Inflation History and the Sacrifice Ratio: Episode-Specific Evidence

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Abstract: This paper examines whether episode-specific analysis can show a negative relationship between inflation and the slope of the Phillips curve that has been found in cross-country analysis. While the relationship between inflation and the Phillips curve slope is widely accepted from cross-country analysis, it has remained unproven in previous episode-specific studies. By defining inflation history as a weighted average of past inflation, this study finds a negative effect of inflation history on the sacrifice ratio, which is what is expected from the cross-country analysis. The negative relationship does not disappear even after including other conventional determinants of the sacrifice ratio.

JEL Codes: E52, E31

1 Introduction

Monetary authorities often face the task of controlling the rate of inflation. A typical example is the disinflation policy of the early 1980s in the United States. Reducing inflation, however, always has some cost. The magnitude of that cost is often summarized by the sacrifice ratio, the percentage of a year's real GDP that must be forgone to reduce inflation by 1 percentage point. Policy makers would like to know how high the cost of a disinflation will be when they commence reducing inflation.

Economists have suggested a wide range of determinants of the sacrifice ratio. Among them, the traditional determinants that are consistently included in the empirical literature are the initial level of inflation (Ball, Mankiw, and Romer 1988), the speed of the disinflation (Ball 1994), an index of nominal wage rigidity (Bruno and Sachs 1985), and the openness of the economy (Romer 1993). In this study we focus on the initial level of inflation. Ball et al. (1988) examine the effect of the average rate of inflation on the short-run tradeoff between output and inflation. They show that higher average inflation increases the frequency of price adjustment, and therefore, makes the Phillips curve steeper. Low inflation countries will have a relatively flat Phillips curve and a large sacrifice ratio, while high inflation countries will have a steep Phillips curve and a small sacrifice ratio. Their findings are confirmed by Defina (1991) and Kiley (2000).

The relationship between average inflation and the Phillips curve slope is well-established, but a puzzle remains. Although the relationship is robust in cross-country analysis, it seems to disappear in episode-specific analysis. This puzzle is first reported by Ball (1994b) and later by Boschen and Weise (2001), and Zhang (2005).

The purpose of this paper is to reconcile Ball's (1994b) episode-specific results with Ball et al.'s (1988) cross-country results. Ball et al.'s finding implies that the Phillips curve faced by policy makers depends on the average rate of inflation and that the slope of the Phillips curve changes when the average rate of inflation changes. However, the fact that the effect of inflation on the Phillips curve slope cannot be found at the episode-specific level makes it difficult for policy makers to know the potential costs of a disinflation.

This paper finds a negative relationship between past inflation history and the sacrifice ratio from episode-specific analysis and helps to reconcile the previously inconsistent findings. We measure inflation history using a geometric lag model of inflation. Including the inflation history variable along with traditional determinants of the sacrifice ratio, we find that the higher historical inflation has been the smaller the sacrifice ratio is during a disinflation.

The paper is organized as follows: section 2 discusses why inflation affects the costs of disinflation or the sacrifice ratio. In section 3, we identify disinflation episodes in annual and quarterly data for seventeen Organization of Economic Co-operation and Development (OECD) countries and calculate the sacrifice ratios. We construct a variable of inflation history with a geometric lag model and show that the sacrifice ratio depends on inflation history in section 4. Section 5 checks our findings by using alternative measures of the sacrifice ratio. Finally, section 6 concludes.

2 The Costs of Disinflation with Differing Initial Inflation Levels

Ball et al. (1988) predict that the sacrifice ratio during disinflation is decreasing in the initial level of inflation. The basic intuition for their argument is clear. Higher initial inflation causes more frequent wage and price adjustments, and thus reduces price rigidities. Hence, countries with higher initial inflation are associated with smaller costs of disinflation.

