

Deflation and Recession: Finding the Empirical Link

Federico Guerrero and Elliott Parker*

Assistant Professor and Professor
Department of Economics
University of Nevada, Reno

Abstract: Does deflation cause recession? We examine two separate data sets and find that though the relationship between deflation and recession is complicated, there is evidence of bidirectional Granger causality between the two, and also evidence that deflation lowers subsequent growth.

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1. Introduction

It is well accepted that recession can cause price deflation if inflation rates are already low, but can deflation cause recession in turn? Deflation is now considered part of the explanation for Japan's continued stagnation since the early 1990s (e.g., Krugman 2000, Eggertsson and Woodford 2003). Furthermore, the Federal Reserve's Federal Open Market Committee issued a press release in 2003 that, according to Bernanke (2003), explicitly recognized an asymmetry between inflation and deflation, and made avoiding deflation a part of U.S. monetary policy. Yet Friedman (1969) showed that in a wide class of standard models the optimal rate of inflation is negative.¹

What does the available evidence say? In a broad review of deflation over the past two centuries, Borio and Filardo (2004: 7) argue that deflationary periods may be grouped into "the good, the bad and the ugly." Good deflations could result from productivity improvements, bad deflations could result from nominal price rigidities, and ugly deflations

* Corresponding author. Department of Economics /030, University of Nevada, Reno, NV 89557-0207 U.S.A., ph. 1-775-784-6408, fax 1-775-784-4728, e-mail: eparker@unr.edu.

could be those rare cases where deflation becomes self-reinforcing due to several factors related to the zero lower bound on nominal interest rates, including Fisher's (1933) debt-deflation connection that could lead firms to default on their loans, falling consumption in anticipation of future deflation, increases in real money demand,² and a falling deposit expansion multiplier that could make monetary policy more difficult.

Bordo and Redish (2003), note that in both the United States and Canada deflations appear to have resulted from simultaneous combinations of negative monetary shocks and positive shocks to aggregate supply, with productivity-driven deflation being the most prevalent type. Indeed, Bordo, Landon, and Redish (2004) estimate a vector autoregression model for the United States, the United Kingdom, and Germany, and they conclude that productivity-driven deflation tended to dominate during the period of the Gold Standard. In a study spanning 100 years and 17 economies, Atkeson and Kehoe (2004) argue that the empirical link between deflation and recession is limited to the Great Depression.

In order to find the empirical link between deflation and recession, this paper is organized as follows. In section 2, we describe our data, and test whether recession and deflation are independent events. In section 3, we test for bidirectional Granger Causality between recession and deflation, and then estimate a fixed effects model to determine the effect of deflation on economic growth. Section 4 summarizes the findings of this paper.

2. Description of Data on Recessions and Deflations

In this paper we examine two different datasets. The first one (which we will call the historical dataset) is an unbalanced panel of data for fifteen of the more developed economies dating from as early as 1820.³ After dropping two observations due to one extreme outlier

(Germany, 1923-24) and adjusting for lags, we have 1742 observations remaining in this dataset. The second one (which we will call the postwar dataset) is a balanced panel of 94 countries for which the World Bank has a complete annual data series on both real GDP and the GDP deflator over the 1960-2001 period, and after adjusting for lags there are 3760 observations.⁴

In the historical dataset for the more developed economies, the average real growth rate was 3.1%, and the average inflation rate was 15.9% (over 33 million percent if we don't exclude Germany in 1923), ranging from an average 1.5% for the U.S. to 94% for Brazil. Defining a recession as a negative annual growth in real GDP and deflation as negative annual growth in the GDP Deflator, we find that recessions and deflations each occurred in about a quarter of these observations. After the Second World War, however, both recession and deflation became less common (11% and 4%, respectively) as average growth and inflation rates rose to 4.0% and 26.8%, respectively.

The virtual disappearance of deflation in the postwar era is not observed in the broader postwar sample, though it does hold for the OECD members, other than Japan. In the postwar dataset, three-fourths of the economies experienced at least one year of deflation, 28 economies had five or more years, and one (Saudi Arabia) had sixteen years.

