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WELLS FARGO SECURITIES

Economics Group

Special Commentary

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Is the Fed Funds Target Rate Effective?

Is there a relationship between the federal funds target rate, inflation rate and the unemployment rate? Recently, the Federal Open Market Committee (FOMC) began rolling back its asset purchases program and, at some point in the future, the FOMC will start increasing its target for the fed funds rate. This raises the question, what would be the likely effect of an increase in the interest rate on inflation and the unemployment rates in our post-Great Recession world?

Our statistical analysis, using a Granger causality test, found mixed evidence about the relationship between interest rates and the inflation and unemployment rates. That is, during the complete sample period (1971-2013), the fed funds rate was found to Granger-cause the inflation and unemployment rates. However, when narrowing the time period to 1990-2013, the fed funds rate does not produce the same Granger causality on the inflation and unemployment rates.[1] This suggests that the changes in the interest rate may not be the key driver of the inflation and unemployment rates movements and, thereby, the link between policy changes in the fed funds rate and the target variables of inflation and unemployment rates is not as straightforward as previously believed. Moreover, contrary to the conventional wisdom, our statistical analysis indicates that the inflation and unemployment rates do not Granger-cause a movement in the fed funds rate, implying these variables are not statistically useful to predict movements in the fed funds rate.

We also found mixed evidence about the effect of a one percentage point increase in the fed funds rate on inflation and the unemployment rate. When looking at 1971-2013, an increase in the interest rate is associated with a rising inflation rate. The interest rate hike is also associated with a declining unemployment rate. For the 1990-2013 period, an increase in the fed funds rate lead to a decline in both the inflation rate and the unemployment rate.

In sum, our statistical analysis shows that the effect of the traditional tools of monetary policy (such as a change in the fed funds rate) on the inflation and unemployment rates may not be as straightforward as suggested by the conventional economic theory. This analysis provides a caution for decision makers that the traditional link between interest rates and the inflation and unemployment rates may have broken down.

The traditional link between interest rates and the inflation and unemployment rates may have broken down.

The Relationship between Interest, Inflation and Unemployment Rates

The FOMC sets the pace of U.S. monetary policy and provides a target for the fed funds rate. Two key factors (among several others) which influence FOMC decisions are the inflation rate and the unemployment rate. In fact, the FOMC announces specific targets for the inflation rate (currently at 2 percent) and the unemployment rate (6.5 percent). The Committee has even stated that the methods of monetary policy may be altered if the inflation rate runs persistently above or below the 2 percent level. The unemployment rate threshold of 6.5 percent is for the short-run and one

[1] For policy recommendations, statistical results must be consistent between different sample (or sub-samples) periods. If the results are not consistent then we must be very careful making policy recommendations based on that relationship. See later part of this report for more details.

of the FOMC's long-term goals is to help the economy return to the full employment level. If the economy persistently suffers a high unemployment rate, that scenario may also influence future FOMC decisions. Typically, during a recession, as unemployment rate tends to move upward the FOMC reduces the fed funds target rate to help the economy and ultimately attempt to bring the unemployment rate down to the preferred natural level.[2]

What would likely be the effect of a temporary one percentage point increase in the fed funds rate on the inflation and unemployment rates?

In theory, it seems interest, inflation and the unemployment rates are related. However, economies, and the relationship between economic-variables, evolve over time and therefore it would be useful for effective decision-making to quantify the precise statistical relationship between these three variables. Specifically, do the data support a causal relationship (cause and effect) between the variables? What would likely be the effect of a temporary one percentage point increase in the fed funds rate on the inflation and unemployment rates?

Figure 1:

