US Inflation 1980 - 2016. A Good Old Quantity Theory Approach

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A Good Old Quantity Theory Approach

This paper presents and discusses the econometric estimation of several models of inflation that follow the New Keynesian (NK) approach, and compares the results with those obtained with a model based on the quantity theory. The period of estimation is from the first quarter of 1980 until the fourth quarter of 2016. The main finding of the paper is that modeling inflation following a quantity theory approach produces a better overall explanation of the dynamics of the US inflation for the period under analysis than the ubiquitous New Keynesian models. Additionally, the quantity theory approach beats the New Keynesian models in offering a more coherent narrative of the relative deceleration that inflation has exhibited since the financial crisis (the so-called inflation puzzle). JEL N° E31, E52

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1.-Introduction

Central banks, many economists, and the economic-financial media have expressed their bewilderment that the US inflation rate has remained so low, while the unemployment rate and other measures of slack in the economy have recovered substantially since the financial crisis worst years (2008-2010). A similar process has been observed in other advanced economies (Japan, EU, England, etc.). More generally, there is a concern among central bankers in advanced economies that the New Keynesian models to which they have pledged almost religious allegiance for more than twenty years, seem out of touch with the dynamics of inflation.

This paper presents and discusses the econometric estimation of several models of inflation that follow the New Keynesian (NK) approach, and compares the results with those obtained with a model based on the quantity theory. The period of estimation is from the first quarter of 1980 (1980Q1) until the fourth quarter of 2016 (2016Q4). The main argument of the paper is that modeling inflation following a quantity theory approach produces a better overall explanation of the dynamics of the US inflation for the period under analysis than the ubiquitous New Keynesian models. Additionally, the quantity theory approach beats the New Keynesian models, offering a more coherent narrative of the relative deceleration that inflation has exhibited since the financial crisis.

The paper is organized in seven sections including this introduction. Section 2 describes the so called puzzle: that inflation after the peak of the financial crisis has remained at levels inconsistent with the prediction of New Keynesian type models that central banks relied on. Section 3 presents the results obtained from the econometric estimation of New Keynesian models with forward and backward inflation (hybrid Phillips curve models). Section 4 examines the econometric estimation of backward-looking New Keynesian models. In section 5 a New Keynesian model that directly relates inflation with the short-term interest rate manipulated by the Federal Reserve (FED) is introduced. Section 6 examines the model based on the quantity theory. In sections 3, 4, 5, and 6 the capacity of these models to explain the apparent puzzle is discussed. Section 7 presents the main conclusions of the study.

The hybrid models were estimated using the generalized methods of moments (GMM), with several lags of the inflation rate and the economy slack variables as instruments. These models were evaluated by the sign and statistical significance of their coefficents.

The backward-looking models are specified as autoregressive distributed lags (ADL) models and estimated by ordinary least squares (OLS), initially with four lags of the inflation rate, and the current and four lags of the explanatory variables. This general model was trimmed eliminating gradually the coefficients with the highest p-values. The trimmed models are presented and examined. Because the models examined are non-nested, the adjusted R squared is used as a criterion for comparison. In addition, sign and statistical significance of the coefficients of the explanatory variables, together with the Bai-Perron test for structural stability are used to compare the models.

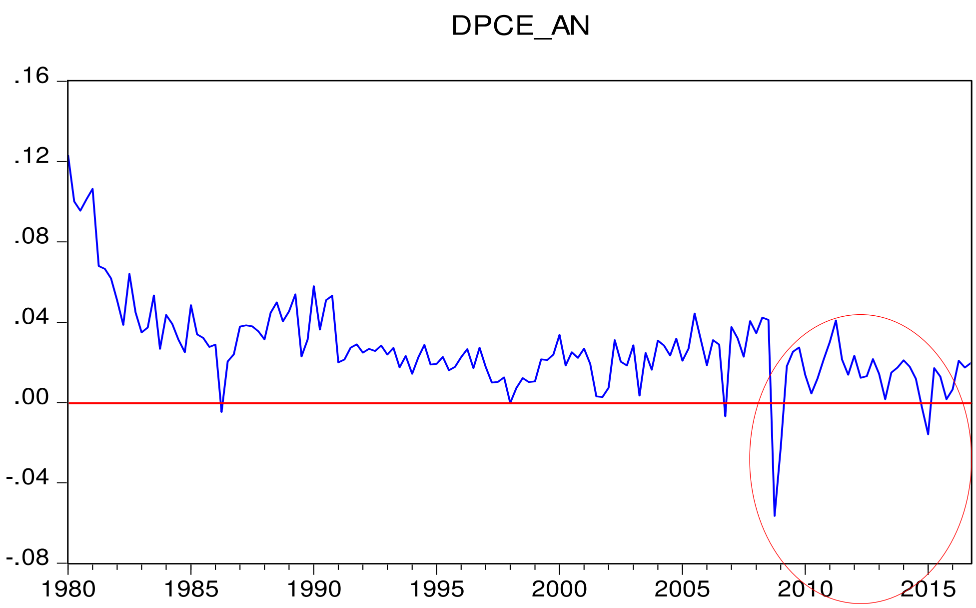
All data information was obtained from the Federal Reserve Bank of St. Louis database (FRED).

2.-The nature of the puzzle

In a recent article, the Financial Times (Chris Giles, October 11, 2017) has documented the concerns of several central bankers and economists, regarding the diminished capacity of the apparently almighty monetary authorities to produce a rate of inflation close to its target (2 percent). The article also points to the failure of the standard Phillips curve models used by the central banks to explain the subdued rate of inflation. The failure of central banks to produce targeted inflation rates and the weakness of their models looks particularly disappointing in light of the New Keynesian claim that central banks can anchor expectations at whatever level they fix their target.

