3	100
Q1/2020	15,603.1	1.376	21,469.9	1.133	18,952.0	21,472.6	100
(% change)	+39.1	-16.6	+16.1	+11.5	+3.9	+15.9	-

Source: own elaboration based on Federal Reserve Bank of St. Louis (2022b, 2022d, 2022e, 2022h).

We find that in the COVID-19 period (Q1/2020-Q2/2022), the rise in *M* was only partly compensated by a decline in *V*, going along with rising *P* and *Q*:

$$M \uparrow \times V \downarrow = P \uparrow \times Q \uparrow \quad (2)$$

Monetary policy seems, therefore, to have contributed to post-COVID-19 inflation. However, for the first two quarters of 2022, we find that M2 declined (-0.1%), *V* increased (+4.4%) going along with growing *P* (+2.2%) and *Q* (+2%). At least for 2022, inflation cannot be attributed to monetary growth.

3.4. Results from testing alternative explanations by means of the whole equation of exchange.

Our analysis does not identify *which* (macroeconomic) factor contributed to *which share* of the current inflation rate. The equation of exchange is true by definition and – says nothing about causal relationships. Expressed in growth rates – it can be written as:

$$\hat{M} + \hat{V} = \hat{P} + \hat{Q} \quad (3)$$

Respectively

$$\hat{P} = \hat{M} + \hat{V} - \hat{Q} \quad (4)$$

While our analysis shows a positive correlation between \hat{M} and \hat{P} in the period of quantitative easing (2020-2021) in support of the quantity theory of money, we are equally interested in testing a recent stream of economic literature highlighting that both demand and supply factors contributed to higher inflation (Aharon and Qadan, 2022; Jiang et al., 2022). According to these contributions, the relative inelasticity of supply in key sectors seems to be the main cause of the rising inflation after the outbreak of the pandemic and Russia's war against Ukraine (Brainard,

³ Annual, seasonally adjusted data. *M* corresponds to M1 (M2 in Table 3), *V* to its velocity, *P* to GDP (implicit price deflator, index (2012=100)) divided by 100 and *Q* to real GDP.

⁴ See footnote 3.

2022). Moreover, supply factors such as labor shortages and global supply disruptions can explain more than half of the higher inflation⁵ after COVID-19, while demand factors about one-third (Shapiro, 2022).

The quantity theory of money is a theory about the long run and, therefore, should not be misapplied to the COVID-19 time (Pinter, 2022). To differentiate between short and long run following the (New) Keynesian theory, we consider possible deviations of actual output Q from potential output Q^* . Departing from a hypothetical situation where all growth rates are such that the economy is at full capacity,

$$\hat{P}^* = \hat{M}^* + \hat{V}^* - \hat{Q}^* \quad (5)$$

and subtracting Eq. 5 from Eq. 4, we obtain:

$$(\hat{P} - \hat{P}^*) = (\hat{M} - \hat{M}^*) + (\hat{V} - \hat{V}^*) - (\hat{Q} - \hat{Q}^*) \quad (6)$$

Thus, a rise in inflation, $(\hat{P} - \hat{P}^*) > 0$, may be:

1. demand-driven, caused by an increase in the growth rate of money and its velocity $(\hat{M} - \hat{M}^*) + (\hat{V} - \hat{V}^*)$ in excess of output growth $(\hat{Q} - \hat{Q}^*)$, and/or;
2. supply-driven, caused by a reduction in the actual growth rate of output, implying a lower or negative output gap $\hat{Q} - \hat{Q}^*$.

By using this methodological approach, large macroeconomic imbalances between aggregate demand and productive capacity should not be sufficiently able to explain the rise in inflation after COVID-19, because the output gap remained negative when inflation began to rise rapidly in 2021 (see Table 4). The small positive output gap in the last quarter of 2021 should also not suffice to explain the rapid rise in inflation (Bivens, 2022a). On the cost side, wage growth below inflation has apparently dampened inflation growth in 2021-2022. For example, in Q2/2022 annual wage growth was 4.3%, which is in the range of 3.5-4.5% consistent with the Fed's long-run inflation target of 2% (Bivens, 2022a). On the other hand, profit margins increased to historically high levels in 2021 (see Table 4).

Table 4. Output gap and profit margins (Q1/2020-Q2/2022)

	Output gap = $\frac{\text{Actual GDP}}{\text{Potential GDP}} - 1$	Post-tax profit margins
Q1/2020	-1.8%	11.5%
Q2/2020	-8.7%	11.1%
Q3/2020	-3.1%	15.2%
Q4/2020	-2.5%	13.4%
Q1/2021	-1.3%	14.3%
Q2/2021	-0.3%	16.1%
Q3/2021	-0.2%	15.8%
Q4/2021	0.8%	15.1%
Q1/2022	-0.6%	13.9%
Q2/2022	-0.9%	n.a.

