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Inflation, Inflation Uncertainty and Output in Tunisia

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Abstract
This study investigates the relationship between inflation, inflation uncertainty and output in Tunisia using real and nominal data. GARCH-in-mean model with lagged variance equation is employed for the analysis. The result shows that inflation uncertainty has a positive and significant effect on the level of inflation only in the real term. Moreover, inflation uncertainty Granger-causes inflation and economic growth respectively. These results have important implications for the monetary policy in Tunisia.

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1. Introduction

One of the most valuable subjects in macroeconomics is to treat the effect of inflation on output. Macroeconomists and monetary policy advisors have been convinced that more unstable prices are potentially damaging the economic growth of an economy. This reasonable conviction is inspired from an apperceive hypothesis advanced by Friedman (1977). Empirical studies of the hypothesis have typically pursued one of two approaches of exploration. The former treats the interrelation between the inflation rate and inflation uncertainty (see Cukeirman and Wachtel 1979, Ball and Cecchetti 1990, Evans 1991, Hess and Brunner 1993, Kallon 1994, Grier and Perry 1998, Wilson and Culver 1999, Fountas 2001, Grier et al. 2004, Apergis 2004, Kontonikas 2004, Berument et al. 2011, Hartmann et al. 2012). The latter presents an extension of the relationship by attending the link between inflation uncertainty and output growth (see Grier and Perry 2000, Hayford 2000, Fountas et al. 2002, Fielding 2009, Fountas 2010).

The motivation of this paper is from the instability of the inflation rate in Tunisia for the past decades. Tunisia's inflation rate averaged at 5.22 percent and reach an all time high of 16.7 percent in July 1982 and a record low of -1.4 percent in June 1970. In 2009, the Average Inflation was reported at 3.73 percent. Recently, the inflation rate in Tunisia was recorded at 5.60 percent in August 2012. This inflation uncertainty is explained theoretically by the adoption of an expansionary monetary policy marked by decreasing interest rates to lower reserve requirements for the banks (see Azam 1999, Tsangarides 2002, Debrun et al. 2011)[1]. Unfortunately, there is no solid empirical work thus far for the case of Tunisia.

The aim of this paper is to empirically explore the relationship between inflation, inflation uncertainty and output by employing the newly developed GARCH in Mean model suggested by Fountas (2010) for the Tunisian case.

The remainder of this paper is organized as follows. Section 2 presents the methodology. Section 3 presents the data. Section 4 presents the main empirical results. Finally, concluding remarks are summarized in Section 5.

2. Methodology

For the reason that a standard GARCH model does not permit average inflation to affect uncertainty, we adopt GARCH-in-Mean model for our analysis. These models are widely used to investigate the real effects of uncertainty. This method uses the conditional variance of inflation as the measure of inflation uncertainty.

We find a great interest to follow Fountas (2010) who modified the model to include the lagged inflation rate in the conditional variance as below:

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[1] See also Dessus et al. (1998) for a politico-economic model to stabilize Africa.

$$\pi_t = \Phi_0 + \sum_{i=1}^{n} \Phi_i \pi_{t-i} + \sum_{i=1}^{m} \Phi_{\varepsilon i} \varepsilon_{t-i} + \gamma h_{\pi t} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t = v_t \sqrt{h_{\pi t}} \qquad (2)$$

$$h_{\pi t} = \omega_\pi + \sum_{j=1}^{k} \alpha_{\pi j} \varepsilon_{\pi t-j}^2 + \sum_{j=1}^{l} \beta_{\pi j} h_{\pi t-j} + \delta \pi_{t-1} \qquad (3)$$

where π_t represents the inflation rate and the conditional variance of ε_t is given by (3).

The in-mean coefficient (γ) tests the impact of inflation uncertainty on inflation. The effect of inflation on inflation uncertainty is tested by δ. A central bank normally adjusts its money supply growth rate to a change in inflation uncertainty with a time lag. Therefore, inflation is also affected with a time lag following a change in inflation uncertainty.

