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Surge of M1 Money supply and Inflation in USA: Short-run dynamic models

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Abstract. *The study purpose is to analyze the impact of U.S. government and Federal Reserve actions on the dynamics of the M1 money supply during economic crises, particularly in 2008 and 2020, and to assess the short-term and long-term consequences of these changes on inflation and economic stability.*

Methods. *The research employs econometric analysis using an Error Correction Mechanism (ECM) model to evaluate the short- and long-term effects of changes in the money supply on inflation. Visualization techniques are used to illustrate the findings.*

Results. *The analysis revealed that during the 2008 crisis, the U.S. government focused on increasing public debt without a substantial rise in the M1 money supply. In contrast, in 2020, measures such as direct payments to households, and extensive government spending led to a four-fold increase in M1. This surge caused inflationary pressures with a certain time lag. The ECM demonstrated a rapid correction of deviations from the inflation-M1 equilibrium, indicating the presence of stabilizing effects. Short-term increases in M1 drive inflationary*

impacts, but further increments show diminishing effects due to expectation dynamics and central bank interventions.

Conclusions. *The combination of fiscal and monetary measures in 2020 was unprecedented in scale, resulting in both positive and negative outcomes. The findings highlight the necessity of carefully balancing policies to mitigate inflationary risks while addressing economic crises. The experiences of 2008 and 2020 provide valuable insights for developing strategies to respond to future challenges.*

Keywords: *monetary policy, public debt, inflation, fiscal stimulus, money supply, COVID-19.*

Зростання грошової маси M1 та інфляція у США: короткострокові динамічні моделі

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Анотація. *Дослідження спрямоване на аналіз впливу дій уряду США та Федеральної резервної системи на динаміку грошового агрегату M1 під час економічних криз, зокрема у 2008 та 2020 роках, а також на визначення короткострокових і довгострокових наслідків цих змін для інфляції та економічної стабільності. Особливий акцент зроблено на вплив заходів фіскальної та монетарної політики на взаємозв'язок між збільшенням грошової маси та інфляційними процесами.*

Методи. *У роботі застосовано економетричний аналіз із використанням моделі механізму корекції помилок (ECM), що дозволило оцінити коротко- та довгостроковий вплив змін у грошовій масі на інфляцію. Для візуалізації результатів використано графічні методи.*

Результати. *Аналіз показав, що під час кризи 2008 року уряд США зосередився на збільшенні державного боргу без суттєвого зростання грошового агрегату М1. Натомість у 2020 році заходи, такі як прямі виплати населенню, масштабне зростання державних витрат, призвели до чотирикратного збільшення М1. Це, у свою чергу, викликало зростання інфляції з певним часовим лагом. Механізм корекції помилок показав швидке повернення інфляції до рівноваги, що свідчить про наявність стабілізаційних ефектів. Зміни в М1 у короткостроковій перспективі спричиняють інфляційний вплив, але подальші прирости мають обмежений вплив через динаміку очікувань.*

Висновки. *Поєднання фіскальних та монетарних заходів у 2020 році було безпрецедентним за масштабами і мало як позитивні, так і негативні наслідки. Результати підкреслюють важливість ретельного балансування політики для уникнення інфляційних ризиків при подоланні економічних криз. Досвід 2008 та 2020 років може бути корисним для розробки стратегії реагування на майбутні виклики.*

Ключові слова: *державний борг, інфляція, фіскальні стимули, грошовий агрегат, COVID-19.*

1. Introduction. The global economic crisis triggered by the COVID-19 pandemic posed unprecedented challenges to the global economy. Governments and central banks around the world were forced to respond swiftly to plummeting economic activity, rising unemployment, and widespread social disruptions. One of the most noticeable responses was a sharp increase in the money supply, particularly in the M1 aggregate.