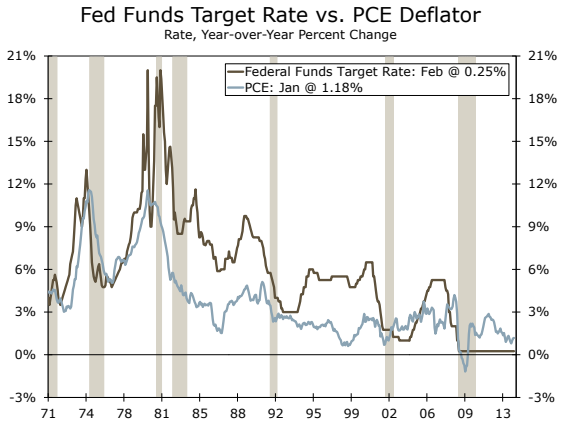
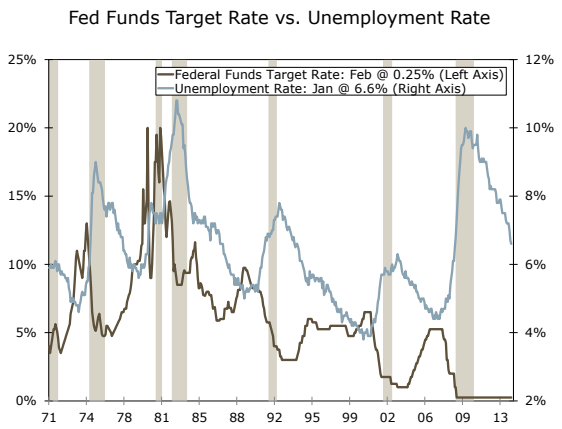


Figure 2:



Source: U.S. Department of Commerce, U.S. Department of Labor and Wells Fargo Securities, LLC

For a visual inspection, we plot the fed funds rate and the PCE deflator (a proxy for inflation) in Figure 1 and the unemployment rate and the fed funds rate in Figure 2.

Testing the Direction of the Relationship: Cause and Effect Discussion

First, we test whether the fed funds rate is statistically useful in explaining movements in the inflation and unemployment rates. The Granger causality test (Granger, 1969) helps identify the direction of a relationship between variables.[3] For instance, in the present case, we test whether the fed funds rate Granger-cause inflation and unemployment rates.[4] That is, whether the fed funds rate helps to increase predictability of the inflation and unemployment rates.[5]

The Granger causality test provides a means to identify a causal relationship between two or more variables rather than simply assuming causality. According to Granger causality, if a variable X_t "Granger-causes" a variable Y_t, then past values of X_t should contain information that helps predict Y_t above and beyond the information contained in past values of Y_t alone.

The Granger causality test also describes the direction of the causality, that is, whether it is one-way or two-way causality. For instance, if X_t "Granger-causes" Y_t but Y_t does not "Granger-cause" X_t then the relationship would be called one-way causality. If X_t "Granger-causes" Y_t and Y_t also "Granger-causes" X_t, then the test indicates two-way causality.

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[2] The Congressional Budget Office (CBO) provides an estimate of the natural unemployment rate which is currently at 5.5 percent.
[3] C.W.J. Granger (1969), "Investigating Causal Relationships by Econometric Models and Cross-Spectral Methods," *Econometrica* 37, no. 3. 424-438.
[4] The Granger causality test identifies whether two (or more) variables statistically cause each other and thereby it is appropriate to say "Granger-causes" instead of "causes." The term "Granger-causes" implies quantifying statistical causality between the variables of interest. See Granger (1969) for more detail.
[5] The statistical techniques here are covered in more detail in *Economic and Business Forecasting*, John E. Silvia, Azhar Iqbal et. al., Wiley, forthcoming 2014.

Table 1

The Granger Causality Test: 1971-2013

Regressor	Dependent variable		
	Fed Funds Rate	PCE Deflator	Unemployment Rate
Fed Funds Rate	NA	0.06***	0.02**
PCE Deflator	0.57	NA	0.12
Unemployment Rate	0.18	0.01*	NA

* Significant at 1 percent, ** Significant at 5 percent, *** Significant at 10 percent

Source: Wells Fargo Securities, LLC

Table 1 provides the Granger causality results to determine the relationship between the fed funds, inflation and unemployment rates over the entire sample period (1971-2013). As shown, the fed funds rate Granger-causes both the inflation and unemployment rates. Therefore, the fed funds rate can be useful in predicting the rate of inflation and the unemployment rate. The inflation and unemployment rates, however, do not Granger-cause the fed funds rate. That means inflation and unemployment rates are not useful predictors of the fed funds rate.

Breaking Down History: Has the Relationship Changed?

The last three recoveries are considered "jobless" recoveries, suggesting a possible structural break in the labor market behavior since the 1990s.