If γ is found not statistically significant, we estimate the GARCH model without the in-mean term. We then use the estimated conditional variance of inflation to examine the Granger causality relationships between inflation uncertainty and inflation. The following equation is run to test the lagged effect of inflation uncertainty on inflation:

$$\pi_t = \phi_{\pi 0} + \sum_{i=1}^{k} \phi_{\pi i} \pi_{t-i} + \sum_{j=1}^{k} \tau_j \hat{h}_{\pi t-j} + \varepsilon_{\pi t} \qquad (4)$$

where $\hat{h}_{\pi t-j}$ is the lagged conditional variance of the inflation rate estimated with the GARCH model. Rejection of the null hypothesis that all $\tau_j = 0$ implies that inflation uncertainty Granger-causes inflation. On the other hand, to test the effect of inflation uncertainty on economic growth (Y_t), we estimate the following equation:

$$Y_t = \phi_{Y0} + \sum_{i=1}^{k} \phi_{Yi} Y_{t-i} + \sum_{j=1}^{k} \lambda_j \hat{h}_{\pi t-j} + \varepsilon_{Yt} \qquad (5)$$

Rejection of the null hypothesis that all $\lambda_j = 0$ implies that inflation uncertainty Granger-causes economic growth. $\sum \lambda_j \prec 0$ is consistent with Friedman (1977) who is providing an intuitive argument that higher inflation leads to inflation uncertainty distorting the effectiveness of the price -mechanism in allocating resources efficiently and generating a negative output effect.

3. Data

The data comprises quarterly observations from 1988 Q3 to 2011 Q4. All data is obtained from the International Financial Statistics of the International Monetary Fund.
We use two sets of variables. The first set is time series includes nominal inflation rate and nominal gross domestic product GDP whilst the second set is real GDP gross domestic product and real inflation rate.
The nominal inflation rate is measured by consumer prices index (2005=100) and the nominal gross domestic product is measured by industrial production index (2005=100).

All data is transformed to natural logarithm prior the analysis. Figure 1 shows that the inflation rate is more volatile than the economic growth.

[Figure 1 here]

4. Empirical Results

Table 1 recapitulates respective trend properties. Using two sets of data, one in nominal term and the other in real term, the ADF unit root test results confirm that all variables are I (1).

Table 2 summarizes the results of the GARCH-in-Mean estimation by laying out coefficients γ and δ and some diagnostics (the Q-statistics for the residuals and squared residuals). Both γ and δ have positive sign. For the real term model, γ is statistical significant at 10 % level of significance but is not significant for the nominal term model.

Similar results are also found in Daal et al. (2005), Fountas (2010), to name a few. However, the Q-statistics show that the in-mean model has the serial correlation problem. The latter could be explained by the presence of asymmetric information between the policymaker and the public and asymmetric stabilization policies (Dematriades, 1988)[2]. Thus, we re-run the model without the in-mean term. All the δ have negative sign but not significant. Hence, we cannot support Friedman (1977) who claimed that a higher inflation rate leads to more uncertainty in the inflation rate.

[Table 2 here]

Table 3 reports the results of Granger-causality test regarding the effect of inflation uncertainty on inflation and economic growth respectively. We find evidence that inflation uncertainty Granger causes inflation in both models. Inflation uncertainty also Granger causes output growth for the real term model but not for the nominal term model. We also find that $\sum \lambda_j$ = 0.1264 for the nominal term model and $\sum \lambda_j$ = -0.0171 for the real term model. However, both coefficients are not statistically significant. Hence, we are not able to support Friedman's argument that inflation uncertainty has negative real effects.

Similar results are also found in Katsimbris (1985), Thornton (1988), Jansen (1989), Levine and Renelt (1992), Levine and Zervos (1993), Bohara and Sauer (1994) and Clark (1997).

We deduce that inflation uncertainty affects inflation and output with a time lag. Similar results are also found in Cukierman and Meltzer (1986). They resort to the Barro-Gordon

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[2] There are conservative, liberal policymakers and public in the economy system. The cost of inflation is abstinent for the liberal policymaker, while it is very high for the conservative policymaker (Ball (1992)).

model to prove that a rise in inflation uncertainty will raise the optimal average inflation rate because it provides an incentive to the policymaker to create an inflation surprise in order to stimulate output growth.