In the United States, this surge reached record levels and was driven by direct payments to individuals, expanded credit programs for businesses, quantitative easing policies, and reduced reserve requirements for banks. These measures had an immediate effect in stabilizing the economy and preventing its collapse. However,

in the medium term, they contributed to inflationary processes that reached multi-decade highs in 2021–2023.

Approaches to addressing the economic consequences of the pandemic varied across countries. For instance, the European Union and Japan adopted more cautious monetary policies, focusing on business support through lending programs, while China implemented strict controls over money flows and prioritized investment-driven strategies. The United States, on the other hand, emphasized rapid direct payments to citizens and companies. This creates an opportunity for comparison and analysis to determine which approach was most effective in mitigating inflationary impacts.

2. Literature Review. Friedman theory claims that the money supply is an external variable and it is determined outside the system and is not affected by internal factors, such as prices, interest rates and output, but rather it affects them [5, p.25]. The Monetarists believes that money supply leads to inflation by raising the general price level in a small manner, this what can stimulate the economy growth [16, p.48]. Friedman developed the ground theoretical basis for his monetary policy rule based on a constant rate of money supply growth [14, p.981] but in 2020 there was an unprecedented rapid growth in the M1 money supply, which goes beyond the Friedman model.

The subject of our research is not economic growth, but the government's fiscal actions to prevent an economic crisis during the pandemic.

There is a considerable number of papers devoted to the issue of the impact of the money supply on inflation, which, however, do not cover the pandemic and post-pandemic periods: Altinisik, E.O., Yucememis, B.T. Published paper in 2023 but data cover before 2020 [1, p.77], the same concern to the paper [4], Doan Van, D. published the paper in 2020 and research data are also collected in the period of 2012-2016 [6, p.122]. Other papers are studying these processes in different country of Asia, Africa, Europe: Raad Nida researched the effect of the Mass of Money Supply during the Period 2020-2022 but for the Iraqi Dinar [13, p.1], Ayad Hicham (2020) [3, p.30] and authors of paper [12, p.24] researched in Africa, Wasanthi

Madurapperuma study money supply, inflation and economic growth of Sri Lanka [15, p.229].

The authors [4] theoretically justify their use through an extension of Ball's (1992) model. These frequency approaches have two advantages: they provide the analyzes for different frequency horizons and do not impose restrictions on the data. We use another methods in this paper.

Altinisik, E.O., Yucememis, B.T specifically investigates the practices of selected country central banks regarding monetary policy, with a focus on understanding the relationship between money supply and inflation. The objective of this study is to unveil the impacts of fiscal policy on US economy [4, p.225]

Antonio Focacci (2024) found that money growth does not exert the decisive spillover effect on the path of inflation (i.e. common shock) throughout our sample [2, p.575]. Moreover, our results indicate that the idiosyncratic component does not show a predominant and determining role of monetary growth in inflationary dynamics. The main flaw in these findings is that researchers looked for a direct effect of money supply on inflation and did not take into account the time lag. This led to erroneous conclusions. In our study, we set out to select econometric models that allow us to take this factor into account.

According to the results of Kudar latest study (2024) [8, p.292], the effects of negative and positive changes in money supply on inflation are not symmetric. Moreover, as broad money increases, inflation goes up further. In the light of this information, it is possible to mention an asymmetric relationship between broad money and inflation. But they gathered data during the period of 1989-2018 only. No one has studied the impact of the government's fiscal policy on the growth of the money supply, especially its most liquid part M1, and, as a result, with a certain time lag, on inflation processes, using latest data 2000-2024.

3. Originality/value. The paper adds to the existing literature a few new ways. First, it fills in the lack of studies in economic processes during COVID-19 pandemic, relating the impact of fiscal policy to money supply and inflation, where there are no papers on this important relationship, especially with a modern

econometric study. Second, it tries to shed light on the asymmetric time lag shocks (both positive and negative shocks and changes) between the money supply M1 and inflation, which was not done in previous studies.