Although the argument is straightforward, it has been difficult to show with a formal model. The difficulty lies in combining disinflation and endogenous time-dependent price-setting rules. Ball et al. (1988) endogenize the fixed price time-dependent rules but do not analyze the effect on output of a disinflationary monetary policy. In contrast, Ball (1994a) does analyze the cost of disinflation in a time-dependent rules setting. His paper is an investigation of the credibility of disinflation policy and assumes that the time period between price adjustments is exogenous. One paper that takes up both these issues is Bonomo and Carvalho (2004) who evaluate the costs of disinflation under endogenous rules setting. Using a theoretical model, they find that higher initial inflation produces deeper and shorter recessions, which is consistent with the finding from Ball et al. Additionally, their model can be used to examine the relationship between initial inflation and the sacrifice ratio. Figure 1 shows a negative relationship between initial inflation and the sacrifice ratio which was obtained using Bonomo and Carvalho's model.[1]

3 Measuring the Sacrifice Ratio

The quarterly data for this study are drawn from a sample of nine countries and the annual data are from seventeen countries. The sample is from 1960 to 2002.[2] Quarterly inflation rates are calculated from the quarterly CPI level data and output is measured by real GDP.[3]

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[1] We reproduced the results of Bonomo and Carvalho (2004) in the case of no strategic complementarities and full disinflation, and then computed the sacrifice ratio for different initial inflation rates.

[2] The inflation and output data from 1957:1 to 2005:3 are used to construct trend inflation and the filtered output series.

[3] The data on inflation and output are from the International Monetary Fund's *International Financial Statistics* (*IFS*). Japan's seasonally adjusted quarterly output data, which are not

To identify the disinflation episodes, we borrow a technique from Ball (1994b). Disinflations for each country are identified as follows. First, trend inflation, which is defined as a nine-quarter moving average of quarterly CPI inflation, is calculated. Second, the 'peaks' and 'troughs' in trend inflation are identified. Period *t* is an inflation peak if trend inflation at *t* is higher than in the previous four quarters and the following four quarters. Similarly, period *t* is a trough if trend inflation at *t* is lower than in the previous four quarters and the following four quarters. Finally, a disinflation is defined as one in which trend inflation declines by 2 percentage points or more from a peak. For annual data, a similar procedure is employed to identify disinflations (see Ball, 1994, p.166).

The 2% rule is intended to separate significant aggregate-demand policy shifts from smaller fluctuations arising from shocks.[4] The application of the rule leads to a sample of thirty-six episodes with quarterly data and eighty episodes with annual data. We have also checked the historical record (mainly by reading the OECD's *Economic Outlook*) to see if each episode corresponds to a contractionary monetary policy. After checking the OECD's *Economic Outlook*, we have excluded one episode from the quarterly data and three episodes from the annual data because we were not able to confirm that there was contractionary monetary policy

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available in *IFS*, are taken from the Cabinet Office, Government of Japan.

[4] There are exceptions to the 2% rule. For the quarterly data, we include Japan, 1970:2-71:3 (in which trend inflation declined 1.82%), the United Kingdom, 1961:2-63:3 (1.63%), and the United States, 1969:4-71:4 (1.90%). For the annual data, we include Australia, 1986-88 (in which trend inflation declined 1.44%) and Canada, 1968-1970 (1.42%). These exceptions are made because the decline in trend inflation is relatively large and the episode matches a known monetary policy contraction.

near the start of the disinflation.[5] Therefore, the final number of episodes is thirty-five for quarterly data and seventy-seven for annual data.

The cost of a disinflation is measured with the sacrifice ratio, defined as the cumulative output gap over the disinflation period divided by the decline in trend inflation. Our measure of the output gap employs Ball's (1994b) method of computing trend output. Output is assumed to be at its trend level at the inflation peak and again at its trend level four quarters after the inflation trough. Trend output is determined by connecting the two points of the log of the output series. The output loss of the disinflation is the cumulative output gap from the inflation peak to four quarters following the inflation trough. Tables 1 and 2 list all the episodes and their sacrifice ratios. The average sacrifice ratio is 1.65 in the quarterly data and 1.17 in the annual data.

4 Inflation History and the Cost of Reducing Inflation

4.1 Episode-Specific Results

Ball et al. (1988) show that trend inflation influences the output-inflation tradeoff. Their finding has a practical implication for the conduct of monetary policy: by looking at the average rate of inflation, policy makers can improve their prediction of the cost of a disinflation. In countries with low inflation, the short-run Phillips curve will be flat and the sacrifice ratio will be large. In contrast, in countries with high inflation, the short-run Phillips curve will be steep and the sacrifice ratio will be small.