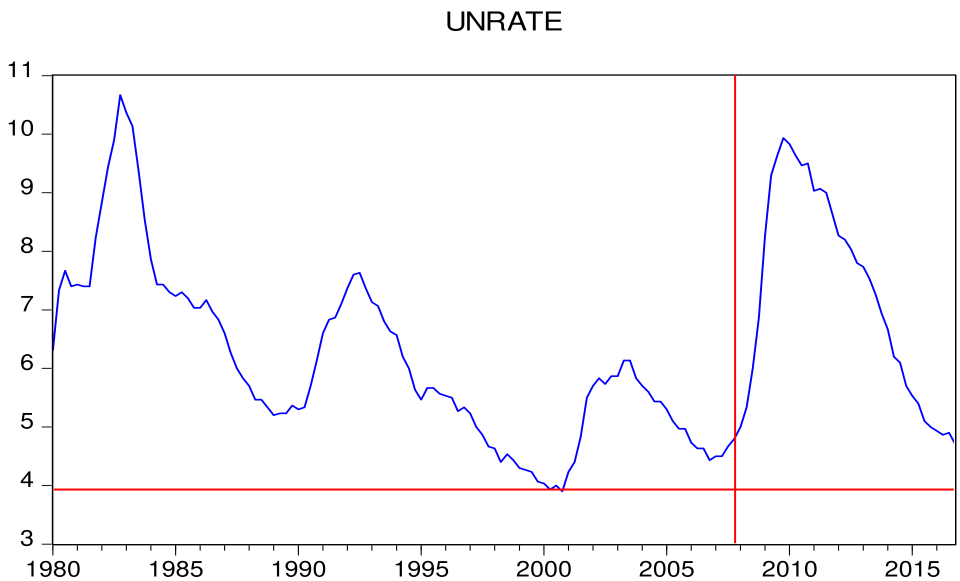
Graph 1 shows that effectively, the US inflation rate measured as the annualized quarterly change in the logarithm of the Personal Consumption Expenditure Index (PCE), has been relatively low since the financial crisis compared to the values observed between 2000-2008Q3.

Graph 1

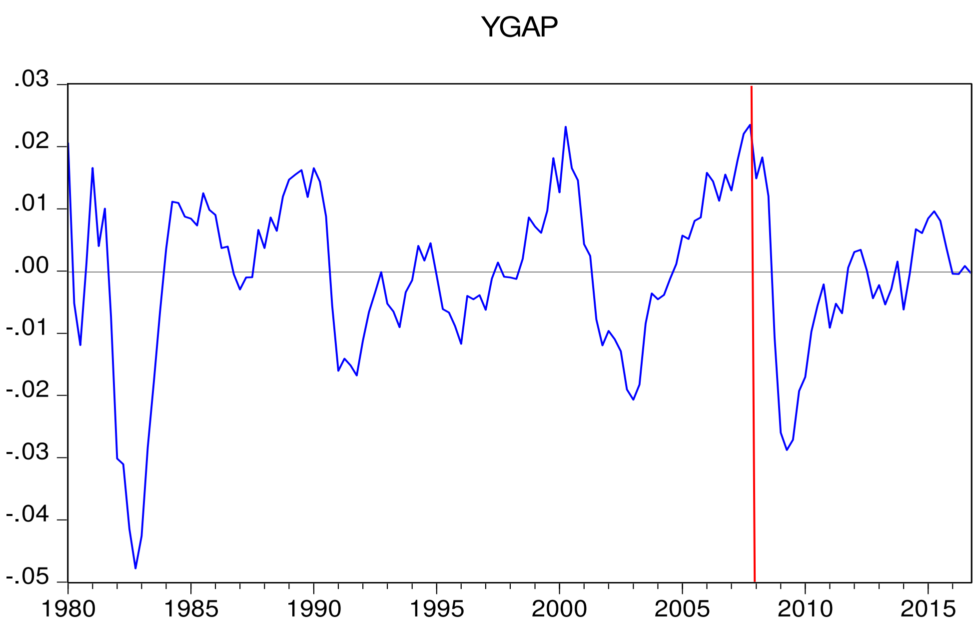


This relatively low inflation rate has persisted despite a substantial, albeit gradual, reduction in the quarterly unemployment rate as documented in graph 2, the disappearance of the negative output gap (Graph 3), and the steep reduction in the Federal Funds rate towards the zero lower bound (Graph 4).

