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Seasonal Patterns of Inflation Uncertainty for the US Economy: An EGARCH Model Results

Hakan Berument, Nezir Kose** and Afsin Sahin****

The purpose of this paper is to assess the seasonal inflation uncertainties for a big open economy, the US, for the period from January 1947 to April 2008. The paper uses EGARCH model which includes volatility in the conditional mean equation capturing the short-term and long-term volatility forecasts and leverage effects. The results indicate that seasonal inflation uncertainty increases in January, April and September and decreases in May, June, July and August.

Introduction

Understanding the dynamics of inflation is a difficult task. Most of the attention has been devoted to the (conditional) mean of inflation (Altinok *et al.*, 2009). As the rate of inflation increases as a result of central banks' policy setting, not only the level of inflation but also the volatility of inflation becomes important to monitor. Modeling volatility in the stock market is of interest (French and Roll, 1986; Foster and Viswanathan, 1990 and 1993; Mookerjee and Yu, 1999; and Franses and Paap, 2000), and following Berument and Sahin (2009), this paper analyzes the seasonal movements in inflation uncertainty for a big open economy, the US.

The adverse effect of inflation has been documented in the literature. Hafer (1986) and Holland (1986) have elaborated the negative effect of inflation uncertainty on employment. Friedman (1977), Froyen and Waud (1987), and Holland (1988) have reported the negative effect of inflation volatility on output. Chan (1994) and Berument (1999) have argued that inflation volatility increases interest rates.

However, there are a limited number of studies that explain the behavior of inflation volatility with various economic and political factors. Aisen and Veiga (2006) argue that

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inflation volatility increases with higher degree of political instability, ideological polarization and political fragmentation. Smith (1999) and Engel and Rogers (2001) claim that inflation volatility increases with exchange rate volatility. Dittmar *et al.* (1999), Gavin (2003) and Berument and Yuksel (2007) link inflation volatility to inflation targeting regimes, and Grier and Perry (1998), Kontonikas (2002) and Berument and Dincer (2005) link inflation volatility to higher inflation.

This paper attempts to measure the inflation uncertainty for the future by EGARCH models rather than using moving standard deviation formula, survey forecasts or Kalman filters.

Data and Methodology

In this paper, we model time-varying risk or conditional volatility, employing EGARCH models. EGARCH type of models assume that the parameters of the model are stable, but estimate the variance of the residual term for inflation specification (Grier and Perry, 1998; Berument, 1999; and Kontonikas, 2002). See Berument *et al.* (2005) for a comparison of different inflation volatility measures. Unconditional variance just captures the degree of being spread out. However, conditional variance considers other variables during estimation, which increases the degree of freedom, and this improves performance and provides a better specification of the underlying risks. EGARCH estimates conditional variance and thickness of tails of a distribution simultaneously. ARCH effect captures short-run persistence and GARCH effect indicates the contribution of shocks to long-run persistence.

Glosten, Jagannathan and Runkle developed the GJR model in order to distinguish between the impact of negative and positive shocks on leverage (Glosten *et al.*, 1993). However, EGARCH model can describe the asymmetric effects including leverage, whereas GJR model cannot accommodate the leverage effect. Moreover, EGARCH uses the standardized residuals rather than the unconditional shocks unlike GARCH and GJR models (see McAleer, 2005 for a comparison of these models). On the other hand, the stochastic volatility models are based on direct correlation between returns innovation and volatility innovation (Asai and McAleer, 2007). So, EGARCH models give more powerful results.

We can measure volatility by the Kalman filter, which is an algorithm allowing recursive estimation of unobserved and time-varying parameters. Filtering obtains estimates of unobservable parameters for the same time period as the information set. The Kalman filter is a discrete, recursive linear filter which measures the uncertainty regarding the structural variability of the parameters of an equation. However, in this paper, we will measure the inflation uncertainty for the future rather than just calculating the observed inflation volatility using the moving standard deviation formula or the volatility stemming from change in the inflation generating process (which could be measured with Kalman filters) or the disagreement on inflation (based on a survey forecast).

Error variances are not constant over time (heteroscedasticity) so we allowed variances of errors to be time dependent. The past has an impact on the present uncertainty and is assumed to be a linear function of both lagged squares of returns and lagged volatilities.