While the cross-country analysis strongly supports the prediction that higher inflation makes

[5] The excluded episodes are: Japan 1997:2-2001:1 (quarterly), Austria 1961-63 (annual), Japan 1997-01 (annual), and Norway 1964-66 (annual).

the short-run Phillips curve steeper, many researchers have asked if the same result holds in episode-specific analysis (Ball (1994b); Andersen and Wascher (1999); Boschen and Weise (2001); Hofstetter (2004); Zhang (2005)). In the context of policy making, episode-specific evidence is more relevant than cross-country evidence. Cross-country evidence is often obtained by estimating a Phillips curve in a long time-series. Ball (1994b) points out that this approach has two limitations. First, this approach constrains the slope of the Phillips curve to be constant across disinflations, reflations and temporary fluctuations in demand. Secondly, the Phillips-curve approach constrains the sacrifice ratio to be the same for all disinflations within a time series. An episode-specific approach enables us to examine the ratios within the experience of a country as well as across countries.

Ball (1994b) shows that the negative effect of initial inflation on the sacrifice ratio is not robust once other determinants of the sacrifice ratio are included. A similar result is obtained by Andersen and Wascher (1999). Boschen and Weise (2001) obtain the wrong sign on their estimate. Hofstetter (2004) obtains coefficients with the expected sign but they are not statistically significant. Finally, Zhang (2005) finds, after allowing for long-lived output effects, there is indeed a significant and negative relationship between initial inflation and the sacrifice ratio. However, when the speed of disinflation is included in the regression, initial inflation becomes statistically insignificant. In sum, the results of the previous studies indicate that the effect of initial inflation on the sacrifice ratio is unclear.

Table 3 reports results from regressions of the sacrifice ratio on initial inflation, π_0. We also report results of regressions that include the length of the disinflation episode (Length) and the change in inflation over the disinflation ($\Delta\pi$). These independent variables are widely used as determinants of the sacrifice ratio. The length of the disinflation episode and the change in inflation are related to the speed of the disinflation.[6]

The results in table 3 are similar to those that are obtained by others. For quarterly data, the coefficient on initial inflation in the multiple regression is of the predicted sign but statistically insignificant. For annual data, the coefficient in regression 3.4 is not only insignificant but has the wrong sign. From these results, one can see that the question of why the effect of initial inflation is weaker than the effect of average inflation on the Phillips curve found by Ball et al. is still unsettled. The remainder of the paper attempts to reconcile the two seemingly inconsistent results.

4.2 Measuring Inflation History with a Geometric Lag Model

In Ball et al.'s theoretical model, trend inflation (or average inflation) is related to the output-inflation tradeoff because average inflation influences the extent of nominal rigidity. When average inflation is higher, firms must adjust their prices more often to keep up with changes in the price level. This implies that in countries with high inflation, the Phillips curve is steeper and the sacrifice ratio is smaller.

When one uses initial inflation as trend inflation, one implicitly assumes that firms will quickly adjust the interval (time) between price changes in response to the movement of actual inflation. The actual situation may be that firms adjust the interval between price changes based on a historical average of inflation rates and not on the current inflation rate.

A natural step would be to use a weighted average of past inflation rates as a proxy for average (initial) inflation. The weighted average of past inflation is tractable because its calculation only requires information that is available contemporaneously to policy makers. The

[6] We have also estimated the regressions with Bruno and Sachs's wage rigidity index and an openness variable. These variables are never significant so they are dropped.

weighted average of inflation is described by a geometric lag model.

$$\begin{aligned}\pi_t^{IH} &= \sum_{i=1}^{\infty}(1-\lambda)\lambda^{i-1}\pi_{t-i} \\ &= (1-\lambda)\left[\pi_{t-1} + \lambda\pi_{t-2} + \lambda^2\pi_{t-3} + \cdots\right].\end{aligned} \quad (1)$$

where the parameter λ is the adjustment coefficient. We will use the term "inflation history" to refer to π^{IH} from equation (1).[7]

The geometric lag model implies that the most recent past will receive the greatest weight and that the influence of past observations will fade uniformly with the passage of time. The model incorporates infinite lags, but it assigns arbitrarily small weights to the distant past. The lag coefficients decline geometrically; $w_i = (1-\lambda)\lambda^{i-1}$, $0 \le w_i < 1$. The mean lag is $\bar{w} = \frac{1}{1-\lambda}$. Since our focus is the effect of inflation history on the sacrifice ratio, we experiment with several values of the parameter $\bar{w}$.

