Effect of Federal Funds Rate on CPI and PPI

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One of the crucial jobs of central banks is to rein in inflation as it creates uncertainty in the economy and in private investment and ultimately negatively impacts the economy. If the source of inflation is positive demand shock, then raising the federal funds rate target is the right way to rein in inflation. If the source of inflation is negative supply shock, then raising the federal funds rate target will make things worse. In this study, the impact of FFR (federal funds rate) on CPI (consumer price index) and producer price index (PPI) is examined. Findings indicate that raising the federal funds rate will have a negative impact on both CPI and PPI with a 2-period lag. The possible explanation of this finding is that raising federal funds rate lowers aggregate demand, lowers the price level and thereby the CPI. And when CPI falls, it lowers per-unit profit, prompting producers to cut supply, which in turn lowers the demand for producer goods and services, and thereby lowers PPI.

Keywords: FFR, CPI, PPI, VAR

INTRODUCTION

One of the crucial jobs of central banks is to rein in inflation as it creates uncertainty in the economy, hurts private investment and ultimately negatively impacts the economy. However, it is equally important that the actual source of inflation be identified. If the source of inflation is positive demand shock, then raising the federal funds rate target is the right way to rein in inflation. But if the source of inflation is negative supply shock, then raising the federal funds rate target will make things worse as it will raise the cost of investment, thereby negatively impacting the supply and causing the price level to rise, making inflation even worse. This study examines the impact of FFR (federal funds rate) on CPI (consumer price index) and producer price index (PPI). If FFR is found to have a negative and statistically significant effect on CPI, then we can conclude that source of inflation is a positive demand shock and, therefore, raising the federal funds rate is the right way to rein in inflation. But if FFR is found to have a positive and statistically significant effect on PPI, then raising FFR will make inflation even worse rather than reining it in.

Cecchetti (1995) argues that, since the relationship of candidate inflation indicators to inflation is neither very strong nor very stable, the relationship between monetary policy instruments, such as the federal funds rate, and inflation also varies substantially over time and cannot be estimated precisely. So, he suggests that federal funds rate be raised immediately following a shock and should not wait for prices to rise before acting, because prices take time to respond to all types of impulses.

Steindel et al (2005) argue that a single indicator of inflation used in isolation has very limited predictive power and, therefore, suggest that policy makers look at more than one indicator.

Williams (2012) claims that despite the textbook monetary theory that holds that increasing the money supply leads to higher inflation, the period after 2008 until 2012 has seen inflation pressures remain subdued although the Federal Reserve tripled the monetary base during this period. He concludes that is because the Fed used the increased monetary base (reserves) to purchase long-term treasury assets, which increased the demand for those assets, increasing their prices and thereby lowering long-term interest rates.

Romer and Romer (2000) reported that federal funds rate increases may raise expected inflation by revealing the Federal Reserve's private information about inflation.

Thorbecke and Zhang (2009) find that funds rate hikes in the 1970s raised gold and silver prices and that increases after 1989 lowered gold and silver prices.

A study by Anari and Kolari (2016) on US data and several other advanced economies supports both Fisher's theory that rise in inflation rate raises the interest rate and Wicksell's theory that a rise in interest rate lowers the inflation rate.

Mishkin (1992) finds no empirical evidence supporting a short-run Fisher effect but does find the evidence supporting a long-run effect. In other words, he finds that a rise (fall) in inflation rate raises (lowers) in interest rate only in the long run but not in the short run.

Thornton (2014) argues that money is essential for monetary policy because it is essential for controlling the price level. He also argues that the Fed's ability to control interest rates is limited and is independent of the demand for money. He found that counter cyclical monetary policy is much less effective.

This study makes a significant contribution to the related literature, because the VECM model of federal funds rate, CPI and PPI is used to examine how these variables interact with each other in both the short run and the long run. Further, recent US data is used, which also covers the period of the pandemic. For these reasons, this study is unique since no similar model has been found in the literature.

The model is developed in section 2, data sources are presented in section 3, analysis and findings are presented in section 4, and the findings are summarized in section 5.

