Empirical Philips Curve of United States from 1990 to 2015

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Tutorial WG02

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Abstract

The paper examines the Philips curve of United States from 1990 to 2015 quarterly. The empirical relation of inflation rate and unemployment rate will be assessed in various perspectives. The equations formulated by Phillips, Staiger, Friedman and Gali (2011) will be analyzed by testing serial correlation and heteroskedatsticity, chow test and goodness of fit.

1. Introduction

The Phillips curve relationship is one of the most controversial topic in macroeconomics. The original Phillips curve (Phillips, 1958) explains the relationship of unemployment and labor costs. Subsequently, adjusted equations were developed by Friedman and Phelps, Staiger and Gali. The present paper will examine Philips curve relationship between price inflation and unemployment in United States. Knowing the relationship of inflation and unemployment is extremely vital, in order to avoid hyperinflation of money becoming worthless or deflation. Therefore, Validity and effects of unemployment on inflation will be calculated by using Eviews and by the estimation output, valid model will be made. The analysis of Philips curve could lead to autocorrelation, but this problem will be solved by adding lagged variables. Problems of heteroskedasticity will be solved using white robust standard errors and furthermore, structural change will be also discussed shortly.

2. Theoretical Background and methods

In 1958, Phillips found the nonlinear relationship of money rate of change of wage rates and unemployment. He explained that when the demand for labour is high, there was fast increase in wages due to overbidding. Phillips concluded that except years of rapid change (structural changes), change of wage rate could be explained by unemployment level and rate of change of unemployment.

According to Staiger (1997), Friedman found that there will be increase in inflation when unemployment rate is below NAIRU. However, there happens to be lack of precision in estimating NAIRU since the confidence interval is too large. Fortunately, Gordan (1982) and Weiner (1993) suggested by assuming NAIRU constant over time, saying u^n has discrete jumps. In this paper, NAIRU, will be calculated will assumption that it is constant. Due to complexity in the final model, NAIRU was dropped with the assumption that it has shifted in the final model, and this idea of dropping NAIRU was proposed by Blanchard and Summers (1986). Gali noted that using lagged variables could smooth high volatility in quarter to quarter differences.

Writing in short the equations made from the people in last paragraph, firstly Friedman-Phelps made the equation, $\Delta\pi_t^p = \pi_t^p - \pi_{t-1}^p = \alpha + \beta(u_{t-1} - u^n) + \varepsilon_t$, Sub sequentially, Staiger (1997) introduced a model, containing control variables.

$$\Delta\pi_t^p = \pi_t^p - \pi_{t-1}^p = \alpha + \delta\,\pi_{t-1}^p + \beta_1(u_{t-1} - u^n) + \beta_2(u_{t-2} - u^n) + \gamma' X_t + \varepsilon_t$$

In this equation, NAIRU could be rewritten as $\mu = -(\beta_1 + \beta_2)\bar{u}$. Gali (2011) made the following adjusted model which is quite similar to model of Staiger and has improved some of the limitations of Staiger.

$$\pi_t^p = \alpha + \delta\,\pi_{t-1}^p + \beta(u_t - u^m) + \beta_1(u_{t-1} - u^n) + \beta_2(u_{t-2} - u^n) + \gamma' X_t + \varepsilon_t$$

u^n, which is NAIRU (level of unemployment) will be assumed to be constant over time in order to be calculated by ordinary least squares. According to Staiger (1997), NAIRU could be approximated by using this equation, $\pi_t^p - \pi_{t-1}^p = \alpha + \beta_1(u_{t-1} - u^n) + \beta_2(u_{t-2} - u^n) + \gamma' X_t + \varepsilon_t$. Staiger noted that precise knowledge of NAIRU is not vital in estimating inflation.

In this equation, NAIRU is $-\frac{\mu}{\beta_1+\beta_2}$. The control variables which consists X_t is crude oil import price, money supply and government expenditure. These variables can result in supply shock or have influence on exchange rate.