4.3 Basic Results

Table 4 reports the results of regressions of the sacrifice ratio on inflation history $\pi^{IH}[\bar{w}=8]$. With $\bar{w}=8$, firms adjust the interval between price changes by looking at past inflation with the mean lag of eight quarters. With quarterly data, the regression results show a negative effect of inflation history on the sacrifice ratio, as predicted by theory. With annual data, however, the coefficient is statistically insignificant, which may be due to greater nominal rigidities.

Tables 5, 6, and 7 present the same regressions with larger $\bar{w}$ values. When firms adjust

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[7] The value of inflation history is calculated in the following way:

$$\pi_t^{IH} = (1-\lambda)\pi_{t-1} + \lambda\pi_{t-1}^{IH}, \quad \pi_{1958}^{IH} = \pi_{1958}.$$

the interval between price changes, they consider past inflation with a mean lag of twenty quarters ($\overline{w} = 20$), forty quarters ($\overline{w} = 40$), and eighty quarters ($\overline{w} = 80$).

In these regressions, the coefficients on inflation history are of the predicted sign (negative), quantitatively large, and statistically significant, indicating that the sacrifice ratio is negatively related to inflation history. Regression 6.2 implies that an increase in inflation history from five percent to ten percent reduces the sacrifice ratio by 1.08. It is interesting to note that inflation history retains its significance even when both the change in inflation ($\Delta\pi$) and inflation history are in the regression. This result stands in sharp contrast to the results of previous studies where initial inflation often loses its statistical significance when both the change in inflation ($\Delta\pi$) and initial inflation are in the regression.[8]

The results suggest that the slope of the Phillips curve (or the extent of nominal rigidity) depends on inflation history and that the slope of the Phillips curve changes as inflation history changes. These findings may provide an answer to the seemingly inconsistent evidence from earlier cross-country and episode-specific analyses.[9]

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[8] It is possible that this study's findings are affected by inflation targeting. To check whether inflation targeting has an effect on the results, we have also used a sample from which the inflation targeting disinflation episodes are excluded. The coefficients on the inflation history variable estimated without the inflation targeting disinflation episodes are similar to those reported.

[9] In his study on disinflations in eighteen Latin-America and the Caribbean countries, Hofstetter (2004) defines inflation history as a simple average of the inflation rate of the past ten years. He examines the effect of inflation history on the sacrifice ratio and obtains results similar to ours for a different sample of countries. To check the robustness of our findings we calculated

5 Results using Alternative Methods for Measuring the Sacrifice Ratio

To check the robustness of the results, we use two new measures of the sacrifice ratio proposed by Zhang (2005) and Hofstetter (2004). Zhang's (2005) sacrifice ratio corrects for possible persistence effects and is based on the idea that recessions may affect output and unemployment even in the long run by changing the natural rate of output or unemployment. Zhang assumes that trend output is not required to be at its actual level four quarters after the inflation trough. In addition to persistence effects, Hofstetter's (2004) method takes into account inflation inertia, which implies that output may peak before inflation peaks. This sacrifice ratio allows the output losses to begin before the start of a disinflation episode.

The results using these alternative sacrifice ratios are presented in Tables 8a and 8b with inflation history calculated with $\overline{w} = 20$. Under both Zhang's and Hofstetter's assumptions, the results generally show a negative effect of inflation history on the sacrifice ratio and support the idea that measuring initial inflation by the inflation history variable gives a more accurate picture of the effect of inflation on the sacrifice ratio.