4. The goal and objectives. The **goal of this research** is to examine the impact of the sharp increase in M1 in the United States in 2020 on inflationary developments and compare this experience with the policies of other countries. Specifically, the study seeks to identify causal links between M1 growth and inflation and assess whether the U.S. could have avoided a similar scenario by employing alternative approaches.

Research objectives:

- Analyze the scale and causes of the M1 increase in the U.S. in 2020.
- Establish the relationship between M1 growth and inflation in 2021–2024.
- Provide recommendations for designing balanced crisis-management policies in the future.

5. Methods and Data sources. The comparative component of the study involved analyzing policy measures adopted by the United States, the European Union, Japan, and China. We examined differences in their fiscal and monetary responses to the COVID-19 pandemic and assessed the varying inflationary outcomes. By juxtaposing these approaches, we aimed to identify the factors that contributed to divergent inflation trajectories across these economies.

The data for the analysis was drawn from multiple authoritative sources from 2000 till 2024 years, including statistical reports from the Federal Reserve System, the U.S. Bureau of Labor Statistics, the European Central Bank. Additional insights were gained from reports by international organizations like the International Monetary Fund and the World Bank, as well as academic studies focusing on the relationship between monetary policy and inflation.

This integrated methodology, combining stationarity testing, dynamic econometric modeling, and comparative analysis, allowed us to rigorously evaluate the causality between M1 growth and inflation in the U.S. while situating these

findings within a broader global context. The results provide valuable insights into the effectiveness and potential drawbacks of various crisis-management strategies.

For this analysis, we utilized a combination of statistical and econometric approaches to examine the relationship between the sharp increase in M1 and inflation in the United States using Gretl software.

6. Methodology and Empirical Results. 6.1 Augmented Dickey-Fuller test. To verify the stationarity of the time series data, including Money supply M1 and inflation rates, we employed the **Augmented Dickey-Fuller (ADF) test**. This step ensured that the data met the necessary prerequisites for econometric modeling, such as the absence of unit roots, which could otherwise bias the results.

An analysis of the stationarity of inflation rates for 2000-2024 years with constant, linear and quadratic trend showed that asymptotic p-value 0.02944 and this variable is stationary. However, Augmented Dickey-Fuller test for the independent variable money supply M1 with constant, linear and quadratic trend including 6 lags of (1-L)M1 showed a completely different result: we got the model: (1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e and asymptotic p-value 0.6645, which is evidence of the non-stationarity of these data, and therefore the impossibility of using standard econometric methods.

In this situation, we concluded that it is necessary to use models that are resistant to non-stationarity (Cointegration and error correction models). The first step in this approach is to check for cointegration: if the dependent variable and the non-stationary variable have a common long-term trend (i.e. they are cointegrated), error correction models (ECM) can be used.

First, we have to check if our non-stationary variables are cointegrated and used the Engle-Granger test. The Engle-Granger test involves a two-step procedure: estimate the long-run equation via Long-Run Regression and check the stationarity of the residuals of this equation.

6.2 Long-Run Regression model. The main idea is that if two or more variables share a common long-term trend, their linear combination may be stationary, and

this relationship can be captured through an ordinary least squares (OLS) regression.

Let we have two economic variables: inflation rate Y_t and money supply M1 X_t. Money supply M1 is non-stationary, possibly because they have a trend and are integrated of order one ($I(1)$) — meaning they become stationary after differencing once.

We hypothesized about **Potential Cointegration**: if inflation rate Y_t and money supply M1 X_t are linked by a long-run equilibrium relationship, then there exists a linear combination:

$$u_t = Y_t - \beta_0 - \beta_1 X_t \,, \tag{1}$$

that is stationary ($I(0)$). Here, β_0 and β_1 describe the long-term relationship between the variables.