Autocorrelation is tested using Breusch-Godfrey test up to second order and if the autocorrelation is detected, lagged variables or control variables will be added. And, if there is no autocorrelation, Heteroskedasticity test will be tested using Breusch pagan test. Fox (1997) and Godfrey (2006) proposed that heteroskedasticity can cause biases in the standard errors and test statistics. If the null hypothesis is rejected, meaning there is heteroskedasticity, it will be solved using white robust standard errors. Chow forecast test and Chow structural stability test will be also used. Goodness of fit will be assessed based on adjusted R squared or by AIC in the case where the model are not comparable and they both solved the autocorrelation and heteroskedasticity problem by rejecting the null hypothesis. Since all of the variables are available quarterly there is no need to add seasonal dummy variables in the equation.

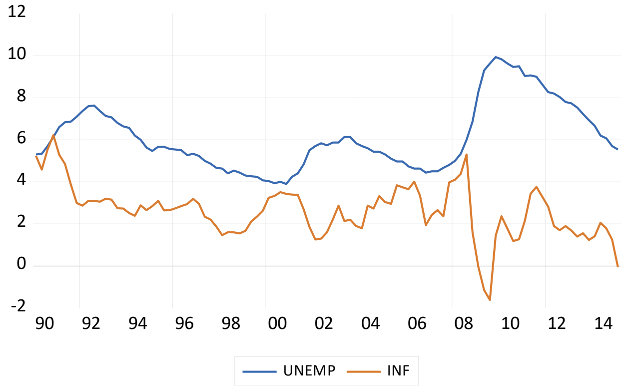
3. Empirical model and the data

I chose consumer price index (CPI), to measure inflation, in terms of annual growth rate. The data was collected in OECD and was seasonally adjusted. The data was selected from 1990 to 2015 in quarterly basis. At first by FRED, not seasonally adjusted data was chosen, but adding quarterly dummy variable was quite complicated so this growth rate was used.

Data of money supply, government expenditure unemployment rate, crude oil import price of United States from 1990 to 2015 was found in either Fred or OECD. Recent data was excluded because data of Covid Crisis had many outliers and un-expectable consequences so the actual is quite different from what was estimated. Therefore, the data was selected from 1990 to 2015 in quarterly basis.. For the unemployment rate, total persons in United States were taken into account. Harmonized unemployment rate was used, because it takes unemployed people proportional of the labour and it is seasonally adjusted, providing quarterly data. Because matching the frequency of the variables is extremely important, this data was used. At first attempt, focusing on male population of unemployment was tried, but the total population had similar trend. Thus, the final sample consists of total population.

Money supply and government expenditure caused asymmetric effects on supply shocks in Takashi Senda's (2001) study. Therefore, I chose crude oil import price, money supply and government expenditure to be control variables. In the appendix there is a variable NAIRU, and it is followed after lagged unemployment variable. NAIRU was assumed to be constant in all years and was calculated using OLS estimator in Table 1. Staiger said that NAIRU can be calculated having meaning as, $-\frac{\mu}{\beta_1+\beta_2}$. After putting coefficients of Table 1, 6.13725 was inserted in the excel file in all date.

4. Results



The figure displays unemployment and inflation evolution over time. From the feature, two measures display similar patterns dropping and fluctuating around depression years. The OLS estimated marginal effect of unemployment on inflation is significant (Table1) at -0.239324, (t=-3.151503, p=0.0021<0.01) from the estimated output of equation ($\pi_t^p = \alpha + \beta u_t + \varepsilon_t$). The Durbin Watson test of table 1 leads to positive autocorrelation. Therefore, LM test was conducted, but the probability of the Chi-Square was smaller than 0.05. Therefore, other model is needed. In order to add lagged unemployment-NAIRU, NAIRU needed to be calculated firstly by using table 2. According to Staiger it could be estimated by $-\frac{-0.582922}{-0.0.367441+0.462422} = 6.13725$. After inserting NAIRU value into the excel file, the estimation of Philips curve was conducted. In table 3-1(Friedman-Phelps equation), inflation equation has negative coefficient (-0.006340) on the current unemployment rate, which is consistent with the Gali. Unfortunately, equation by Friedman-Phelps ($\Delta\pi_t^p = \pi_t^p - \pi_{t-1}^p = \alpha + \beta(u_{t-1} - u^n) + \varepsilon_t$) had autocorrelation problem (Chi-squared p value 0.0451<0.05).