The conditional variance is always positive in the EGARCH model, as mentioned by Nelson (1991), where the disturbance term is distributed as a generalized error distribution (ε_t, $t \in Z$) which captures the leptokurtosis and is assumed to be a white noise: $f(\varepsilon_t) = \frac{\varepsilon \exp\left[-(1/2)|\varepsilon_t / \lambda|^{\varepsilon}\right]}{\lambda . 2^{[(\varepsilon+1)/\varepsilon]}\Gamma(1/\varepsilon)}$ where $\Gamma(.)$ is a gamma function, and $\lambda = \left\{\frac{2^{(-2/\varepsilon)}\Gamma(1/\varepsilon)}{\Gamma(3/\varepsilon)}\right\}^{1/2}$ is a constant. ε is a positive parameter governing the thickness of the tails. $f(\varepsilon_t)$ becomes normal probability density function for the values of $\varepsilon = 2$ and $\lambda = 1$.

For the observed variable π_t, we employ AR(13)-EGARCH(1,1)-M model. Equation (1) represents the mean equation. The data employed are seasonally adjusted, therefore, no seasonal monthly dummy variables have been added to the mean equation.

$$\pi_t = \alpha_0 + \sum_{i=1}^{13} \alpha_i \pi_{t-i} + \lambda h_t^2 + \varepsilon_t \qquad \text{...(1)}$$

where $\varepsilon_t \sim \left(0, h_t^2\right)$

Let $\varepsilon_t = \sqrt{\sigma_t |\sigma_{t-1}} . v_t$, where $\{v_t\}$ is i.i.d. sequence with zero mean and unit variance. α_is represent the coefficients of the lagged inflation series up to 13 lags. We also consider the effect of the last year's month on the same current month. We determined the lag as 13 to consider the effect of the last year's month on the same current month.

Equation (2) is the variance equation estimated simultaneously by the mean equation. We added seasonal dummy variables for the base and the clustered models.

$$\log h_t^2 = \beta_0 + \beta_1 \log h_{t-1}^2 + \beta_2 \left(\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| - E\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \chi \frac{\varepsilon_{t-1}}{h_{t-1}} \right) \qquad \text{...(2)}$$

Results and Discussion

The monthly data employed in the models are obtained from FRED II of the Federal Reserve Bank of St. Louis covering the period from January 1947 to April 2008. Inflation is calculated as the logarithmic first difference of the seasonally adjusted consumer price index (1982-84 = 100). We have also estimated the model for three clustered periods: 1974:02-2008:04 (after the quantity targeting regime), 1979:10-2008:04 (after the oil shock and the Governorship of Paul A Volcker), 1984:01-2008:04 (remember that in 1987 Greenspan had become the Governor). Clustering of data takes into consideration the regime shifts, in order to avoid overestimation of volatility persistency.

Table 1 presents the results of the base model. Panel A presents the estimates of the mean equation (Equation 1), Panel B presents the estimates of the conditional variance specification (Equation 2). Panel C presents the set of diagnostic tests for the standardized residuals $\left(\frac{\varepsilon_{t-1}}{h_{t-1}}\right)$, and Panel D shows the summary statistics.

Column 1 presents the estimates of the full sample. None of the seasonal dummy variables in the conditional variance equations are statistically significant.[1] This suggests that none of the months show higher level of inflation than that of June. However, for the post February 1974 and January 1984 samples, uncertainty increases significantly in January relative to June (we call this January effect). Next, we plot the conditional variances obtained

Table 1: EGARCH Base Model Parameter Estimation Results with the Seasonally Adjusted Data

	Full Sample	Post 1974	Post 1979	Post 1984
Panel A: Mean Specification				
Constant	0.0314** (0.0143)	0.0172 (0.0183)	0.6893*** (0.2215)	0.1046*** (0.0275)
π_{t-1}	0.2872*** (0.0390)	0.4064*** (0.0543)	0.8225*** (0.1306)	0.2626*** (0.0519)
π_{t-2}	0.0825** (0.0394)	−0.0451 (0.0536)	−0.3456*** (0.0896)	−0.1353*** (0.0504)
π_{t-3}	0.0520 (0.0393)	0.1650*** (0.0508)	0.1689*** (0.0635)	0.0519 (0.0518)
π_{t-4}	0.0687* (0.0402)	0.0568 (0.0533)	0.02245 (0.05732)	0.0181 (0.0529)
π_{t-5}	0.0509 (0.0393)	0.0498 (0.0458)	−0.04396 (0.0561)	−0.0311 (0.0524)
π_{t-6}	0.1185*** (0.0388)	0.0874* (0.0478)	0.1611*** (0.0574)	0.1287** (0.0525)
π_{t-7}	0.0436 (0.0371)	0.07 (0.0438)	−0.0482 (0.0602)	0.0241 (0.0516)
π_{t-8}	0.0701* (0.0362)	0.0522 (0.0434)	0.0914 (0.0602)	0.0074 (0.0480)
π_{t-9}	0.0895** (0.0350) .	0.1246*** (0.0350)	0.0758 (0.0579)	0.0621 (0.0487)
π_{t-10}	0.1071*** (0.0367)	0.0764** (0.0364)	0.0281 (0.0591)	0.0445 (0.0496)