Long-Run Regression: To find β_0 and β_1 , we estimated a simple OLS regression:

$$Y_t = \beta_0 + \beta_1 X_t + \epsilon_t \,, \tag{2}$$

Although the variables may be non-stationary individually, if they are cointegrated, OLS will provide consistent estimates of the long-run parameters β_0 and β_1 converge to the true long-run parameters as the sample size increases. In other words, OLS is a reliable method for finding the long-term equilibrium relationship. While running OLS on non-stationary variables is generally problematic, it is justified in the context of cointegration because it provides meaningful long-run estimates. The results of calculations in Gretl software is shown in the Table 1.

6.3 The Engle-Granger test. After estimating the model (2), we obtained the residuals, calculated expression (1). The next step is t**esting for Stationarity of the Residuals**: If the residuals are stationary, this implies that inflation rate Y_t and money supply M1 X_t are cointegrated. We used ADF test for the residuals with constant, linear and quadratic trend including 3 lags of (1-L)u_t and got the model:

(1-L)y = b0 + b1*t + b2*t^2 + (a-1)*y(-1) + ... + e (3)

that shown asymptotic p-value 0.009269. Now we proved the error correction models (ECM) can be used. Once cointegration is confirmed, we can formulate an ECM that explains how the variables adjust in the short run to maintain their long-run equilibrium relationship.

Table 1

OLS, using observations 2001-2024 (T = 24)

Dependent variable: Inflation

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	4.13190	1.29198	3.198	0.0043	**
Debt	−0.03170	0.016050	−1.975	0.0615	*
Money supply M1	0	0	3.718	0.0013	**

Mean dependent var	2.512375	S.D. dependent var	1.625493
Sum squared resid	35.61886	S.E. of regression	1.302358
R-squared	0.413886	Adjusted R-squared	0.358066
F(2, 21)	7.414614	P-value(F)	0.003663
Log-likelihood	−38.79238	Akaike criterion	83.58476
Schwarz criterion	87.11893	Hannan-Quinn	84.52238
rho	−0.137097	Durbin-Watson	2.129228

Source(s): Author calculation, using Gretl software, 2024

6.4 Short-run dynamics: Error Correction Model. To investigate the influence of money supply M1 growth on inflation, we constructed an **Error Correction Model (ECM)**. This modeling technique allowed us to distinguish between short-term dynamics and long-term equilibrium relationships, providing a comprehensive understanding of how changes in M1 impacted inflation over different time horizons. The ECM also enabled us to account for potential lags in the relationship, reflecting the delayed effects of monetary changes on price levels.

Error Correction Model can be present as:

$$\Delta Y_t=\alpha_0+\alpha_1\Delta X_t+\alpha_2\Delta X_{t-1}+\lambda u_{t-1}+\epsilon_t\ , \quad (4)$$

ΔY_t: dependent variable (inflation rate) in the differences.

ΔX_t: independent variable (money supply M1) in the differences.

ΔX_{t-1} - shows time lag of influence of money supply M1 in the differences

u_{t-1}: lagged residual from the long-run equation (Error Correction Term).

λ: error correction coefficient. Negative value expected (if *Y* returns to equilibrium).

The results of **Error Correction Model** calculations in Gretl software is shown in the Table 2.

7. Analysis and Key Findings. The error correction model (ECM) aims to capture both the short-term fluctuations and the speed at which the system returns to its long-run equilibrium relationship. In this study, the dependent variable is the first difference of inflation (d_Inflation), while the independent variables include the first difference of M1 money supply (d_M1), its lagged or additional differenced term (d_d_M1), and the error correction term from the long-run equation (uhat2_1).

7.1**Dependent variable interpretations**

- **d_M1 (current changes in M1)**

The coefficient for d_M1 is positive and statistically significant (t-ratio ≈ 2.60, p=0.0181). This suggests that in the short run, an increase in M1 immediately exerts an upward pressure on inflation. In other words, when M1 grows abruptly within the same period, it tends to elevate inflation rates. While the exact magnitude (displayed as “0” due to the formatting in the table) is small, the significance indicates that current money supply expansions do influence short-term inflation dynamics positively.