Some argue that the U.S. economy, in particular inflation and the labor market, performed differently in the post-1990 era compared to the pre-1990 period. For instance, the mean and standard deviation of the inflation rate for the 1990-2013 period are 2.13 and 0.98 percent, respectively, which are smaller than the average and standard deviation for the complete period which are 3.75 and 2.61 percent, respectively. This suggests that the post-1990 era experienced a lower inflation rate, on average, and the volatility around average inflation was also lower than the complete sample period. The post-1990 era is also known as the great moderation for these reasons, Bernanke (2004).[6] The labor market also showed different characteristics in the post-1990 era compared to the past. The last three recoveries are considered "jobless" recoveries by some observers, suggesting a possible structural break in the labor market behavior since the 1990s. Silvia (2006) provided a detailed discussion about the structural changes in the U.S. labor market in a global context.[7]

Table 2

The Granger Causality Test: 1990-2013

Regressor	Dependent variable		
	Fed Funds Rate	PCE Deflator	Unemployment Rate
Fed Funds Rate	NA	0.39	0.18
PCE Deflator	0.21	NA	0.03**
Unemployment Rate	0.87	0.0*	NA

* Significant at 1 percent, ** Significant at 5 percent, *** Significant at 10 percent

Source: Wells Fargo Securities, LLC

To test the idea of a structural break, we run a Granger causality test with the dataset for the post-1990s era. The idea behind using the sub-sample dataset is that if the results are statistically different from the complete period, then this difference suggests that the relationship between the three variables has changed since 1990. The Granger causality results based on the 1990-2013 period are reported in the Table 2 and indicate there is no causality between the three variables. That is, the fed funds rate does not help in the predictability of the inflation and unemployment

[6] The volatility in the major U.S. macroeconomic series such as real GDP, industrial production and the inflation rate declined in the post 1990s and it is known as the great moderation. For more detail see, Bernanke, Ben (2004), "The Great Moderation", Feb. 20, 2014.

[7] "Domestic Implications of a Global Labor Market," *Business Economics*, V. 41, No. 3, July 2006. This paper received the Adolph G. Abramson Award for the best paper written in *Business Economics*, 2006.

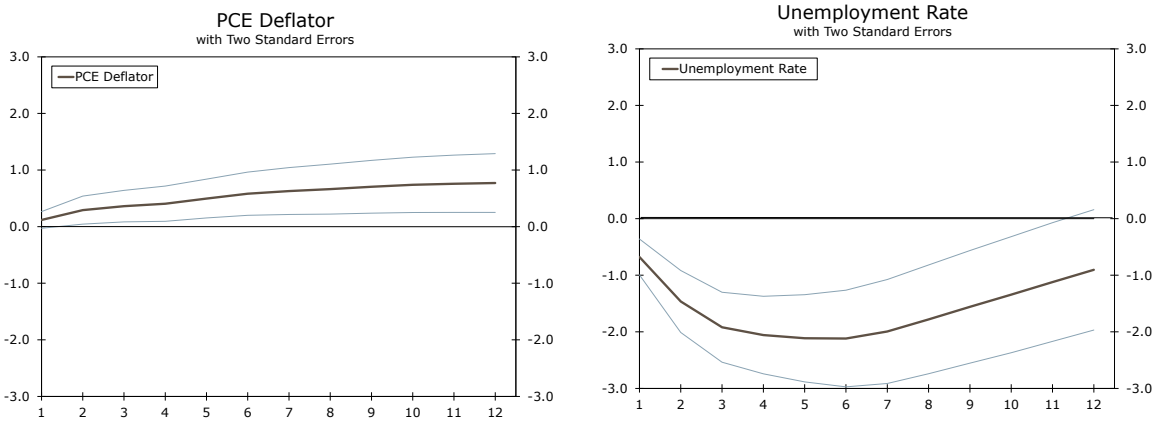
rates, nor do the unemployment and inflation rates provide a good prediction for the fed funds rate in the post-1990s era. This implies that the traditional tools of monetary policy may not influence inflation and unemployment as much as they have in the past.

Traditional tools of monetary policy may not influence inflation and unemployment as much as they have in the past.

The Fed Funds, Inflation and Unemployment Rates: The VAR and Impulse Response Function

What would be the likely effect of a one percentage point increase in the fed funds rate on the inflation and unemployment rates? To answer this question, we turn to the vector autoregression (VAR) modeling methodology.[8] The beauty of VARs is that they are simple statistical representations of economic systems as they rely only on the variables that comprise the system and a few lagged values of those variables. In addition, VARs can be "shocked" to show how all the variables respond to a change in one of the other variables. The way the variables respond over time to a change in the "shocked" variable are called impulse response functions (we refer interested readers to the appendix for more detail on VARs and impulse response functions).

