Moderate Inflation and the Deflation-Depression Link

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ABSTRACT

Recent research has concluded that the historical evidence only provides weak support for the contention that deflation episodes are harmful to economic growth. In this paper, we revisit this relationship by allowing for inflation and growth to have a non-linear specification dependent on inflation levels. In particular, we allow for the possibility that high inflation is negatively correlated with growth, while a positive relationship exists over the range of negative-to-moderate inflation. Our results confirm a positive relationship between inflation and growth at moderate inflation levels, and support the contention that the relationship between inflation and growth is non-linear over the entire sample range.

Keywords: Inflation, deflation, depression, growth, empirics

JEL Classification: E5, E52, E58, E6, E65, E42, E3, E31

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1. Introduction

Policymakers since the Great Depression have been concerned that deflation can lead to lower growth rates, if not recessions, and the recent Japanese experience has exacerbated such concerns [see Krugman,(1997)]. However, theoretical models offer differing perspectives. Milton Friedman's argument that for economic efficiency the nominal interest rate should be zero and that the price level should fall steadily at the real rate of interest is well known, and has been formally reconfirmed by Chari, Christiano, and Kehoe (1996) and by Cole and Kocherlakota (1998) [See also Benhabib and Bull (1983)]. Others, working with calibrated models embedding sticky prices and market distortions, find the Friedman rule non-optimal [Schmitt-Grohe and Uribe (2004)]. More to the point, Auerbach and Obstfeld (2005) find that the welfare and output costs associated with liquidity traps and deflations can be very significant.

Empirical evidence on the relationship between inflation and economic performance has cast doubt on the existence of a strong relationship. In a recent paper, Atkeson and Kehoe (2004) demonstrated the lack of a robust empirical relationship between inflation and growth for a cross-section of countries with 19th and 20th century data, concluding that the historical evidence only provides weak support for the contention that deflation episodes are harmful to economic growth. Bruno and Easterly (1998) also fail to find a relationship between inflation and growth over 30-year cross-country data, but they do find a negative relationship between high inflation – exceeding 40% - and growth over high-frequency data. [1]

[1] See also Ghosh and Phillips (1998).

Folklore has it that too much inflation (hyperinflation) is bad for the economy because it increases "shoe-leather" costs, and that deflation is also bad because prices are sticky, or because of other less-well understood reasons that have something to do with expectations. If so, we should not expect a linear relation between growth and inflation, but an inverted U-shaped one. In this paper we re-examine the long-term evidence on inflation and growth by considering such a non-linear relationship.

Following the methodology of Atkeson and Kehoe [AK (2004)], we are only attempting to characterize the empirical relationship between inflation and economic growth, and do not claim that there are any causal conclusions from our results. Our analysis speaks to AK's conclusion based on a linear specification that the data show no obvious relationship, which raises the bar for those who claim that deflation and depression are closely linked. It may be the case that our non-linear specification might proxy for other missing variables that might be included in a more structural specification.

Using a long cross-country panel data set of five-year growth episodes, we examine a non-linear specification which allows for the capture of an inverted U-shape. We obtain a large and statistically significant estimate of the relationship between inflation and growth in ranges of moderate-to-negative inflation.

We then divide the sample according to inflation levels using both the Hansen (2000) method, and an imposed break at the sample 50^{th} percentile. These correspond in our full sample to annual inflation rates of 3.25% and 2.40% respectively.[2] We examine a simple linear specification for the sub-samples with average five-year inflation levels

[2] We also divide the sample at the 75^{th} percentile, which corresponds in our sample to a 5.48% annual inflation level and achieved similar results. These results are available on request.

below and above these threshold levels. Our results again show that for sub-samples limited to negative and moderate inflation levels, the relationship between inflation and growth is quite strong.

Finally, we examine the robustness of our results to conditioning for the volatility of inflation. It has been argued [e.g. Barro (1976), Judson and Orphanides (1999)] that it is inflation volatility, rather than inflation itself, that is the primary cause of poor economic performance during high inflation episodes. Our basic results are robust to conditioning for inflation volatility, in that we continue to observe that growth is positively related to inflation at moderate inflation levels.