5. Concluding Remarks

We examine the relationships between inflation, inflation uncertainty and economic growth in Tunisia. Our findings conclude that recession in economy is essentially due to high inflation uncertainty enhanced by lowering the level of the interest rate of the Central Bank of Tunisia. This strategy should find convenient financial reforms as a support, especially after the Tunisian spring revolution, to cover the best conduct of monetary policy eligible to handle the inflation uncertainty level.

References

Apergis, N. (2004) ‘Inflation, next term output growth, volatility and causality: evidence from panel data and the G7 countries’ *Economics Letters,* 83: 185–191.

Azam,J.P. (1999) ‘Institutions for Macroeconomic Stability in Africa’ *Journal of African Economies,* 8: 6-29.

Ball, L. (1992) ‘Why does high inflation raise inflation uncertainty?’ *Journal of Monetary Economics,* 29: 371–388.

Ball, L., Cecchetti, S. (1990) ‘Inflation uncertainty at short and long horizons’ *Brooking Papers on Economic Activity,* 1: 215–245.

Berument, M.H.,Yelcin,Y., Yildirim,J.O. (2011) ‘The inflation and inflation uncertainty relationship for Turkey: a dynamic framework’ *Empirical Economics*, 41: 293-309.

Bohara, A.K., Sauer, C. (1994) ‘The role of inflation uncertainty in Germany: Friedman’s hypothesis revisited’ *Empirical Economics*, 19: 611–627.

Clark, T.E. (1997) ‘Cross-country evidence on long-run growth and inflation’ *Economic Inquiry,* 35: 70–81.

Cukierman, A., Meltzer, A. (1986) ‘A theory of ambiguity, credibility, and inflation under discretion and asymmetric information’ *Econometrica,* 54: 1099–1128.

Cukeirman, A., Wachtel, P. (1979) ‘Differential inflationary expectations and the variability of the rate of inflation: Theory and evidence’ *American Economic Review,* 69: 595–609.

Daal, E., Naka, A., Sanchez, B. (2005) ‘Re-examining inflation and inflation uncertainty in developed and emerging countries’ *Economics Letters*, 89: 180–186.

Debrun, X., Masson,P.R., Pattillo,C. (2011) ‘Should African Monetary Unions Be Expanded? An Empirical Investigation of the Scope for Monetary Integration in Sub-Saharan Africa’ *Journal of African Economies*, 20: 104-150.

Demetriades, P. (1988) ‘Macroeconomic aspects of the correlation between the level and the variability of inflation’ *Economics Letters,* 26: 121-124.

Dessus,S., Lafay,J.D., Morrisson,C. (1998) ‘A Politico-economic Model for Stabilisation in Africa’ *Journal of African Economies,* 7: 91-119.

Evans, M. (1991) ‘Discovering the links between inflation rates and inflation uncertainty’ *Journal of Money Credit and Banking,* 23: 169–184.

Fielding,D. (2009) ‘Non-monetary Determinants of Inflation Volatility: Evidence from Nigeria’ *Journal of African Economies,* 19: 111-139.

Friedman, M. (1977) ‘Inflation and unemployment’ *Journal of Political Economy,* 85: 451–472.

Fountas, S. (2010) ‘Inflation, inflation uncertainty and growth: are they related?’ *Economic Modelling*, 27: 896–899.

Fountas, S. (2001) ‘The relationship between inflation and inflation-uncertainty in the UK: 1885-1998’ *Economics Letters*, 74: 77-83.

Fountas, S., Karanasos, M., Kim, J. (2002) ‘Inflation and output growth uncertainty and their relationship with inflation and output growth’ *Economics Letters*, 75: 293-301.

Grier, K., Perry, M. (1998) ‘On inflation and inflation uncertainty in the G7 countries’ *Journal of International Money and Finance*, 17: 671–689.

Grier, K., Perry, M. (2000) ‘The effects of real and nominal uncertainty on inflation and output growth: some GARCH-Mevidence’ *Journal of Applied Econometrics,* 15: 45–58.