6 Conclusions

This paper has examined whether the episode-specific analysis produces the same effect of inflation on the Phillips curve that is found in cross-country analysis. While the relationship between inflation and the Phillips curve slope is widely accepted, it has not been conclusively

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a simple average of the inflation rate over the past 8, 20, 40, and 80 quarters instead of using a weighted average of the inflation rate. The regression results with inflation history defined as a simple average are similar to those in Tables 4-8.

shown in previous episode-specific studies. By defining inflation history as a weighted average of past inflation, this study finds a negative effect of inflation on the sacrifice ratio. The effect of inflation does not disappear even after other conventional determinants of the sacrifice ratio are included.

This study implies that the sacrifice ratio depends on past inflation and that it changes as past inflation changes. For example, consider the disinflations in the United States. Table 1 shows that the costs of disinflation measured by the sacrifice ratio are lower in the 70s (1.9 for the 74:2-76:4 episode) and the early 80s (1.9 for the 80:1-83:4 episode) than the cost in the 60s (2.9 for the 69:4-71:4 episode) and the late 80s (2.7 for the 89:4-94:3 episode). In contrast, the value of the inflation history variable with $\overline{w}=8$ is higher in the 70s (6.3 percent in 74:2) and the early 80s (9.3 percent in 80:1) than in the 60s (4.1 percent in 69:4) and the late 80s (4.2 percent in 89:4). This suggests that the lower cost of disinflation in the 70s and the early 80s can be partly explained by the higher level of inflation in the 70s.

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Table 1: Disinflations: Quarterly Data

Episode	Length in Quarters	Initial Inflation	Change in Inflation	Sacrifice Ratio (Ball)	Sacrifice Ratio (Zhang)	Sacrifice Ratio (Hofstetter)
Australia						
60:2-62:3	9	3.23	3.19	3.4508	3.7244	1.1483
74:2-78:1	15	14.64	6.54	0.7256	-0.6971	1.5387
82:1-84:1	8	10.45	4.95	1.4851	1.0698	0.9948
89:1-93:1	16	7.45	6.30	1.1530	2.4130	3.3974
95:2-98:1	11	3.65	3.10	0.2226	-0.9196	-1.0249
Canada						
74:3-77:1	10	10.62	3.30	0.6440	1.5804	2.6983
81:2-85:2	16	11.49	7.66	2.1780	1.5913	0.5847
90:1-93:4	15	5.71	4.72	3.6811	3.4885	6.1782
France						
74:3-77:1	10	11.89	2.98	2.0096	3.5646	4.7499
81:1-87:1	24	12.98	10.44	0.2827	0.1066	2.6070
Germany						
65:4-67:3	7	3.39	2.10	2.3724	4.1391	3.8040
73:1-77:3	18	6.91	4.06	2.4549	6.5979	5.1633
81:1-86:3	22	5.92	5.93	1.8473	0.4084	5.3097
Italy						
63:4-67:4	16	6.59	5.27	2.8539	0.7095	-0.2655
80:4-87:3	27	18.99	14.42	1.1644	1.0905	4.1226
89:4-93:3	15	6.45	2.44	0.3224	6.0167	7.4864
95:1-98:3	14	4.62	2.88	0.8176	0.7967	-4.5771
Japan						
65:2-66:3	5	6.06	2.41	0.6332	-0.6473	4.2871
70:2-71:3	5	7.19	1.82	1.1447	4.5181	4.4245
74:2-78:3	17	17.24	13.54	0.5100	-0.0339	3.5238
80:2-87:1	27	6.72	6.72	2.3557	2.3200	5.3381
90:2-96:1	23	3.65	3.78	1.6344	13.0671	12.5091
Switzerland						
66:2-68:4	10	4.51	2.30	3.2828	3.4811	6.2006
73:4-77:4	16	9.47	8.43	1.7698	4.2944	5.7024
81:3-83:4	9	6.08	3.59	1.8988	3.0277	2.5861
United Kingdom						
61:2-63:3	9	3.94	1.63	3.4266	3.1011	1.8780
65:2-66:3	5	4.74	2.10	-0.0671	0.9367	3.4421
75:1-78:2	13	19.55	9.70	0.9899	-0.0917	0.1335
80:2-83:3	13	15.55	11.26	0.5841	-0.0590	2.4064
84:2-86:3	9	6.18	3.02	0.6979	-1.5452	-3.1528
89:2-93:3	17	8.77	7.06	1.8438	3.4601	5.0868
United States						

