DO CHANGES IN THE FEDERAL FUNDS RATE CAUSE CHANGES IN THE UNEMPLOYMENT RATE?

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ABSTRACT

This paper looks at the causal linkage between the federal funds rate and the unemployment rate in the U.S. for the period 1955-1999. To that end, the paper uses the cointegration technique to test for co-movement between the two variables. Additionally, the error correction methodology is employed to study the issue of causality between the two variables. From the empirical analysis, two important results are to be highlighted. The first is that the federal funds rate and the unemployment rate are cointegrated. The second is that there is bi-directional causality between the federal funds rate and the unemployment rate.

INTRODUCTION

In the U.S., there has been much discussion in the popular press about the relationship between the federal funds rate, as an indicator of monetary policy, and the unemployment rate, as a measure of the strength of the economy. While several pathways have been discussed in the theoretical literature for monetary policy to affect activity in the economy,[1] the traditional Keynesian transmission mechanism is the most common explanation given for tying the federal funds rate to the unemployment rate. In that model, an increase in the federal funds rate is expected to lead to an increase in short-term interest rates as the cost of funds to lenders increases. With businesses and consumers responding to the higher interest rate by reducing their expenditures, economic activity is expected to fall, thereby, leading to an increase in the unemployment rate. Given the special role that the federal funds rate plays in influencing economic activity, it is important to determine if there is indeed co-movement between the federal funds rate and the unemployment rate. For while several studies have looked at the causal relationship between the money supply and output,[2] the empirical relationship between the federal funds rate and the unemployment rate needs further analysis. Because even though Bernanke and Blinder (1992) have looked at this relationship as part of a broader analysis of the transmission mechanism of monetary policy, the results from that exercise were somewhat mixed. For when the Granger causality model is estimated using monthly data for the period 1958-1989, with the variables in levels form, the federal funds rate is a significant predictor of the unemployment rate. With the data in first differences form, however, the results are not significant. Given the potential for the confirmation of spurious relationships if non-stationary time series data are utilized or for the relevant long-run information to be omitted if the incorrect model for causality testing is selected, the purpose of this paper is to use cointegration and error correction methodology to examine the relationship between the federal funds rate

and the unemployment rate. To that end, annual data for the period 1955 to 1999 will be used to ascertain if a long-run relationship exists between the federal funds rate and the unemployment rate. The paper will also examine the nature of the causal link between the two variables. Since, even though the monetary authorities may hold the view that changes in the federal funds rate cause changes in the unemployment rate, the relationship between the two variables could reflect reverse causation. For as Taylor (1993, 1999), and Clarida et al. (1998) have suggested, changes in economic conditions, as reflected in the unemployment rate, could induce the Federal Reserve to change the federal funds rate. Indeed it is often anticipated that as conditions in the economy improves (deteriorates) and the unemployment rate falls (increases), the Federal Reserve would raise (lower) the federal funds rate to keep the economy on a stable growth path.

The remainder of this paper is organized into three sections. Section II presents the methodology that is used to empirically test for cointegration and causality. In Section III, the data and results are discussed. Section IV contains the concluding remarks.

METHODOLOGY

To examine the interrelationship between the federal funds rate and the unemployment rate, the following methodology is adopted. First, all time series variables are examined for stationarity. Through this analysis, if the time series data are found to be stationary, the simple Granger causality test would be performed on the two variables. If the variables are, however, non-stationary, the cointegration and error-correction models would be utilized. For this analysis the following cointegration regression is specified:

$$4_t = \forall_0 + \forall_1 y_t + e_t \tag{1}$$

Where x_t = the unemployment rate, y_t = the federal funds rate, and e_t is the stochastic error term. The variables x_t and y_t are integrated of order (i.e., I(d)) if the time series data on x_t and y_t have to be differenced d time to restore stationarity. For d = 0, x_t and y_t are stationary in levels and no differencing is needed. Again, for d = 1, first differencing is needed to restore stationarity.

To test for the stationarity of the individual time series data, unit root tests are to be conducted for which the following equations are considered:

$$x_t = \mu + \exists I + \forall\, x_{t-1} + \Gamma \sum_{i=1}^{k} c_i)\, x_{t-1} \tag{2}$$

$$y_t = 1 + B\, I + \Theta\, y_{t-1} + \Gamma \sum_{i=1}^{k} d_i)\, y_{t-1} \tag{3}$$

Each time series has a non-zero mean and non-zero drift. Therefore, the estimation should include both a constant and a trend term in each specification. The relevant null hypothesis is that $* \forall * = 1$ or $* P * = 1$ against the corresponding alternative hypothesis that $* \forall * < 1$ or $* P * < 1$. A failure to reject the null hypothesis would imply that each variable is nonstationary. Next, the following ADF regression is considered:

$$)e_t = ae_{t-1} + \Gamma\, b_i\,)e_{t-i} + q_t \quad (4)$$

The ADF test is applied on to infer about the null hypothesis of no cointegration. The null hypothesis is rejected if the calculated pseudo t-value associated with is greater than its critical value, provided in MacKinnon (1992).

