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Inflation and Inflation Uncertainty in the Jordan Evidence from GARCH Modeling

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Abstract

Among the harmful effects of inflation, the negative consequences of inflation volatility are of particular concern. These include higher risk premia, hedging costs and unforeseen redistribution of wealth, so that our study came to examines the relationship between Inflation and Inflation uncertainty for one of emerging country; Jordan by using monthly data from 1976:1 to 2013:12.

The maximum likelihood estimates from the GARCH model indicate strong support for the presence of a positive relationship between the level of inflation and its uncertainty. The Granger causality results report a feedback between inflation and uncertainty. With Granger causality running both ways, the Friedman-Ball and Cukierman-Meltzer hypotheses hold simultaneously in Jordan.

The results of this study may be useful for policymakers at central bank to devise more efficient monetary policy.

Key words: GARCH; Inflation; Inflation volatility

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INTRODUCTION

Inflation received a great deal of attention because of its impact on all economic activities, and the cost they have to pay through uncertainty, the latter is defined as "a state of having limited knowledge where it is impossible to exactly describe existing state or future outcome, more than one possible outcome" Hubbard (2009).

Inflation is taken to be a bad boy and desolation for the economy with great consensus by economists. Loss of predictability, delayed decisions of investment and a fall in purchasing power (hence demand) are amongst some of the costs of unstable inflation compelling "Price Stability" as prime objective for policy makers. Higher inflation levels are believed to cause uncertainty about future inflation by distorting price mechanism.

The Jordan experienced high levels of inflation during the nineties accordingly many studies has been done but none of them mentioned the relationship between inflation and uncertainty. Inflation is defined as continuous growth of general prices, or an increase in purchasing power not matched with increase in supply of goods, large quantity of money purchasing few goods. It is calculated as percentage growth rate either of General Price Level, or Consumer Price Index CPI. Inflation was explained by many economists of which are Fischer and Keynes.

This paper has two contribution ion literatures. Firstly it is first attempt in Jordan to model the impact of inflation on inflation uncertainty. Secondly, and more importantly, amid Accelerated higher inflation rate in Jordan this work has greater policy relevance. Our work fills the void by extending the issue in two directions. Firstly, Instead of standard deviation or variance of inflation, conditional volatility is used as proxy for inflation uncertainty. We model inflation in GARCH process to generate conditional volatility of the inflation series. Secondly, the direction of causality between inflation and inflation uncertainty is examined by applying granger causality technique.

This study examines the relationship between Inflation and Inflation uncertainty for Jordan by using quarterly data from 1992-2013.

GARCH model is applied to estimate conditional volatility, used as proxy for Inflation uncertainty.

Granger-causality test reveals that an increase in inflation has a positive impact on inflation uncertainty.

The results of the study may be useful for policymakers at central bank to devise more efficient monetary policy.

The rest of the paper is organized as follows. The next section discusses literature review concerning the inflation-uncertainty relationship. Section 3 presents an overview the data and methodology. Section 4 provides conclusions.

1. LITERATURE REVIEW

The relationship between inflation and its uncertainty can be traced back to 1970s (see for instance Okun,1971; Friedman, 1977). The idea that a rise in the level of inflation raises uncertainty about future inflation is central in Friedman's (1977) Nobel address. The uncertainty about future inflation can stem from the expectations about the role of central bank for future in the presence of costs of disinflation. Ball (1992) puts a case for the argument in a game theoretical framework where asymmetric information notion holds. According to Friedman-ball, higher inflation rates generate greater uncertainty about the future policy so about future inflation rates.

Reversing the 'causation' link of the Friedman-Ball view is proposed by Ungar and Zilberfarb (1993), extending on Pourgerami and Maskus (1987), where a great allocation of resources to understand the inflation uncertainty in presence of high inflation decreases the future uncertainty.

In the latter regard, Brunner and Hess (1993) and Grier and Perry (1998) find the evidence supporting Friedman and Ball hypothesis using ARCH and GARCH models respectively for G-7 countries. But a week support was found for Cukierman and Meltzer hypothesis. Nas and Perry (2000) put strong evidence that inflation rates increases inflation uncertainty in turkey. Using ARCH model to measure uncertainty, similar results are reported in Neyapti and Kaya (2001). Again Zeynel and Mahir (2008), using GARCH modeling, establishes a strong and weak evidence for Friedman-Ball and Cukierman and Meltzer hypothesis respectively for Jordan, Philippines and Turkey. Positive impact of inflation uncertainty on inflation is also reported by Golob (1994) for US using quarterly data. In his study on UK, Joyce (1995) reports higher sensitivity if inflation uncertainty to positive inflation shocks as compared to negative shocks. Ricketts and Rose (1995), in Markov-Switching model, found the evidence that inflation uncertainty increases during high inflation periods in Canada.

In the latter regard, recent studies have tended to use the estimated conditional variance from Generalized Auto regressive Conditional Heteroskedastic (GARCH) models to measure inflation uncertainty and generally have been supportive of the Friedman hypothesis. These studies include Grier and Perry (1998) for the G7 countries: Fountas (2001) for the UK inllation experience over a long time span; Fountas. loannidis, and Karanasos (2004) for the inflation experience in five out of six European countries; and Conrad and Karanasos (2005) in a study of inflation in the United States, the United Kingdom, and Japan.

