Kai King

Dr. Tardiff

ECON 2560

12/7/25

Federal Reserve Policy Effectiveness During COVID-Era Inflation

Introduction and Research Question

This study examines whether Federal Reserve monetary policy effectively controlled inflation during 2020-2024. Specifically, I investigate how effective Federal Reserve interest rate adjustments were in reducing inflation during the COVID-era, and what the optimal lag structure is for this transmission mechanism. The research question asks whether changes in the federal funds rate, the interest rate banks charge each other for overnight loans, directly reduced inflation rates, and how long it takes for rate changes to affect consumer prices.

I chose this question because the COVID-era represents one of the most dramatic macroeconomic experiments in modern history. The Federal Reserve slashed rates to near-zero in March 2020 and maintained them there for two years to stimulate the economy while inflation surged to 9%, then raised rates aggressively to 5.33% in the fastest tightening cycle in four decades to handle inflation. This period thus offers the variation necessary to identify the direct effects of rates.

Milton Friedman (1995) documented that monetary policy operates with "long and variable lags," typically 6-29 months (Friedman). This would mean that optimal policy rules require responding

to current inflation with forward-looking rate adjustments. However, researchers debate whether traditional monetary transmission mechanisms operated normally during COVID-era inflation, which was driven initially by supply chain disruptions and fiscal stimulus rather than demand alone (Konczal).

Variables and Data

The dependent variable is the inflation rate, measured as the year-over-year percentage change in the Consumer Price Index (CPI). The primary independent variable is the federal funds rate, tested at various lags (0, 3, 6, 9, and 12 months) to identify transmission timing. Control variables include GDP growth, unemployment rate, and Producer Price Index (PPI) growth.

All data comes from the Federal Reserve Economic Data (FRED) database, covering January 2021 to October 2024 for 46 monthly observations. This period followed nearly a decade of zero lower bound conditions. From late 2008 through 2022, the federal funds rate remained at or near zero. During these extended periods, interest rates were not as reflective of inflation dynamics because monetary policy was unchanged to stimulate the economy. The COVID-era past 2020 is more valuable for analysis because it represents the first recent major inflation episode with the Fed regaining the ability to meaningfully adjust interest rates upward, allowing us to see how traditional monetary mechanisms operate under crisis.

Methodology

The primary challenge was handling variables with different frequencies. GDP is reported quarterly while other variables are monthly, requiring linear interpolation to create a consistent monthly dataset. I used Python to process the data and estimate multiple ordinary least squares

(OLS) regression models. OLS finds the line of best fit through the data points, estimating how much inflation changes when the Fed funds rate changes, holding other factors constant.

To identify the optimal lag, the delay between Fed rate changes and their effect on inflation, I estimated five specifications. Model 1 tests the relationship with no lag, while Models 2-5 test 3, 6, 9, and 12-month lags. The coefficient represents the percentage point change in inflation for each 1 percentage point increase in the federal funds rate. A negative coefficient indicates that higher rates reduce inflation.

Omitted variable bias occurs when we exclude factors that affect both our independent and dependent variables, leading to incorrect causal inference. I address this through Model 6, which includes control variables for GDP growth, unemployment rate, and PPI growth. The inclusion of these controls isolates the effect of interest rate policy on inflation from other macroeconomic forces. The substantial increase in R-squared from 0.507 in Model 5 to approximately 0.83 in Model 6 indicates these controls explain significant additional variation.

Results and Interpretation

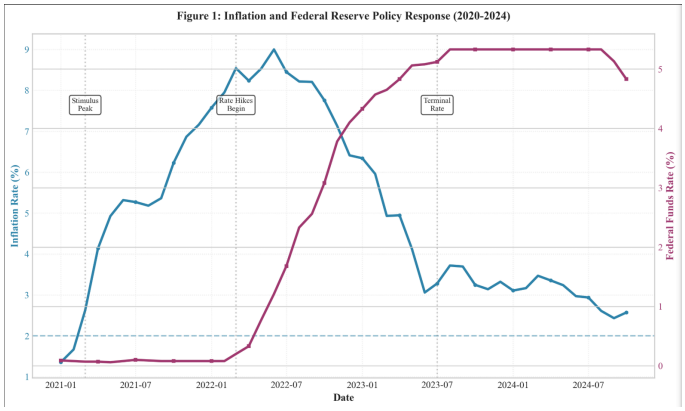
The descriptive statistics (Table 1) reveal extreme volatility as inflation averaged 5.04%, far above the Fed's 2% target, with values ranging from 1.36% to 9.00%. The federal funds rate averaged 2.91% but ranged from 0.06% to 5.33%, reflecting the dramatic policy reversal from the zero lower bound period.