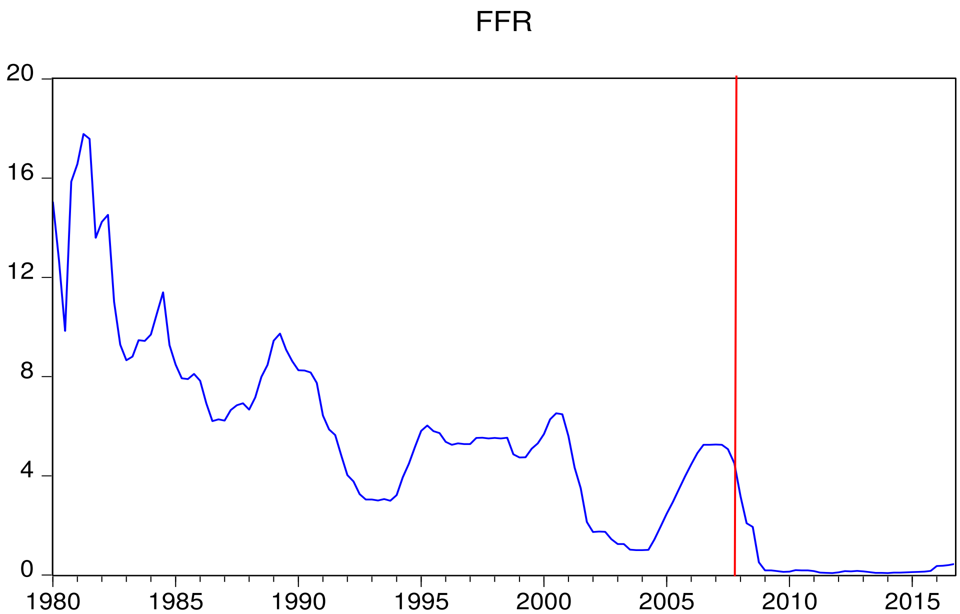
Graph 2



Graph 3



Graph 4



However, Joseph Gagnon from the Peterson Institute in a note published on November 17, 2017 holds that "Yet inflation is behaving exactly as the Phillips curve would predict. The decline in the US unemployment rate is too recent and too small to have caused any significant rise in inflation to date." Gagnon argues that the true puzzle is the lack of downward movement in inflation in 2010-14, when the economy was far below potential employment. But this puzzle can be explained by recurring to a non-linear Phillips curve that captures the downward rigidity of wages and prices.

But as Claudio Borio from de Bank of International Settlements (BIS) states in the FT article (2017), "the link between measures of domestic slack and inflation has proved rather weak and elusive for at least a couple of decades". This article shares the view of Mr. Borio, although for different reasons, regarding the poor performance of the Phillips curve type models to capture the dynamics of inflation in the US economy.

3. Estimation of hybrid Phillips curve models

This section presents the econometric estimation of two hybrid Phillips curve models, that is models that include as explanatory variables the inflation rate forward one period and the inflation rate backward one period. Both versions use as the dependent variable the quarter to quarter difference of the logarithm of the Personal Consumer Expenditure index (DPCE). This variable according to the Augmented Dickey-Fuller (ADF) test is a stationary variable, either with a constant or a constant plus a deterministic trend.

The first model employs as a measure of the slack in the economy the output gap. The output gap is defined as the difference between the logarithm of observed real GDP and the logarithm of trend real GDP obtained through the Hodrick-Prescott filter (HP filter). The results of this model estimated by GMM are shown in table 1.

Table 1

Dependent Variable: DPCE
Method: Generalized Method of Moments
Date: 01/07/18 Time: 12:08
Sample: 1980Q1 2016Q4
Included observations: 148
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: DPCE(-2) DPCE(-3) DPCE(-4) YGAP(-1) YGAP(-2) YGAP(-3) YGAP(-4)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000415	0.000334	1.242413	0.2161
DPCE(1)	0.265456	0.256875	1.033406	0.3031
DPCE(-1)	0.658257	0.214544	3.068164	0.0026
YGAP	-0.002860	0.015145	-0.188832	0.8505

R-squared	0.633608	Mean dependent var	0.006734
Adjusted R-squared	0.625975	S.D. dependent var	0.005357
S.E. of regression	0.003276	Sum squared resid	0.001546
Durbin-Watson stat	2.818081	J-statistic	7.644599
Instrument rank	8	Prob(J-statistic)	0.105500

In this model the coefficient of the output gap is negative but not statistically different from zero. The forward inflation rate is also not statistically significant. Only the coefficient of the backward inflation rate is statistically relevant. This is consistent with the results reported by Fuhrer and Rudebusch according to which future inflation has a reduce role once lagged inflation is added to the Phillips curve (see Walsh, 2010).

Table 2 shows the estimation by GMM of a model that contains the real marginal cost as the measure of slack in the economy. The real marginal cost is measured as the real wage multiplied by the labor share in total income (Walsh, 2017) [1].

[1] The estimation is for the period 1980Q1-2014Q4 due to the limited availability of the figures of the labor share. Additionally, the labor share figures are only available on an annual basis; therefore the same annual figure is repeated for every quarter of a given year.

Table 2

Dependent Variable: DPCE
Method: Generalized Method of Moments
Date: 01/07/18 Time: 16:59
Sample (adjusted): 1981Q1 2014Q4
Included observations: 136 after adjustments
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: DPCE(-2) DPCE(-3) DPCE(-4) MC(-1) MC(-2) MC(-3) MC(-4)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002072	0.004418	0.469029	0.6398
DPCE(1)	0.671842	0.255833	2.626093	0.0097
DPCE(-1)	0.302067	0.156835	1.926018	0.0563
MC	-9.39E-06	2.01E-05	-0.467254	0.6411

R-squared	0.448880	Mean dependent var	0.006439
Adjusted R-squared	0.436355	S.D. dependent var	0.004386
S.E. of regression	0.003293	Sum squared resid	0.001431
Durbin-Watson stat	2.888918	J-statistic	8.673105
Instrument rank	8	Prob(J-statistic)	0.069810

In this hybrid model, both the future inflation DPCE(1) and the past inflation DPCE(-1) are statistically significant. It is important to note that in this equation, in contrast to the previous one, the coefficient of the forward inflation more than doubles the one for the past inflation. This is consistent with the findings of some researchers that hold, that the higher weight on lagged inflation obtained when the output gap is used reflects the fact that this gap may be a poor proxy for real marginal cost (Walsh, 2010). In this model, however, the coefficient of the real marginal cost is negative though not statistically significant.

Overall, the main weakness of the hybrid models is the lack of statistical significance of the variables used to capture the degree of slack in the economy. This lack of significance of the variables that capture the influence of economic activity on inflation, makes them unfit to understand the apparent inflation puzzle.

4.- Estimation of Phillips curve backward-looking models

In this section the econometric estimation of two versions of the backward-looking Phillips curve are presented. Both versions use as dependent variable the quarter to quarter difference of the logarithm of the Personal Consumer Expenditure index (DPCE).