THE MODEL

When CPI (consumer price index), a measure of inflation, rises due to positive demand shock, the Federal Reserve (the Fed) raises the federal funds rate to combat the inflation. So, FFR is a function of CPI. On the other hand, when the federal funds rate is raised it raises the market interest rate causing a decline in aggregate demand, which lowers prices and ultimately the CPI. Thus, CPI is a function of FFR. Further, when aggregate demand falls as a consequence of the increase in FFR by the Fed, the demand for producer goods and services falls resulting in the decline in PPI. In this sense, PPI is a function of FFR. Again, when prices of producer goods or services rise due a negative supply shock, the PPI rises. This rise in PPI is later passed on to consumers which raises the CPI. Thus, CPI is a function of PPI. Such an interconnection among CPI, PPI, and FFR can be modeled as a VAR (vector autoregressive model). So, the following structural VAR with 3 variables and two lags is proposed, as following:

$$CPI_t = a_0 + a_1 CPI_{t-1} + a_2 CPI_{t-2} + a_3 PPI_{t-1} + a_4 PPI_{t-2} + a_5 FFR_{t-1} + a_6 FFR_{t-2} \quad (1)$$

$$PPI_t = b_0 + b_1 PPI_{t-1} + b_2 PPI_{t-2} + b_3 CPI_{t-1} + b_4 CPI_{t-2} + b_5 FFR_{t-1} + b_6 FFR_{t-2} \quad (2)$$

$$FFR_t = c_0 + c_1 FFR_{t-1} + c_2 FFR_{t-2} + c_3 CPI_{t-1} + c_4 CPI_{t-2} + c_5 PPI_{t-1} + c_6 PPI_{t-2} \quad (3)$$

In equations (1), (2), and (3) a_i, b_i, and c_i are constants. EViews version 12 software is used to perform the calculations on a Windows-based personal computer.

DATA

The data on FFR (federal funds rate) has been obtained from FRED: (FFR) Economic Data: St. Louis Fed: (https://fred.stlouisfed.org/series/FEDFUNDS), on CPI (consumer price index) from Economic Report of the President: https://www.govinfo.gov/content/pkg/ERP-2022/pdf/ERP-2022.pdf and that on PPI (producer price index) from FRED: Economic Data: St. Louis Fed: Producer Price Index: All commodities: https://fred.stlouisfed.org/series/PPIACO. The data used in this study covers the period from 1990 to 2019.

EMPIRICAL ANALYSIS

The long-term and short-term relation between the model variables, CPI, PPI, and FFR is sought. For a set of variables to be in a long-run relation, they all must be stationary or integrated of the same order. So, the Augmented Dickey-Fuller unit-root test was conducted and provided the following results in Table 1.

TABLE 1
SUMMARY OF UNIT-ROOT TEST RESULTS

Variable	t-statistic	Critical Value at 5%	Stationary?
CPI	-0.232202	-2.963972	Non-stationary
d(CPI,2)	-4.409591	-2.967767	Stationary
PPI	0.169222	-2.967767	Non-stationary
d(PPI,2)	-6.314530	-2.971853	Stationary
FFR	-2.209747	-2.977767	Non-stationary
D(FFR,2)	-4.923160	-2.971853	Stationary

Since all variables are found to be integrated of the same order, I(1), a VAR was conducted to determine the appropriate lag length using the cointegration test, Johansen (1990). The results in Table 2 were obtained.

TABLE 2
LAG SELECTION RESULTS

Lag Selection						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-210.9185	NA	2812.278	16.60043	16.60043	16.49707
1	-108.3324	173.6072	2.117201	9.256338	9.836998	9.423547
2	-88.06073	29.62782*	0.919870*	8.389287*	9.405442*	8.681905*

Since five of the six criteria selected the lag length of 2 the Johansen cointegration test was conducted with a lag length of two. The statistics in Table 3 were obtained.

TABLE 3
UNRESTRICTED COINTEGRATION RANK TEST RESULTS

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None	0.546344	27.85104	29.79707	0.0825