Source: own elaboration based on Bivens (2022a) with profit margins calculated as unit profits divided by the sum of unit.

Table 5 shows that while the share of price changes accounted for by unit labor costs declined from 56% in the pre-COVID period (1979-2019) to 22% after the recovery from the COVID-19 recession (Q2/2020-Q2/2022), the contribution of profits increased from 13% to 40%, that is, by a factor of three.

Even compared to the business cycle peak at the end of 2019, profit growth is two and a half times its normal contribution to price growth – around 34% (Bivens, 2022b). According to

⁵ Measured for personal consumption expenditures (PCE) inflation.

Glover et al. (2023), markups could account for even more than 50% of inflation in 2021, compared to almost zero in the decade before the pandemic. Firms seem also to raise prices in anticipation of future cost increases (Weber and Wasner, 2023).

Table 5. Share of price growth attributable to growth in various input costs and profits.

	Profits	Labor costs	Non-labor costs
1979-2019 average	13.1%	56.0%	30.8%
Q4/2019-Q2/2022	33.8%	53.0%	13.2%
Q2/2020-Q2/2022	40.1%	21.5%	37.8%

Source: own elaboration based on Bivens (2022b).

4. Discussion, policy conclusions and concluding remarks

Based on the equation of exchange, we find M soaring and P following closely, which in a period of quantitative easing (Q1/2020-Q4/2021) supports the “monetarist” view (Lynch, 2022). Therefore, the excessive growth of M due to countercyclical monetary stimuli contributed to the inflationary pressures, along with structural factors. In contrast, inflation in 2022 is less explainable by monetary factors.

Policy action based on the equation of exchange and targeted at reducing P can be fourfold:

1. Q should grow to cover (i.e., “collateralize”) a greater share of M . Under these circumstances, Eq. 1 would *ceteris paribus* turn into:

$$\bar{M} \times \bar{V} = P \downarrow \times Q \uparrow \quad (7)$$

While an expansionary fiscal policy is unlikely to have a strong impact on inflation (Capolongo and Gros, 2020), recessionary forces typical of uncertain times and “bottlenecks” in production (Santacreu and LaBelle, 2022) may partially impede this adjustment. In fact, “efficiency in product markets reduces the inflation persistence effect” (Batten and Wagner, 2014).

2. M should shrink (i.e., be sterilized by the central bank) turning Eq. 1 into:

$$M \downarrow \times \bar{V} = P \downarrow \times \bar{Q} \quad (8)$$

Restrictive monetary policy could, however, negatively affect the US economy, suppress wage growth and put the burden even more on workers (Bivens, 2022a).

3. V should further shrink so that:

$$\bar{M} \times V \downarrow = P \downarrow \times \bar{Q} \quad (9)$$

This scenario bears risks because of contributing to the historical reduction of V and to the hoarding of economic resources. The dynamicity of the expenditure cycle in the economy might be endangered.

4. P , respectively its growth rate, may be reduced by taxing excessive profits or by antitrust policy to restrain firms’ market power, resulting potentially also in higher output:

$$\bar{M} \times \bar{V} = P \downarrow \times Q \uparrow \quad (10)$$

The safest approach might consist in combining an increase of Q (i.e., real production at the basis of generalized wealth) with a gradual absorption of M and – if also necessary – a higher level of profit taxes and antitrust policy.:

$$M \downarrow \times V \uparrow = P \downarrow \times Q \uparrow \quad (11)$$

To conclude, the general cause of inflation is conflict over the distribution of income (Blanchard, 2022; Lorenzoni and Werning, 2023), and “money can influence prices only through its effect on this conflict” by altering the level of demand (Rowthorn, 1977). The equation of exchange shows that the massive expansion of M in 2020-2021 contributed to the vigorous increase of P after COVID-19, while since 2022 inflation seems rather to be driven by structural factors. The “neoclassical monetarism” ignores the central role of market power for inflation (Rowthorn, 1977). It should be further explored to what extent post-COVID-19 inflation has been driven by distributional conflicts, and whether restrictive monetary policy “is a

highly inefficient way to deal with distributional conflicts” (Blanchard, 2022). If so, the Inflation Reduction Act of 2022 might be a step in the right direction to address the supply side not only with extensive government investment, but also with higher taxes for the largest corporations and provisions to cut prescription drug cost through price negotiations (The White House, 2022). Future research needs to analyze its effectiveness in combatting inflation, along with monetary policy tightening.

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