Inflation and inflation uncertainty in Argentina, 1810–2005

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Abstract

Unit root tests results suggest that inflation in Argentina for the period 1810–2005 is a stationary series when account is taken of structural breaks that coincide with bouts of hyperinflation. A GARCH (1,1) model of annual inflation suggests a positive short-run relation between the mean and variance of inflation, supporting Friedman’s hypothesis that high inflation is associated with more variable inflation.

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1. Introduction

In a seminal paper, Friedman (1977) argued that increased variability or uncertainty of inflation distorts relative prices and adds an additional risk to long term contracting. In addition, he asserted that high levels of inflation are costly since they raise inflation variability. This hypothesis has given rise to a host of empirical studies examining the link between inflation and inflation uncertainty. A review of the many early studies on the issue by Davis and Kanago (2000) highlights the mixed results, partly reflecting differences in the countries studied, sample periods, frequency of the data sets, and empirical methodologies, including the representation of inflation uncertainty. Many of the more recent studies have...
tended to favor the use of GARCH-based measures of inflation uncertainty to test the Friedman hypothesis. These studies typically either have used the simultaneous estimation approach to determine whether a positive short-run relationship between the mean and variance of inflation exists, and/or have employed a Granger-causality approach to determine the direction of the impact of a change in inflation on inflation uncertainty. Recent studies of this type generally have been supportive of Friedman’s hypothesis, and include Fountas (2001) for the UK inflation experience over long time span, Fountas et al. (2004) for the recent inflation experience in five out of six European countries, and Conrad and Karanasos (2005) in a study of recent inflation in the USA, the UK, and Japan. In contrast, Hwang (2001) found no evidence that high inflation led to a high variance of inflation using a long series of monthly US inflation data.

Most recent empirical tests of the hypothesis have been on the inflation experience of one or more of the G7 advanced economies, where average inflation rates typically have been low, with the exception of a brief period in the 1970s. This note contributes to the empirical evidence by using GARCH measures of inflation uncertainty to test for a positive short-run relation between the mean and variance of inflation in Argentina using a long series of consumer price data. It reports results from annual data spanning almost 200 years, which covers a variety of inflation and deflation experiences, including bouts of hyperinflation in the beginning in the early 1970s and the late 1980s. The results provide empirical support for Friedman’s hypothesis.

2. The model

The GARCH time series studies that examine the link between inflation and inflation uncertainty use a variety of empirical methodologies. Following Fountas (2001), I use a GARCH (1,1) model extended to allow for the inclusion of the inflation rate as an exogenous regressor in the variance equation in which inflation, \( y_t \), is an AR(2) process with time varying conditional variance:

\[
y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_p y_{t-p} + \varepsilon_t; \quad E(\varepsilon_t / \theta_{t-1}) = 0; \quad \text{Var}(\varepsilon_t / \theta_{t-1}) = \sigma_t^2, \quad (1)
\]

\[
\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \ldots + \beta_v \sigma_{t-v}^2 + \delta y_t, \quad (2)
\]

where \( \alpha_0 > 0, \alpha_i \geq 0, i = 1, \ldots, q, \beta_j \geq 0, j = 1, \ldots, v \) and \( \theta_t \) is the information set available at time \( t \), and where according to Friedman’s hypothesis, \( \delta > 0 \).

3. Data and results

I use annual data for the Argentine consumer price index for 1810–2005 from Ferres (2005) and the International Monetary Fund’s International Financial Statistics data base. Fig. 1 illustrates the volatility of price changes over the period and summary statistics for the series are given in Table 1. The large value of the Jarque–Bera statistic implies a deviation from normality, and the significant \( Q \) statistics of the squared deviations of the inflation rate from the sample means indicates the existence of ARCH effects. This evidence is also supported by the LM(1) statistic, which is highly significant.
In light of the instability in the series, I use three types of unit root tests to examine the stationarity properties of consumer prices. The first type of tests is relatively common in the literature but has been criticized because of their bias towards non-rejection of the null hypothesis of a unit root against the alternative of (trend) stationarity in the presence of structural breaks and low power for near-integrated processes. These are the Augmented Dickey and Fuller (1979) test and the Phillips and Perron (1988) test. The second type of tests allows for one break in the series, and is the tests developed by Zivot and Andrews (1992) and Lee and Strazicich (2004). The Zivot-Andrews test considers the null hypothesis of unit root with no break against the alternative of a trend-stationary process with a break occurring at an unknown point in time. In the presence of a break under the null, however, the asymptotic results are not valid and the test exhibits size distortions such that the unit root null hypothesis is rejected too often. The Lee and Strazicich (2004) unit root test with one endogenously determined structural break is based on a Lagrange multiplier (LM) test (with a distribution invariant to breakpoint nuisance parameters) and allows for a break under both the null and alternative hypotheses, such that the alternative hypothesis unambiguously implies trend stationarity. The third type of test allows for two breaks in the series and is the Clemente et al. (1998) test, which allows for two changes in the mean for non-trending additive and innovative outliers models. Table 2 reports the unit root test results for the series in first differences over the full sample. The tests, both with and without breaks, suggest that the hypothesis of a unit root can be