[1] The level of significance is at 5%, unless otherwise mentioned.

Table 1 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
π_{t-11}	0.1027*** (0.0358)	0.1593*** (0.0379)	0.2082*** (0.0577)	0.1924*** (0.0487)
π_{t-12}	−0.0841** (0.0367)	−0.1662*** (0.0417)	−0.3019*** (0.0617)	−0.1843*** (0.0548)
π_{t-13}	−0.0819** (0.0334)	−0.0004 (0.0394)	0.0793 (0.0503)	−0.0799* (0.0454)
h_t^2	−0.1424 (0.2187)	−0.8565* (0.4533)	−17.9777*** (6.2422)	1.5842** (0.6201)
Panel B: Variance Specification				
Constant	−0.2271 (0.3283)	−1.7207*** (0.4691)	−4.0863*** (0.2175)	−0.4903 (0.4815)
M_{1t}	0.3270 (0.4505)	1.0761* (0.5527)	−0.1189 (0.0789)	1.4002** (0.6081)
M_{2t}	0.0194 (0.4422)	1.1474** (0.5200)	0.1352* (0.0738)	−0.3636 (0.6166)
M_{3t}	−0.0873 (0.4190)	0.5983 (0.5070)	0.0409 (0.0677)	−0.0596 (0.6534)
M_{4t}	0.0370 (0.4236)	1.5031*** (0.5537)	0.0752 (0.0702)	0.7561 (0.6349)
M_{5t}	−0.5949 (0.5465)	0.5714 (0.6697)	0.1044 (0.0779)	−0.8556 (0.7497)
M_{7t}	0.1044 (0.5388)	1.8771*** (0.5888)	0.0735 (0.0733)	0.2800 (0.7630)
M_{8t}	−0.0355 (0.4173)	0.4837 (0.5183)	0.0299 (0.0678)	0.1001 (0.6424)
M_{9t}	−0.0581 (0.4200)	1.0248* (0.5596)	−0.0158 (0.0701)	0.7858 (0.6129)
M_{10t}	−0.1178 (0.4304)	1.1460** (0.5013)	0.0860 (0.0686)	−0.1209 (0.6272)
M_{11t}	−0.3239 (0.4374)	0.5693 (0.4955)	0.0450 (0.0689)	−0.3391 (0.6352)
M_{12t}	−0.3748 (0.4428)	1.1543* (0.6186)	0.1492* (0.0814)	−0.5793 (0.6108)
$\lvert \varepsilon_{t-1}/h_{t-1} \rvert$	0.2391*** (0.0545)	0.4824*** (0.1307)	0.0163 (0.0213)	0.2343*** (0.0840)
$\varepsilon_{t-1}/h_{t-1}$	0.0472 (0.0351)	−0.0720 (0.0725)	0.1147*** (0.0392)	0.0504 (0.0563)
$\log h_{t-1}^2$	0.9568*** (0.0182)	0.8715*** (0.0698)	−0.2216*** (0.0580)	0.9346*** (0.0473)

Table 1 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
Panel C: Diagnostic Tests				
Ljung-Box *Q* Statistics				
12	[0.9950]	[0.9400]	[0.7930]	[0.957]
24	[0.5160]	[0.2040]	[0.5140]	[0.889]
36	[0.3720]	[0.2940]	[0.4360]	[0.870]
ARCH–LM Tests				
12	[0.8299]	[0.4004]	[0.2480]	[0.0940]
24	[0.2873]	[0.4809]	[0.7940]	[0.1420]
36	[0.8954]	[0.6434]	[0.5252]	[0.4254]
Panel D: Summary Statistics				
GED	1.4844*** (0.1107)	1.4350*** (0.1721)	1.1152*** (0.1112)	1.1585*** (0.1574)
R^2	0.4247	0.5666	0.5436	0.2690
Adj. R^2	0.3998	0.5324	0.4999	0.1850
SE of Regression	0.2600	0.2154	0.2024	0.1947
Sum sq. resid.	46.7290	17.6260	12.8189	9.8969
DW-stat.	1.9777	1.9351	1.9283	1.8230
LK (l_u)	72.0477	101.6886	93.6027	118.6251
LRT	10.2829	15.3890	17.2523	26.9196***

