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Abstract

We use over two hundred years of US inflation data to examine the impact of inflation uncertainty on inflation. An analysis of the full period without allowing for various regimes shows no impact of uncertainty on inflation. However, once we distinguish between recessions and non recessions, we find that inflation uncertainty has a negative effect on inflation only in recession times, thus providing support to the Holland hypothesis.

Keywords: asymmetric GARCH, recession, inflation uncertainty
JEL Classification: C22, E31

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1 Introduction

The relationship between inflation and inflation uncertainty has drawn significant attention in the empirical macroeconomic literature recently. Macroeconomic theory predicts a bidirectional causal relationship. Friedman (1977) argues that in inflationary times there is uncertainty among the public regarding the likely response of the monetary authority, thus leading to inflation uncertainty. Hence, inflation has a positive effect on inflation uncertainty. The sign of the impact of inflation uncertainty on inflation, though, is ambiguous from a theoretical point of view. It depends on the reaction of the central bank to an increase in inflation uncertainty. The central bank may react opportunistically creating an inflation surprise to reap output gains (Cukierman and Meltzer, 1986). Alternatively, the central bank may act in a stabilizing manner reducing inflation in order to offset the increase in inflation uncertainty and its output destabilizing effects (Holland, 1995).

The empirical literature on the inflation-inflation uncertainty nexus has multiplied tremendously over the last few years. The majority of this literature has examined the link between the two variables abstracting from the consideration of regime changes in inflation and/or inflation uncertainty (e.g., Grier and Perry, 1998, Bredin and Fountas, 2009). In general, there is no consensus arising from this vast literature, in particular on the Cukierman-Meltzer hypothesis. It is anticipated though that regime shifts are important and the impact of inflation uncertainty on inflation may be sensitive to such shifts. Evans (1991) considers the sensitivity of inflation uncertainty to regime shifts in inflation. Using a similar approach, Caporale and Kontonikas (2009) highlight the impact of the impact of the euro regime on inflation uncertainty in eurozone countries.

In this paper, we focus on the impact of recessions on the effect of inflation uncertainty on inflation. Recessionary periods are expected to have an influence on inflation uncertainty and possibly on the reaction of the central bank, thus altering the sensitivity of inflation to changes in inflation uncertainty. One innovation lies in the use of a very long US inflation data set that covers over two centuries and encompasses several periods of recession. This represents the most comprehensive sample examined to date for the issue in hand. Historical inflation data sets for other countries have been used to examine the inflation-inflation relationship but none of these studies have considered the impact of recession regimes. Fountas (2001) uses UK data, and Thornton (2008) uses data on Argentina. Using an asymmetric Generalized Autoregressive Conditional Heteroskedasticity in-mean (GARCH-M) model we find that inflation uncertainty increases during recessions and the central bank responds by decreasing inflation. This evidence for the Holland hypothesis does not apply when no allowance is made for recessions in the full sample. The following section describes the data and the model. Section 3 presents and discusses the results and section 4 concludes.

2 Data and model

Our annual US inflation data covers over 200 years for the period 1801-2008. The raw CPI data are taken from Mitchell (2003) and the IMF and inflation rates are constructed taking the logged differences, $ln(CPI_t/CPI_{t-1})$. The dates of US recessions are taken from the NBER for the period 1854-2008. For the earlier years, the dates are taken from Knoop (2004). The inflation series along with recession dates are graphed in Figure 1.

We estimate an asymmetric GARCH-M model for inflation where allowance is made for recessionary periods using a recession dummy. The model is a threshold GARCH (TARCH) suggested by Glosten, Jaganathan and Runkle (GJR, 1993). Equations (1) and (2) below are the mean and conditional variance equations, respectively.

$$\pi_t = \beta_0 + \sum_{i=1}^{n} \beta_i \pi_{t-i} + \alpha_1 dum^{rec} + \alpha_2 \sqrt{h_t} + \alpha_3 dum^{rec} \sqrt{h_t} + \epsilon_t \quad (1)$$

$$h_t = \gamma_0 + \gamma_1 \epsilon_{t-1}^2 + \gamma_2 h_{t-1} + \gamma_3 dum^{dec} + \gamma_4 \epsilon_{t-1}^2 I_{t-1} \quad (2)$$

where dum^{rec} is the recession dummy taking the value one during recessions and zero otherwise.