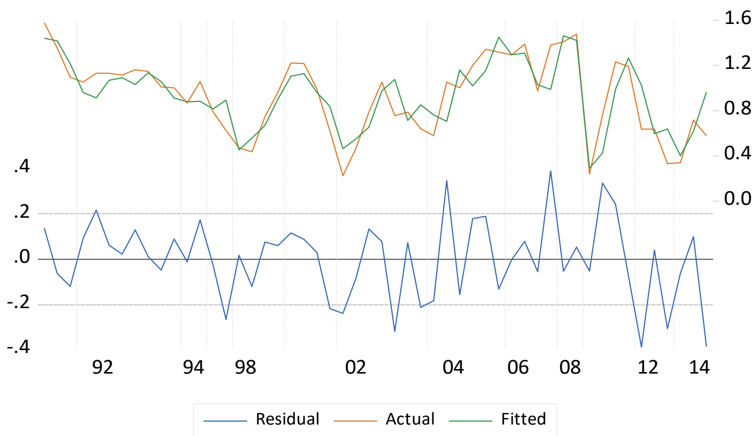
Starting from Staiger equation ($\Delta\pi_t^p = \pi_t^p - \pi_{t-1}^p = \alpha + \delta\,\pi_{t-1}^p + \beta_1(u_{t-1} - u^n) + \beta_2(u_{t-2} - u^n) + \gamma' X_t + \varepsilon_t$), control variables (money supply, government expenditure, oil price) was added. From the lagged inflation estimation output (Table4), oil had positive marginal effect of 0.003435(t=1.34, p>0.01) on inf-inf(-1). Estimated marginal effect of money supply was significant (p<0.01), however government expenditure had insignificant effect (p>0.01). In order to test the autocorrelation, Breusch-Godfrey Serial Correlation LM test was conducted and stagier equation had probability of Chi-square (0.0991>0.05), meaning there is no autocorrelation. OLS estimator is inefficient and no longer BLUE.

Gali ($\pi_t^p = \alpha + \delta\,\pi_{t-1}^p + \beta(u_t - u^m) + \beta_1(u_{t-1} - u^n) + \beta_2(u_{t-2} - u^n) + \gamma' X_t + \varepsilon_t$) developed an equation and it was also tested using eviews. Only money supply (p<0.01) had significant effect on inflation while oil price (p>0.01) and government expenditure (p>0.01) didn't. Also by Breush-Godfrey Serial Correlation LM test, autocorrelation was tested. P value of chi-squared was larger than 0.05, meaning no serial correlation. Both of the Gali equation with and without control variables had extremely low Chi Squared probability, close to zero, having heteroskedasticity in Breusch Pagan Godfrey test. Both of these equations were inefficient because although they solved autocorrelation problem they had heteroskedasticity.

When first making the model which doesn't have autocorrelation problem, many lagged variables were added. However Adding or dropping variables didn't solved heteroskedasticity. Huber white robust standard errors were used. At first, a model with control variables were tried(Inf=c+inf(-1)+inf(-2)+inf(-3)+unemp(-1)+unemp(-2)+oil+exp+m1. In the table 7, all the control variables have p value >0.05, meaning insignificant. The equation still doesn't have serial correlation but has heteroskedasticity problem (0.1790>0.05). Therefore, a model without control variables was made. The model was valid, efficient and BLUE (lm test chi-square>0.05, breusch pagan Godfrey test chi square >0.05). Among all these equations, only this equation is valid, neither having heteroskedasticity nor autocorrelation. There was no need to compare adjusted R-squared. By evaluating whether unemployment has negative coefficient, whether it solves autocorrelation and heteroskedasticity and by comparing adjusted R-squared(not here), the most optimal model was chosen, and when substituting the coefficients, the preferred model was the newly built equation without control variables (Money supply, Government expenditure, Oil price) (Table6).