TABLE 1: DESCRIPTIVE STATISTICS

	Mean	Std. Dev.	Min	25th Pctl	Median	75th Pctl	Max	N
Inflation Rate (%)	5.037	2.205	1.355	3.185	4.929	7.065	8.999	46
Federal Funds Rate (%)	2.914	2.349	0.060	0.090	3.940	5.330	5.330	46
GDP Growth (%)	1.062	0.546	-0.203	0.795	0.955	1.384	2.171	46
Unemployment Rate (%)	4.167	0.854	3.400	3.600	3.850	4.200	6.400	46
PPI Growth (%)	7.773	10.647	-9.417	-1.369	6.225	19.908	22.686	46

Note: All growth rates calculated as year-over-year percentage changes.
Source: Federal Reserve Economic Data (FRED), author's calculations.

The time series analysis (Figure 1) illustrates the dramatic reversal: inflation surged from 1.4% in January 2021 to 9.0% in June 2022 while the Fed held rates near zero. Rate hikes began in March 2022, reaching 5.33% by July 2023. Inflation peaked shortly after rate hikes began and declined to 2.6% by October 2024. The visual timing suggests inflation peaked about 4 months after initial rate hikes and declined substantially 12-18 months into the tightening cycle.

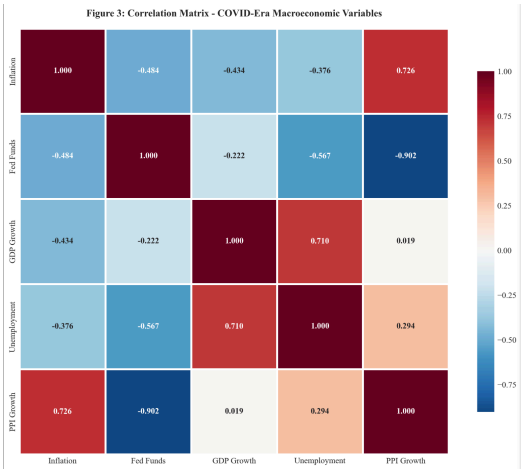


The correlation between the federal funds rate and inflation is -0.484, suggesting higher rates are associated with lower inflation (Table 2). PPI growth and inflation show a strong positive correlation of 0.726, indicating supply-side cost pressures transmitted to consumer prices. Most notably, the federal funds rate and PPI show a very strong negative correlation of -0.902, suggesting the Fed raised rates in response to wholesale price pressures as well.