69:4-71:4	8	5.53	1.90	2.8941	1.2915	4.4151
74:2-76:4	10	9.65	3.87	1.9094	1.5822	5.1382
80:1-83:4	15	11.92	8.59	1.9284	1.3998	2.9451
89:4-94:3	19	5.18	2.57	2.6751	3.5318	7.4164

Table 2: Disinflations: Annual Data

Episode	Length in Years	Initial Inflation	Change in Inflation	Sacrifice Ratio (Ball)	Sacrifice Ratio (Zhang)	Sacrifice Ratio (Hofstetter)
Australia						
60-62	2	3.39	3.43	1.6759	2.3242	1.2077
74-78	4	14.81	6.70	0.5358	1.9578	4.3288
82-84	2	10.54	5.35	1.0648	0.0118	1.5624
86-88	2	8.58	1.44	-0.1963	-5.4515	-2.6847
89-92	3	7.43	5.89	0.7356	3.1695	2.1882
95-97	2	3.75	3.24	0.3645	-0.9587	-1.4960
Austria						
64-66	2	4.52	2.32	0.0234	2.4627	0.9869
74-78	4	8.89	5.50	1.4671	4.7989	5.6368
80-82	2	6.49	2.28	1.2540	3.4520	4.4294
84-86	2	4.75	3.34	-0.1654	-0.1129	1.9413
92-98	6	3.85	3.20	2.5513	6.0375	9.5141
Belgium						
65-67	2	4.71	2.62	0.5208	2.7254	3.9511
74-78	4	11.99	7.77	0.5991	3.7497	4.1309
82-87	5	8.17	6.87	1.5925	0.1217	1.8341
Canada						
68-70	2	4.34	1.42	0.2779	3.0237	2.9244
74-76	2	10.23	2.36	0.4088	1.8225	3.0674
81-85	4	11.54	7.67	1.9028	2.4378	2.4429
90-93	3	5.31	4.43	2.3432	4.0099	7.2300
Denmark						
62-64	2	7.49	4.35	0.9403	1.3358	0.9542
67-69	2	8.21	4.22	-0.3896	-0.3880	0.6895
74-76	2	12.47	3.51	0.8108	1.4445	6.4552
80-86	6	12.52	8.92	1.1825	-0.2392	1.7512
88-90	2	4.60	2.09	0.4605	2.8545	3.7354
Finland						
63-65	2	7.68	3.58	-0.7771	0.4364	2.6375
67-69	2	7.50	5.16	0.9513	-0.9043	1.0966
74-78	4	16.73	9.16	1.4451	4.1245	5.2015
80-86	6	11.46	8.00	0.6415	1.0985	-0.7444
89-94	5	6.21	5.26	4.9220	13.6548	10.7139
France						
62-66	4	5.27	2.94	-0.8334	2.0574	0.3903
74-77	3	12.29	3.17	1.5359	5.0248	7.5832
81-86	5	12.66	9.79	0.2289	0.8871	1.9620
89-94	5	3.36	1.70	-0.9339	9.7659	1.6474
Germany						
65-67	2	3.59	2.08	1.2167	7.1481	7.7872