In equation (1) the inflation uncertainty variable ($\sqrt{h_t}$) enters both additively and multiplicatively. Coefficient α_2 captures the effect of inflation uncertainty on inflation in non recessionary periods and α_3 captures the difference in the effect between recessions and non recessions. A finding that $\alpha_2 + \alpha_3 < 0$ indicates evidence in favour of the Holland hypothesis during recessions. Equation (2) allows for the existence of asymmetric effects of positive and negative shocks on inflation uncertainty via the threshold term I_{t-1} which equals 1 if $\epsilon_{t-1} < 0$ and $= 0$, otherwise. If $\gamma_4 < 0$, there is evidence of asymmetry, i.e., positive inflation shocks increase uncertainty more than negative shocks.

3 Results

Table 1 reports summary statistics of inflation residuals. We first test for a unit root in inflation using the ADF and Phillips-Perron tests. The results reported in Table 1 show that inflation is stationary. The results also indicate the absence of normality, a typical finding in series showing ARCH effects. These effects are indicated by the rejection of the null of no ARCH effects.

Table 2 reports the estimated GARCH models. We include results for two models for comparison: First, the model without the recession dummy and, second, the model with the dummy. The first model shows evidence for asymmetries as γ_4 is negative and statistically significant. However, the insignificance of α_2 implies that inflation uncertainty has no effect on inflation. Results are quite different when a recession dummy is included in both the conditional mean and the conditional variance equations. Once again, there is evidence of asymmetries. This evidence is consistent with Friedman (1977) in the sense that more inflation (positive inflation shocks) should lead to more uncertainty than less inflation (negative inflation shocks). In addition, γ_3 is positive and statistically significant, indicating more inflation uncertainty during recessions, while α_3 is negative and statistically significant implying that higher inflation uncertainty during recessions leads to less inflation.

Taken together, these results may be explained as follows: During recessions the public does not know how the central bank will react, i.e., whether it will expand money growth or it will take a cautious approach fearing missing its price stability target. Hence, inflation uncertainty increases during recessions ($\gamma_3 > 0$). This is particularly the case for prolonged recessions, as indicated by the conditional variance in Figure 2. The central bank anticipating that inflation uncertainty may deepen the recession (through its presumed negative effects on output[1]), decides to contract money growth in order to fight inflation uncertainty ($\alpha_3 < 0$). The null hypothesis that $\alpha_2 + \alpha_3 = 0$ is rejected as the χ^2 statistic is 18.053 (p-value=0.000). This result implies conclusive evidence in favour of the Holland hypothesis.

Finally, from an econometric point of view, the reported diagnostics tend to support the second model against the first as indicated by the maximum value of the log-likelihood function. The above analysis shows that recession regimes tend to influence the inflation-inflation uncertainty relationship. Even though such a relationship is absent when no account is taken of recession periods, evidence for the Holland hypothesis, i.e., a negative effect of inflation uncertainty on inflation, obtains during recession periods.

4 Conclusions

This paper uses historical US inflation data covering over two centuries to examine the impact of recessions on the inflation-inflation uncertainty

[1] Using data on real GDP and Granger-causality tests, we find that inflation uncertainty affects real growth negatively during the recession years. Results are available on request.

nexus. We obtain the following results. First, inflation uncertainty is higher during recessions. Second, the central bank responds to higher inflation uncertainty reducing inflation. Our results support the Holland hypothesis. Third, if we do not distinguish between recessions and non recessionary periods, we find no evidence for the Holland hypothesis. Therefore, these findings highlight the importance of the consideration of various regimes, in the present case recessions, when analyzing the link between inflation and nominal uncertainty.