The first model employs as a measure of the economy slack the quarterly unemployment rate (UNRATE). The ADF indicates that this variable is stationary. The general model includes four lags of DCPE and the current and four lags of UNRATE. This general model is pruned eliminating gradually the coefficients with the highest p-values. Table 3 presents the results of the trimmed model:

Table 3

Dependent Variable: DPCE
Method: Least Squares
Date: 11/22/17 Time: 16:08
Sample: 1980Q1 2016Q4
Included observations: 148
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002315	0.000900	2.573240	0.0111
DPCE(-1)	0.483144	0.068324	7.071340	0.0000
DPCE(-3)	0.337140	0.068875	4.894932	0.0000
UNRATE	-0.001940	0.000884	-2.194941	0.0298
UNRATE(-2)	0.003772	0.001393	2.707648	0.0076
UNRATE(-4)	-0.002037	0.000633	-3.218129	0.0016

R-squared	0.634667	Mean dependent var	0.006734
Adjusted R-squared	0.621804	S.D. dependent var	0.005357
S.E. of regression	0.003295	Akaike info criterion	-8.553395
Sum squared resid	0.001541	Schwarz criterion	-8.431886
Log likelihood	638.9512	Hannan-Quinn criter.	-8.504026
F-statistic	49.33738	Durbin-Watson stat	1.985532
Prob(F-statistic)	0.000000	Wald F-statistic	36.77745
Prob(Wald F-statistic)	0.000000		

The overall fit of the equation measured by the adjusted R squared is 0.62. The inflation rate lagged one quarter and three quarters which combined summed to 0.82, capture the relatively high persistence of the inflation rate. The contemporaneous unemployment rate (UNRATE) and its fourth lag exhibit the expected negative sign, but UNRATE(-2) shows a positive sign. In fact the null hypothesis that the sum of the coefficients of UNRATE, UNRATE(-2), and UNRATE(-4) is zero cannot be rejected at standard levels of significance. Thus, the unemployment rate does not seem to have a durable effect on inflation. Additionally, the Bai-Perron sequential test for the detection of multiple structural breaks indicates that the model is not stable during the period under analysis (Table 3a).

Table 3a

Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 12/20/17 Time: 18:06
Sample: 1980Q1 2016Q4
Included observations: 148
Breaking variables: C DPCE(-1) DPCE(-3) UNRATE UNRATE(-2) UNRATE(-4)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined breaks: 4

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	6.133349	36.80009	20.08
1 vs. 2 *	6.682733	40.09640	22.11
2 vs. 3 *	5.158107	30.94864	23.04
3 vs. 4 *	11.19628	67.17771	23.77
4 vs. 5	3.115681	18.69409	24.43

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008Q4	1985Q3
2	2002Q2	1996Q3
3	1991Q1	2002Q2
4	1996Q3	2008Q4

In contrast to the argument of Gagnon, however, a significant threshold is not found when DPCE(-1) is used as the indicator variable for the detection of a threshold.

This basic model was modified to include the quarter to quarter variation of a global price index of industrial materials (DGPIMI). The results of a model with DGPIMI, DGPIMI(-3), and DGPIMI(-4) are shown in the appendix. The model exhibits a lower adjusted R squared than the original model (0.52 vs 0.62), but a better (lower) Schwarz criterion. However, this models still presents four structural breaks according to the Bai-Perron sequential tests, and the sum of the coefficients of UNRATE, UNRATE(-2), UNRATE(-4) is not statistically different from zero.

The second Phillips curve type model estimated uses the output gap (YGAP) as a measure of the economy slack. After starting with a general specification as in the case of the unemployment rate based Phillips curve, the pruned model obtained is shown in table 4.

Table 4

Dependent Variable: DPCE
Method: Least Squares
Date: 12/18/17 Time: 15:52
Sample: 1980Q1 2016Q4
Included observations: 148
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001183	0.000448	2.641236	0.0092
DPCE(-1)	0.484140	0.067550	7.167098	0.0000
DPCE(-3)	0.314229	0.065938	4.765531	0.0000
YGAP	0.099619	0.043751	2.276982	0.0243
YGAP(-2)	-0.137665	0.058955	-2.335096	0.0209
YGAP(-4)	0.076881	0.030923	2.486252	0.0141

R-squared	0.635963	Mean dependent var	0.006734
Adjusted R-squared	0.623145	S.D. dependent var	0.005357
S.E. of regression	0.003289	Akaike info criterion	-8.556947
Sum squared resid	0.001536	Schwarz criterion	-8.435439
Log likelihood	639.2141	Hannan-Quinn criter.	-8.507579
F-statistic	49.61401	Durbin-Watson stat	1.994960
Prob(F-statistic)	0.000000	Wald F-statistic	45.88367
Prob(Wald F-statistic)	0.000000		

The overall fit of the equation measured by the adjusted R squared is equal to the previous model (0.62). But in this case, the sum of the coefficients of YGAP, YGAP(-2), and YGAP(-4) is positive as expected and statistically different from zero at the standard levels of significance. Thus, the output gap does have a durable effect on the inflation rate in contrast to the unemployment rate. However, similar to the previous case, the Bai-Perron sequential test indicates the presence of instability in this specification (Table 4a). Also in this model, there is no sign of a threshold when DPCE(-1) is used as the indicator variable for the threshold.