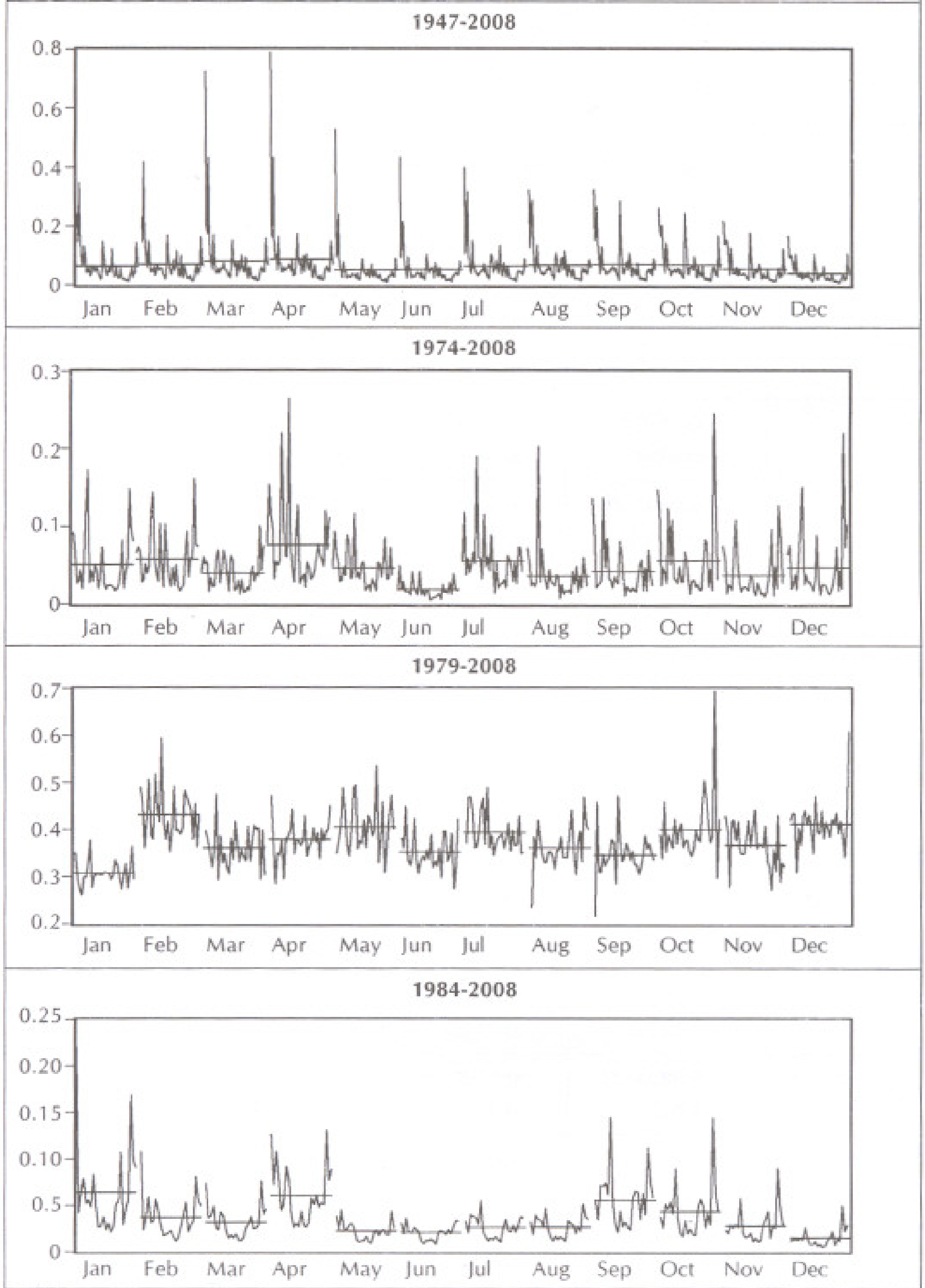
Note: Standard errors are reported in ( ) and *p*-values are reported in [ ]; LRT denotes the log likelihood ratio test calculated from the restricted and unrestricted versions of the equation: $-2*(l_r - l_u)$ where $l = -\frac{T}{2}\left(1+\log(2\pi)+\log(\hat{\varepsilon}'\hat{\varepsilon})\right)$.