2. Data

Our data set is very similar to that in Atkeson and Kehoe.[3] Our sample begins in 1859, as data for earlier five year episodes are often unavailable for more than two countries, and ends in 2004. Data on the general price level and output data up to 1980 are obtained from Rolnick and Weber (1997) and Backus and Kehoe (1992) for Argentina, Australia, Brazil, Canada, Chile, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and the United States. This data runs from early periods to 1992 through 1995 depending on the country. Remaining years are filled in using data from the IMF's *International Financial Statistics*.

As in AK, we group the data into five-year episodes that start and end in years 9 or 4, so that the entire depression is contained in a single five year sub-sample. We also

[3] We have five extra years of data for Italy, 1862-1867, and one extra year for Argentina, Australia and Denmark, 1884, 1861, and 1870 respectively.

follow AK by restricting our attention to moderate inflation or deflation, by restricting our sample to five year periods that average less than 20% inflation or 20% deflation, and between -10% and 20% annual output growth.[4]

In addition to the full sample, we also introduce a number of historical sub-periods. We include the sub-periods in AK: 1. The full sample excluding 1939-1949 and 1929-1934,,2. The sample *Before WWII* (1859-1939), and 3. the sample *After WWII* (1950-2004). However, the data suggests that average inflation levels in our sample trended upwards over time. This implies that separating the data by inflation levels may correspond to separating the data by historical events unrelated to inflation. As a robustness check, we also separate the full sample by episodes that appeared to result in substantive increases in average inflation worldwide. We divide the sample into three historical sub-samples: 4. the *Gold Standard* (1959-1914), which has average inflation rates of 0.72%, 5. *Mid-20th Century* (1915-1969), which has average inflation rates of 3.65%, and 6. *After Bretton Woods* (1970-2004), which has average inflation rates of 5.98%.

Over the full sample, our data exhibits a positive correlation between average growth and average inflation equal to 0.16. However, the before and after World War II sub-samples demonstrate that these correlations change over time. For the pre-WWII sample, the correlation between inflation and growth is equal to 0.25, while the post-WWII correlation falls to 0.05.

[4] Similar results were obtained for data sets that included 5-year episodes of inflation of up to 40% per year, as in Bruno and Easterly (1998). These are also available upon request from the authors. The growth restrictions are not in Atkeson and Kehoe, but only result in the removal of two outlier periods from the Netherlands, 1939-1944 and 1945-1949.

As discussed above, we examine the robustness of our results to conditioning for the volatility of inflation, σ_π^2, which we measure for each individual country over the five year observation period as

$$\sigma_\pi^2 \equiv \frac{1}{5}\sum_{t=1}^{5}\left(\pi_t - \overline{\pi}\right)^2 \tag{1}$$

where $\overline{\pi}$ is the mean level of inflation in the country over the five year period $\overline{\pi} \equiv \sum_1^5 \pi_t / 5$. Table 1 demonstrates that there is a strong correlation between the level of inflation and the volatility of inflation, as would be expected. We also tend to find a negative correlation between economic growth and inflation volatility, with the exception of the post-World War II sub-sample.

3. Non-linear Specification

We first estimate the relationship between inflation and growth under a nonlinear specification that satisfies

$$\Delta y_{it} = \alpha_i + \beta_1 \pi_{it} + \beta_2 \left(\pi_{it}\right)^2 + \varepsilon_{it} \tag{2}$$

where Δy_{it} represents average annual growth for country *i* during five-year period *t*, α_i is a country-specific fixed effect, π_{it} represents average annual inflation for country *i* during five-year period *t*, and ε_{it} represents an i.i.d. normal disturbance term. We estimate using a panel specification with robust standard errors.[5]

[5] We also estimated a cross-section specification without fixed effects with robust standard errors and clustering by country. The results were quite similar and are available on request.