Table 4a

Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 12/20/17 Time: 18:44
Sample: 1980Q1 2016Q4
Included observations: 148
Breaking variables: C DPCE(-1) DPCE(-3) YGAP YGAP(-2) YGAP(-4)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined breaks: 4

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.499160	26.99496	20.08
1 vs. 2 *	8.070724	48.42435	22.11
2 vs. 3 *	4.127090	24.76254	23.04
3 vs. 4 *	6.044090	36.26454	23.77
4 vs. 5	1.282183	7.693100	24.43

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008Q4	1991Q1
2	2002Q2	1996Q3
3	1991Q1	2002Q2
4	1996Q3	2008Q4

This basic model was modified to include the quarterly variation of a global price index of industrial materials (DGPIMI). The results of a model with DGPIMI and DGPIMI(-3) are shown in the appendix. For this model the adjusted R squared is lower than the one in the basic model (0.57 vs 0.62), but the Schwarz criterion is better (lower). The inclusion of the variations of the index for industrial materials makes the model stable according to the Bai-Perron sequential test. However, the sum of the coefficients of YGAP and YGAP(-2) is not statistically different from zero, thus in this model the output gap does not have a durable influence on inflation.

The specific observation of Gagnon (2017) that the reduction of the unemployment rate to pre-crisis levels has been relatively small and recent does not solve the more general and fundamental problem of the weaknesses of the backward-looking Phillips curve models to fit the data for the period 1980Q1-2016Q4. In addition, the output gap that might have a more durable impact on inflation that the unemployment rate, moved rapidly towards cero after it touched its more negative value in 2009Q2 (Graph 3).

5.- Estimation of a New Keynesian monetary model of inflation

In the New Keynesian (NK) models the key monetary variable that is manipulated to achieve the target inflation rate is a short-run interest rate, in the US case the Federal Funds rate (FFR). Hence, in this section an econometric model that relates directly the Federal Funds rate with the inflation rate is estimated. The Dickey-Fuller test indicates that, including a deterministic trend, the Federal Funds rate is a stationary variable. The estimation of a trimmed version of a more general model is presented in table 5.

Table 5

Dependent Variable: DPCE
Method: Least Squares
Date: 11/22/17 Time: 21:46
Sample: 1980Q1 2016Q4
Included observations: 148
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001161	0.000505	2.297943	0.0230
DPCE(-1)	0.421603	0.086688	4.863429	0.0000
DPCE(-3)	0.211273	0.106296	1.987588	0.0488
FFR	0.000646	0.000267	2.422947	0.0166
FFR(-2)	-0.000395	0.000171	-2.308428	0.0224

R-squared	0.630393	Mean dependent var	0.006734
Adjusted R-squared	0.620054	S.D. dependent var	0.005357
S.E. of regression	0.003302	Akaike info criterion	-8.555276
Sum squared resid	0.001559	Schwarz criterion	-8.454019
Log likelihood	638.0904	Hannan-Quinn criter.	-8.514136
F-statistic	60.97434	Durbin-Watson stat	1.948527
Prob(F-statistic)	0.000000	Wald F-statistic	37.65400
Prob(Wald F-statistic)	0.000000		

The overall fit of the model according to the adjusted R squared is 0.62, identical to the Phillips curve models. The contemporaneous value of FFR has a positive sign, but FFR(-2) has a negative sign. The sum of the two coefficients is positive contrary to what is expected (the price puzzle), but it is not statistically different from zero at the standard levels of significance (p-value=0.107). Hence, at the levels of significance commonly used, the Federal Funds rate does not have a durable influence on the inflation rate. If the standard significance levels are slightly relaxed, the Federal Funds rate would have a positive impact on inflation. Additionally, the sequential version of the Bai-Perron test detects the presence of two structural breaks (Table 5a).

Table 5a

Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 12/22/17 Time: 18:19
Sample: 1980Q1 2016Q4
Included observations: 148
Breaking variables: C DPCE(-1) DPCE(-3) FFR FFR(-2)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey -West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined breaks: 2

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	11.73762	58.68809	18.23
1 vs. 2 *	6.176957	30.88478	19.91
2 vs. 3	3.866304	19.33152	20.99

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008Q4	2002Q2
2	2002Q2	2008Q4

A modified version of this basic model including the quarterly variation of a global price index of industrial materials (DGPIMI) is presented in the appendix. The model with DGPIMI, DGPIMI(-1), and DGPIMI(-3) has a lower adjusted R squared than the basic model (0.59 vs 0.62), but a better (lower) Schwarz criterion. The Bai-Perron sequential test detects one structural break, and the sum of the coefficients of FFR and FFR(-2) is positive, contrary to what is expected, and is statistically different from zero (the price puzzle).

Apart from the general problems of this version of the NK model to explain the dynamics of inflation for the period under analysis (1980Q1-2016Q4), it is quite evident that the steep reduction in the Federal Funds rate observed during and after the financial crisis (Graph 4) and the relative deceleration in the rate of inflation that occurred during this same period (Graph 1), does not fit well with the NK narrative.

6.- Estimation of a model based on the quantity theory

In contrast to the NK models that completely ignore money supply and money demand concentrating exclusively on a short-term interest rate, the good old quantity theory place special emphasis in money market equilibrium as a key factor to understand inflation dynamics.

This section starts exploring the possibility of a cointegration relationship between the price level and the money supply in terms of the narrow aggregate M1. The logarithm of the Personal Consumer Expenditure index is a stationary variable according to the ADF test. In contrast, the logarithm of M1 contains a unit root according to the ADF test, the ADF-GLS test, and a unit root test with one endogenous break. Therefore, it is not possible to establish a cointegration relation between these two variables for the period under analysis.

Given that the logarithm of the velocity of circulation of M1 also contains a unit root (according to the ADF test, the ADF-GLS test, and a unit root test with one endogenous break), a model in terms of quarter to quarter differences of the logarithm of PCE (DPCE), the logarithm of M1 (DM1), and the logarithm of the velocity of M1 (DM1V) was estimated. The results of a trimmed model are shown in table 6.