In this paper we focus on the inflation-uncertainty issue in one of emerging markets; Jordan. Specifically, we use the estimated conditional variance from a GARCH type model to measure inflation uncertainty and employ Granger methods to test for the direction of causality between inflation and inflation uncertainty in Jordan.

The results provide strong empirical support for the Friedman-Ball and Cukierman-Meltzer hypotheses hold simultaneously in Jordan.

2. DATA AND METHODOLOGY

In our empirical analysis, for the inflation measuring, we consider the Consumer Price Index (CPI), similar to the studies on this topic of Gillman and Nakov (2004), Gillman and Harris (2008), Mladenovic (2009) and Khan and Nenovsky (2012). The data source is represented by central bank of Jordan "Statistics database", and cover the Period from 1976:1 to 2013:12, on the consumer price index (CPI). For a precise and robust measure of inflation, we take into consideration Fountas, Karanasos and Kim (2006) procedure, we calculated inflation rate as the log difference of monthly CPI, and the number of observations (allowing for differencing) was 456.

The data set for uncertainty of inflation represents the time series on conditional variances of inflation constructed using the GARCH model.

GARCH techniques have recently become more popular in empirical investigations of the relation between inflation and inflation uncertainty since they provide a more sophisticated method of estimating time-varying uncertainty compared to the two-step procedures. See for instance Fountas *et al.* (2001), Berument and Dincer (2005), Conrad and Karanasos (2005), Daal *et al.* (2005), and Grier and Grier (2006) for different versions of GARCH models.

In order to model inflation, we used an *nth* order autoregressive process, AR (n):

$$\pi_t = \beta_0 + \sum_{i=1}^{n} \beta_i \pi_{t-i} + \varepsilon_t \qquad (1)$$

Where π_t, is the inflation level at time t, n is the number of lags, ε_t is the residual term at time t. Here, inflation has an autoregressive expression at the lag length of n to account for the effect of auto correlated residuals and we assume that ε_t has a zero mean and time varying variance of h_t^2. To model the time varying variance, Engle (1982) used autoregressive conditional heteroscedastic (ARCH) model, which is a conditional variance of the inflation equation.

$$h_t^2 = \alpha_o + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}^2 \quad (2)$$

Later, Bollerslev (1986) included past values of h_t^2 in addition to the lagged values of the squared residuals to capture the conditional variance - generalized autoregressive conditional heteroscedasticity model: GARCH (p, q).

$$h_t^2 = \alpha_o + \sum_{i=1}^{p} \alpha_{1i} h_{t-i}^2 + \sum_{j=1}^{q} \alpha_{2j} \varepsilon_{t-j}^2 \quad (3)$$

In this specification, two points need attention as sufficient conditions; firstly due to the non-negativity property of variances, the constant and the coefficients should be positive (α_0, α_{1i}, α_{2j} >0,for all i, j). Secondly, conditional variance should not explode; hence, to provide non-explosiveness, the sum of the coefficients except the constant should be less than 1:

$$\sum_{i=1}^{p} \alpha_{1i} + \sum_{j=1}^{q} \alpha_{2j} < 1$$

3. EMPIRICAL EVIDENCE

Summary statistics for the monthly inflation rates are presented in Table 1. The kurtosis and skewness statistics indicate that the distributions generally are not normal, being skewed to the right. The deviation from normality is confirmed by the large values of the Jarque-Bera statistics, and ARCH effects are indicated by the significant Q-statistics of the squared deviations of the monthly inflation rate from the sample means and the LM (12) statistics.

Table1
Summary Statistics for Monthly Inflation

Mean	0.004464
Median	0.002968
Maximum	0.136132
Minimum	-0.139825
Std. Dev.	0.022661
Skewness	1.407922
Kurtosis	14.26873
Jarque-Bera	2563.352
Probability	0
Observations	456
Q-Stat(12)	127.78 (0.000)
LM(12)	112.36(0.000)

The empirical evidence on this issue is mixed with a substantial literature supporting nonstationarity. A particular problem in the Jordan which one of the emerging markets economies is the impact on the inflation series of the varying degrees of financial crisis and liberalization measures (including of administered prices) that each experienced during the sample periods under study.

In this context, we use two unit root tests to determine whether the inflation series are stationary, the Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1979); and the Phillips and Perron (1988) (PP) test.

Our empirical investigation into the long run relationship between inflation and uncertainty of inflation by testing for nonstationairity in these two variables, we test for the null of nonstationarity against the alternative of stationarity.

Table 2 represent the results of unit root tests, the ADF, and PP tests statistics reject the null hypotheses, which mean that the inflation is a stationary series.