INF = 0.828539159097 + 1.05034733914*INF(-1) - 0.365244482356*INF(-2) + 0.0566943137934*INF(-3) - 0.495883858586*UNEMP(-1) + 0.461926735748*UNEMP(-2)

This model is the most suitable equation which implies the inverse relation of the inflation and unemployment. It is surprising that no control variables were added.



From the feature, the fitted line looks quite similar with the actual line. However the fit doesn't seems to be well fitted in 1996-1998 and 2007-2008 areas. Dramatic change seems to have occurred in many parts, especially in 2007-2008 and it was due to financial crisis with lead to collapse of United States market. Structural breakdown was doubted and in order to check there was structural breakpoint, Chow test was used because both of the subsamples are large enough. And according to the appendix graph1-table, null was not rejected (0.0076<0.05) in 2009 meaning there was structural break.

5. Conclusion

The final model INF = C(1) + C(2)*INF(-1) + C(3)*INF(-2) + C(4)*INF(-3) + C(5)*UNEMP(-1) + C(6)*UNEMP(-2) might have some limitations, but this is the equation that is efficient, solving heteroskedasticity and autocorrelation problem. Except the structural break time series, the model I made seems to follow well the actual line. Hence, testing by Breusch-Godfrey serial correlation LM test and Breusch-Pagan-Godfrey test and structural break, we can conclude that unemployment is in the model of estimating inflation growth of United States from 1990 to 2015.

6. References

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Appendix

Table0

Chow Breakpoint Test: 2009Q1
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1990Q4 2015Q1

F-statistic	2.805000	Prob. F(6,86)	0.0153
Log likelihood ratio	17.51552	Prob. Chi-Square(6)	0.0076

Table 1 Estimation output of equation ($\pi_t^p = \alpha + \beta u_t + \varepsilon_t$)

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 10:53
Sample (adjusted): 1 101
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.067284	0.479799	8.477064	0.0000
UNEMP	-0.239324	0.075940	-3.151503	0.0021

R-squared	0.091176	Mean dependent var	2.602351
Adjusted R-squared	0.081996	S.D. dependent var	1.247018
S.E. of regression	1.194799	Akaike info criterion	3.213437
Sum squared resid	141.3270	Schwarz criterion	3.265221
Log likelihood	-160.2785	Hannan-Quinn criter.	3.234400
F-statistic	9.931972	Durbin-Watson stat	0.371848
Prob(F-statistic)	0.002149		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	87.49146	Prob. F(2,97)	0.0000
Obs*R-squared	64.97936	Prob. Chi-Square(2)	0.0000

Table 2

Dependent Variable: INF-INF(-1)
Method: Least Squares
Date: 06/17/21 Time: 10:58
Sample (adjusted): 3 101
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.582922	0.311243	-1.872886	0.0642
UNEMP(-1)	-0.367441	0.257082	-1.429278	0.1563
UNEMP(-2)	0.462422	0.251889	1.835812	0.0696
OIL	0.003435	0.002549	1.347553	0.1811
M1	-0.170348	0.054602	-3.119787	0.0024
EXP01	0.018619	0.039870	0.466988	0.6416

R-squared	0.166393	Mean dependent var	-0.046918
Adjusted R-squared	0.121575	S.D. dependent var	0.742014
S.E. of regression	0.695447	Akaike info criterion	2.170169
Sum squared resid	44.97919	Schwarz criterion	2.327449
Log likelihood	-101.4234	Hannan-Quinn criter.	2.233805
F-statistic	3.712664	Durbin-Watson stat	1.616805
Prob(F-statistic)	0.004149		

Table 3-1(Friedman)

Dependent Variable: INF-INF(-1)
Method: Least Squares
Date: 06/17/21 Time: 11:27
Sample (adjusted): 1990Q2 2015Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.053006	0.074443	-0.712031	0.4781
UNEMP-NAIRU	-0.006340	0.047380	-0.133820	0.8938