73-78	5	7.03	3.93	3.8602	7.6157	6.4032
80-86	6	5.71	5.71	1.9075	4.3354	6.5428
Italy						
63-67	4	6.35	4.71	2.4052	2.5524	4.1631
74-78	4	16.90	4.57	2.7850	4.5833	4.7737
80-87	7	19.34	14.69	1.3675	2.7651	2.8205
90-93	3	6.17	2.04	0.1900	5.6762	6.6502
95-98	3	4.78	3.04	0.2182	-0.0235	-2.0068
Japan						
62-64	2	7.88	2.72	3.0063	-0.1684	1.6347
65-66	1	5.99	2.02	-0.0065	0.5279	-8.0107
70-71	1	7.21	1.58	1.2315	5.1808	6.2659
74-78	4	16.84	13.16	0.4012	1.4201	5.4237
80-87	7	6.33	6.14	1.8427	1.8360	2.9476
90-95	5	2.92	2.87	0.3814	10.1301	9.1722
Netherlands						
65-67	2	5.45	2.25	1.5283	2.7806	2.2713
75-78	3	9.59	5.80	-1.1905	0.0799	3.7189
80-86	6	6.32	6.75	2.7422	3.6974	2.8362
91-97	6	3.64	1.60	6.7827	8.6842	9.8904
New Zealand						
75-78	3	15.26	3.50	1.7857	6.7654	8.9276
80-83	3	15.54	9.19	0.5360	-0.6504	-0.2494
86-88	2	13.95	8.67	-0.9102	-1.5393	-1.9296
89-92	3	5.90	4.76	2.1432	3.9284	6.3406
94-98	4	3.29	2.63	-0.9996	-0.2841	-6.4701
Norway						
75-78	3	10.43	4.15	-0.6988	-1.6968	-1.2781
81-85	4	12.06	6.35	1.3086	0.9765	3.9420
87-93	6	8.16	6.46	3.2839	4.4541	5.9713
Sweden						
66-68	2	5.86	3.71	0.4160	0.7407	3.1470
76-78	2	10.59	2.33	2.6534	4.8226	7.2063
80-82	2	12.64	4.28	0.4105	1.4527	1.2772
83-86	3	8.38	4.78	-0.3431	-2.3657	-2.4804
90-97	7	9.81	9.64	3.0785	4.1856	4.7500
Switzerland						
66-68	2	4.41	1.87	1.3457	1.9393	6.7987
74-77	3	8.67	7.29	1.7712	5.5145	6.6030
81-83	2	5.81	2.60	1.7029	3.1945	2.4276
84-86	2	3.24	2.28	-1.1593	-1.7399	-4.5523
90-94	4	5.46	4.20	0.7780	6.6474	4.3678
United Kingdom						
61-63	2	4.23	1.99	2.0298	-0.2391	0.5085
74-78	4	18.73	9.89	0.6897	0.6794	3.2824

80-83	3	15.66	11.26	0.6003	0.5994	2.2481
84-86	2	5.95	2.51	0.3458	-3.5961	-4.6869
89-93	4	8.66	6.74	1.6879	4.1455	4.7020
United States						
69-71	2	5.62	1.89	2.6954	5.1506	7.6797
74-76	2	9.76	3.47	1.4123	1.1134	5.5845
79-83	4	12.02	8.24	1.9774	2.9463	2.8568
89-94	5	4.82	2.11	4.1103	11.1677	10.5013

Table 3: The Sacrifice Ratio and Initial Inflation
(dependent variable: Ball's sacrifice ratio)

	3.1 Quarterly	3.2 Quarterly	3.3 Annual	3.4 Annual
Constant	2.399*** (0.352)	2.125*** (0.559)	1.332*** (0.369)	-0.090 (0.450)
π_0	-0.088** (0.037)	-0.095 (0.076)	-0.019 (0.039)	0.047 (0.056)
$\Delta\pi$		-0.005 (0.121)		-0.195** (0.092)
Length		0.026 (0.040)		0.134*** (0.029)
$\bar{R}^2$	.122	.086	-.010	.198
Sample size	35	35	77	77

Note: Standard errors are in parentheses.
Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 4: The Sacrifice Ratio and Inflation History ($\bar{w}$ = 8)
(dependent variable: Ball's sacrifice ratio)

	4.1 Quarterly	4.2 Quarterly	4.3 Annual	4.4 Annual
Constant	2.508*** (0.346)	2.301*** (0.517)	1.557*** (0.376)	0.243 (0.458)
π^{IH}	-0.131*** (0.047)	-0.184* (0.092)	-0.060 (0.054)	-0.028 (0.076)
$\Delta\pi$		0.050 (0.110)		-0.109 (0.091)
Length		0.021 (0.037)		0.122*** (0.029)
$\bar{R}^2$	.166	.150	.003	.192
Sample size	35	35	77	77

