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Hidden Effect of Monetary Surprises on US Unemployment*

시장 기대와 다른 미국 통화 금리의 변동이 실업률에 미치는 영향에 관한 연구

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This paper studies the impact on the change in fed funds rate held by U.S FOMC. In analyzing the interest rate policy's impact on the output indicator and unemployment, I studied stylized facts from both long-run and short-run analyses. The significant impact on the monetary policy in changing output growth and the unemployment rate is found in the crouching vector error correction model, which considers the asymmetric shape of long-run equilibrium. In the short-run analysis, I also found significant evidence that the unexpected change in the fed funds rate has the significant impact on unemployment. To measure the pure surprising factor of the change in fed funds rate, I extract the surprising factor after eliminating the fed funds futures rate from the total change in the fed funds rate. The interest rate policy's significance is shown in the crouching ordinary least squares model, consisting of decomposed surprises, percentage change in price levels, and unemployment in two directions, increase and decrease. The short-run results show that when a monetary authority surprises a market by increasing the fed funds rate higher than expected (a contractional policy), the unemployment rate increases.

Key words: Fed Funds Rate, Surprise, Asymmetry, Crouching Vector Error Correction Model
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I. Introduction

During the late 1960s through the 1970s, the U.S. experienced high and volatile inflation. By the mid-1970s; thus, it became a serious[1] policy concern of the central bank to attenuate the volatility of the inflation rate and the Federal Reserve System has started to control a financial market by executing the Fed's interest rate policy in various way. The authority's policy makers acknowledged that a monetary policy, which fighting against high inflation should be set with a finesse because inflation was related to developments of the economy. Since then, the Phillips curve became a central part of macroeconomic modeling and monetary policy analysis. The Federal Reserve System's MPS model; for example, (as surveyed in Goodfriend, 2002) incorporated the Phillips curve by showing the rate of wage inflation depended on the unemployment rate and the lagged rate of change of nominal prices.

Among many sorts of monetary policies, the interest rate policy has been studied widely because economists regarded that it has the most direct and immediate effects through the effect of market rates on interest-sensitive components of aggregate demand. Particularly, changing the fed funds rate has been popularly used to achieve the ultimate objective of monetary policy, expressed in terms of macroeconomic variables such as output, employment, and inflation by affecting asset prices and returns. In the neoclassical synthesis that emphasizes the role of expected future income prospects, the real wage and the real interest rate for household consumption and labor supply, the credit channel has been regarded as a powerful channel for realizing this policy's long and variable impacts.

On the other hand, some believed that inflation was mainly governed by psychological factors and momentum only. Sargent and Wallace (1975) incorporated

1) The effective Clarida et al. (1999) that revealed that the Fed's interest rate policy becomes very sensitive to changes in inflation expectations for the above period.

Friedman's view that perceived variations in money led simply to changes in prices, with only misperceived monetary changes having real effects. The introduction of rational expectations into macroeconomics led to a broader questioning of the effect of monetary policies when its intention is expected. In the long run, the future intentions of the central bank are very important for the evolution of the price level, or the inflation due to its effect on the expected inflation with the limited relevance for real activity as long as they are accurately perceived. This is the first analytical point of this paper in studying the effect of a series of changes in the effective fed funds rate: the hidden long-run equilibrium relationship between cumulated changes in interest rates, employment, and the output growth. With regards to the asymmetric relationship between employment and output growth, this paper suggests an appropriate form in identifying the long run effect of changes in fed funds rate: I find that the magnitude of the market's response depends on the sign of a monetary policy. The labor cost response to a monetary policy depends on the direction of the action. In this paper, "the crouching analysis" specifically indicates the empirical model with the crouching[2] factors of a variable. By the crouching factors, I mean the decomposition of positive and negative factors that are found in the first-differences of a series. The estimation results of crouching vector error correction model shows the significant nonlinear long run equilibrium that was not shown in a linear cointegration model. The results imply that tight money raises unemployment by increasing the wage so that the policy results. The result implies the prominent role of a monetary policy in determining the long-run output growth path in the economy.

The long-term interest rate may be interpreted, as signaling the increase in inflationary expectations. When the Fed aims to maintain its reputation in its fight against inflation, it has responded by raising short-term interest rates by changing the fed funds rate. This short-term instrument would be ground out by a well-specified

2) These factors huddled or "crouched" over a threshold to crowd or nestle closely together.

Real Business Cycle model with a low, constant markup. In this paper, I analyze the short-run effect of the instant changes in fed funds rate by isolating the direction of surprising action from the context in which it occurs. In this short-run analysis, I also consider the nonlinear relationship between monetary policy shocks[3] the monthly changes in price level and the monthly unemployment rate. After isolating a surprising factor from a nominal change, the nonlinear ordinary least squares model results present the statistical evidence that shows the significant effect of monetary policies on unemployment in a relatively near term, as well. The asymmetric effect of the Fed's fed funds rate policy is explained by the Fed's high tolerance[4] to lowering the interest rates.

This paper is organized into seven sections. In Section 2, the precedent literature is reviewed. Section 3 provides the source and descriptive statistics of data. This section includes both the short- and long-run features of each variable. Section 4 presents the empirical setup in measuring the effect of a monetary policy. In Section 5, I first examine the long-run impact of the changes in fed funds rate in crouching vector error correction model. The second half of Section 5 presents the results that show the short-term effect of monetary policy shocks. In Section 6, concluding remarks and the contribution are highlighted.

3) In this paper, "a monetary surprise" is preferred instead of "a monetary policy shock" because the unexpected changes of the fed funds rates imply surprising factors which are different than market's expectations but not necessarily intended by monetary policy makers at all the time. Although most of them are the unexpected shocks relative to the monetary policy, we use a more general term following Bernanke and Kuttner (2005) to include all surprises for market participants.

4) Enders and Silos (2001) provides the discussion on the Fed's asymmetric response according to the technological shock to the economy.

II. Literature Review

The nature of the trade-off between inflation and unemployment became central to macroeconomic policy, as well as to macroeconomic modelling. Accordingly, one of the most popular areas of a monetary policy research that integrates statistical evidence relates to the Phillips curve because policy advisors worried about a wage-price spiral and were concerned that inflation could develop a momentum of its own, as appeared to be the case in the recession. In MPS model developed by the Federal Reserve System, for instance, the nature of the trade-off between inflation and unemployment was specified by a markup of price over marginal cost that determines the price level with the nominal wage rate being a core factor of the entire manufacturing cost. In addition, the MPS model made the markup, which is contingent on the extent of utilization and allowed the price level to gradually adjust toward the marginal cost.