Table 6

Dependent Variable: DPCE
Method: Least Squares
Date: 11/23/17 Time: 19:43
Sample: 1980Q1 2016Q4
Included observations: 148
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000710	0.000477	1.489324	0.1386
DPCE(-1)	0.470029	0.064959	7.235758	0.0000
DPCE(-3)	0.320069	0.061429	5.210366	0.0000
DM1(-1)	0.028462	0.010294	2.765069	0.0065
DM1(-3)	0.014234	0.008358	1.703162	0.0907
DM1V	0.103259	0.037671	2.741070	0.0069
DM1V(-3)	-0.039966	0.023445	-1.704664	0.0905

R-squared	0.692020	Mean dependent var	0.006734
Adjusted R-squared	0.678914	S.D. dependent var	0.005357
S.E. of regression	0.003036	Akaike info criterion	-8.710653
Sum squared resid	0.001299	Schwarz criterion	-8.568893
Log likelihood	651.5883	Hannan-Quinn criter.	-8.653057
F-statistic	52.80354	Durbin-Watson stat	1.890856
Prob(F-statistic)	0.000000	Wald F-statistic	32.46751
Prob(Wald F-statistic)	0.000000		

The overall fit of this equation in terms of the adjusted R squared (0.67) is slightly superior to that registered in the NK models (0.62). The sum of the coefficients of DM1(-1) and DM1(-3) is positive as expected and statistically significant. The sum of the coefficients of DM1V and DM1V(-3) is also positive as expected and statistically significant. It is important to note, that an endogeneity test applied to a two stage least square estimation of the equation indicates that it is not possible to reject the null hypothesis that DM1V is exogenous. The other relevant feature of this equation is that the Bai-Perron sequential test does not detect any structural break (Table 6a)

Table 6a

Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 12/24/17 Time: 11:59
Sample: 1980Q1 2016Q4
Included observations: 148
Breaking variables: C DPCE(-1) DPCE(-3) DM1(-1) DM1(-3) DM1V DM1V(-3)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

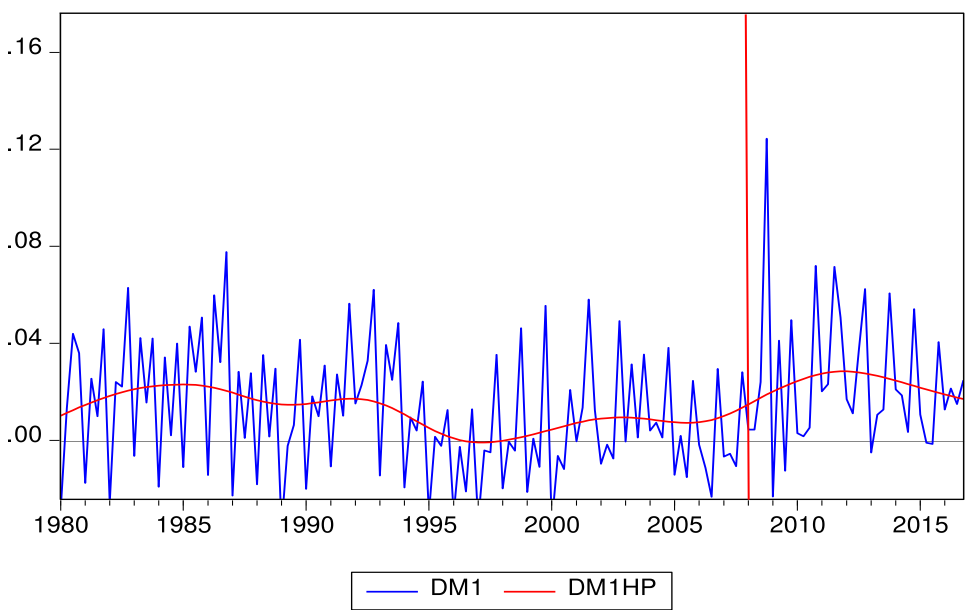
Sequential F-statistic determined breaks: 0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	2.551662	17.86163	21.87

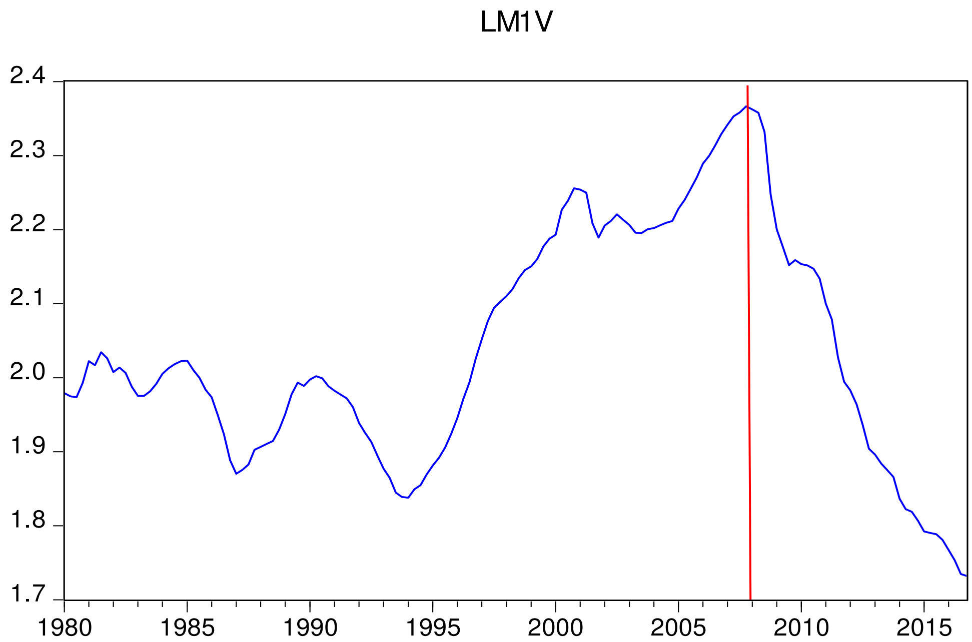
* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Apart from its better adjustment to the data for the period 1980Q1-2016Q4 in comparison to the NK models, the quantity theory approach offers a coherent explanation of the relative slowdown observed in inflation since the financial crisis.