The chi-square test statistics are: 24.725 (1%), 19.675 (5%), 17.275 (10%); ***, ** and * indicate significance at 1%, 5% and 10% level.

from the EGARCH specification for the four different periods. Figure 1 presents the seasonal stacked graphs of the EGARCH variance series. The solid horizontal lines represent the means of the conditional variances. As seen in Figure 1, the means of monthly uncertainties are nearly same for the full sample. For the post 1974 and 1984 samples, it is seen that in the months of January, April and September the means of seasonal dummies are higher than May, June, July and August. Inclusion of 11 dummies might be too cumbersome. Thus, we include the dummy variable *'High'* for January, April and September, and the dummy variable 'Low' for May, June, July and August.

The results of the clustered models A, B and C are presented in Tables 2, 3 and 4 respectively. We added both the *High* and *Low* dummy variables to the clustered Model A.

Figure 1: Seasonal Stacked Graphs of the EGARCH Variance Series Obtained from the Base Model



In the post 1974 and 1984 samples, the *High* dummy variable increases the uncertainty, however, the *Low* dummy variable is found to be nonsignificant after 1974. The clustered Model B includes only the *High* dummy variable for all the four samples. In the post 1974 and 1984 samples, the *High* dummy variable increases uncertainty significantly. The clustered Model C includes only the *Low* dummy variable and it decreases inflation uncertainty after 1984.

Table 2: EGARCH Clustered Model A Parameter Estimation Results with the Seasonally Adjusted Data

	Full Sample	Post 1974	Post 1979	Post 1984
Panel A: Mean Specification				
Constant	0.0362** (0.0141)	0.024 (0.025)	0.4586* (0.2473)	0.1023*** (0.0301)
π_{t-1}	0.2899*** (0.0391)	0.3644*** (0.0466)	0.5410*** (0.1112)	0.2970*** (0.0535)
π_{t-2}	0.0835** (0.0397)	–0.0896** (0.0451)	–0.2412** (0.1212)	–0.1413** (0.0502)
π_{t-3}	0.0710* (0.0399)	0.0699 (0.0459)	0.1936* (0.1062)	0.0323 (0.0511)
π_{t-4}	0.0705* (0.0401)	0.0171 (0.0476)	0.0012 (0.0897)	0.0264 (0.0511)
π_{t-5}	0.0470 (0.0389)	–0.0107 (0.0465)	0.0382 (0.0702)	–0.0485 (0.0516)
π_{t-6}	0.1157*** (0.0379)	0.0835* (0.0431)	0.1128* (0.0619)	0.1352** (0.0511)
π_{t-7}	0.0334 (0.0369)	0.0359 (0.0429)	0.0169 (0.0512)	0.0277 (0.0503)
π_{t-8}	0.0719* (0.0373)	–0.0313 (0.0448)	0.0542 (0.0510)	–0.0058 (0.0520)
π_{t-9}	0.0821** (0.035)	0.1200** (0.0439)	0.1171** (0.0481)	0.0618 (0.0501)
π_{t-10}	0.1143*** (0.0365)	0.0616 (0.0440)	0.0599 (0.0502)	0.0405 (0.0470)
π_{t-11}	0.0977** (0.0352)	0.1891*** (0.0426)	0.1819*** (0.0484)	0.1862*** (0.0475)