Beyond affecting the availability of financial intermediary credit, or the spreads between market rates and regulated deposit rates, practitioners of the neoclassical synthesis recognized that the monetary policy could effectively control inflation. Okun (1970)'s perspective[5] was representative to emphasize the role of a monetary policy in controling inflation. However, there is no reliable theory to predict the short-run division of nominal income growth between the price level and real output. To meet the need, monetary macroeconomists have developed the new Keynesian models to interpret the apparent short-run non-neutrality of money by incorporating the result of price-level stickiness. The new Keynesian have extended the study the effect of expectation in realizing the different results from a policy action because expectations

5) In Okun's (1970), he mentioned that "the basic cure for inflation is to remove or offset its cause: cut aggregate demand by fiscal or monetary policy sufficiently so that money spending will no longer exceed the value of goods." In addition, Tobin (1972) supported this idea by emphasizing the tightening monetary policy to fight sharply raising inflation that "the burden of restraint fell almost wholly on the Fed which acted vigorously and courageously".

determined the degree to which prices and wages would adjust to neutralize an injection of money in a short run.

On the other hand, the impact of monetary policies has been shown to be limited in some studies when one can predict the effect of a policy action at a point in time with taking account of the nature of the policy regime from which it comes. This limitation has raised the question on the shape of the Phillips curve. Some empirical studies including Kuttner and Robinson (2010) failed to prove the shape of the relationship when they consider the curve in the late 1960s and early 1970s. Many studies focused on later periods as well because since then, Federal Reserve had been directed by Paul Volcker, who dramatically changed the Fed's major focus and deployed aggressive inflation-targeting policies[6]. Some of monetary literature; for example, Kuttner and Robinson (2010), suggests evidence[7] of the flattening Phillips curve during the late 1960s in the context of new-Keynesian economic theory: a positive output gap has been less inflationary, but the cost of the decrease in inflation has increased (Krueger and Kuttner, 1996; and Kuttner and Robinson, 2010).

From a fundamental point of view, Blanchard and Quah (1989) provided a more structural perspective on the relationship between unemployment and output. Their identification strategy, which was used in vector autoregression model that decomposed economic shocks from a macroeconomic structure has motivated many studies to find a nonlinear long-run relationship between a monetary indicator and macro variables. For example, it was easy to find empirical evidence on an asymmetric response in unemployment to increase in output; when output is increasing, it does not share a common stochastic trend with unemployment rate. This asymmetry is widely noted in literature, which remarks a "hysteresis hypothesis" when output

6) The change is usually described as "Volcker Rule" in the monetary policy literature.

7) Kuttner and Robinson (2012) surveyed on these reasons - globalization, the alternative definition of marginal costs, and the data problems. Measuring output gaps and labor shares are also studied in Krueger (1999).

returns to a level where it was before the shock, unemployment fails to return to its original level. The hysteresis effect was one of the results by modeling a labor market with a human capital, an insider-outsider model, or an institutional model (Schorderet, 2001)

Accordingly, many empirical studies on this subject have adopted structural breaks or asymmetric thresholds (See Philip, 1998; Lee, 2000; Harris and Silverstone, 2001). In order to capture the effect of a monetary policy in a long-run equilibrium, I integrate the asymmetric relationship between output growth and unemployment by adopting Granger and Yoon (2002). Their work provide the basis of a crouching vector error correction model through the completion of Monte Carlo simulations. They were able to integrate the empirical evidence obtained from the endogenous relationship in a theoretical sense. This paper applies this approach by decomposing a surprise in two directions, a surprising increase and decrease. The sign and magnitude of the estimated coefficient successfully explain the shape of the Phillips curve and the effect of monetary policy.

Last, but not the least, estimating the response of output growth to monetary policy actions is complicated by the fact that the market is unlikely to respond to policy actions that were already anticipated. Extracting a surprising component from the shock is first attempted by Kuttner (2001) and Bernanke and Kuttner (2005). Their work mostly focused on the stock market's immediate reaction to the shocks. In this paper, I focus on changes in macro indicators, such as changes in the unemployment rates, and inflation rates by the unexpected impact when a monetary policy is held. The unexpected part or a surprising part is extracted from the nominal shock by subtracting the expected part. The expected part in the changes in the effective fed funds rate is the implied price of a change in the future's market on Chicago Board of Trade (CBOT). The price is based on the market's expectations regarding a commonly used monetary policy, any change in the effective fed funds rate. Surprises in this

target interest rate derive a market's instant reaction toward the direction, that was intended by policy makers.

III. Data

1. Source

Before obtaining the data on monetary policy surprises, I extracted the market's expected terms from the price of fed funds futures on the Chicago Board of Trading (CBOT). Kuttner (2001) and Bernanke and Kuttner (2005) provided the basis for this empirical strategy. The underlying unit of these futures is the interest on fed funds with a face value of $5,000,000. It is calculated on a 30-day basis at a rate equal to the average overnight fed funds rate of the contract month. The rate is 100 minus the settlement price[8] corresponding to the one-month futures contract on the last day of the previous month. I extract the expected change in the funds rate by subtracting the current month's futures price from the monthly average of the fed funds' target rate. Finally, a surprise is defined as the difference between the futures price on the last day of the month and the effective fed funds rate of the last day of the previous month. Many papers used this series to study the impact of monetary policy surprises on asset return (Konrad, 2009; D'Amico and Farka, 2011), on the long-term interest rates at the zero lower bound (Wright, 2012), and on the global stock prices (Laeven and Tong, 2010). Although the use of monthly data is not free from time-aggregation issues over the course of a month, the evaluation of surprises on a monthly basis allows us to

8) The settlement price of the fed funds futures contracts is determined by the average over the calendar month, carrying the prior business day's rate over weekends and holidays. See Bernanke and Kuttner (2005) for details. The data are obtained from Bloomberg Terminals and Datastream.

incorporate endogenous reactions to changes in economic indicators. Daily price data are available from the first day of trading, "December 31, 1988". Thus, all series discussed in the paper are designed to match the availability of monthly data on changes in futures' prices over the period from January 1989 to August 2013.

For measuring unemployment, I used the official rate of unemployment, U3 that is published by the Bureau of Labor Statistics (BLS) on a monthly basis. In robustness checks on the long-run feature of the unemployment rate, I also examine the U6 series that captures the broader definition by aggregating individuals who are unemployed, marginally attached (are not looking for a job but want and are available for one and have looked for work sometime in the recent past), and part-time workers (who want and are available for full-time work but had to settle for part-time schedule). Generally, these two plots overlap for the period from the second quarter of 1970 to the last quarter of 2012. Referring to hourly wage for workers in a private sector and the natural rate of unemployment from the BLS, I detected the long-run feature of unemployment.

With regards to any potential distortion in the unemployment measure resulted by hysteresis[9] and information asymmetry in a labor market, the job flow data are considered as an alternative employment indicator that is mostly driven by the demand side. The net change in employment, which is calculated as job creation minus job losses, integrates births, deaths, and continuing employers, as in Davis et al. (2006). A series is prepared by Business Employment Dynamics (BED) that represents a virtual census of establishments from 2001Q3 to 2013Q2. In comparison with the Job Openings and Labor Turnover Survey (JOLTS) or Longitudinal Employer Household Dynamics (LEHD), the BED data yield greater job flows; for approximately every 12 jobs filled at a point in time, an average of one job disappears in the following three

9) Blanchard and Summers (1996) discussed the asymmetric membership effects in bad times and good times.

months. In a growing economy, more new jobs are created and more positions are established[10]. However, due to the limited availability of job creation/loss rates, the sample period for these series is restricted to the period from December 2000 to August 2013.