The trace statistic of **27.85104** against the hypothesis of no cointegrating vector is less than its 5% critical value of **29.79707**. This result does not reject the hypothesis of no cointegrating vector. That means no long run relation exists among the model variables. So, instead of running a VECM model, a VAR model was used. It generated the following results:

$$CPI_t = \underset{(-0.05)}{-0.11} + \underset{(4.63)}{1.75}CPI_{t-1} \underset{(-1.83)}{-0.66}CPI_{t-2} \underset{(-1.92)}{-0.16}PPI_{t-1} + \underset{(1.19)}{0.09}PPI_{t-2} + \underset{(1.10)}{0.12}FFR_{t-1} \underset{(-2.11)}{-0.23}FFR_{t-2} \quad (4)$$

$$PPI_t = \underset{(-0.91)}{-8.75} \underset{(-0.14)}{-0.06}b_1PPI_{t-1} + \underset{(1.92)}{0.63}PPI_{t-2} + \underset{(1.86)}{3.16}CPI_{t-1} \underset{(-1.63)}{-2.64}CPI_{t-2} + \underset{(1.41)}{0.69}FFR_{t-1} \underset{(-2.46)}{-1.19}FFR_{t-2} \quad (5)$$

$$FFR_t = \underset{(2.32)}{7.26} + \underset{(6.87)}{1.10}FFR_{t-1} \underset{(-4.39)}{-0.69}FFR_{t-2} + \underset{(0.03)}{0.02}CPI_{t-1} \underset{(-0.10)}{-0.05}CPI_{t-2} \underset{(-0.54)}{-0.07}PPI_{t-1} + \underset{(0.37)}{0.04}PPI_{t-2} \quad (6)$$

For this model: R-squared = 0.99834, adjusted R-squared = 0.997865, and the F-statistic = 2104.544.

The figures in the parentheses are the corresponding t-values. The only coefficients that are statistically significant are those associated with FFR_{t-2} in equations (4) and (5). Since those coefficients are negative, it can be concluded that raising federal funds rate has a negative impact on both CPI and PPI with a 2-period lag. The possible explanation of this finding is that raising federal funds rate lowers the aggregate demand, which lowers prices and thereby the CPI. When CPI falls, per-unit profit falls, prompting the producers to decrease supply, which lowers the demand for producer goods and services thereby lowering PPI.

SUMMARY AND CONCLUSIONS

Around the world, one of the crucial jobs of central banks is to rein in inflation as unstable price levels create uncertainty in the economy, hurts private investment, and ultimately negatively impacts the economy. However, if the source of inflation is positive demand shock, then raising the federal funds rate target can rein in inflation. But if the source of inflation is other than a positive demand shock, for example a negative supply shock, then raising the federal funds rate target will raise the cost of investment, thereby negatively impacting supply and cause prices to rise, which means inflation is worsened.

Further, when CPI, a measure of inflation, rises due to positive demand shock, the Fed raises the federal funds rate to combat the inflation. So, FFR is a function of CPI. But when federal funds rate is raised it raises the market interest rate which lowers aggregate demand, lowering prices and ultimately the CPI. Therefore, CPI is a function of FFR. But interestingly, when aggregate demand falls as a consequence of the increase in FFR by the Fed, the demand for producer goods and services falls also resulting in the decline in PPI. In this sense, PPI is a function of FFR. Again, when price of producer good or service rises due a negative supply shock, the PPI rises. This rise in PPI is later passed on to the consumers which raises the CPI. Thus, CPI is a function of PPI. Such a relationship among CPI, PPI, and FFR can be modeled as a VAR (vector autoregressive model).

So, in this study a structural VAR model was estimated with three variables and two lags. The coefficient associated with the independent variable, FFR was found to be negative and statistically significant in the VAR system in which CPI and PPI are dependent variables with a two-period lag. This led to the conclusion that raising the federal funds rate would have a negative impact on both CPI and PPI with a two-period lag. The possible explanation of this finding is that raising the federal funds rate would

lower the aggregate demand, lower the price level and thereby the CPI. When CPI would fall, per-unit profit would fall, prompting the producers to decrease supply, which would lower the demand for producer goods and services and thereby lower PPI. Since it takes time for market agents to respond to any market event, these changes would occur with a time lag.

The major policy implication of this study is that, although raising the federal funds rate to curb inflation by putting a downward pressure on the consumer price index and on the producer price index does seem to have a negative impact on the rate of inflation, but the impact comes only with a two-period (i.e. two-year) lag. In other words, raising the federal funds rate is not an immediate solution to the inflation problem. In other words, the Federal Reserve may need to use other policy instrument to fight the inflation.

This study however has its own limitations as its finding depends on the analysis of U.S. data over the period, 1990-2019. A longer period data, therefore, could produce a different result. Also, this study only examines the effect of one monetary policy instrument. So, future studies may be directed toward examining other monetary policy instruments using a longer-period data to see how those instruments influence the inflation rate in the short run and in the long run.

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