R-squared	0.000183	Mean dependent var	-0.052956
Adjusted R-squared	-0.010020	S.D. dependent var	0.740721
S.E. of regression	0.744423	Akaike info criterion	2.267383
Sum squared resid	54.30823	Schwarz criterion	2.319486
Log likelihood	-111.3691	Hannan-Quinn criter.	2.288470
F-statistic	0.017908	Durbin-Watson stat	1.555704
Prob(F-statistic)	0.893819		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	3.172107	Prob. F(2,96)	0.0463
Obs*R-squared	6.198899	Prob. Chi-Square(2)	0.0451

Dependent Variable: INF-INF(-1)
Method: Least Squares
Date: 06/17/21 Time: 12:46
Sample (adjusted): 1990Q2 2015Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014094	0.299795	-0.047011	0.9626
UNEMP	-0.006340	0.047380	-0.133820	0.8938

R-squared	0.000183	Mean dependent var	-0.052956
Adjusted R-squared	-0.010020	S.D. dependent var	0.740721
S.E. of regression	0.744423	Akaike info criterion	2.267383
Sum squared resid	54.30823	Schwarz criterion	2.319486
Log likelihood	-111.3691	Hannan-Quinn criter.	2.288470
F-statistic	0.017908	Durbin-Watson stat	1.555704
Prob(F-statistic)	0.893819		

Table 4 Staiger

Dependent Variable: INF-INF(-1)
Method: Least Squares
Date: 06/17/21 Time: 11:28
Sample (adjusted): 1990Q3 2015Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.94E-06	0.156656	-3.15E-05	1.0000
UNEMP(-1)-NAIRU	-0.367441	0.257082	-1.429278	0.1563
UNEMP(-2)-NAIRU	0.462422	0.251889	1.835812	0.0696
OIL	0.003435	0.002549	1.347553	0.1811
M1	-0.170348	0.054602	-3.119787	0.0024
EXP01	0.018619	0.039870	0.466988	0.6416

R-squared	0.166393	Mean dependent var	-0.046918
Adjusted R-squared	0.121575	S.D. dependent var	0.742014
S.E. of regression	0.695447	Akaike info criterion	2.170169
Sum squared resid	44.97919	Schwarz criterion	2.327449
Log likelihood	-101.4234	Hannan-Quinn criter.	2.233805
F-statistic	3.712664	Durbin-Watson stat	1.616805
Prob(F-statistic)	0.004149		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.228411	Prob. F(2,91)	0.1135
Obs*R-squared	4.622251	Prob. Chi-Square(2)	0.0991

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	3.736931	Prob. F(5,93)	0.0040
Obs*R-squared	16.56253	Prob. Chi-Square(5)	0.0054
Scaled explained SS	38.15803	Prob. Chi-Square(5)	0.0000

Table 5-1 Gali with X_t

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 11:30
Sample (adjusted): 1990Q2 2015Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.349014	0.219005	1.593637	0.1144
INF(-1)	0.851152	0.060542	14.05888	0.0000
UNEMP-NAIRU	-0.319821	0.247625	-1.291550	0.1997
UNEMP(-1)-NAIRU	0.345487	0.243263	1.420220	0.1589
OIL	0.003847	0.002453	1.568264	0.1202
M1	-0.144225	0.055806	-2.584388	0.0113
EXP01	0.002483	0.038466	0.064541	0.9487

R-squared	0.710431	Mean dependent var	2.576046
Adjusted R-squared	0.691749	S.D. dependent var	1.224813
S.E. of regression	0.680021	Akaike info criterion	2.134042
Sum squared resid	43.00582	Schwarz criterion	2.316404
Log likelihood	-99.70212	Hannan-Quinn criter.	2.207848
F-statistic	38.02775	Durbin-Watson stat	1.573971
Prob(F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.897510	Prob. F(2,91)	0.0603
Obs*R-squared	5.986899	Prob. Chi-Square(2)	0.0501