Table 2
Unit Root Test Statistics for Monthly Inflation

ADF Test Statistic	-10.90202	1% Critical Value*
		5% Critical Value
		10% Critical Value
PP Test Statistic	-21.47195	1% Critical Value*
		5% Critical Value
		10% Critical Value

PP is the Phillips-Perron test, ADF is the Augmented Dickey-Fuller test. Lag length is chosen on the basis of the Schwartz Bayesian Criterion in the case of the ADF test , the Newey-West criterion in the case of the Phillips-Perron test.

*MacKinnon critical values for rejection of hypothesis of a unit root.

The GARCH modelestimation are reported in Table 3. The results support the existence of a positive relationship between the level and variability of inflation. In all cases the reported parameters in the inflation and covariance equations are highly significant and of the hypothesized signs. The intercept in the conditional variance equation is positive, which is consistent with the non negativity of the variance. The summation of the ARCH and GARCH coefficients in the conditional variance equation is less than one equal to 0.827 which is consistent with the conditional variance of inflation being stationary. Finally, the parameter ε in the covariance equation is positive and significant, and indicates that if inflation rises by one unit; its conditional variance goes up by 0.005. Q-statistics in Table 2 shows no patterns with the exceptions of a significant spike at the 12th lagged residual.

Results proof of a cointegrated relationship between the two variables of inflation and uncertainty of inflation.

Table 3
GARCH (p,q) Model for Inflation and Inflation Uncertainty

Dependent Variable: INF Method: ML - ARCH Date: 01/22/14 Time: 19:59				
Sample: 1976:01 2013:12 Included observations: 456				
Convergence achieved after 202 iterations				
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
GARCH	40.65593	3.771437	10.77996	0
C	-0.00909	0.001113	-8.16057	0
Variance Equation				
C	2.51E-05	3.85E-06	6.530838	0
ARCH(1)	0.042233	0.002741	15.40742	0
GARCH(1)	0.787128	0.010211	77.08327	0
INF	0.005434	0.000352	15.42824	0
R-squared	0.175551	Mean dependent var		0.004464
Adjusted R-squared	0.166391	S.D. dependent var		0.022661
S.E. of regression	0.02069	Akaike info criterion		-5.41255
Sum squared resid	0.192639	Schwarz criterion		-5.35831
Log likelihood	1240.061	F-statistic		19.16387
Durbin-Watson stat	1.836855	Prob(F-statistic)		0

In Table 4, we can easily notice that the null hypothesis that inflation does not Granger-cause inflation uncertainty is rejected at the 0.01 significance level, in other words, we find that inflation does precede the course of the inflation uncertainty. When the sign of the sum of the coefficients are examined, the total effect of inflation on inflation uncertainty turns out to be positive, a result that supports what the Friedman-Ball hypothesis adduces.

Both Friedman-Ball research provide theoretical background in support for the first hypothesis, with evidence of a positive relationship between inflation and inflation uncertainty. They state that when the inflation rate increases, the monetary authority do not have a predictable and reliable response, and that generates uncertainty about the future rate of inflation for the public, because the money supply growth cannot be predicted.

Also the second hypothesis that inflation uncertainty Granger-causes inflation is rejected at the 0.01 significance level, the suggest a positive causal relation from inflation uncertainty to inflation, supporting the Cukierman and Meltzer (1986) hypothesis of an 'opportunistic' central bank.

Table 4
Causaiity Test for Inflation and Inflation Uncertainty

Pairwise Granger Causality Tests			
Date: 01/24/14 Time: 16:54			
Sample: 1976:1 2013:12			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
INF does not Granger Cause INFUNCERTANITY	454	337.337	0.00000
INFUNCERTANITY does not Granger Cause INF		1.8E+17	0.00000

CONCLUSION AND POLICY IMPLICATION

This paper contributes to this effort by analyzing the relationship between inflation and inflation uncertainty in Jordan. Initial estimates show the inflation rate to be a stationary process. The results of the GARCH model indicate strong support for the presence of a positive relationship between the level of inflation and its uncertainty. The Granger causality results report a feedback between inflation and uncertainty. With Granger causality running both ways, the Friedman-Ball and Cukierman-Meltzer hypotheses hold simultaneously in Jordan.

The evidence on the effect of inflation uncertainty on average monthly inflation was also found, where increased uncertainty is associated with higher inflation and its related uncertainty can impose costs on real economic output in any economy.

For an emerging market like Jordan, these costs may be higher than those in developed economies as inflation is still higher than desired. In order to minimize the adverse economic consequences and welfare costs of increases in the inflation rate, policymakers in Jordan need a clear understanding of the major channels through which inflation may affect the real economy. One such channel comes from the effects that higher inflation has on inflation uncertainty.

The goal should be to minimize the marginal effect of inflation on inflation uncertainty. This can be done in a number of ways. First, implement quick policy responses to inflation developments thereby reducing inflation uncertainty both in the short and long run. Second, share information on all major drivers of domestic inflation with the general public in order to help rationalize inflation expectations. Given the importance of food and energy in Jordan's priced index calculation; publishing information on these items, inflation rate in major trading partners, projections of important import and export prices, etc. would be beneficial. Finally, an improved coordination between monetary and fiscal policies would help to react effectively to both demand and supply shocks to the economy.

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