Grier, K., Henry, O.T., Olekalns, N., Shields, K. (2004) ‘The asymmetric effects of uncertainty on inflation and output growth’ *Journal of Applied Econometrics*, 19: 551–565.

Hartmann, M., Herwartz, H. (2012) ‘Causal relations between inflation and inflation uncertainty- Cross sectional evidence in favour of the Friedman- Ball hypothesis’ *Economics Letters*, 115: 144-147.

Hayford, M.D. (2000) ‘Inflation uncertainty, unemployment uncertainty and economic activity’ *Journal of Macroeconomics*, 22: 315–329.

Hess, G.D., Brunner, A.D. (1993) ‘Are higher levels of inflation less predictable? A state dependent conditional heteroskedasticity approach’ *Journal of Business and Economic Statistics,* 11: 187–197.

Jansen, D.W. (1989) ‘Does inflation uncertainty affect output growth’ *Federal Reserve Bank of St. Louis Economic Review,* July/August, 43–54.

Kallon,K.,M. (1994) ‘An Econometric Analysis of Inflation in Sierra Leone’ *Journal of African Economies,* 3: 199-230.

Katsimbris, G.M.(1985) ‘The relationship between the inflation rate, its variability, and output growth variability: Disaggregated international evidence’ *Journal of Money, Credit and Banking,* 17: 179–188.

Kontonikas,A. (2004) ‘Inflation and inflation uncertainty in the United Kingdom, evidence from GARCH modelling’ *Economic Modelling,* 21: 525–543.

Levine, R., Renelt, D. (1992) ‘A sensitivity analysis of cross-country growth regressions’ *American Economic Review,* 82: 942–963.

Levine, R., Zervos, S. (1993) ‘What have we learned about policy and growth from cross-country analysis’ *American Economic Review Papers and Proceedings,* 83: 426–430.

Thornton, J. (1988) ‘Inflation and output growth: Some time series evidence, a note’ *American Economist,* 32: 55–58.

Tsangarides,C.G. (2002) ‘On Cross-country Growth and Convergence: Evidence from African and OECD Countries’ *Journal of African Economies,* 10: 355-389.

Wilson, B.K., Culver, S.E. (1999) ‘On measuring the response of real GDP growth to changes in inflation volatility’ *Quarterly Journal of Business and Economics,* 38: 3–15.

Table 1: Unit Root Test for Variables

Variable	Level	First Difference
Nominal GDP	-0.9974	-4.7330***
Nominal Inflation	-1.5330	-8.4581***
Real GDP	-1.7791	-9.7400***
Real Inflation	-1.5395	-8.4784***

Note: * (**) *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 2: Estimated Coefficients and Q-statistics

Variables	γ	δ	Q(4)	$Q^2(4)$
Nominal Inflation	0.2149 (0.6818)	-0.0029 (0.4869)	1.1077 (0.206)	1.7252 (0.134)
Real Inflation	1.9700* (0.0518)	-0.0012 (0.8620)	99.219*** (0.0000)	47.050*** (0.0000)
Nominal Inflation	-	-0.0036 (0.4518)	0.6559 (0.242)	1.8633 (0.172)
Real Inflation	-	-0.0036 (0.4414)	0.6540 (0.241)	1.8465 (0.174)