Table 2 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
π_{t-12}	−0.0870** (0.0353)	−0.1654*** (0.0457)	−0.1935*** (0.0514)	−0.1843*** (0.0526)
π_{t-13}	−0.0860** (0.0330)	−0.0412 (0.0412)	0.0004 (0.0473)	−0.0709 (0.0452)
h_t^2	−0.2109 (0.2209)	2.6639*** (0.9374)	−11.2861* (6.3132)	1.7104** (0.6964)
Panel B: Variance Specification				
Constant	−0.4033*** (0.0980)	−0.3990*** (0.0960)	−5.4667*** (0.3899)	−0.7753*** (0.2202)
High	0.2299 (0.2196)	0.8275*** (0.2558)	−0.1269 (0.0813)	1.2146*** (0.3536)
Low	0.0226 (0.0822)	0.1551* (0.0866)	−0.0448 (0.0679)	0.1157 (0.1372)
$\lvert \varepsilon_{t-1}/h_{t-1} \rvert$	0.2440*** (0.0500)	0.0989*** (0.0383)	0.0549* (0.0310)	0.2266*** (0.0831)
$\varepsilon_{t-1}/h_{t-1}$	0.0491*** (0.0349)	0.0731** (0.0335)	0.0445 (0.0439)	0.0415 (0.0565)
$\log\ h_{t-1}^2$	0.9514 (0.0187)	0.9806*** (0.0130)	−0.6822*** (0.1128)	0.9250*** (0.0518)
Panel C: Diagnostic Tests				
Ljung-Box *Q* Statistics				
12	[0.9900]	[0.9830]	[0.6510]	[0.9920]
24	[0.5460]	[0.8780]	[0.3240]	[0.9490]
36	[0.4430]	[0.7880]	[0.2460]	[0.9050]
ARCH-LM Tests				
12	[0.6612]	[0.5232]	[0.1330]	[0.2213]
24	[0.3361]	[0.4922]	[0.8169]	[0.6829]
36	[0.8369]	[0.4049]	[0.2535]	[0.2812]
Panel D: Summary Statistics				
GED	1.4605*** (0.1042)	1.3051*** (0.1406)	1.1470*** (0.1154)	1.1681*** (0.1500)
R^2	0.4271	0.5678	0.5272	0.2642
Adj. R^2	0.4099	0.5445	0.4964	0.2070
SE of Regression	0.2578	0.2126	0.2032	0.1921
Sum sq. resid.	46.5346	17.5765	13.2783	9.9620

Table 2 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
DW-stat.	1.9868	1.9000	1.9561	1.8907
LK (l_u)	68.1721	99.8890	87.8700	113.5864
LRT	1.1638	11.2471	5.7870	16.8422

Note: Standard errors are reported in ( ) and *p*-values are reported in [ ]; LRT denotes the log likelihood ratio test calculated from the restricted and unrestricted versions of the equation: $-2*(l_r - l_U)$ where $l = -\frac{T}{2}(1+\log(2\pi)+\log(\hat{\varepsilon}'\hat{\varepsilon}))$.

The chi-square test statistics are: 24.725 (1%), 19.675 (5%), 17.275 (10%); ***, ** and * indicate significance at 1%, 5% and 10% level.

Table 3: EGARCH Clustered Model B Parameter Estimation Results with the Seasonally Adjusted Data

	Full Sample	Post 1974	Post 1979	Post 1984
Panel A: Mean Specification				
Constant	0.0366*** (0.014)	0.0243 (0.018)	0.6054 (0.4709)	0.1072*** (0.0295)
π_{t-1}	0.2893*** (0.0385)	0.3884*** (0.0482)	0.7136*** (0.1388)	0.2928*** (0.0553)
π_{t-2}	0.0834** (0.0396)	–0.0621 (0.0488)	–0.3483** (0.1552)	–0.1439*** (0.0513)
π_{t-3}	0.0721* (0.0399)	0.1067** (0.0479)	0.2194 (0.1374)	0.0407 (0.0516)
π_{t-4}	0.0698* (0.0400)	0.0195 (0.0504)	–0.0184 (0.1101)	0.0195 (0.0513)
π_{t-5}	0.0475 (0.0390)	0.0242 (0.0483)	0.01475 (0.0832)	–0.0446 (0.0521)
π_{t-6}	0.1159*** (0.0378)	0.0833* (0.0444)	0.1463** (0.0653)	0.1324*** (0.0514)
π_{t-7}	0.0334 (0.0369)	0.0448 (0.0444)	–0.0123 (0.0582)	0.0312 (0.0500)
π_{t-8}	0.0723* (0.0374)	0.0155 (0.0462)	0.0603 (0.0562)	–0.0019 (0.0526)
π_{t-9}	0.0822** (0.0350)	0.1182* (0.0453)	0.0867 (0.0556)	0.0601 (0.0492)
π_{t-10}	0.1146*** (0.0365)	0.0688 (0.0455)	0.0517 (0.0564)	0.0463 (0.0468)