Finally, the inflation rate is calculated as the yearly percentage change in the monthly basis consumer price index for all urban consumers and all items less food and energy (1982-84 = 100, end of the year). The data is obtained from the Federal Reserve Economic Data (FRED) provided by the Federal Reserve Bank (FRB) of St. Louis. Additionally, to match a monthly basis of unemployment data, I use the percentage changes in the consumer price index for all urban consumers and all items less food and energy[11] from month ago. The series is seasonally adjusted. In order to examine the monthly growth of output in U.S economy, I used seasonally adjusted industrial production and capacity utilization that is collected in a monthly basis from the Federal Reserve System (2007 = 100). This G.17 series provides useful information on the National Gross Output particularly in a monthly basis when either GNP or GDP is only available at a quarterly basis.

2. A Unit Root Test

This section first provides a snapshot of indicators' trend in Figure 1 but also reviews the long-run stochastic components of variables. Each component is examined by the augmented Dickey-Fuller (ADF) test[12]. According to the results in Table 1, we fail to

10) For more details, see Davis et al. (2006)

11) Because the percentage changes in monthly CPI may contain high volatility by the price changes in food and energy items, the FRB publishes this series for studies on changes in the price level on a monthly basis.

12) I examine the series by using the KPSS, Phillips-Perron, and augmented Dickey-Fuller tests, with GLS estimates according to the characteristics of each series. Although these results are not reported in the paper, they are consistent with the results reported in Table 1 and available upon request.

reject the hypothesis that a series contains unit root for the historical hourly wage, and the effective fed funds rate. The presence of a long-run component implies that there is a cumulative memory of monetary policy changes, as discussed in Bernanke and Kuttner (2005). The fed funds rate contains a long-run stochastic trend by showing its failure to reject the hypothesis that the series contains a unit root. Industrial production and workers' hourly wage are also shown to follow I(1) process when it is examined after their natural-log transformation.

The hypothesis that unemployment contains a unit root is examined with various types of unemployment in the augmented Dickey-Fuller (ADF) test[13]. I investigate the unit root in I) U3, the official definition published by the BLS; ii) U6, a new and broader definition; and iii) job hires, openings and loss data published by in firm reports in BED. The results with the deterministic time trend are provided in the first part of Table 1. It is shown failed to reject the non-stationarity of U3 and U6. On the other hand, Job Hires and Job Loss data are shown to be stationary at 5% and 1% statistical significance, respectively. The unemployment rate has the persistent effect on itself and the results are consistent among alternative series, representing a random walk. This is a special case of the stochastic trend model in which all stochastic shocks have non-decaying effects on the sequence, which thus meanders without exhibiting any tendency to increase or decrease. The long-run stochastic component of unemployment has been discussed in many studies[14]. These studies show that the

13) There have been many attempts to minimize errors contained in test statistics. Kwiatkowski et al. (1992) develop their own test focusing primarily on fixing the low power of the Dickey-Fuller test, to correct severely mis-specified long-run components. This test used to detect random walks in the macro variables of Nelson and Plosser (1982), and shows the evidence of nonstationarity. In examining stationarity in the unemployment rate, the results of Kwiatkowski et al. (1992) are inconclusive with regard to whether it should be called nonstationary or stationary, at the 5% significance level with a Newey-West Bartlett kernel. The results of examining the unemployment variables using the Phillips-Perron test, as done by (Perron, 1989; Perron, 1990) show that I cannot reject the null of a unit root.

14) Fair (2000) attempted to cleanse the frictions by the different choice of the window, definition and test strategy. In his study, unemployment contains a unit root when it is defined by the civilian unemployment rate obtained quarterly from 1952Q1 - 1998Q1.

unemployment rate is sensitive to frequency choices when filtering out frictional noises from a long-run trend. Finally, in Table 1, by rejecting the hypothesis of a unit root, I claim that the percentage changes in monthly CPI or the year-to-year inflation rates are stationary.

〈Table 1〉 Augmented Dickey–Fuller Test with a Deterministic Time Trend

Null Hypothesis: A series contains a unit root

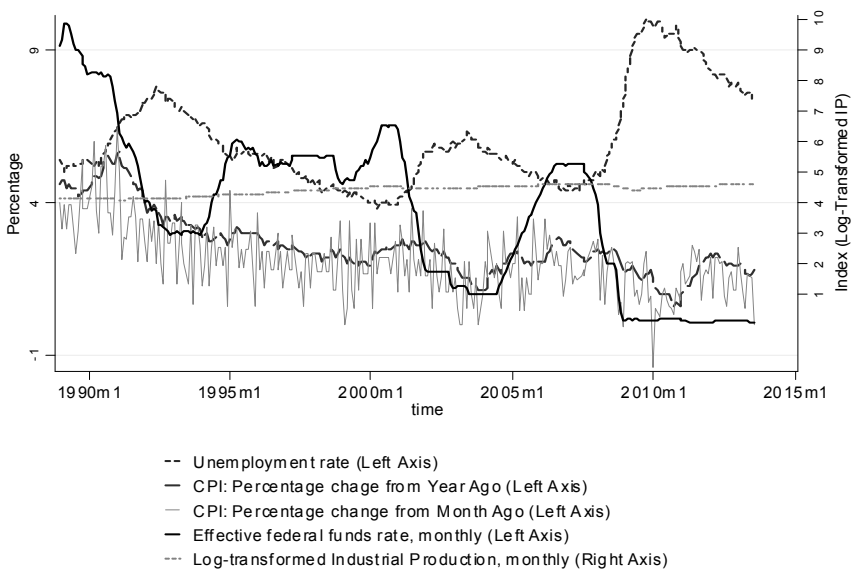
Series	Test Statistic	Number of observations	P–value
U3	-0.671	294	0.8540
U6	-0.161	234	0.9430
Job Hires	-2.451	150	0.1278
Job Loss	-2.586*	150	0.0959
Job Openings	-2.970**	150	0.0378
Natural Rate of Unemployment	-3.203**	294	0.0198
Log transformed Industrial Production, monthly	-1.406	295	0.5504
Percentage Changes in CPI for all items from year ago, monthly	-1.853	295	0.3547
Percentage Changes in CPI for all items less food and energy from month ago, monthly	-10.498***	295	0.0000
Effective Federal Funds Rate	-1.642	295	0.4615

Source: The data related to unemployment including U3, U6, the natural rate of unemployment, and hourly wage are obtained from the Bureau of Labor Statistics. Job hires, loss, and openings are obtained from Business Employment Dynamics (BED). The consumer price index for all urban consumers and all items (1982-84 = 100, end of the year) is obtained from the Federal Reserve Economic Data (FRED) provided by the Federal Reserve Bank (FRB) of St. Louis. All values are seasonally adjusted.