- **uhat2_1 (Error Correction Term, lagged residual):**

The error correction term, uhat2-1, is highly significant (p=0.0004) and negative (−0.8657). This negative and relatively large magnitude (close to −1) indicates that if inflation and M1 deviate from their long-run equilibrium relationship, a substantial portion—approximately 86.5%—of the disequilibrium is corrected in one period. In practical terms, if inflation is temporarily higher or lower than what the long-run relationship with M1 would predict, the inflation rate adjusts rapidly back toward that equilibrium. The strong statistical significance underscores

that the long-run equilibrium exerts a powerful corrective force on short-run inflationary movements.

Table 2

Short-run dynamics (ECM), using observations 2003-2024 (T = 22)

Dependent variable: d_Inflation

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−0.066713	0.221159	−0.3017	0.7664	
d_M1	0	0	2.601	0.0181	**
uhat2_1	−0.865655	0.200204	−4.324	0.0004	**
d_d_M1	−0.000756	0.0002106	−3.590	0.0021	**

Mean dependent var	−0.014409	S.D. dependent var	1.878886
Sum squared resid	16.85492	S.E. of regression	0.967670
R-squared	0.772644	Adjusted R-squared	0.734751
F(3, 18)	20.39031	P-value(F)	5.10e-06
Log-likelihood	−28.28625	Akaike criterion	64.57250
Schwarz criterion	68.93667	Hannan-Quinn	65.60057
rho	−0.206324	Durbin-Watson	2.295053

Source(s): Author calculation, using Gretl software, 2024

d_d_M1 (changes in the differenced M1):

The variable d_d_M1 is negative (−0.000756) and statistically significant (p=0.0021). Interpreting d_d_M1 requires understanding what this term represents. It appears to be a second-level difference or a lagged difference term that captures more complex dynamics of how M1 growth impacts inflation after the initial period. The negative sign suggests that once the initial positive effect of increasing M1 has been realized (captured by d_M1), subsequent adjustments or continuing increments in M1 do not simply push inflation further upward. Instead, these additional or lagged changes may dampen the previously induced inflationary pressure, potentially reflecting market adjustments, delayed reactions, or policy countermeasures. This complex interplay indicates that while immediate increases in M1 raise inflation, continuous or sequential increments in the short run may produce diminishing or even corrective effects on inflationary trends.

7.2 Model Quality Indicators. The R-squared (0.7726) is quite high for an ECM in macroeconomic data, suggesting that the variables included explain about 77% of the short-run variance in inflation changes. The Durbin-Watson statistic (2.295) near 2 indicates no severe autocorrelation of the residuals, which supports the reliability of the model's inferences.

The strongly negative and significant error correction term indicates that any short-term deviations from the long-run inflation–M1 equilibrium are rapidly corrected. This means the economy does not remain persistently off-balance; rather, inflation reacts quickly to move back toward its equilibrium path.

Model shows complex lagged dynamics: The negative coefficient for d_d_M1 suggests that after the initial inflationary impact of M1 growth, further changes in M1 do not perpetually inflate prices. Instead, additional increments may have a stabilizing or countervailing influence, indicating the presence of more intricate dynamics—perhaps due to expectations, central bank policies, or other market adjustments that mitigate ongoing inflationary pressures over time.

8. Overall Interpretation. The ECM results show a nuanced short-run relationship between M1 and inflation. Increases in M1 in the current period significantly raise short-term inflation, reinforcing the notion that sudden liquidity injections can be inflationary in the short run.

The graph in Fig. 1 clearly shows the different ways to combat the financial and economic crisis. During the 2008 crisis, we do not see an increase in the money supply M1, instead the government only increased its public debt to maintain its fiscal policy. Already in 2020, the US government contributed to the increase in public debt in a number of actions that led to a rapid increase in the money supply M1.