Table 3 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
π_{t-11}	0.0971*** (0.0351)	0.1746*** (0.0444)	0.1729*** (0.0558)	0.1815*** (0.0469)
π_{t-12}	−0.0871** (0.0351)	−0.1561*** (0.0443)	−0.2052*** (0.0560)	−0.1702*** (0.0519)
π_{t-13}	−0.0861** −0.0329	−0.0353 −0.0420	0.0225 −0.0501	−0.0778* −0.0449
h_t^2	−0.2193 (0.2207)	1.0531* (0.5661)	−14.7846 (11.8992)	1.4548** (0.6412)
Panel B: Variance Specification				
Constant	−0.3923*** (0.0868)	−0.4445*** (0.1029)	−4.9868*** (0.6383)	−0.8364*** (0.2598)
High	0.2016 (0.1958)	0.7941*** (0.2479)	−0.0852 (0.0778)	1.1368*** (0.3051)
$\lvert \varepsilon_{t-1}/h_{t-1} \rvert$	0.2470*** (0.0488)	0.1800*** (0.0606)	0.0476 (0.0376)	0.2674*** (0.0996)
$\varepsilon_{t-1}/h_{t-1}$	0.0485 (0.0351)	0.0686 (0.0459)	0.0922* (0.0505)	0.0549 (0.0650)
log h_{t-1}^2	0.9510*** (0.0188)	0.9674*** (0.0214)	−0.5364*** (0.2047)	0.9006*** (0.0654)
Panel C: Diagnostic Tests				
Ljung-Box *Q* Statistics				
12	[0.9880]	[0.9930]	[0.6970]	[0.9940]
24	[0.5430]	[0.8310]	[0.3620]	[0.9510]
36	[0.4460]	[0.8240]	[0.2780]	[0.9020]
ARCH-LM Tests				
12	[0.6421]	[0.8630]	[0.1684]	[0.3245]
24	[0.3415]	[0.8467]	[0.9596]	[0.7841]
36	[0.8399]	[0.7917]	[0.2617]	[0.3106]
Panel D: Summary Statistics				
GED	1.4602*** (0.1032)	1.3855*** (0.1507)	1.1336*** (0.1175)	1.2016*** (0.1553)
R^2	0.4273	0.5618	0.5304	0.2556
Adj. R^2	0.4110	0.5393	0.5013	0.2007
SE of Regression	0.2576	0.2138	0.2021	0.1928
Sum sq. resid.	46.5186	17.8222	13.1901	10.0780

Table 3 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
DW-stat.	1.9853	1.8886	1.9680	1.8860
LK (l_u)	68.1351	98.6292	87.2027	112.9938
LRT	1.0896	8.7275	4.4525	15.6570

Note: Standard errors are reported in ( ) and *p*-values are reported in [ ]; LRT denotes the log likelihood ratio test calculated from the restricted and unrestricted versions of the equation: $-2*(l_r - l_u)$ where $l = -\frac{T}{2}(1+\log(2\pi)+\log(\hat{\varepsilon}'\hat{\varepsilon}))$.
The chi-square test statistics are: 24.725 (1%), 19.675 (5%), 17.275 (10%); ***, ** and * indicate significance at 1%, 5% and 10% level.

Table 4: EGARCH Clustered Model-C Parameter Estimation Results with the Seasonally Adjusted Data

	Full Sample	Post 1974	Post 1979	Post 1984
Panel A: Mean Specification				
Constant	0.0383*** (0.0141)	0.0313* (0.0171)	0.5249*** (0.1510)	0.1296*** (0.0283)
π_{t-1}	0.2890*** (0.0391)	0.3815*** (0.0527)	0.5998*** (0.0956)	0.2722*** (0.0609)
π_{t-2}	0.0835* (0.0395)	–0.0355 (0.0515)	–0.3015*** (0.1010)	–0.1563*** (0.0557)
π_{t-3}	0.0748* (0.0397)	0.1441*** (0.0512)	0.2522*** (0.0908)	0.1250** (0.0575)
π_{t-4}	0.0704* (0.0402)	0.0206 (0.0532)	–0.0658 (0.0793)	–0.0029 (0.0532)
π_{t-5}	0.0461 (0.0391)	0.0315 (0.0492)	0.0767 (0.0674)	0.0169 (0.0506)
π_{t-6}	0.1154*** (0.0379)	0.0907* (0.0470)	0.0998 (0.0626)	0.0928* (0.0523)
π_{t-7}	0.0321 (0.0368)	0.0450 (0.0470)	0.0314 (0.0548)	0.0499 (0.0508)
π_{t-8}	0.0748** (0.0374)	0.0438 (0.0460)	0.0403 (0.0530)	0.0175 (0.0522)
π_{t-9}	0.0835** (0.0350)	0.1303*** (0.0426)	0.1289** (0.0506)	0.0955** (0.0475)
π_{t-10}	0.1162*** (0.0363)	0.0912** (0.0434)	0.0650 (0.0519)	0.0478 (0.0487)