Note: The test reports one-sided critical values and p-values for the test of the null hypothesis against the alternative: $\beta < 0$ of $\triangle y_t = \alpha + \beta y_{t-1} + \delta t + \epsilon_t$, which is equivalent of $\rho < 1$ for the equation, $y_t = \alpha + \rho y_{t-1} + \delta t + u_t$. Critical values are found from the Augmented Dickey-Fuller test with the number of observations (1% critical value is −3.456, 5% critical value is −2.878 and 10% critical value is −2.570 with the number of observations 295). Accordingly, ** indicates statistical significance at 5% level, and * denoting significance at 10% level. P-value in the table is MacKinnon approximate p-value for the test statistic.

In Figure 1, the movements of the representative unemployment rate U3, the effective fed funds rate, and the industrial production are described between January 1990 and December 2013. The historical average unemployment rate that is remarked in blue-dotted line for the period is 6.07% with its standard deviation of 1.59%. The effective fed funds rate (a black-solid line) has been moving with the high standard deviation around the historical mean of 3.68%. The percentage change in CPI from year ago and from month ago share the same long-run deterministic movement but the monthly change fluctuate in a higher degree as indicated by pink-solid line against a purple long-dashed line. The mean inflation rate measured by the average of the percentage change in CPI from a year ago is 2.6% with 1.02% standard deviation. On the other hand, the average of the monthly change is 2.09 with the higher standard deviation of 1.14. The natural log-transformed industrial production, which is drawn by a thick red line, shows the inclining pattern since January, 1990 (Scaled on the right axis in Figure 1).

〈Figure 1〉



It is worth noting in Figure 1 that the historical movement of the unemployment rate is in the opposite direction of the fed funds rate. This observation is related to the target of monetary policy makers when they have developed monetary policies to promote the intentional change in the labor market by controlling the fed funds rate. The bidirectional relationship between the fed funds rate and unemployment; however, has been limited for finding the long-run relationship between monetary policies and output growth, or unemployment. Most studies including the empirical works by Friedman (1977) used the de-trended unemployment data to eliminate short-run frictions. In their results, eliminating noises between real- and nominal wages, as well as their stickiness, are filtered out to show the significant long-run equilibrium.

IV. Empirical Model

In this section, I first suggest the empirical model for the long-run analysis on the relationship between the effective fed funds rate and other macro indicators. In finding the long-run relationship by a common stochastic trend, I examine whether there is a cointegrating vector between variables. In the following part, I examine the effect of sudden changes in fed funds rate according to the robust ordinary squares model.

1. Long-run Analysis on the Effect of Changes in Fed Funds Rate with Shock Decomposition

Following the precedent literature, I examine a linear long-run equilibrium relationship between the infinite memory of errors in the unemployment rate (U3), fed funds rate (R), and industrial production growth (Y). Table 2 presents the significant number of lags is 3 or 4 according to FPE, AIC, HQIC, AND SBIC criteria.

〈Table 2〉 Lag Selection Test

Lag	LL	LR	DF	P value	FPE	AIC	HQIC	SBIC
0	-664.30				0.02	4.70	4.71	4.74
1	492.51	2313.60	9	0.00	0.00	-3.38	-3.32	-3.23
2	526.83	68.63	9	0.00	0.00	-3.56	-3.45	-3.29
3	**567.21**	**80.76**	**9**	**0.00**	**0.00**	**-3.78**	**-3.63***	**-3.40***
4	**576.32**	**18.22**	**9**	**0.03**	**0.00***	**-3.78***	-3.58	-3.28
5	579.42	6.19	9	0.72	0.00	-3.74	-3.50	-3.13
6	586.39	13.95	9	0.12	0.00	-3.73	-3.43	-3.00
7	588.42	4.07	9	0.91	0.00	-3.68	-3.34	-2.83
8	593.14	9.43	9	0.40	0.00	-3.65	-3.26	-2.69
9	601.56	16.85	9	0.05	0.00	-3.64	-3.21	-2.57
10	613.26	23.40*	9	0.01	0.00	-3.66	-3.18	-2.47
11	618.52	10.53	9	0.31	0.00	-3.64	-3.11	-2.33

Note: * indicates statistical significance. The number of observations is 283 for the period from January, 1990 to July, 2013. The tests are LL: the log likelihood test (Hamilton, 1994), FPE: the test statistic suggested by Lutkepohl (2005), AIC: Akaike testing, SBIC: Bayesian Testing, HQIC: the applied test statistic suggested in Lutkepohl (2005).

I used Johansen test for testing the existence of a cointegrating relationship between these I(1) variables. Referring to the testing results shown in Table 2, I used three lags in the cointegration test. The results reported in Table 2 show that the fed funds rate, output and unemployment do not share a common stochastic trend. The result is consistent with Granger and Yoon (2002) and reference therein. Historically, many scholars have hardly found the common term between stochastic components of these variables. With respect to a monetary policy's main objectives and achievements that are mostly understood in macroeconomic variables, such as output growth and unemployment indicator, there are some studies in emphasizing the nonlinearity of the cointegrating relationship.

〈Table 3〉 Johansen Tests for Cointegration for
Fed funds rate (R), Log-transformed Industrial Production (Y), and Unemployment (U3)

Maximum rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	30	1438.324	.	**24.2653***	29.68
1	35	1446.718	0.05605	7.4785	15.41
2	38	1449.849	0.02129	1.2151	3.76
3	39	1450.457	0.00417		

Note: * indicates statistical significance. The number of observations is 289 for the period from July, 1989 to July, 2013. The number of lags is three. The test results with four lags are not reported due to its similarity with the results shown in this table. The results are available upon request.

I consider asymmetry over a business cycle, inspired by the observation of Figure 1, to find a statistically significant cointegrating vector. Specifically, I use the analysis on nonlinearity developed by Granger and Yoon (2002). The long-run component in random walk variables, such as fed funds rates, output growth, and unemployment is decomposed into two directions with respect to the threshold d_0^i for each variable i. The mathematical formulations for unemployment (U), the monthly production output growth (Y) and an accumulated change in the fed funds rate (R) are calculated through equations (1), (2) and (3), respectively.

$$U_t = U_{t-1} + \varepsilon_t = U_0 + \sum_{i=1}^{t} \varepsilon_i^+ + \sum_{i=1}^{t} \varepsilon_i^- - d_0^u \tag{1}$$

$$Y_t = Y_{t-1} + \eta_t = Y_0 + \sum_{i=1}^{t} \eta_i^+ + \sum_{i=1}^{t} \eta_i^- - d_0^y \tag{2}$$

$$R_t = R_{t-1} + \varepsilon_t = R_0 + \sum_{i=1}^{t} \xi_i^+ + \sum_{i=1}^{t} \xi_i^- - d_0^r \tag{3}$$