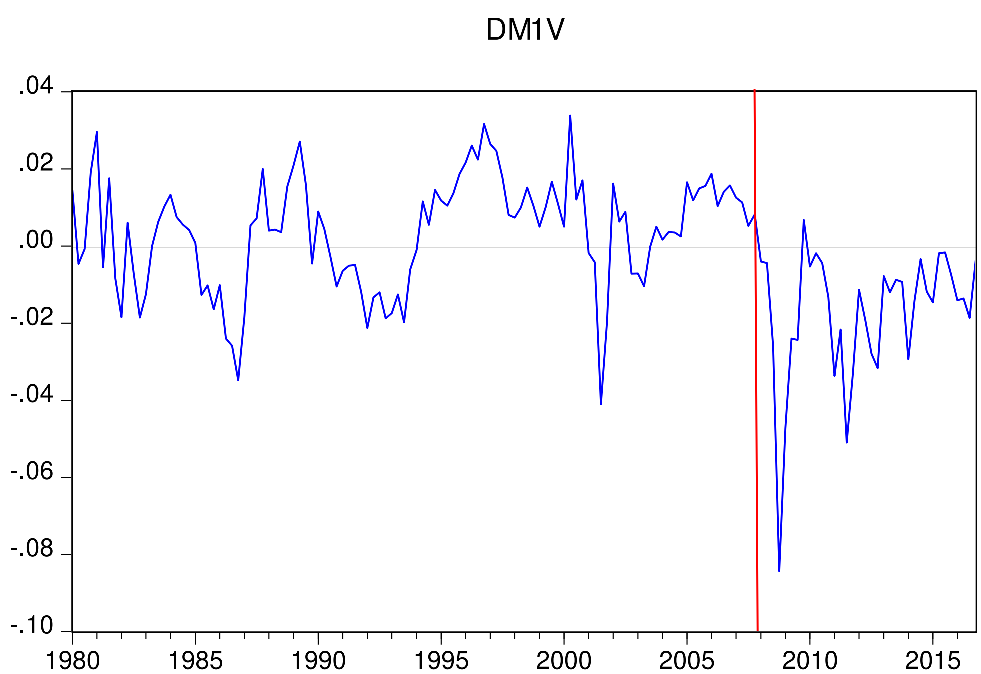
Graph 5



Graph 6



Graph 6a



Graph 5 shows that since the financial crisis, the quarterly variations of the logarithm of M1 have tended to increase. This acceleration in money growth evidently points in the direction of a more rapid inflation not less. But in graph 6 and 6a, it can be seen that the sizable fall in the velocity of circulation of M1 (increase in the demand for money) has more than offset the increase in the rate of growth of the money supply. The steep reduction in interest rates brought about by the Quantitative easing (QE) strategy resulted in a strong and persistent reduction of the velocity of circulation of M1 to its lowest level in the 36 years covered by this study. Apart from the impact of the reduction in interest rates on the velocity of circulation, it is probable that this variable has being also affected by a more or less durable negative shock that reflects changes in the perception of some agents toward risks in financial markets.

7.-Conclusions

This paper presents evidence that suggests that the NK models that are dominant in central banks discussions about inflation dynamics produce a relatively poor fit to the data for the period 1980Q1-2016Q4. In addition, these models face problems to explain the relative slowdown in inflation during and after the financial crisis. A monetary model based on the quantity theory generates a better adjustment to the data for the period under analysis, and a more coherent explanation of the behavior of inflation during and after the financial crisis.

In the context of these results, it is hard to understand the exclusive adherence of central banks and most of the economic profession to the NK models, and their complete neglect of money supply and money demand conditions as determinants of inflation. The idea behind NK models that money is unimportant, particularly in advanced economies with low inflation, seems evidently at odds with the empirical evidence. This neglect of monetary conditions has been arguably reinforced by another element that has locked the profession into an almost impenetrable paradigm: the widespread adoption of the calibration methodology. As pointed out by Friedman in his interview with John Taylor (2000), calibration is “a perfectly legitimate way to derive hypothesis, but it doesn’t test them”.

References

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Appendix

Modify Phillips Curve Model (Unemployment Rate + Global Price Index Industrial Materials)

Table A1
Dependent Variable: DPCE
Method: Least Squares
Date: 11/29/17 Time: 18:57
Sample (adjusted): 1981Q2 2016Q4
Included observations: 143 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002121	0.000906	2.340033	0.0208
DPCE(-1)	0.378574	0.060484	6.259037	0.0000
DPCE(-3)	0.344357	0.067924	5.069765	0.0000
UNRATE	-0.001282	0.000570	-2.250756	0.0260
UNRATE(-2)	0.001977	0.000933	2.120407	0.0358
UNRATE(-4)	-0.000808	0.000595	-1.357522	0.1769
DGPIMI	0.020803	0.008704	2.390056	0.0182
DGPIMI(-3)	-0.014142	0.005670	-2.494139	0.0138
DGPIMI(-4)	0.007628	0.003531	2.160627	0.0325

R-squared	0.553948	Mean dependent var	0.006084
Adjusted R-squared	0.527318	S.D. dependent var	0.004115
S.E. of regression	0.002829	Akaike info criterion	-8.837059
Sum squared resid	0.001072	Schwarz criterion	-8.650586
Log likelihood	640.8497	Hannan-Quinn criter.	-8.761285
F-statistic	20.80170	Durbin-Watson stat	2.192788
Prob(F-statistic)	0.000000	Wald F-statistic	36.68746
Prob(Wald F-statistic)	0.000000		

Table A1a
Wald Test:
Equation: EQPC02A

Test Statistic	Value	df	Probability
t-statistic	-0.752399	134	0.4531
F-statistic	0.566104	(1, 134)	0.4531
Chi-square	0.566104	1	0.4518

Null Hypothesis: C(4)+C(5)+C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4) + C(5) + C(6)	-0.000113	0.000150

Restrictions are linear in coefficients.