In 2020, the U.S. government implemented a series of unprecedented fiscal measures in response to the economic crisis caused by the COVID-19 pandemic. These actions, coupled with the Federal Reserve's monetary policies, led to a rapid increase in the M1 money supply. Below are the key actions taken by the government:

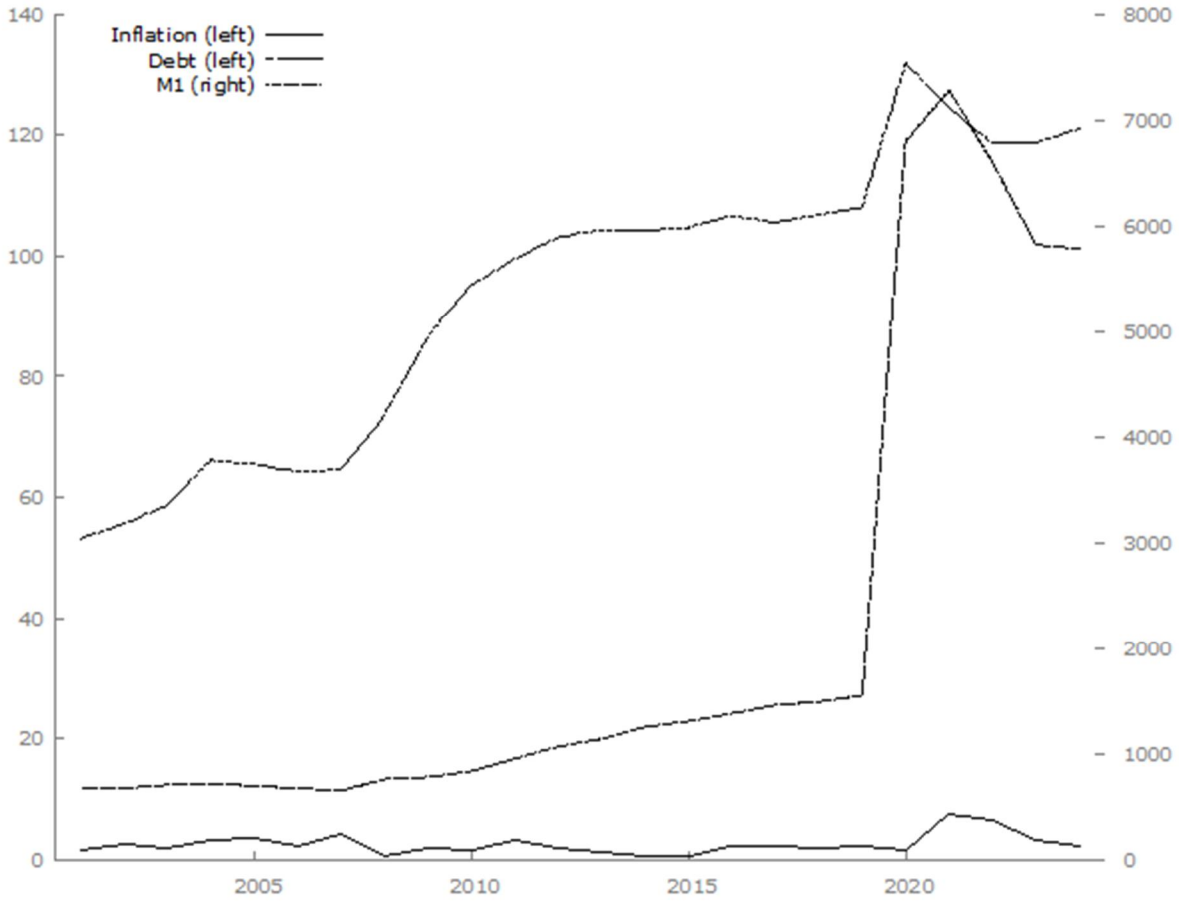

Figure 1 – Inflation, Debt and Money supply in USA for 2000-2024 years

Source(s): National Statistics Office, Latest actual data; BEA and IMF's Government Finance Statistics Yearbook.