Figure 3: A Shock to Fed Funds Target Rate (1971-2013)



Source: U.S. Department of Labor, U.S. Department of Commerce and Wells Fargo Securities, LLC

Using the complete sample period (1971-2013), we "shocked" (increased) the fed funds rate by one percentage point to examine the effect on the inflation and unemployment rates. Furthermore, the total effect of a change in the fed funds rate on the variables may be distributed over a prolonged period of time. Therefore, we generate the effect of a change in the interest rates in the current quarter on the inflation and unemployment rates over the next 12 quarters. Figure 3 shows what effect a temporary one percentage point increase in the fed funds rate has on the inflation and unemployment rates. The hike in the interest rate did not reduce the inflation rate as inflation increased 0.1 percentage point in the first quarter and continues on an increasing trend. The largest increase in the inflation rate was seen in the 12th quarter with a jump of 0.8 (rounded upward) percentage points. The upward shock in the fed funds rate reduces the unemployment rate by 0.7 (rounded upward) percentage points in the first quarter, with the largest drop of 2.1 percentage points experienced in the sixth quarter.

During an economic expansion, the FOMC tends to raise the fed funds target rate to combat inflationary pressure.

Typically, during an economic expansion, the FOMC tends to raise the fed funds target rate to combat inflationary pressure. While, at the same time, as the economy is growing there may be downward pressure on the unemployment rate trend. The impulse response function results are consistent with a declining unemployment rate but inflation has an increasing trend, possibly suggesting, in our sample period, traditional tools of monetary policy are unable to reduce inflationary pressures.

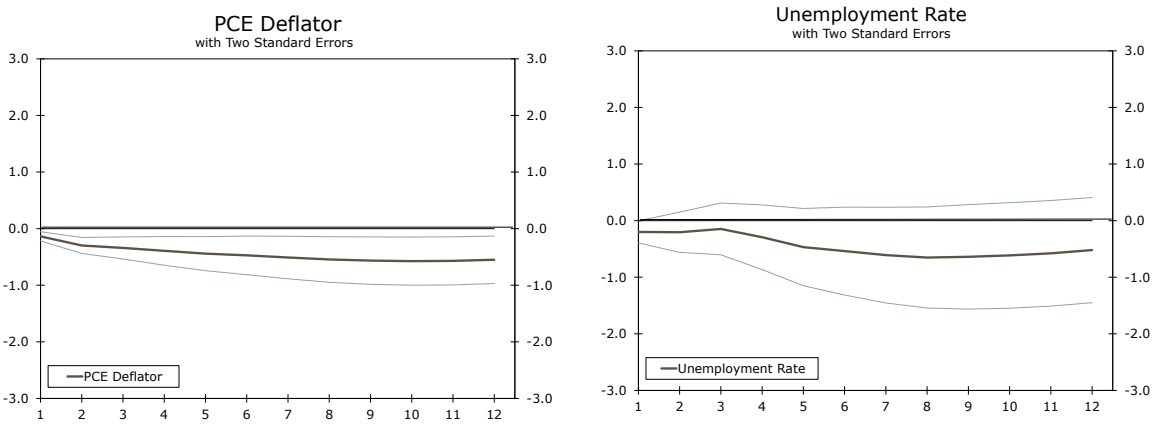
[8] **See Christopher Sims, "Macroeconomics and Reality,"** ***Econometrica*** **48 (1980), p.1-48.**

Breaking Down History: The Lucas Critique and Policy Recommendations

The Granger causality test results suggest that the relationship between interest rates, inflation and unemployment rates has changed since the 1990s. Furthermore, the inflation and unemployment rates behaved differently in the post-1990s era compared to the past. Therefore, to analyze the effect of a one percentage point increase in fed funds rates on the inflation and unemployment rates we rerun the VAR model using the dataset for 1990-2013 (Figure 4).

Results suggest that the relationship between interest rates, inflation and unemployment rates has changed since the 1990s.