If recessions and deflations were independent events, the joint probability of their coincidence would be equal to the product of the individual probabilities, and if deflations were generally "good," as Bordo, et al. (2004) conclude, then we would expect to find an observed coincidence lower than this product. In Table 1 we show the frequency of recessions and deflations in the two datasets, and it is clear that they occur together (or that one precedes the other) more often than independence suggests. Using a simple χ^2 test of

independence, we can reject the hypothesis that recession and deflation are independent events for both datasets, usually with 1% significance.

3. An Empirical Analysis of Recession and Deflation

Following Atkeson and Kehoe (2004), we focus our analysis on the relationship between output and the price level. We define the growth rate (y) as the log difference of output, and the inflation rate (π) as the log difference of the price level. An Augmented Dickey-Fuller (ADF) test on both the levels and the log differences finds that we cannot reject unit roots for the *levels* of either output or the price level, but we can reject unit roots for both growth and inflation rates.

Granger Causality Tests:

The multivariate causal relation between inflation and growth has been extensively studied in the literature (Gylfason & Herbertsson, 2001 and Guerrero, 2006 are among the most recent contributions). However, here we consider only recession (r) and deflation (d), which we define as follows:

$$r = \begin{cases} -y; & \text{if } y < 0, \\ 0, & \text{if } y \geq 0; \end{cases}$$

$$d = \begin{cases} -\pi; & \text{if } \pi < 0, \\ 0, & \text{if } \pi \geq 0. \end{cases}$$

We perform bidirectional Granger causality tests on r and d , and the F-statistics for the null hypotheses of no Granger causation are shown in Table 2. We find both that recession Granger-causes deflation and that deflation Granger-causes recession, for both two and four lags (though the first lag was generally the one with the most significance). Our results are

much stronger for the postwar dataset than for the historical dataset, perhaps because the more developed economies were more likely to have experienced productivity-led deflation prior to the Great Depression.

The strong significance for the postwar dataset contradicts the conclusions of Atkeson and Kehoe (2004) that the link between deflation and recession was limited to the Great Depression, at least when one examines a broader sample of countries. For the historical dataset, which is practically the same one used by Atkeson and Kehoe, our results are not as strong but are still not insignificant. Atkeson and Kehoe, however, examine “medium-term fluctuations,” and in doing so they average their data into five-year periods. A downside of their procedure is an obvious loss of degrees of freedom in their estimates. By focusing on the year-to-year variation in deflation and recession, we increase the degree of precision in our estimates.

Our results also differ from previous findings by Bordo and Redish (2003) and Bordo, Landon, and Redish (2004) that productivity-driven deflation tended historically to be the prevalent type of deflation. Though our methods are different, the primary reason our results differ is that we consider a greater number of countries over a longer period of time. We find that the results that characterize a few of the major economies during the Gold Standard era do not generalize to all countries or subsequent periods.

The Effects of Deflation and Inflation on Growth:

We next consider the possibility that deflation reduces the growth rate, even when it does not necessarily cause a full-blown recession. To our knowledge, this has not been considered in the literature before. We also consider the potential asymmetry between

deflation and inflation by first defining positive growth (g), positive low inflation (i), and high inflation (h) as follows:

$$g = \begin{cases} 0 & \text{if } y < 0, \\ y & \text{if } y \geq 0; \end{cases}$$

$$i = \begin{cases} 0 & \text{if } \pi < 0, \\ \pi & \text{if } 0 < \pi \leq \pi^h, \\ 0 & \text{if } \pi \leq \pi^h; \end{cases}$$

$$h = \begin{cases} 0 & \text{if } \pi \leq \pi^h, \\ \pi & \text{if } \pi > \pi^h; \end{cases}$$

where we follow Bruno and Easterly (1998) by setting the threshold for high inflation (π^h) at 40%. We then estimate a regression of the form:

$$y_{j,t} = \beta_{0,j} + \beta_i i_{j,t-1} + \beta_h h_{j,t-1} + \beta_d d_{j,t-1} + \beta_g g_{j,t-1} + \beta_r r_{j,t-1} + e_{j,t}$$

where the growth rate y for country j at time t is a function of lagged values of low positive inflation, high inflation, deflation, positive growth, and recession, and e is the error term. Though the effects of deflation are likely much more subtle than can be captured by a single lag (i.e., current deflation and the expectation of future deflation may also have negative effects), we use the first lag as a predetermined variable to avoid a potential endogeneity problem.