The initial value of each series, which is denoted by a subscript 0, is obtained by the mean over the period between 1998 January and 1998 December by following Bernanke and Kuttner (2005). Shocks in each period are decomposed into either positive or negative with a center of the ensemble average d_0. In unemployment decomposition equation (1), the shock that is greater than d_0 are denoted by ε_t^+ and

those lower than the threshold by ε_t^-. The natural log-transformed industrial output, Y_t, is decomposed in two shocks in a similar way. The ensemble mean of the difference in the Y_t at t and at $t-1$ is found at the deterministic trend. The related shocks are denoted by η_t^+ for the shock that is greater than d_0 and those lower than the threshold by η_t^-. In equation (3), the decomposed shocks on the fed funds rate are indicated by ξ_t^+ and ξ_t^-, respectively. Finally, the decomposed variable is expressed by the accumulated shocks that are decomposed in equation (1) to (3). Each crouching variable are denoted by + and − according to the direction as shown in equations (4) to (6). Note that the shock is generated by the accumulated short-term difference into two directions.

$$U_t^+ \equiv \sum_{i=1}^{t} \varepsilon_i^+ \quad U_t^- \equiv \sum_{i=1}^{t} \varepsilon_i^- \tag{4}$$

$$Y_t^+ \equiv \sum_{i=1}^{t} \eta_i^+ \quad Y_t^- \equiv \sum_{i=1}^{t} \eta_i^- \tag{5}$$

$$R_t^+ \equiv \sum_{i=1}^{t} \xi_i^+ \quad R_t^- \equiv \sum_{i=1}^{t} \xi_i^- \tag{6}$$

After capturing asymmetries following Granger and Yoon (2002), I analyze the impact of accumulated changes in the effective fed funds rate on the unemployment and output growth. Table 4 summarizes the estimation and the statistical significance of a common stochastic trend in those variables. In contrast to an insignificant cointegrating vector, the asymmetric components have the significant cointegrating relationship, at least two, for each pair of three indicators. Particularly, the expansionary monetary policy by serial decreases in fed funds rates (shown in (3) and (4) of Table 4) implies the significant positive relationship in lowering unemployment (3). It is consistent with the negative relationship between this policy and the increases in unemployment rates (4). Additionally, The asymmetric behavior of fed funds rate is associated with the changes that are evident in output changes. The asymmetric magnitude of the market's reaction is shown by the insignificance of the impact from a R_t^+ in (1) and (2) on U_t^- or U_t^+.

〈Table 4〉 Johansen Tests Results and Cointegrating Vector Estimation

(1) Fed funds rate(+); Log-transformed Industrial Production(+); U3(-)

Number of Observations = 293, Lags = 3

$U_t^- = 22.03 + 73.73^{***} Y_{t-3}^+ - 37.55 R_{t-3}^+ - 0.06\tau$

Maximum rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	21	556.1052	.	106.6691	29.68
1	26	593.573	0.22567	31.7334	15.41
2	29	609.1937	0.10114	**0.4921***	3.76
3	30	609.4397	0.00168		

(2) Fed funds rate(+); Log-transformed Industrial Production(-); U3(+)

Number of Observations = 293, Lags = 3

$U_t^+ = 0.87 + 27.14^{***} Y_{t-3}^- + 11.62 R_{t-3}^+ + 0.05\tau$

Maximum rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	21	530.7813	.	132.7072	29.68
1	26	580.1955	0.2863	33.8787	15.41
2	29	597.0741	0.10882	**0.1215***	3.76
3	30	597.1349	0.00041		

(3) Fed funds rate(-); Log-transformed Industrial Production(+); U3(-)

Number of Observations = 295, Lags = 1

$U_t^- = -14.08 - 33.17^{***} Y_{t-1}^+ + 30.18^{***} R_{t-1}^- - 0.04\tau$

Maximum rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	3	275.0019	.	310.493	29.68
1	8	393.8696	0.55331	72.7575	15.41
2	11	430.2022	0.21833	**0.0924***	3.76
3	12	430.2484	0.00031		

(4) Fed funds rate(-); Log-transformed Industrial Production(-); U3(+)

Number of Observations = 289, Lags = 7

$U_t^+ = 3.73 + 20.28^{***} Y_{t-7}^- - 42.61^{***} R_{t-7}^- + 0.037\tau$

Maximum rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	57	438.0182	.	90.8728	29.68
1	62	467.6722	0.18553	31.5648	15.41
2	65	483.4536	0.10346	**0.0020***	3.76
3	66	483.4546	0.00001		

Note: * indicates statistical significance. The number of observations is 289 for the period from July, 1989 to July, 2013. The number of lags is six.

The empirical results imply that it is prominent to understand asymmetry when dealing with details in the effectiveness of policies. In investigating a monetary policy's effectiveness, the results show that it is necessary to incorporate asymmetry in estimating a long-run equilibrium relationship. Long-lasting nominal rigidity and membership effects are consistent with the asymmetric characteristics of unemployment, as argued by Blanchard and Summers (1986). For instance, they show that the job inflow rate has accounted for a significant amount of increases in unemployment during recessions but the opposite is not true. In order to model this proven long-run equilibrium relationship and the short-run dynamics, I build a vector error correction model such as,

$$M_t = \Gamma Z_{t-\alpha} + \Theta \triangle M_{t-\alpha} + \Xi_t \tag{7}$$

where M_t represents a three-by-one vector of variables, U_t, Y_t, and the expected R_t. The vector error correction model is estimated with α lag as indicated on the right hand side by subscript $t-\alpha$. The residual estimated in the cointegrating vector estimation of Table 4 is denoted by $Z_{t-\alpha}$. The error correction coefficient from the long-run stochastic equilibrium are presented by a three-by-three matrix of Γ. The short-term effects of the differenced variables, $\triangle M_{t-\alpha}$, are noted by the matrix, θ. The estimation results will be provided in Section IV.

2. Short-run Analysis of the changes in Fed Funds Rate – Asymmetry and Surprise

The examination of the relationship from a short-term perspective deserves additional attention because policies aiming to boost aggregate demand are implemented with a short-term focus. This policy is intended to achieve the long-term goal. By observing the pattern of accumulated monetary shocks; for example, we can

take the falling long-term interest rate as signaling lower expected inflation induced by future economic slowdown. The agents' adjustment is evident through the settlement prices of fed funds futures when relevant economic news is released. If the monetary authorities understand this adjustment as expected, they are able to predict how the market will react to indicators and will be able to find room to implement a surprising event to distort the current state of the market.

Assuming that market participants are surprised by a shock which is unexpected, policy makers in monetary authorities such as Federal Reserve Bank prefer policies in a timely manner especially when the market is bear by an adverse productivity shock. Choosing the right timing is a key for lowering market interest rates as well as minimizing the cost of high inflation. Furthermore, the recent technological development in the information market - such as high-tech credit rationing, and easy access to high frequency data and international news in a stock market- encourages a more comprehensive look on the instant reaction of the market participants to an unexpected policy. In this section, I examine the effectiveness of monetary policy from the changes in unemployment and inflation according to the influence of effective fed funds rate surprises. I examine the joint behavior of the first-differenced official unemployment rate ($\triangle U3$), the inflation rate measured by the percentage changes in CPI from month ago ($\triangle \Pi$), and the expected and the unexpected of the changes in the fed funds rates ($\triangle R$). In Table 5, all decomposed series are shown to be stationary at 1% statistical significance.