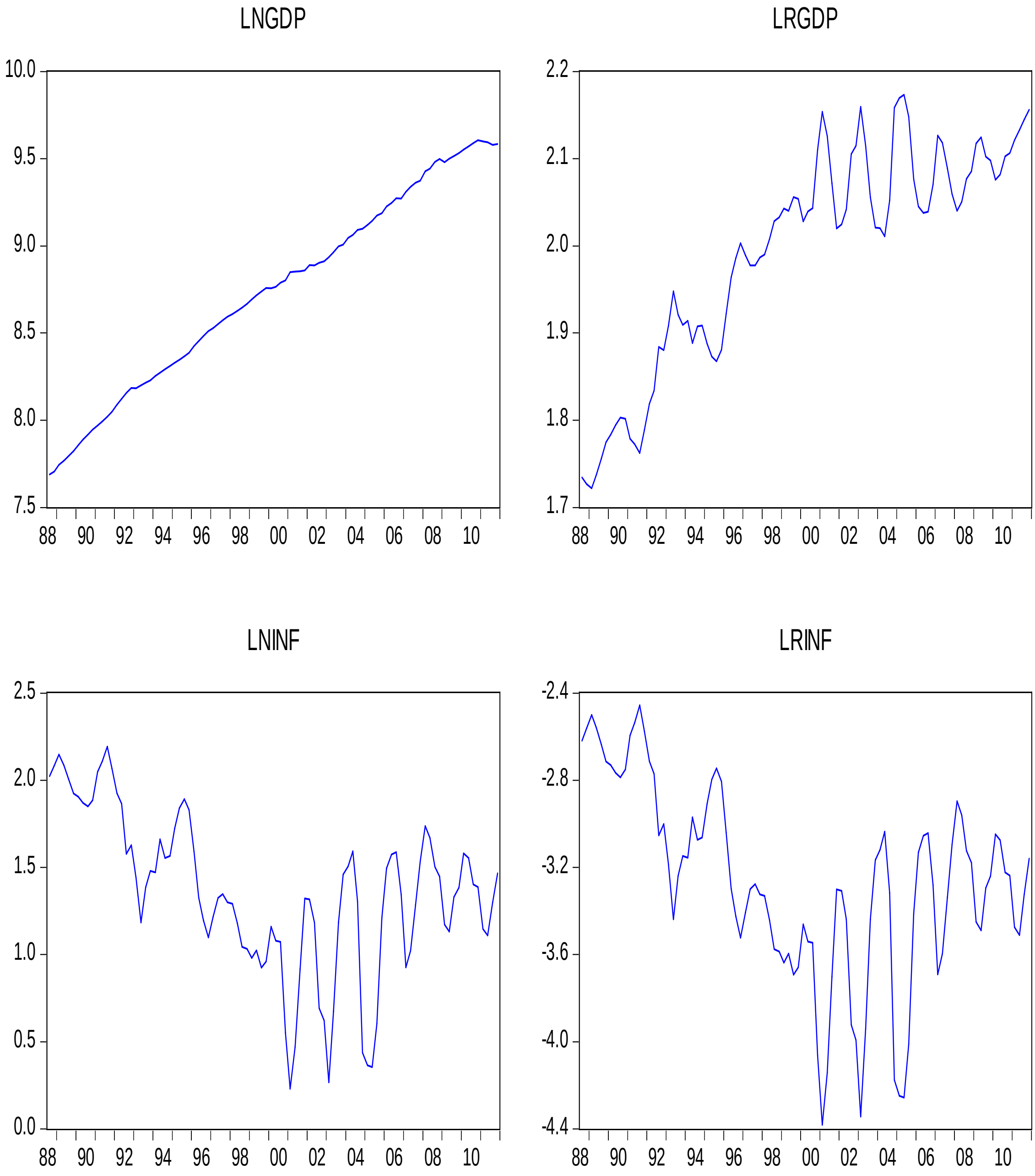
Notes: γ is the coefficient of the in-mean effect in the inflation equation. δ is the coefficient on the lagged inflation rate in the conditional variance of inflation equation. The Q-statistics test for serial correlation in the residuals and squared residuals, respectively. P-values are given in brackets. *(**)*** denote statistical significance at the 10%, 5% and 1% levels respectively.

Table 3: F-statistic for Granger Causality Tests

Model	$H0_1$	$H0_2$
Nominal Inflation	2.0599* (0.0943)	0.8355 (0.5068)
Real Inflation	2.1038* (0.0884)	2.2907* (0.0672)

Note: $H0_1$: inflation uncertainty does not Granger cause inflation. $H0_2$: inflation uncertainty does not Granger cause economic growth. P-values are given in brackets. * (**) *** denote statistical significance at the 10%, 5% and 1% levels respectively.

Figure 1: Time Series Plots



Note: LNGDP, LNINF, LRGDP and LRINF denote nominal GDP, nominal inflation, real GDP and real inflation respectively.

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