We estimate a fixed effects model that allows for country-specific intercepts, with a heteroskedastic, panel-corrected covariance matrix, and we show our results in Table 3. For both datasets, deflation has a negative effect on growth that is statistically significant, and though the effect of low inflation is insignificantly different from zero, we can easily reject the hypothesis that β_i equals $-\beta_d$. Supporting the hypothesis that a little deflation is worse than a little inflation, we find that β_d is significantly larger than β_i . The coefficient for high

inflation is negative, as we would expect, though it is only statistically significant in the postwar dataset. The growth rate is also positively correlated with prior growth, as long as it is positive, but recession does not seem to have a significant effect on the following period's growth rate.

4. Summary

We consider here whether deflation may cause recessions, and examine two separate datasets, one a historical dataset for 15 countries and the second a postwar dataset for 94 countries. In spite of a complicated relationship between deflation and recession in theory, we find evidence of bidirectional causality between the two, and we further find that a higher deflation rate reduces the subsequent growth rate (even if it does not always lead to recession). Thus, there appears to be reason to believe that deflation is bad for growth even if it has become a relatively rare experience for most developed economies in the postwar era.

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Table 1: The Coincidence of Recession and Deflation in Annual Data

	(1) Historical Data		(2) Postwar Data	
Observed Recessions	384	(22%)	618	(16%)
Observed Deflations	431	(25%)	300	(8%)
Expected Coincidence	95		49	
Observed Coincidence:		χ^2 stat		χ^2 stat
Recession with Deflation	131	23.2***	65	6.5**
Recession before Deflation	141	37.9***	76	18.8***
Deflation before Recession	125	16.4***	76	18.8***
Total Observations	1762		3760	

Note: ** Statistically significant at the 5% level
*** Statistically significant at the 1% level

Table 2: Granger Causality Tests

	F-Statistics	
	<u>(1) Historical Data</u>	<u>(2) Postwar Data</u>
<i>Recession Granger-causes Deflation:</i>		
Two lags	5.8 ***	3.1 **
Four lags	2.4 **	4.4 ***
<i>Deflation Granger-causes Recession:</i>		
Two lags	2.5 *	19.5 ***
Four lags	2.1 *	10.9 ***

Note: * Statistically significant at the 10% level

** Statistically significant at the 5% level

*** Statistically significant at the 1% level

Table 3: Growth Rates and Deflation

	(1) Historical Data		(2) Postwar Data	
	<u>coefficient</u>	<u>t-statistic</u>	<u>coefficient</u>	<u>t-statistic</u>
Regressing Growth (y) on:				
Lagged Positive Inflation (i_{-1})	-0.0305	-1.12	-0.0118	-1.40
Lagged High Inflation (h_{-1})	-0.0140	-1.52	-0.0102	-2.89 ***
Lagged Negative Deflation (d_{-1})	-0.1176	-2.52 **	-0.2962	-5.03 ***
Lagged Positive Growth (g_{-1})	0.1290	3.03 ***	0.2946	10.93 ***
Lagged Negative Recession (r_{-1})	0.0245	-0.49	0.0300	0.57
R^2	0.026		0.163	

Note: ** Statistically significant at the 5% level
*** Statistically significant at the 1% level

NOTES:

¹ Assuming a constant population, Friedman's rule would call for a rate of inflation equal to the negative real interest rate.

² Cargill and Parker found evidence that deflation led to both rising money demand (2004a) and falling consumption (2004b) in Japan.

³ We thank Patrick Kehoe for providing these data, which appear to be a preliminary version of what was used in Atkeson and Kehoe (2004). Countries (and years) included in the panel are Argentina (1884-1984), Brazil (1912-1991), Canada (1870-1994), Chile (1908-1991), France (1820-1994), Germany (1860-1991), Italy (1862-1994), Japan (1885-1994), the Netherlands (1900-1992), Norway (1865-1992), Portugal (1833-1991), Spain (1849-1983), Sweden (1861-1994), the United Kingdom (1870-1991), and the United States (1889-1991).

⁴ There were 98 economies in the broader postwar panel that had complete series on GDP and the price deflator, but we dropped four outliers from the sample, including the Democratic Republic of the Congo (formerly Zaire), Liberia, St. Vincent and the Grenadines, and Rwanda.