〈Table 5〉 Augmented Dickey–Fuller Test for Series after Decomposition

Null Hypothesis: A series contains a unit root

Series	Test Statistic	Number of observations	P–value
△U3	-14.333***	293	0.0000
△U6	-11.750***	233	0.0000
△Job Hires	-21.463***	149	0.0000
△Job Loss	-22.112***	149	0.0000
△Job Openings	-17.702***	149	0.0000
△Log transformed Industrial Production, monthly	-13.605***	294	0.0000
△Percentage Changes in CPI for all items from year ago, monthly	-29.607***	294	0.0000
△Percentage Changes in CPI for all items less food and energy from month ago, monthly	-15.695***	294	0.0000
△Effective Federal Funds Rate, Expected	-25.026***	294	0.0000
△Effective Federal Funds Rate, Surprise	-37.334***	294	0.0000

Note: △ denotes that the series is first-differenced. The test reports one-sided critical values and p-values for the test of the null hypothesis against the alternative: $\beta<0$ of $\triangle y_t=\alpha+\beta y_{t-1}+\delta t+\epsilon_t$, which is equivalent of $\rho<1$ for the equation, $y_t=\alpha+\rho y_{t-1}+\delta t+u_t$. Critical values are found from the Augmented Dickey-Fuller test with the number of observations. Accordingly, *** indicates statistical significance at 1% level. P-value in the table is MacKinnon approximate p-value for the test statistic.

Kuttner (2001) showed that the market's reaction is asymmetrically sensitive to monetary surprises and the release of unemployment rate reports. Subsequently, with these decomposed factors, I test the pair-wise correlation to examine whether it is necessary to analyze the relationship according to the direction of monetary shocks to analyze the effect of a monetary policy. Table 6 presents the correlation matrix. The effects of monetary policy on U3, percentage changes in monthly CPI are significantly asymmetric because they are contingent on the direction of the surprising change in

the effective fed funds rate. The second triangular matrix in Table 6 shows that there is the significant increase in the unemployment rate when a contractional monetary policy is implemented by a sudden positive increase (0.0221) in the fed funds rate. In response to the shock, the movement of monthly percentage changes in the price level moves in the opposite direction by 0.0519. Generally, all results in Table 6 shows that market indicators move in the expected direction in response to an expansionary shock.

〈Table 6〉 Pairwise Correlations: Unemployment Rates, Percentage Change in CPI, monthly, and Monetary Policy Surprises

	ΔFF Rate, Surprise	ΔU3	ΔInflation Rate
ΔFF Rate	1.0000		
ΔU3	0.0047	1.0000	
ΔInflation Rate	0.0513	-0.1891	1.0000
	ΔFF Rate, Surprise+	ΔU3+	ΔInflation Rate−
ΔFF Rate, Surprise+	1.0000		
ΔU3+	0.0221	1.0000	
ΔInflation Rate -	0.0519	0.0096	1.0000
	ΔFF Rate, Surprise−	ΔU3−	ΔInflation Rate+
ΔFF Rate, Surprise-	1.0000		
ΔU3-	0.0399	1.0000	
ΔInflation Rate +	0.0117	0.0326	1.0000

Note: All inflation rates are calculated by taking percentage changes in the corresponding consumer price index for all urban areas from the Federal Reserve St. Louis. The first-difference data is obtained after decomposing a series into positive and negative components as suggested in the text. All pairwise correlation coefficients in the table are significant at 10% significant value.

However, this correlation does not consider that an adverse demand shock by the unexpected increase in the fed funds rate increases unemployment for a protracted period of time. In the following section, the ordinary least squares model is built to examine the protracted reaction of unemployment to the changes in fed funds rates by including both the expected interest rate changes and the unexpected in the regression

equation. The empirical model is consistently set up with the theoretical intuitions from Blanchard and Quah (1989) that identified the structure of the economy, according to long-run restrictions. They assumed that the structural inflexibility in a contract prevents an economy from returning to equilibrium having a persistent impact on unemployment after a few terms later. In contrast, after the monetary action is imposed for fighting against the inflation, it is considered as a demand-side disturbance effectively changes unemployment, in a relatively near-term with this effect disappearing over time. Thus, the channel that transmits the effects of monetary shocks to real sectors in the short term is described in Model (1).

Model (1):

$$\Delta U_{t+\alpha} = \beta_1 \Delta \Pi_t + \beta_2 \Delta R_t + \varepsilon_{t+\alpha} \tag{8}$$

where β_i denotes the corresponding coefficient of each regressor, the change in the inflation rate is denoted by $\Delta \Pi_t$ and the surprising change in the rate is denoted by ΔR_t. for the changes in the fed funds rate $\varepsilon_{t+\alpha}$ indicates the error term after α months later. I extend model (1) to develop the ordinary linear squares models with the decomposed short-run factors. In this decomposed setup, we are free to choose a sign-combination of the decomposed variable as long as we can estimate and interpret β_i, according to the sign-combination. The decomposed OLS models are set up such as

Model (2):

$$\triangle U^{-}_{t+\alpha} = \beta_{-,1} \Delta \Pi^{+}_{t} + \beta_{-,2} \triangle R^{-}_{t} + \varepsilon^{-}_{t+\alpha} \tag{9}$$

Model (3):

$$\triangle U^{+}_{t+\alpha} = \beta_{+,1} \Delta \Pi^{-}_{t} + \beta_{+,2} \triangle R^{-}_{t} + \varepsilon^{+}_{t+\alpha} \tag{10}$$

where the variable notation is consistent with the equations (4) to (6). In order to incorporate the potentially asymmetric responses of unemployment and inflation to surprises, I disaggregate the cases into an expansion ($\triangle U_{t+\alpha}^{-}$) in model (2) and a recession ($\triangle U_{t+\alpha}^{+}$) in model (3), according to the intentional directions of shocks, which are expansionary (a surprising decrease as noted by $\triangle R_t^{-}$) and contractionary (a surprising increase as noted by $\triangle R_t^{+}$), respectively. The differences in the inflation rate $\Delta \Pi_t$ is also decomposed into two different series, $\Delta \Pi_t^{+}$ and $\Delta \Pi_t^{-}$ and then included in the corresponding equation, according to the intentional direction of shocks in $\triangle R_t$

V. Results

1. Long-run Effects: Crouching Vector Error Correction Model

In this section, I examine the role of the accumulated changes in fed funds rate in determining the long-run behavior of economic indicators. Specifically, by exploiting the long-run stochastic component between macroeconomic indicators shown in the estimation of a cointegrating vector of Table 4, I estimate the crouching vector error correction model. The number of lags is selected by the results in the lag selection tes t[15]. Generally, changes in one indicator are only relevant to its own past. In Table 7, the effect of historical increases in fed funds rate represent the contractional monetary policy on economic variables. Pairs of M_t are ($U3^{-}$, Y^{+}, R^{+}) and ($U3^{+}$, Y^{-}, R^{+}). The crouching VECM estimation results summarized show that i) all variables have the significant short correction term from a long run equilibrium ii) the instant changes in industrial production are to decrease the unemployment rate a few periods

15) The test results are obtained by AIC, BIC criteria. The test results are available upon request.

later as shown in VECM I and II. The results in VECM II show the consistent evidence that the changes in the unemployment rate, △U3(+) have the negative impact on the decrease in production, $\bar{Y}$ (-1.247).