Note: Standard errors are in parentheses.
Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 5: The Sacrifice Ratio and Inflation History ($\overline{w}$ = 20)
(dependent variable: Ball's sacrifice ratio)

	5.1 Quarterly	5.2 Quarterly	5.3 Annual	5.4 Annual
Constant	2.667*** (0.356)	2.276*** (0.458)	1.789*** (0.387)	0.633 (0.421)
π^{IH}	-0.172*** (0.054)	-0.204** (0.078)	-0.104* (0.059)	-0.143** (0.068)
$\Delta\pi$		-0.004 (0.076)		-0.045 (0.071)
Length		0.043 (0.033)		0.120*** (0.027)
$\overline{R}^2$	.210	.215	.026	.237
Sample size	35	35	77	77

Note: Standard errors are in parentheses.

Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 6: The Sacrifice Ratio and Inflation History ($\overline{w}$ = 40)
(dependent variable: Ball's sacrifice ratio)

	6.1 Quarterly	6.2 Quarterly	6.3 Annual	6.4 Annual
Constant	2.693*** (0.365)	2.247*** (0.436)	1.804*** (0.391)	0.722* (0.404)
π^{IH}	-0.201*** (0.064)	-0.216*** (0.074)	-0.118* (0.067)	-0.180*** (0.065)
$\Delta\pi$		-0.064 (0.062)		-0.075 (0.060)
Length		0.063* (0.033)		0.132*** (0.026)
$\overline{R}^2$	.208	.246	.027	.266
Sample size	35	35	77	77

Note: Standard errors are in parentheses.

Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 7: The Sacrifice Ratio and Inflation History ($\overline{w}$ = 80)
(dependent variable: Ball's sacrifice ratio)

	7.1 Quarterly	7.2 Quarterly	7.3 Annual	7.4 Annual
Constant	2.591*** (0.370)	2.229*** (0.436)	1.782*** (0.377)	0.774* (0.393)
π^{IH}	-0.223*** (0.079)	-0.239*** (0.084)	-0.135* (0.076)	-0.221*** (0.069)
$\Delta\pi$		-0.104* (0.058)		-0.106* (0.056)
Length		0.071** (0.033)		0.141*** (0.026)
$\overline{R}^2$	.170	.241	.028	.289
Sample size	35	35	77	77

Note: Standard errors are in parentheses.
Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 8a: The Sacrifice Ratio and Inflation History ($\overline{w}$ = 20)
(dependent variable: Zhang's sacrifice ratio)

	8a.1 Quarterly	8a.2 Quarterly	8a.3 Annual	8a.4 Annual
Constant	4.320*** (0.994)	2.172* (1.171)	4.694*** (0.890)	1.821* (0.944)
π^{IH}	-0.347** (0.151)	-0.272 (0.198)	-0.345** (0.137)	-0.320** (0.152)
$\Delta\pi$		-0.327 (0.195)		-0.310* (0.159)
Length		0.249*** (0.085)		0.314*** (0.060)
$\overline{R}^2$	.112	.260	.066	.304
Sample size	35	35	77	77

Note: Standard errors are in parentheses.
Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Table 8b: The Sacrifice Ratio and Inflation History ($\overline{w}$ = 20)
(dependent variable: Hofstetter's sacrifice ratio)

	8b.1 Quarterly	8b.2 Quarterly	8b.3 Annual	8b.4 Annual
Constant	4.783*** (1.206)	2.374 (1.440)	4.947*** (1.031)	2.684** (1.196)
π^{IH}	-0.238 (0.183)	-0.357 (0.244)	-0.291* (0.158)	-0.413** (0.193)
$\Delta\pi$		-0.117 (0.240)		-0.019 (0.202)
Length		0.271** (0.105)		0.229*** (0.076)
$\overline{R}^2$	.020	.161	.030	.137
Sample size	35	35	77	77

Note: Standard errors are in parentheses.
Significance at the 0.10, 0.05, and 0.01 level is indicated by *, **, and ***, respectively.

Figure 1 Sacrifice Ratio and Initial Inflation