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	6.908847	Prob. F(6,93)	0.0000
Obs*R-squared	30.83089	Prob. Chi-Square(6)	0.0000
Scaled explained SS	52.83600	Prob. Chi-Square(6)	0.0000

Table 5 -1 Gali without X_t

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 11:29
Sample (adjusted): 1990Q2 2015Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.421189	0.174648	2.411642	0.0178
INF(-1)	0.819949	0.060963	13.44991	0.0000
UNEMP-NAIRU	-0.508106	0.236259	-2.150636	0.0340
UNEMP(-1)-NAIRU	0.469501	0.238294	1.970254	0.0517

R-squared	0.684352	Mean dependent var	2.576046
Adjusted R-squared	0.674488	S.D. dependent var	1.224813
S.E. of regression	0.698801	Akaike info criterion	2.160275
Sum squared resid	46.87894	Schwarz criterion	2.264482
Log likelihood	-104.0138	Hannan-Quinn criter.	2.202450
F-statistic	69.37869	Durbin-Watson stat	1.565835
Prob(F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.936363	Prob. F(2,94)	0.0579
Obs*R-squared	5.880211	Prob. Chi-Square(2)	0.0529

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	7.553656	Prob. F(3,96)	0.0001
Obs*R-squared	19.09724	Prob. Chi-Square(3)	0.0003
Scaled explained SS	51.06305	Prob. Chi-Square(3)	0.0000

Table 6 New model

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 12:05
Sample (adjusted): 1990Q4 2015Q1
Included observations: 98 after adjustments
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.828539	0.346672	2.389983	0.0189
INF(-1)	1.050347	0.145505	7.218639	0.0000
INF(-2)	-0.365244	0.123086	-2.967387	0.0038
INF(-3)	0.056694	0.097481	0.581593	0.5623
UNEMP(-1)	-0.495884	0.367062	-1.350954	0.1800
UNEMP(-2)	0.461927	0.357736	1.291251	0.1999

R-squared	0.707982	Mean dependent var	2.525384
Adjusted R-squared	0.692111	S.D. dependent var	1.181848
S.E. of regression	0.655781	Akaike info criterion	2.053290
Sum squared resid	39.56446	Schwarz criterion	2.211553
Log likelihood	-94.61120	Hannan-Quinn criter.	2.117304
F-statistic	44.60975	Durbin-Watson stat	1.966682
Prob(F-statistic)	0.000000	Wald F-statistic	19.79605
Prob(Wald F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	2.315326	Prob. F(3,89)	0.0812
Obs*R-squared	7.094679	Prob. Chi-Square(3)	0.0689

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/17/21 Time: 14:09
Sample: 1990Q4 2015Q1
Included observations: 98
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.158246	0.519075	0.304861	0.7612
INF(-1)	0.592724	0.336296	1.762505	0.0814
INF(-2)	-1.059264	0.488911	-2.166578	0.0329
INF(-3)	0.433124	0.255388	1.695944	0.0934
UNEMP(-1)	0.083812	0.263285	0.318330	0.7510
UNEMP(-2)	-0.096554	0.257743	-0.374615	0.7088
RESID(-1)	-0.613041	0.352686	-1.738208	0.0856
RESID(-2)	0.468086	0.316892	1.477116	0.1432
RESID(-3)	0.367233	0.160740	2.284635	0.0247

R-squared	0.072395	Mean dependent var	-1.07E-15
Adjusted R-squared	-0.010986	S.D. dependent var	0.638656
S.E. of regression	0.642154	Akaike info criterion	2.039365
Sum squared resid	36.70020	Schwarz criterion	2.276760
Log likelihood	-90.92890	Hannan-Quinn criter.	2.135387
F-statistic	0.868247	Durbin-Watson stat	1.767197
Prob(F-statistic)	0.546347		

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.640432	Prob. F(5,92)	0.1572
Obs*R-squared	8.021899	Prob. Chi-Square(5)	0.1550
Scaled explained SS	26.60814	Prob. Chi-Square(5)	0.0001