The short-run frictions associated in a labor market are based on the stickiness of job contracts and the inflexibility of labor supply decisions that require sufficient time. Blanchard and Quah (1989) emphasized the importance of disaggregative demand factors from the supply component in dealing with unemployment as a stationary process in interpreting the short-run frictions. In contrast, Blanchard and Summers (1986) showed that unemployment is sensitive to disturbances even in the long-run. According to their study, it relates to increasing returns to scale in an economy, in which changes in savings rates affect the output growth rate. The correlation between output and unemployment is mostly discussed based on historical trends and is shown to be negative in European countries.

〈Table 7〉 VECM Results: The Impact of Contractionary Monetary Policy by Historical Increases the Fed funds rate

Variables in VECM I	U3 (–)	L3. IP (+)	L3. R (+)
Cointegration Errors	-0.001***	-0.0114***	0.001***
	[0.0002]	[0.00113]	[0.0002]
L. △U3 (-)	-0.0215	-0.428	0.0678
	[0.0588]	[0.267]	[0.0548]
L4. △IP (+)	0.0427***	-0.165***	-0.0111
	[0.0130]	[0.059]	[0.0121]
L4. △R (+)	0.0827	-0.104	-0.483***
	[0.0549]	[0.250]	[0.0512]
Trend	0.000	0.000	0.000
	[0.0001]	[0.0003]	[0.0001]
Constant	-0.0461***	0.003	-0.002
	[0.0099]	[0.0449]	[0.0092]
Observations	291	291	291
Variables in VECM II	U3 (+)	L3. IP (–)	L3. R (+)
Cointegration Errors	-0.0049***	-0.0240***	0.000
	[0.0006]	[0.0026]	[0.0005]

L. △U3 (+)	0.091 [0.0588]	-1.247*** [0.243]	0.024 [0.0506]
L4. △IP (-)	0.0653*** [0.0141]	-0.113* [0.0584]	0.009 [0.0121]
L4. △R (+)	-0.013 [0.0595]	0.382 [0.246]	-0.498*** [0.0512]
Trend	0.000 [0.0001]	0.000 [0.0003]	0.000 [0.0001]
Constant	0.0312*** [0.0107]	-0.005 [0.0444]	-0.007 [0.00923]
Observations	291	291	291

Note: *** significant at 1% ** significant at 5%, * significant at 10%. Standard errors in brackets. L. indicates the variables with one-period lagged.

Table 8 summarizes the similar results by defining M_t with ($U3^-$, Y^+, R^-) and ($U3^+$, Y^-, R^-). In other words, accumulated decreases in fed funds rate represent the expansionary policy because there is a significant decrease in negative components in industrial production (i.e. IP increases). When the unemployment rate report shows higher-than-expected, it indicates that there was a substantial adverse shock to production (-0.412) several months ago.

〈Table 8〉 VECM Results: The impact of Expansionary Monetary Policy by Historical Decreases in the Fed funds rate

Variables in VECM III	U3 (–)	L. IP (+)	L. R (–)
Cointegration Errors	0.001 [0.0006]	0.0269*** [0.0025]	-0.0034*** [0.0009]
L. △U3 (-)	-0.019 [0.0586]	-0.764*** [0.253]	0.061 [0.0884]
L2. △IP (+)	0.014 [0.0135]	-0.127** [0.0585]	-0.018 [0.0204]
L2. △R (-)	-0.022 [0.0372]	0.386** [0.161]	-0.216*** [0.0561]
Trend	0.000 [0.0001]	0.000 [0.0002]	0.000 [0.0001]
Constant	-0.0449***	0.002	-0.003

	[0.0100]	[0.0434]	[0.0152]
Observations	293	293	293
Variables in VECM IV	U3 (+)	L7. IP (–)	L7. R (–)
Cointegration Errors	0.000	-0.0256***	0.0062***
	[0.000828]	[0.00321]	[0.00102]
L. △U3 (+)	0.324***	-0.412*	-0.091
	[0.0563]	[0.219]	[0.0694]
L8. △IP (-)	-0.012	-0.165***	-0.024
	[0.0154]	[0.0596]	[0.0189]
L8. △R (-)	-0.021	-0.492***	-0.138**
	[0.0464]	[0.180]	[0.0571]
Trend	0.000	0.000	0.000
	[0.0001]	[0.0003]	[0.0001]
Constant	0.0333***	0.002	0.007
	[0.0120]	[0.0464]	[0.0147]
Observations	287	287	287

Note: *** significant at 1% ** significant at 5%, * significant at 10%. Standard errors in brackets. L. indicates the variables with one-period lagged.

In contrast to sensitivity of industrial production with respect to the changes in short-term changes, the unemployment rate is shown to be inflexible. Broadly, the long run feature of the average total hours worked per week by private workers shown in Table 1 substantiates the nominal rigidity of the demand side. The value of leisure time; however, provides the structural evidence in the long-run, through abstracting the short-run friction in a labor market[16]. If the rigid contracts of firm's with the fixed working time, approximately forty hours per week, is already made, by fully accounting for the maximum labor hours, any significant disturbance to a labor market can only be attributable to structure changes on the supply side. Those

16) The historical estimation of the capital share of production which has been calculated as fixed around .34 in Real Business Cycle theory, is not relevant as evidence against the Phillips curve. It implies that $1-\alpha$, labor's share of income given a Cobb-Douglas-style production function, for example, has been set at .34 in Cooley and Prescott (1995) and Walsh (2003) as the benchmark. Since then, the steady-state value of the labor supply has been discussed as having a value of .3 (or the value of demanded leisure is .7) to represent the inelastic leisure time comprising eight hours of sleeping, eating, and resting on average.

amendments have been developed with the improved bargaining power of labor unions, which appear in the long-run. This rigidity in unemployment generates its insignificance with respect to the short run changes in a monetary policy in VECM results.

2. Short-run Effects: Nonlinear Ordinary Least Squares Model Results

The short-run impact of the changes in fed funds rate on economic variables is shown in the estimation results in Table 9. The estimated results of Model (1) present that there is a significant negative impact by the expected changes in the fed funds rate in lowering the unemployment rate instantly. The surprising terms have a bigger impact with its coefficient −0.416 but its statistical significance is rejected. Here, I suggest modifying Model (1) into a model that can incorporate the trade off relationship between price level changes and the unemployment rate.

When we study a nonlinear model by considering asymmetric effect of the changes in fed funds rate, surprising factors are emphasized. In the estimation results of Model (2) and (3), surprising FRB events, the sudden changes in the fed funds rate, have the significant effects on the benchmark unemployment rate, U3. The direction of the marginal effect of a monetary surprise in these models provides evidence that the sudden changes in the effective target rate move unemployment in the opposite direction. It is consistent with the description in Figure 1 that a monetary policy surprise implies the negative impact on the change in the unemployment rate.