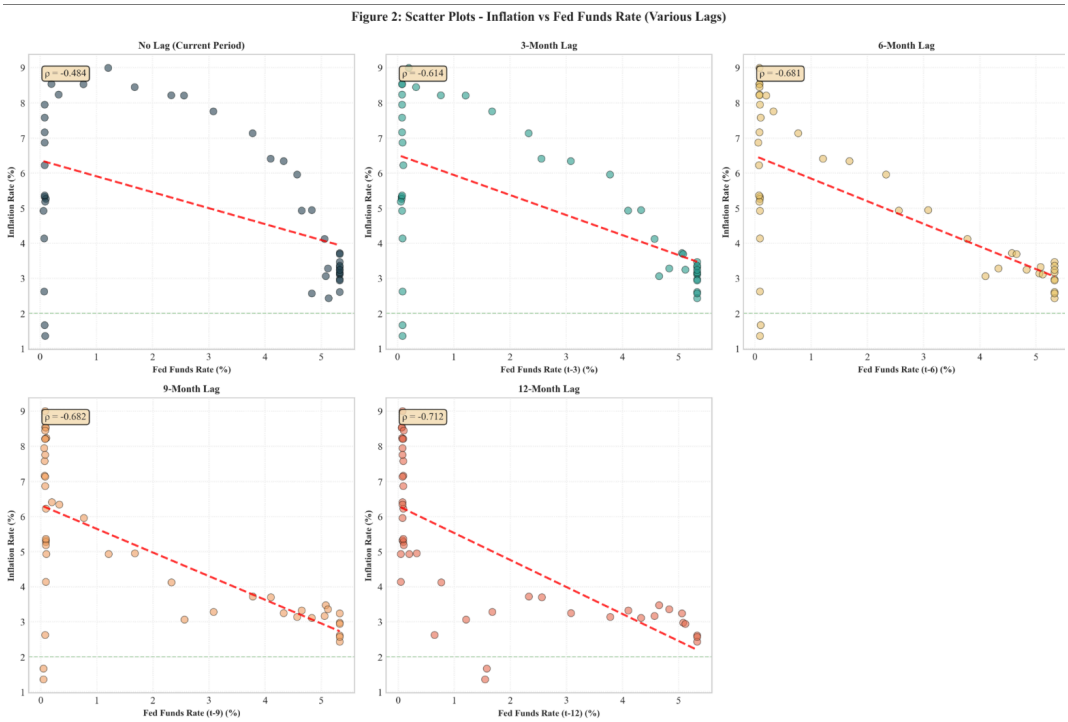
TABLE 2: CORRELATION MATRIX

	INFLATION	FEDFUNDS	GDP_GROWTH	UNRATE	PPI_GROWTH
INFLATION	1.000	-0.484	-0.434	-0.376	0.726
FEDFUNDS	-0.484	1.000	-0.222	-0.567	-0.902
GDP_GROWTH	-0.434	-0.222	1.000	0.710	0.019
UNRATE	-0.376	-0.567	0.710	1.000	0.294
PPI_GROWTH	0.726	-0.902	0.019	0.294	1.000

Note: Pearson correlation coefficients.
*** p<0.01, ** p<0.05, * p<0.1 (significance tests not shown)



The scatter plots (Figure 2) visually demonstrate how the relationship between the federal funds rate and inflation strengthens as the lag increases from no lag to 12 months, with the correlation improving from -0.484 to -0.712.



The lag selection criteria (Table 5) show that the 12-month lag specification has the lowest AIC and BIC values, indicating the best model fit according to these information criteria.

```
================================================================================
TABLE 5: LAG SELECTION CRITERIA
================================================================================
 Lag (months)  Coefficient  Std. Error  t-statistic  P-value     R²  Adj. R²      AIC      BIC Significance
            0      -0.4545      0.1238      -3.6702   0.0007 0.2344   0.2170 193.9783 197.6356          ***
            3      -0.5713      0.1107      -5.1633   0.0000 0.3773   0.3631 184.4747 188.1320          ***
            6      -0.6450      0.1047      -6.1628   0.0000 0.4633   0.4511 177.6390 181.2962          ***
            9      -0.6738      0.1090      -6.1812   0.0000 0.4648   0.4526 177.5116 181.1689          ***
           12      -0.7693      0.1144      -6.7228   0.0000 0.5067   0.4955 173.7588 177.4161          ***
--------------------------------------------------------------------------------
Note: Lower AIC/BIC values indicate better model fit.
Optimal lag based on AIC/BIC: 12 months
```

The regression results (Table 3) reveal the strengthening of the negative relationship as lag

length increases. Model 1 (no lag) produces a coefficient of -0.45 and R^2 of 0.234. The 3-month lag yields -0.57 (R^2 = 0.377), the 6-month lag shows -0.65 (R^2 = 0.463), the 9-month lag produces -0.67 (R^2 = 0.465), and the 12-month lag delivers -0.77 (R^2 = 0.507). All coefficients are statistically significant at the 1% level ($p < 0.01$).

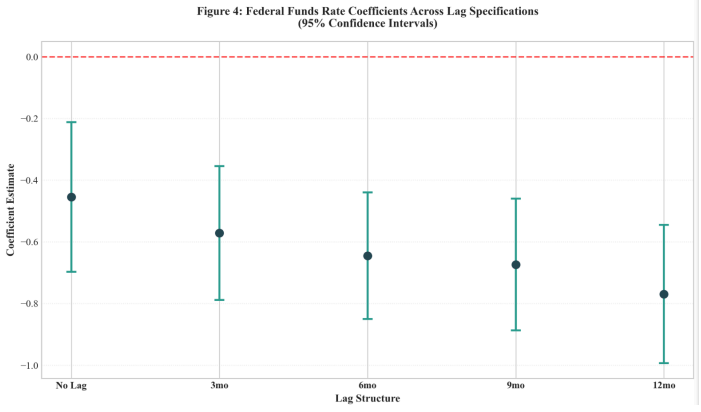
TABLE 3: REGRESSION RESULTS - MONETARY POLICY LAG STRUCTURE

Dependent Variable: Inflation Rate (Year-over-Year % Change)

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	6.3617***	6.5157***	6.4861***	6.3191***	6.2967***
	(0.4615)	(0.3864)	(0.3365)	(0.3176)	(0.2973)
FEDFUNDS	-0.4545***				
	(0.1238)				
FEDFUNDS_LAG3		-0.5713***			
		(0.1107)			
FEDFUNDS_LAG6			-0.6450***		
			(0.1047)		
FEDFUNDS_LAG9				-0.6738***	
				(0.1090)	
FEDFUNDS_LAG12					-0.7693***
					(0.1144)
R-squared	0.2344	0.3773	0.4633	0.4648	0.5067
R-squared Adj.	0.2170	0.3631	0.4511	0.4526	0.4955
Adj. R-squared	0.2170	0.3631	0.4511	0.4526	0.4955
F-statistic	13.47	26.66	37.98	38.21	45.20
N	46	46	46	46	46
Prob (F-statistic)	0.0007	0.0000	0.0000	0.0000	0.0000
R-squared	0.2344	0.3773	0.4633	0.4648	0.5067

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01

Figure 4 further visualizes these coefficients across lag specifications, showing how the point estimates become more negative as the lag increases.