Table 4 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
π_{t-11}	0.0984*** (0.0351)	0.1643*** (0.0421)	0.1496*** (0.0498)	0.1678*** (0.0460)
π_{t-12}	−0.0890** (0.0350)	−0.1606*** (0.0428)	−0.1546*** (0.0495)	−0.1923*** (0.0465)
π_{t-13}	−0.0875*** (0.0328)	−0.0373 (0.0412)	−0.0271 (0.0436)	−0.0588 (0.0451)
h_t^2	−0.2691 (0.2236)	−0.1102 (0.4819)	−13.0017*** (4.0194)	−0.1284 (0.5121)
Panel B: Variance Specification				
Constant	−0.3413*** (0.0850)	−0.3158** (0.1522)	−5.5352*** (0.3089)	−0.8058* (0.4812)
Low	−0.0204 (0.0744)	−0.1777 (0.1098)	0.0384 (0.0468)	−0.2698* (0.1466)
$\lvert \varepsilon_{t-1}/h_{t-1} \rvert$	0.2475*** (0.0506)	0.2568*** (0.0817)	0.0729*** (0.0262)	0.4328*** (0.1457)
$\varepsilon_{t-1}/h_{t-1}$	0.0470 (0.0356)	0.0536 (0.0565)	0.0713** (0.0346)	−0.0036 (0.0959)
$\log h_{t-1}^2$	0.9490*** (0.0192)	0.9455*** (0.0334)	−0.6779*** (0.0998)	0.8351*** (0.1221)
Panel C: Diagnostic Tests				
Ljung-Box *Q* Statistics				
12	[0.9870]	[0.9920]	[0.5830]	[0.9970]
24	[0.5400]	[0.6120]	[0.3920]	[0.6720]
36	[0.4570]	[0.6450]	[0.3610]	[0.6610]
ARCH-LM Tests				
12	[0.5768]	[0.6651]	[0.2711]	[0.2347]
24	[0.3219]	[0.3436]	[0.8918]	[0.8713]
36	[0.7322]	[0.7142]	[0.1848]	[0.4108]
Panel D: Summary Statistics				
GED	1.4606*** (0.1047)	1.3758*** (0.1444)	1.1230*** (0.1113)	1.1913*** (0.1449)
R^2	0.4289	0.5657	0.5171	0.2478
Adj. R^2	0.4126	0.5434	0.4872	0.1923
SE of Regression	0.2573	0.2128	0.2049	0.1939
Sum sq. resid.	46.3925	17.6617	13.5623	10.1838

Table 4 (Cont.)

	Full Sample	Post 1974	Post 1979	Post 1984
DW-stat.	1.9841	1.8902	1.9502	1.8562
LK (l_u)	67.6291	95.7926	85.4593	107.1864
LRT	0.07776	3.05434	0.9655	4.0422

Note: Standard errors are reported in ( ) and *p*-values are reported in [ ]; LRT denotes the log likelihood ratio test calculated from the restricted and unrestricted versions of the equation: $-2*(l_r - l_u)$ where $l = -\frac{T}{2}(1+\log(2\pi)+\log(\hat{\varepsilon}'\hat{\varepsilon}))$.

The chi-square test statistics are: 24.725 (1%), 19.675 (5%), 17.275 (10%); ***, ** and * indicate significance at 1%, 5% and 10% level.

Conclusion

The estimates obtained allow us to draw certain interpretations for the monetary policy setup The central banks usually consider the seasonally adjusted data while forecasting severa variables. However, we have observed that even though the data are seasonally adjusted uncertainties which are hidden in the form of information within the series, cannot b completely eliminated. Thus, the central banks should consider the inflation uncertaintie while determining their inflation targets and setting up optimum reaction functions.

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