〈Table 9〉 OLS Results of Surprises, and Expected terms in the Fed Funds Rate Changes, Percentage Change in Monthly CPI, and Unemployment

Variables	Model (1) ΔU3	Model (2) ΔU3−	Model (3) ΔU3+
L.Δ% Changes in monthly CPI from month ago (L.$\triangle\pi_t$)	-0.00362		
	[0.00695]		
L.ΔFF Rate, expected (L.$\triangle R_t^e$)	-0.252***		
	[0.0439]		
L.ΔFF Rate, surprise (L.$\triangle R_t^s$)	-0.416		
	[0.303]		
L.Δ% Changes in monthly CPI + (L.$\triangle\pi_t^+$)		-0.0341***	
		[0.00759]	
L.ΔFF Rate, expected (L.$\triangle R_t^e$)		0.0536	
		[0.0528]	
L.ΔFF Rate, surprise - (L.$\triangle R_t^-$)		0.736***	
		[0.270]	
L.Δ% Changes in monthly CPI - (L.$\triangle\pi_t^-$)			-0.365***
			[0.0609]
L.ΔFF Rate, expected (L.$\triangle R_t^e$)			0.00673
			[0.0165]
L.ΔFF Rate, surprise +(L.$\triangle R_t^+$)			0.457**
			[0.194]
Observations	294	295	295
R-squared	0.102	0.086	0.121

Note: *** significant at 1%, ** significant at 5%, * significant at 10%. Robust standard errors in brackets.

According to crouching OLS regression results, the directional implication of the monetary policy meets our expectations by the Phillips curve; a monetary shock involving an unanticipated increase in the rate, which is in association with lowering the inflation rates, is held at the cost of high unemployment. The marginal impact of lagged percentage changes in CPI at a monthly basis[17] is significant in generating a

change in unemployment and their relationship is negative. The CPI's negative changes imply a positive marginal impact on the positive changes in unemployment (Model (3)), and vice versa (Model (2)).

More importantly, the crouching OLS results of model (2) and (3) show that the size of a surprise's impact is different in changing inflation and unemployment rates according to a business cycle. From January 1989 to August 2013, an recessionary policy derives a greater impact (0.736) than an expansionary policy (0.457). I also examine the sign and statistical significance of the coefficients with various sample periods,[18] with respect to high volatility of macro variables during a recession. In these robustness checks, the results imply the consistent results on the general shape of the Phillips curve. Accordingly, the effect of the monetary policy was shown significant when it was implemented by FRB even in recent years during the Great Recession from 2007 to 2009.

The hysteresis effect supports the asymmetry by presenting the long-run evidence. If we incorporate a unit root contained in hourly wage and other employment indicators into the analysis, the positive relationship between wages and employment implied by the Phillips curve appears when the membership effect is enhanced by the asymmetric recognition of signals, meaning that it takes longer for outsiders to join firms than for insiders to leave firms. Membership in unemployment tends to remain long-lasting and broadly defined; the stronger marginal effect (73.6%) of expansionary events is shown in model (2) in contrast to the smaller marginal effect (45.7%) of contractional events shown in model (3). This asymmetric behavior of unemployment to the fed fund rate changes is often found in European countries in an inflexible labor market when

17) I also conducted the OLS regression with the inflation rate, calculated by percentage changes in CPI at the end of the year. The sign and magnitude of coefficients are consistent with Table 4. The test results are available upon request.

18) For controlling the effect of monetary policies according to high fluctuation of the rates over a recessionary period, I verify the model's robustness by running robust regressions with the sample before 2007. The results are available upon requests.

output returns to a level, where it was before the shock, unemployment fails to return to its original level. The rigidity of job contracts, as a part of the social safety net, is also one of the relevant factors in generating some lags after the direct impact from an adverse shock in cases when the terms and conditions of contracts are binding for a fixed period. In this protracted transition, the impact is sometimes distorted and under-estimated.

Ⅵ. Concluding Remarks

This paper provides the empirical evidence on the effect of changes in fed funds rate, which is statistically significant in the US economy in both long and short-run. In the long-run analysis, the crouching vector error correction model is used with the accumulation of decomposed shocks according to its direction. Particularly, this paper exploits fed funds futures rate to calibrate an asymmetry in a surprising monetary policy and explains its impact on unemployment in association with output growth. The hidden effects of monetary policy are discovered by a crouching model that allows nonlinearity in the estimation model by separating the stochastic component according to the optimal threshold.

In estimating the short-run components of surprises in changes of the effective fed funds rate, this paper uses the signs of policy-surprises or the directions of rate changes in other variables. The empirical analysis in this paper implies that a monetary policy can be effective in a short-term when it changes the interest rate surprisingly. Economic indicators are the first-difference in the unemployment rate and the monthly percentage changes in CPI. Using monthly data, the crouching ordinary least squares estimation results show the significance of unanticipated monetary shocks in impacting on real sectors in a relatively near term. The asymmetric relationship between

monetary surprise and output growth is highlighted because it enables us to verify the dynamics toward equilibrium. When an expansionary policy is made by lowering the fed funds rate, we expect to see the substantial decrease in the change in unemployment along with the change in inflation.

The limit of this analysis is its restricted focus on fed fund rate changes among many instruments in achieving the monetary authority's goal. This paper; however, can serve as a platform to encourage more research on a monetary policy and labor market policies during recessions. In addition, because the present discussion only applies to the US labor market, there is much room to extend the analysis on the impact of a monetary policy in the context of Lucas's analysis on the rational expectation and the design of relevant policies design to European or Asian markets. In these markets, long-run joint behavior may be vary and bring about different short-term reactions if there are strong membership effects in these countries, where the bargaining power of labor unions or the unemployment benefits are considerable.

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요 약

본 논문은 미국 연방 준비 은행의 금리 정책 충격 요소의 실효성을 실증 분석하기 위하여 미국 연방공개시장위원회(FOMC)의 금리 정책 중, 연방기금 금리를 조정하였을 때 노동시장 지표 및 생산성 지표에 유효한 영향력을 끼치고 있는지 장, 단기적 분석을 동시에 다루었다. 특히 경기의 비대칭성을 감안한 장, 단기 요소들을 분리하여 그 영향력의 크기와 방향을 분석하였다. 장기 효과 분석에서는 지표들의 장기 성분 간 비대칭 상관관계를 분석한 준좌벡터오차수정모형을 사용하여 통화정책의 장기적인 유효성을 보여주었다. 더불어 단기적인 이자율 변동 효과를 효과적으로 분석하기 위하여 연방기금 금리의 변동성에 대해 미리 시장에서 예측된 기대치를 제거하고 남은 "충격" 요소만을 추출하여 순수한 통화정책 실효성을 측정하였다. 실업률, 월별 물가 상승률, 통화 정책의 충격치의 양(+)과 음(－)의 요소들로 구성된 회귀 분석 결과는 단기적으로 시행된 통화 정책이 시장의 예상과 다르게 적용되었을 때 실물 경기에 상당한 영향력이 있는 것을 입증하였다.

※ 국문 색인어: 연방 기금 금리, 충격, 비대칭성, 준좌벡터오차수정모형