The Engle-Granger (1987) cointegration procedures are not without drawbacks since they do not consider explicitly the error structure of the data processes. The cointegration procedure, as developed in Johansen (1988) and Johansen and Juselius (1990, 1992), avoid the above drawback by allowing interactions in the determination of the relevant economic variables and being independent of the choice of the endogenous variable. Most importantly, it allows explicit hypotheses test of parameter estimates and rank restrictions using likelihood ratio tests. The empirical exposition of Johansen and Juselius methodology is as follows:

$$)v_t = \vartheta + \Sigma V_{t-1} + \Gamma \sum_{j=1}^{k-1})V_{t-j} + m_t \quad (5)$$

Where V_t denotes a vector of unemployment rate and federal funds rate, and $\Sigma = \forall\exists$. Here, $\forall$ is the speed of adjustment matrix and $\exists$ is the cointegration matrix, $r < n$. This procedure applies the maximum eigenvalue test (8_{max}) and the trace test (8_{trace}) for null hypotheses on r. Of these two test, 8_{max} test is expected to offer a more reliable inference as compared to 8_{trace} test (Johnson and Juselius 1990). Again, the Johansen and Juselius test procedure suffers from its supersensitivity to the selection of the lag structures. As a result, this study pursues both the ADF and Johansen-Juselius procedure for cointegration. It is likely that these two procedures could provide contradictory evidence in some instances.

If x_t and y_t are found cointegrated by either ADF procedure or Johansen-Juselius procedure or both, there will exist an error-correction representation(Engle and Granger(1987)). The error-correction model may take the following form:

$$)x_t = \exists_1 e_{t-1} + \Gamma \sum_{i=t}^{k} N_j\,)x_{t-1} + \Gamma \sum_{j=1}^{k} *_j\,)y_{t-j} + u_{1-t} \quad (6)$$

$$)y_t = \exists_2 e_{t-1} + \Gamma \sum_{i=1}^{k} B_j\,)x_{t-1} + \Gamma \sum_{j=1}^{k} K_j\,)y_{t-j} + u_{2t} \quad (7)$$

The reverse specification is considered due to plausible bidirectional causality. In these two equations, the series x_t and y_t are cointegrated when at least one of the coefficients $\exists_1$ or $\exists_2$ = is not zero. If $\exists_1 > 0$ and $\exists_2 = 0$, then y_t will lead x_t in the long run. Again, if $\exists_2 > 0$ and $\exists_1 = 0$, then x_t will lead y_t in the long run. If $*_j$'s are not all zero, movements in y_t will lead those in x_t in the short-run. If B's are not all zero, movements in x_t will lead movements in y_t in the short run.

The error-correction model(ECM) was first introduced by Sargan (1964) and subsequently popularized by numerous papers (i.e., Davidson et al. (1978), Hendry et al. (1984)). It has enjoyed a revival in popularity due to the recent work of Granger (1986, 1988), and Engle and Granger (1987) on cointegration. Its importance lies in its ability to combine short-run dynamics and long-run relationship in a unified system. If two variables are cointegrated, the long-run Granger causality will stem at least from one direction. Sometimes it is desirable to exclude the insignificant lags to

improve the efficiency of OLS estimates of parameters (Baghestani and Mott (1997)). A lack of cointegration does not, however, preclude the short-run dynamics and Granger causality. In the absence of a long-run relationship, equations (5) and (6) should not include the error-correction term for the detection of Granger causality between two variables (Bahmani and Peyesteh (1993)).

EMPIRICAL RESULTS

Annual data on the unemployment rate and the federal funds rate for the period 1955 to 1999 are utilized. The data for the unemployment rate were taken from the internet site of the Bureau of Labor Statistics. The data for the Federal Funds Rate were meanwhile taken from the internet site of the Board of Governors' of the Federal Reserve.

As figure 1 shows, the unemployment rate has been quite variable over the period 1955 to 1999. During this time span, the unemployment rate peaked at 9.7% in 1982 with a low of 3.5% in 1969.

Figure 2 shows that there has also been much variability in the Federal Funds Rate. Indeed, for this variable, the data show a range in values from a low of 1.57% in 1958 to a high of 16.39% in 1981. A scatter diagram depicting the relationship between the unemployment rate and the federal funds rate is shown in figure 3.

For more rigor, the cointegration and error-correction methodologies are used to examine the relationship between the unemployment rate and the federal funds rate. To that end, the data is first tested for unit roots. Those results are reported in table 1.

They clearly indicate that the series on the unemployment rate as well as the series on the federal funds rate are respectively nonstationary in level form. Each series becomes stationary after being differenced one time only. The final prediction error (FPE) criterion (Hsiao (1981)) determines the optimum lag-length as reported in parentheses.

Given these results, the next step is to determine if the two series together are cointegrated. Initially, the Engle-Granger test for cointegration is applied. The results from that procedure are reported in table 2.