Figure 4: A Shock to Fed Funds Target Rate (1990-2013)



Source: U.S. Department of Labor, U.S. Department of Commerce and Wells Fargo Securities, LLC

There are some noticeable differences in Figure 4 (using dataset for the 1990-2013 period) compared to Figure 3 (based on the 1971-2013 period). The post-1990s era shows that tightening of monetary policy is attached to softening inflationary pressure. That is, a hike in the fed funds rate reduces the inflation rate by 0.1 percentage point in the first quarter while the largest decline is reported at 0.6 (rounded upward) percentage points in the 10th quarter. The figure shows a declining trend in the unemployment rate, 0.2 (rounded upward) percentage points for the first quarter and the largest drop at 0.6 (rounded upward) percentage points in the eighth quarter. Figure 4 shows a drop in the unemployment rate, but the magnitude of the drop is much smaller than the one shown in Figure 3 (largest decline of 0.6 percentage points vs. 2.1 percentage points). In sum, in the post-1990 era, a hike in the fed funds rate reduces inflationary pressure and unemployment rates.

Both the Granger causality test and VAR analysis suggest that the relationship between interest rates, inflation and unemployment rates is different in the post-1990 era compared to the complete sample period. This finding is vital for decision makers. For policy recommendations, an estimated relationship should be consistent among all sub-samples in order to base any decisions on that relationship. Put differently, in the present case, would a hike in the fed funds rate increase inflationary pressure (as suggested by the complete sample period analysis) or would it reduce inflationary pressure (findings of the 1990-2013 period)? The answer is uncertain.

The above scenario may also reflect the Lucas Critique (Lucas 1976).[9] In simple words, the Lucas Critique suggests, that if the estimated relationship (or parameters) changes whenever policy changes (or sample period changes), then policy conclusions based on the estimation are misleading. In sum, the relationship between interest rates, inflation and unemployment is uncertain in our analysis. This may suggest that the effect of traditional tools of monetary policy

[9] **Lucas, Robert (1976). Econometric Policy Evaluation: A Critique.** ***Carnegie-Rochester Conference Series on Public Policy*** **Vol.1.**

(fed funds target rate, for example) on the inflation and unemployment rates may not be as straightforward as suggested by the conventional economic theory. These findings are possible reasons why the Federal Reserve Board has employed different tools of monetary policy during the past seven years. These tools include both the traditional (such as setting the fed funds target rate at a 0-0.25 percent range) and the non-traditional (like several rounds of asset purchases programs, also known as quantitative easing).

Conclusion

Two key drivers of market interest rates are the inflation and unemployment rates. One of the important tools of monetary policy to meet the FOMC's long-term goals is the fed funds target rate. In theory, all three variables are related. However, our statistical analysis suggests that the relationship between the fed funds, inflation and unemployment rates is different in the post-1990 era compared to the complete sample period. This finding is vital for decision makers. For policy recommendations, an estimated relationship should be consistent during sub-samples and if the relationship is not consistent between different periods then we must be very careful to make policy recommendations based on that relationship.

Appendix

The VAR Approach

Sims (1980) introduced the vector autoregression (VAR) modeling approach as an alternative to the large scale structural model, also known as macro-econometric model. The basic idea behind a VAR approach is that instead of including hundreds of variables in a model, we can include a handful of variables (sometimes eight variables) to represent major sectors of an economy and then that model can be utilized for forecasting and policy analysis (see Sims (1980) for more details).

A traditional VAR of n-variables will consist of n-equations, one equation for each variable. Each equation includes a constant and lag(s) of n-variables, including lag(s) of the left-hand-side variable. The lag order, how many lags of a variable, is denoted by "P". Therefore, a VAR (P) of n-variables indicates up to p-lags of each variable are utilized in each equation.

Here we share a simple example of a two-variable VAR model which include one lag of each variable, we'll call it VAR(1), because P=1 in this case.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 X_{t-1} + \varepsilon_{1t}$$
$$X_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_{2t}$$

Impulse Response Function

In an n-variables VAR model, an impulse response function (IRF) shows the effect of a one percentage point increase in one variable in the current period on all variables in the model. The basic idea behind an IRF is that you increase one percentage point (or one unit) of one the VAR variables in the current period, let's say the U.S. real GDP growth rate, assuming that the increase will disappear in the subsequent periods. Furthermore, we keep the VAR errors for other (n-1) variables equal to zero; that is, actual values are equal to estimated values. That would allow generating the effect of an increase in one variable on all others variables.

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