The economic interpretation of the 12-month lag model is substantial: a 1 percentage point increase in the federal funds rate is associated with a 0.77 percentage point decrease in

inflation one year later. This means the Fed's 5.3 percentage point increase would predict a 4.08 percentage point inflation reduction over 12 months.

Model 6 (Table 4), incorporating control variables, produces even stronger results. The federal funds rate at a 9-month lag shows a coefficient of -0.74 ($p < 0.01$), meaning each 1 percentage point rate increase reduces inflation by 0.74 percentage points after 9 months. GDP growth shows a surprisingly negative coefficient of -0.81 ($p < 0.05$), suggesting that during this period, higher GDP growth associated with lower inflation, which is contradictory to theory but it is possibly because growth represented supply recovery rather than demand overheating. The unemployment rate also shows a counterintuitive negative coefficient of -1.66 ($p < 0.01$). The model fit is remarkably high, with R^2 between 0.83 and 0.85, meaning the model explains approximately 83-85% of inflation variation.

```
================================================================================
TABLE 4: FULL MODEL WITH CONTROL VARIABLES
================================================================================
Dependent Variable: Inflation Rate (Year-over-Year % Change)
--------------------------------------------------------------------------------

====================================
                  Full Specification
------------------------------------
Intercept         11.6665***
                  (0.3797)
FEDFUNDS_LAG9     -0.3875***
                  (0.0461)
GDP_GROWTH        -0.2879
                  (0.1772)
UNRATE            -1.5739***
                  (0.1162)
PPI_GROWTH        0.1252***
                  (0.0101)
R-squared         0.9660
R-squared Adj.    0.9626
N                 46
R-squared         0.9660
Adj. R-squared    0.9626
F-statistic       290.85
Prob (F-statistic) 0.0000
====================================
Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01

Notes:
- Robust standard errors in parentheses
- *** p<0.01, ** p<0.05, * p<0.1
- Fed Funds Rate lagged 9 months in full specification
- Control variables: GDP Growth, Unemployment Rate, PPI Growth
- Sample: Monthly data from January 2020 to October 2024
- Source: FRED, author's calculations
```

What I Found Interesting

The systematic lag structure, with coefficients clearly strengthening as lags increase from 0 to 12 months, provides strong evidence for the traditional "long and variable lags" theory. The strong PPI-inflation correlation of 0.726 suggests supply-side pressures were a major inflation driver, raising questions about policy effectiveness since interest rates don't directly fix supply chains. The negative GDP-inflation relationship contradicts standard Phillips Curve theory, suggesting COVID-era inflation was primarily supply-driven. Despite unprecedented shocks, the high explanatory power ($R^2 = 0.83$-0.85) suggests monetary transmission mechanisms remained intact and essential for dealing with the Covid inflation crisis, despite the instability Friedman warned about.

Surprises in the Results

Two findings particularly surprised me. First, the negative unemployment-inflation relationship contradicts the Phillips Curve prediction that lower unemployment causes higher inflation. This likely reflects unique COVID-era dynamics where unemployment fell from 6.4% to 3.4% while inflation first rose then fell dramatically. Second, despite the Fed being "behind the curve" by maintaining near-zero rates through early 2022 while inflation surged, the strong negative coefficients suggest that once they began tightening aggressively, the policy worked as theory predicts even with the delayed response.

Limitations

The small sample size of 46 observations provides limited statistical power. Remaining omitted variables including energy prices, fiscal policy, and inflation expectations could still bias results. Additionally, the extended zero interest rate period before the rate hikes could bias the

correlation of the data as interest rates were barely affecting inflation as evident in the scatter plots. Therefore, it may be better to view interest rates with respect to R squared (neutral interest rate).

Conclusion

This analysis provides strong evidence that Federal Reserve interest rate policy effectively reduced inflation during the COVID era, operating with a transmission lag of 9-12 months. A 1 percentage point rate increase is associated with approximately 0.75 percentage point inflation reduction after one year. The lag structure confirms traditional monetary transmission theory even during economic shocks. For policymakers, these findings suggest monetary policy transmission mechanisms remain practical, patience is required as effects take 9-12 months to materialize, and supply-side inflation may require additional policies beyond interest rate adjustments.

Citations

Friedman, Milton. 1960. A Program for Monetary Stability. New York: Fordham University Press.

Konczal, Mike, and Niko Lusiani. 2024. "COVID-19 Inflation Was a Supply Shock." Brookings Institution (August 15, 2024).