When the computed value of the ADF test statistic is compared with the MacKinnon ADF critical values, the unemployment rate and the federal funds rate are found to be cointegrated at the 1 percent level of significance. This result suggests that there is a long-run relationship between the federal funds rate and the unemployment rate.

To overcome the limitations of the Engle-Granger ADF test for cointegration, the Johansen-Juselius cointegration test is also utilized. Those results are reported in table 3.

They indicate that one must reject the null hypothesis of no cointegration between the federal funds rate and the unemployment rate for the 8 max and the 8 trace tests are both significant at the 95% confidence level. The cointegrating or long-run equation associated with this test is as follows:

$$UR = 4.08 + 0.30\ FFR \qquad (8)$$

where UR = the unemployment rate, and FFR = the federal funds rate. This equation shows that there is a positive relationship between the federal funds rate and the unemployment rate. In addition, it indicates that for every percentage point increase

in the federal funds rate the unemployment rate increases by three-tenths of a percentage point.

Since the two variables in this study are both I(1) and cointegrated, the error-correction models given in Equation 6 and 7 are estimated. Those results are reported in table 4.

Table 1:
Units Root Tests*

Varible	Adf Test	Phillips-Perron Test	Kpss Test
Unemployment Rate (UNR)	-2.507(1)	-2.196(3)	0.334(1)
Federal Fund Rate (FDR)	-1.651(2)	-2.071(3)	0.4108(2)
) UNR	-5.412(1)	-6.001(3)	0.0513(1)
) FDR	-6.190(1)	-5.125(3)	0.0245(2)

*ADF regressions include a constant term and a time trend. The optimum lag lengths are provided in parentheses. For ADF and Phillips-Perron tests, at 5 percent and 10 percent levels the critical values are -3.50 and -3.18, respectively [see Fuller (1996)]. For KPSS test, lag window size, 1=4 and at 1 percent, 5 percent and 10 percent levels the critical values are 0.216, 0.146 and 0.119 respectively.

Table 2
Cointegration Tests Based On Adf ProcedurE

Dependent Variable	Independent Variable	ADF	DW	ADJ-R^2
UR	FFR	-3.64*(1)	0.75	0.11
FFR	UR	-3.48**(1)	0.64	0.11

Notes: UR = the unemployment rate; FFR = the federal funds rate; ADF = the Augmented Dickey-Fuller Test statistic, ADJ-R^2 ; = adjusted R^2 ; DW = Durbin Watson Statistic. The Lag lengths are provided in parentheses.

* Significant at the 1% level
** Significant at the 5% level.

Table 3
Cointegration Test Based On The Johansen Procedure

Data Vector	Null Hypothesis	8 Max	8 Trace
(UNR, FDR)	r#1	5.09161(1)	.0916(1)
	r∃0	19.26923(1)*	24.3608(1)*

ignificant at 95% level.

Table 4
Causality Test

Dependent Variable	"Causal" Variable	Lag Orders	F-Statistics	T-Statistics For The Error-Term
UNR	FDR	m=3, n=3	8.527*	2.9994*
FDR	UNR	m=3, n=3	2.5899***	-2.507**

* Significant at 1% level.
** Significant at 5% level.
*** Significant at 10% level.

Based on the joint F-test for Granger causality, the results indicate that at the one percent level of significance changes in the unemployment rate are caused by changes in the federal funds rate. In addition to the short-run relationship between the two variables, the results also indicate that changes in the unemployment rate have also responded to variations in the error-correction term. At the 10 percent level of significance, changes in the unemployment rate are also found to be generating changes in the federal funds rate. In addition to the short-run impact, the statistical significance of the error-correction term also suggest that long-run factors have also caused changes in the federal funds rate. Taken together, these results suggest that while changes in the federal funds rate do cause changes in the unemployment rate, the changes in the unemployment rate also cause changes in the federal funds rate. These results are therefore indicative of bi-directional causality between the unemployment rate and the federal funds rate. They are consistent with the view that the Federal Reserve adjusts the federal funds rate in order to affect economic activity. At the same time , the decision to change the federal funds rate is based on the conditions prevailing in the economy. Indeed, the current cuts in the federal funds rate are being made in order to stimulate activity in a slumping economy.

SUMMARY

This paper examines the causal linkage between the federal funds rate and the unemployment rate in the U.S. over the period 1955-1999. The important empirical findings of this study are two-fold. First, the results indicate that the federal funds rate and the unemployment rate are cointegrated. Second, the results indicate that there is bi-directional causality between the federal funds rate and the unemployment rate. This relationship is consistent with the view that changes in the federal funds rate affect activity in the economy and that the latter is the force impelling changes in the federal funds rate.

ENDNOTES

1. For instance see studies by Bernanke and Gertler (1995), Hubbard (1995), Taylor (1993), Modigliani (1971) and Tobin (1969).
2. For instance see studies by Christiano and Ljungqvist (1988), Hafer (1982), and Sims (1972)

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