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/17/21 Time: 14:09
Sample: 1990Q4 2015Q1
Included observations: 98
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.175480	0.546898	0.320865	0.7490
INF(-1)	0.187704	0.318122	0.590038	0.5566
INF(-2)	-0.137782	0.207153	-0.665124	0.5076
INF(-3)	-0.053404	0.096225	-0.554989	0.5802
UNEMP(-1)	1.093531	0.782077	1.398239	0.1654
UNEMP(-2)	-1.054193	0.755190	-1.395931	0.1661

R-squared	0.081856	Mean dependent var	0.403719
Adjusted R-squared	0.031957	S.D. dependent var	1.113341
S.E. of regression	1.095407	Akaike info criterion	3.079399
Sum squared resid	110.3923	Schwarz criterion	3.237662
Log likelihood	-144.8906	Hannan-Quinn criter.	3.143413
F-statistic	1.640432	Durbin-Watson stat	1.995263
Prob(F-statistic)	0.157159		

New model with control variables

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 12:06
Sample (adjusted): 1990Q4 2015Q1
Included observations: 98 after adjustments
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.353427	0.394335	0.896259	0.3725
INF(-1)	1.058595	0.123888	8.544746	0.0000
INF(-2)	-0.344726	0.131829	-2.614948	0.0105
INF(-3)	0.072227	0.110485	0.653723	0.5150
UNEMP(-1)	-0.373633	0.345589	-1.081151	0.2826
UNEMP(-2)	0.400569	0.354844	1.128862	0.2620
OIL	0.002565	0.002873	0.892966	0.3743
EXP01	0.023010	0.051746	0.444678	0.6576
M1	-0.121883	0.085807	-1.420440	0.1590

R-squared	0.728995	Mean dependent var	2.525384
Adjusted R-squared	0.704635	S.D. dependent var	1.181848
S.E. of regression	0.642305	Akaike info criterion	2.039835
Sum squared resid	36.71744	Schwarz criterion	2.277230
Log likelihood	-90.95190	Hannan-Quinn criter.	2.135856
F-statistic	29.92591	Durbin-Watson stat	2.000312
Prob(F-statistic)	0.000000	Wald F-statistic	18.93926
Prob(Wald F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	1.509952	Prob. F(3,86)	0.2177
Obs*R-squared	4.903641	Prob. Chi-Square(3)	0.1790

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	3.586280	Prob. F(8,89)	0.0012
Obs*R-squared	23.89020	Prob. Chi-Square(8)	0.0024
Scaled explained SS	47.02168	Prob. Chi-Square(8)	0.0000

New model with only M1

Dependent Variable: INF
Method: Least Squares
Date: 06/17/21 Time: 13:04
Sample (adjusted): 1990Q4 2015Q1
Included observations: 98 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.421146	0.409348	1.028823	0.3063
INF(-1)	1.059660	0.100001	10.59648	0.0000
INF(-2)	-0.345376	0.141124	-2.447319	0.0163
INF(-3)	0.062367	0.102672	0.607436	0.5451
UNEMP(-1)	-0.345274	0.244091	-1.414529	0.1606
UNEMP(-2)	0.388332	0.239139	1.623875	0.1079
M1	-0.116726	0.050799	-2.297792	0.0239

R-squared	0.723996	Mean dependent var	2.525384
Adjusted R-squared	0.705797	S.D. dependent var	1.181848
S.E. of regression	0.641040	Akaike info criterion	2.017298
Sum squared resid	37.39480	Schwarz criterion	2.201939
Log likelihood	-91.84762	Hannan-Quinn criter.	2.091982
F-statistic	39.78414	Durbin-Watson stat	1.999107
Prob(F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 3 lags

F-statistic	1.315120	Prob. F(3,88)	0.2746
Obs*R-squared	4.205165	Prob. Chi-Square(3)	0.2401

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	2.582215	Prob. F(6,91)	0.0235
Obs*R-squared	14.25763	Prob. Chi-Square(6)	0.0269
Scaled explained SS	30.30452	Prob. Chi-Square(6)	0.0000