8**.1 Direct Stimulus Payments to Households.** The U.S. government issued direct payments to individuals and families as part of the **CARES Act** and subsequent relief packages. These payments included: **Economic Impact Payments** of $1,200 per adult (plus additional amounts for dependents) and **Expanded Unemployment Benefits**, including a $600 weekly federal supplement and extended eligibility periods. These funds were deposited directly into checking accounts, which are a core component of M1.

8.2 Paycheck Protection Program (PPP). The government introduced the **Paycheck Protection Program** to provide forgivable loans to small businesses. These loans were intended to cover payroll and other essential expenses, effectively keeping employees on payroll and injecting funds directly into the economy. When

these funds were paid out as wages, they increased the M1 supply via deposits into employees' checking accounts.

8.3 Increased Government Spending. Massive government spending, financed through the issuance of Treasury securities, injected trillions of dollars into the economy. A significant portion of this spending entered the financial system as deposits in checking accounts, further boosting M1

Thus, the actions of the US government during the Trump presidency led to a rapid four-fold increase in the M1 money supply, an increase in public debt, which with some delay caused an increase in inflation. And only the measures of the next president to reduce the money supply and public debt helped restore balance in the economy.

9. Conclusions. The analysis of the relationship between the M1 money supply and inflation, particularly during times of economic crises, highlights the complex interplay between fiscal and monetary policy. The findings provide valuable insights into how policy responses to crises influence short-term and long-term economic dynamics.

Short-Term Inflationary Effects of M1 Growth: The Error Correction Mechanism (ECM) results reveal that rapid increases in M1 significantly raise inflation in the short term. This reinforces the principle that sudden liquidity injections, like those observed in 2020, can exert inflationary pressures, albeit with diminishing effects over time due to the presence of stabilizing mechanisms.

Comparison of Policy Responses in 2008 and 2020: A clear distinction emerges between the responses to the 2008 financial crisis and the COVID-19 pandemic. In 2008, the government primarily relied on increasing public debt without expanding the M1 money supply, reflecting a more conservative fiscal approach focused on debt-financed fiscal policy. Conversely, in 2020, the U.S. government combined an increase in public debt with direct liquidity injections into the economy, resulting in a four-fold increase in the M1 money supply. These actions underscored the unprecedented scale and immediacy of the response to the COVID-19 crisis.

Role of Fiscal and Monetary Measures in 2020: The U.S. government's fiscal actions, including direct stimulus payments, the Paycheck Protection Program, and increased public spending, significantly contributed to the rapid growth of M1. These measures provided immediate relief to households and businesses but also set the stage for inflationary pressures in subsequent periods.

Inflationary Lag and Subsequent Stabilization: The increase in inflation following the surge in M1 highlights the lagged effect of such interventions. While these policies were instrumental in addressing the immediate economic fallout, their inflationary consequences became evident with a delay. Measures taken under subsequent administrations to reduce the money supply and public debt were crucial in restoring economic balance and curbing inflation.

Long-Run Dynamics and Equilibrium: The significant and strongly negative error correction term indicates that the economy has a self-correcting mechanism that prevents persistent deviations from the inflation-M1 equilibrium. This underscores the importance of well-coordinated fiscal and monetary policies to ensure that short-term measures do not destabilize long-term economic fundamentals.

Policy Implications: The study emphasizes the importance of a balanced approach in crisis management. While liquidity injections and fiscal stimulus are effective tools for addressing immediate challenges, their long-term implications for inflation and debt sustainability must be carefully managed.

In conclusion, the findings highlight the intricate dynamics between money supply, inflation, and fiscal policy. They underscore the necessity for adaptive and forward-looking economic strategies to navigate crises while maintaining long-term economic stability. The contrasting approaches of 2008 and 2020 provide a valuable framework for policymakers to evaluate and refine their responses to future economic challenges.

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