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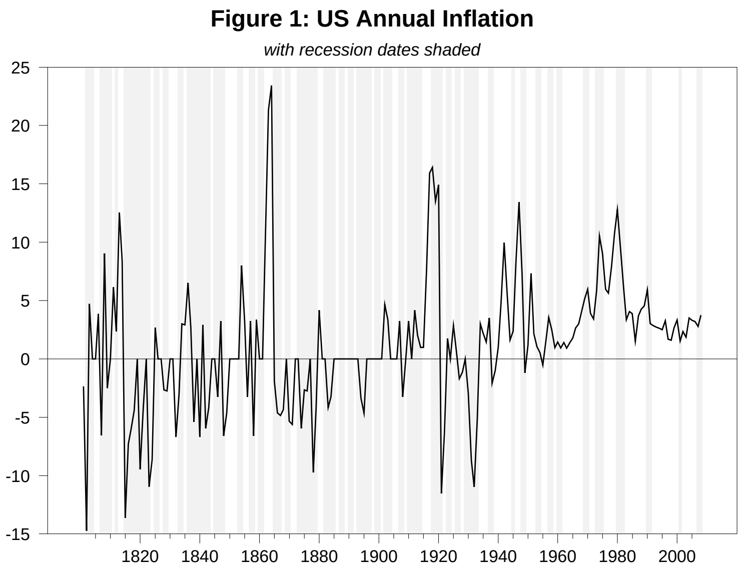
Figure 1: US Annual Inflation
with recession dates shaded
25
20
15
10
5
0
-5
-10
-15
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000

Figure 2: Conditional Variance

with recession adjustment & with recession dates shaded

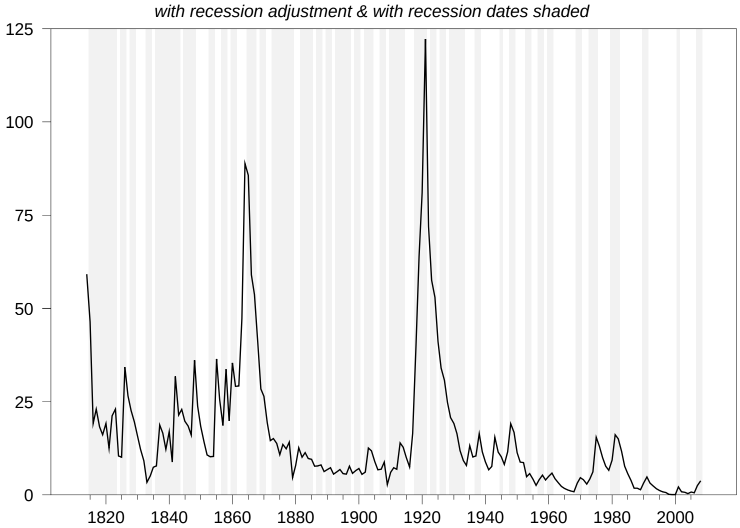

Table 1: Summary Statistics: US Inflation

Mean	Skewness	Kurtosis	Norm. Test
1.220	0.513	2.348	56.900
Lags	ADF	PP	ARCH
Zero	-8.306	-8.255	
Five	-4.416	-8.358	63.221
			(0.000)

Note: A * represents significance at the 5% level. P-values in parenthesis. The normality test is the Jarque-Bera normality test. The LM test of order 5 is used to test for ARCH. The 5% critical value for the unit root tests is -2.875.

Table 2: GARCH Model for US Inflation

	No Recession Dummy		Recession Dummy)	
Coefficient	Estimate	Standard Error	Estimate	Standard Error
Mean				
β_0	1.045*	0.325	0.706*	0.261
$\beta_1\pi_{t-1}$	0.764*	0.079	0.767*	0.063
$\beta_2\pi_{t-2}$	-0.261*	0.089	-0.240*	0.065
$\beta_3\pi_{t-3}$	0.144*	0.097	0.130*	0.075
$\beta_4\pi_{t-4}$	0.050	0.091	0.048*	0.075
$\beta_5\pi_{t-5}$	0.157*	0.070	0.112	0.060
$\beta_6 dum^{rec}$			2.760*	0.922
$\beta_7\sqrt{h_t}$	-0.195*	0.132	0.249	0.150
$\beta_8 dum^{rec}\sqrt{h_t}$			-1.311*	0.313
Variance				
γ_0	0.168	0.130	0.001	0.103
$\gamma_1\epsilon_{t-1}^2$	0.438*	0.092	0.397*	0.117
$\gamma_2 h_{t-1}$	0.800*	0.036	0.773*	0.043
$\gamma_3 dum^{rec}$			2.061*	0.707
$\gamma_4\epsilon_{t-1}^2 I_{t-1}$	-0.421*	0.104	-0.494*	0.140
Max-Lik	-332.850		-313.286	
Serial Corr	0.372		0.530	
ARCH	0.530		0.430	

Note: A * represents significance at the 5% level. The p-value for the LM test for serial correlation and the LM test for ARCH are reported in the last two rows.