Table A1b
Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 01/02/18 Time: 10:25
Sample: 1980Q1 2016Q4
Included observations: 143
Breaking variables: C DPCE(-1) DPCE(-3) UNRATE UNRATE(-2) UNRATE(-4) DGPIMI DGPIMI(-3) DGPIMI(-4)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined breaks: 4

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.006284	36.05656	25.65
1 vs. 2 *	3.790239	34.11215	27.66
2 vs. 3 *	18.95723	170.6150	28.91
3 vs. 4 *	8.659104	77.93194	29.67
4 vs. 5	0.000000	0.000000	30.52

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008Q4	1991Q1
2	1991Q1	1997Q2
3	2003Q3	2003Q3
4	1997Q2	2008Q4

Modify Phillips Curve Model (Output Gap + Global Price Index Industrial Materials)

Table A2
Dependent Variable: DPCE
Method: Least Squares
Date: 12/30/17 Time: 13:07
Sample (adjusted): 1981Q1 2016Q4
Included observations: 144 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001384	0.000345	4.006684	0.0001
DPCE(-1)	0.366533	0.062424	5.871641	0.0000
DPCE(-3)	0.371707	0.062552	5.942344	0.0000
YGAP	0.070918	0.036764	1.929006	0.0558
YGAP(-2)	-0.045669	0.028048	-1.628267	0.1058
DGPIMI	0.021526	0.008060	2.670837	0.0085
DGPIMI(-3)	-0.013593	0.004910	-2.768211	0.0064

R-squared	0.596807	Mean dependent var	0.006219
Adjusted R-squared	0.579149	S.D. dependent var	0.004410
S.E. of regression	0.002861	Akaike info criterion	-8.827752
Sum squared resid	0.001122	Schwarz criterion	-8.683386
Log likelihood	642.5981	Hannan-Quinn criter.	-8.769090
F-statistic	33.79789	Durbin-Watson stat	2.123896
Prob(F-statistic)	0.000000	Wald F-statistic	47.54081
Prob(Wald F-statistic)	0.000000		

Table A2a
Wald Test:
Equation: EQPC01A

Test Statistic	Value	df	Probability
t-statistic	1.154096	137	0.2505
F-statistic	1.331936	(1, 137)	0.2505
Chi-square	1.331936	1	0.2485

Null Hypothesis: C(4)+C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4) + C(5)	0.025248	0.021877

Restrictions are linear in coefficients.

Table A2b

Multiple breakpoint tests

Bai-Perron tests of L+1 vs. L sequentially determined breaks

Date: 01/02/18 Time: 10:30

Sample: 1980Q1 2016Q4

Included observations: 144

Breaking variables: C DPCE(-1) DPCE(-3) YGAP YGAP(-2) DGPIMI DGPIMI(-3)

Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05

Test statistics employ HAC covariances (Bartlett kernel, Newey-West fixed bandwidth) assuming common data distribution

Sequential F-statistic determined breaks:	0

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1	2.264819	15.85373	21.87

* Significant at the 0.05 level.

** Bai-Perron (Econometric Journal, 2003) critical values.

Modify NK Model (Federal Funds Rate + Global Price Index Industrial Materials)

Table A3
Dependent Variable: DPCE
Method: Least Squares
Date: 12/30/17 Time: 13:16
Sample (adjusted): 1981Q1 2016Q4
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001435	0.000435	3.297944	0.0012
DPCE(-1)	0.240009	0.074595	3.217507	0.0016
DPCE(-3)	0.274447	0.072489	3.786066	0.0002
FFR	0.000581	0.000214	2.711739	0.0076
FFR(-2)	-0.000279	0.000198	-1.410806	0.1606
DGPIMI	0.019534	0.004029	4.848811	0.0000
DGPIMI(-1)	0.006622	0.004517	1.466018	0.1450
DGPIMI(-3)	-0.011683	0.003735	-3.127881	0.0022

R-squared	0.617935	Mean dependent var	0.006219
Adjusted R-squared	0.598270	S.D. dependent var	0.004410
S.E. of regression	0.002795	Akaike info criterion	-8.867690
Sum squared resid	0.001063	Schwarz criterion	-8.702700
Log likelihood	646.4737	Hannan-Quinn criter.	-8.800647
F-statistic	31.42297	Durbin-Watson stat	1.953611
Prob(F-statistic)	0.000000		

Table A3a
Wald Test:
Equation: EQFFR03

Test Statistic	Value	df	Probability
t-statistic	3.041922	136	0.0028
F-statistic	9.253287	(1, 136)	0.0028
Chi-square	9.253287	1	0.0024

Null Hypothesis: C(4)+C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4) + C(5)	0.000302	9.92E-05

Restrictions are linear in coefficients.

Table A3b
Multiple breakpoint tests
Bai-Perron tests of L+1 vs. L sequentially determined breaks
Date: 01/02/18 Time: 10:33
Sample: 1980Q1 2016Q4
Included observations: 144
Breaking variables: C DPCE(-1) DPCE(-3) FFR FFR(-2) DGPIMI DGPIMI(-1) DGPIMI(-3)
Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05

Sequential F-statistic determined breaks: 1

Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	4.227989	33.82391	23.70
1 vs. 2	2.031063	16.24851	25.75

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2008Q4	2008Q4