Table 1
Summary statistics for consumer price inflation, 1810–2005

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.1780</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.4587</td>
</tr>
<tr>
<td>Minimum</td>
<td>−0.5108</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.4746</td>
</tr>
<tr>
<td>Skewness</td>
<td>4.1482</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>24.0285</td>
</tr>
<tr>
<td>Jarque-Bera statistic</td>
<td>4152.097 (0.000)</td>
</tr>
<tr>
<td>Q²</td>
<td>5.2013 (0.023)</td>
</tr>
<tr>
<td>LM(1)</td>
<td>5.1813 (0.024)</td>
</tr>
</tbody>
</table>

Q² is the Ljung-Box test for serial correlation in the squared deviations of the inflation rate from its sample mean, where the 1st order test statistic is reported. LM(1) is the Engle test for ARCH effects. Values in parenthesis are P-values.
strongly rejected. However, both the Zivot and Andrews (1992) and Lee and Strazicich (2004) tests indicate a structural break in the early 1970s (1973 and 1974, respectively), which coincides with the first bout of hyperinflation in the twentieth century. The Clemente et al. (1998) test also confirms a structural break in 1973 and indicates a second break in 1992, which coincides with the second bout of hyperinflation in modern times.

On the basis of the unit root test results, I confine the estimate of the GARCH model to the period 1810–1972, for which no structural break is indicated.2 The maximum likelihood estimates of the GARCH model are reported in Table 3. In carrying out the estimates, I began with an inflation lag of 24 years, which was then shortened on the basis of the minimum value of the Schwarz Bayesian Criterion. The results strongly support the existence of a positive relationship between the level and variability of inflation. 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 nonnegativity of the variance. The sum of the ARCH and GARCH coefficients in the conditional variance equation is less than one, which is consistent with the conditional variance of inflation being stationary. Finally, the parameter $\delta$ in the covariance equation is positive and significant, and indicates that if inflation rises by one unit, its conditional variance rises sharply (by 0.2 units for each 1 unit rise in inflation).3 The $Q$ statistics for the standardized residuals and squared residuals indicate no serial correlation. Finally, a Granger-causality test of the inflation–inflation uncertainty relation indicates that it is strongly bi-causal and positive. For example, using a four-year lag the null hypothesis that inflation does not Granger-cause inflation uncertainty is rejected with an $F$-statistic of $F_{1,189}=2653.02$; and the null hypothesis that inflation uncertainty does not Granger-cause inflation is rejected with an $F$-statistic of $F_{1,189}=8.03$.4

4. Conclusions

Unit root tests results suggest that inflation in Argentina for the period 1810–2005 is a stationary series when account is taken of structural breaks that coincide with bouts of hyperinflation. In addition, a

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Table 2
Unit root tests results for consumer prices, 1810–2005

<table>
<thead>
<tr>
<th>Test</th>
<th>$t$-statistic</th>
<th>Breaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dickey and Fuller (1979)</td>
<td>$-3.46^*$</td>
<td>(3)</td>
</tr>
<tr>
<td>Phillips and Perron (1988)</td>
<td>$-5.36$</td>
<td>(17)</td>
</tr>
<tr>
<td>Zivot and Andrews (1992)</td>
<td>$-6.29^*$</td>
<td>(3)</td>
</tr>
<tr>
<td>Lee and Strazicich (2004)</td>
<td>$-5.26^*$</td>
<td>(8)</td>
</tr>
<tr>
<td>Clemente et al. (1998)</td>
<td>$-5.01^*$</td>
<td>(12)</td>
</tr>
</tbody>
</table>

Tests are for the first difference of the log of the consumer price index; in each case; in each case, results for the level of the index were not statistically significant. * indicates significance at the 95% level. All equations include an intercept trend.

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2 The remaining years of the sample period do not provide sufficient observations for sensible estimates from a GARCH model.
3 As the unit of measurement for the inflation series is 0.1 or 10%, the unit of measurement for the conditional variance is 0.01 or 1%.
4 Granger-causality tests were run with lags from 2 to 12 years and in each confirmed a positive bicausal relation between inflation and inflation uncertainty.
GARCH model of annual inflation suggests a positive short-run relation between the mean and variance of inflation for the period 1810–1973. The results are in line with those from several recent studies that have used GARCH models to examine the inflation experience in one or more of the G7 economies and provide further evidence in favor of Friedman’s hypothesis that inflationary periods are associated with high inflation uncertainty.

### References