Our results are shown in Table 2. We run the specification for the full sample and for six historic sub-samples. Inflation in levels enters positively, as expected, in our full sample and all six sub-samples. For the full sample, the coefficient on inflation indicates that an increase in inflation of 1% leads to an expected increase in average annual growth of 0.21%. Moreover, the coefficient on inflation in levels is statistically significant at the 5% level for the full sample and most of the historic sub-samples. The exceptions are the more recent sub-samples, as inflation in levels enters at a 10% confidence level for the post-Bretton Woods sub-sample, and is insignificant for the entire post-WWII sub-sample. Still, the point estimate on inflation comes in at substantive levels of 0.19 and 0.15 for these periods respectively.

The non-linear term enters negatively throughout, as was also expected, though not always at statistically significant levels. The nonlinear term does enter significantly at a 1% confidence level in the case of our full sample. However, the more interesting result is that allowing for the non-linear term markedly increases the economic and statistical significance of the coefficient on the level of inflation. This is in contrast to the limited significance found for inflation in levels in the literature.

The data driving this result can be seen in Figure 1, which plots the fitted nonlinear specifications. Again, except for the post-WWII sub-sample, we find a pronounced nonlinear relationship between inflation and growth. Concentrating on the full sample, it can be seen that this nonlinearity is driven by the fact that episodes of very poor economic performance tend to be associated with high or low inflation levels, while episodes of exceptionally strong economic performance tend to be clustered around modest inflation levels.

It should be acknowledged that the reported goodness of fit measures indicate that inflation alone explains little of the variation in the data, both within and between country observations. This is not surprising given our parsimonious specification. We do get higher between country variation when the sample is restricted to the before or after WWII sub-samples, but the poor fit of between country variation for the full sample indicates that a substantial amount of variation takes place within countries across time.

4. Sample split into high and moderate inflation levels

The results above provide some indication that the relation between inflation and economic performance is nonlinear, although the sample may be too noisy to closely fit a nonlinear specification. In this section, we instead split our samples in two, above and below some threshold that may be associated with the level at which inflation begins to become problematic. Because the value at which this may occur is uncertain, we split the samples using two alternative approaches: We first use Hansen's (2000) regression-based method of threshold estimation to choose and then test for an inflation threshold. This method yields asymptotically balanced threshold confidence intervals based on inverting the likelihood statistic, as well as valid probability values for parameter instability at the threshold. As a robustness check, we also impose a threshold at the 50^{th} percentile and conduct an F-test to determine whether or not the data suggest that the coefficient estimate on the level of inflation is stable above and below this threshold.

We estimate the simple linear specification

$$\Delta y_{it} = \alpha_i + \beta_1 \pi_{it} + \varepsilon_{it} \qquad (3)$$

where the parameter definitions are the same as those in equation (2). We report Lagrange multipliers and F-statistics for the existence of a threshold for the estimated and 50^{th} percentile thresholds respectively.

Because our sample panels are unbalanced, and the imposed inflation threshold may also divide individual countries unevenly, the remaining historical sub-samples often end up with very small numbers of observations for individual countries on either side of the threshold. As a result, we do not include country-specific fixed effects in the specifications for our smaller historical sub-samples.

Our results are shown in Table 3. For the full sample, the Hansen method chooses an inflation threshold of 3.25%. For inflation below the estimated threshold, we obtain a coefficient estimate on inflation equal to 0.31 which is significant at a 1% confidence level. In contrast, the coefficient on inflation above the 3.25% threshold is -0.15, and is also statistically significant at a 5% confidence level. Our LM-test for a structural break above and below the threshold is significant at a 10% confidence level. We obtain similar results with WWII (1939-1949) and the Great Depression (1929-1934) excluded. The coefficient on inflation is still positive and significant at 0.14 for the sample below the threshold and negative and significant at -0.12 for the sample above the threshold, both at 5% significance levels.

Moving to the historical sub-samples, the earlier sub-periods, *Before WWII* and *Gold Standard*, yield implausibly low threshold estimates, -1.10 and 0.68 respectively. Still, we obtain positive estimates on inflation below the threshold for both sub-samples. For the *Gold Standard* period we obtain a statistically significant coefficient estimate of 0.60, while for the *Before WWII* sub-sample, our coefficient estimate is 0.14 but

insignificant. The later sub-periods, *After WWII* and *After BW*, have plausible threshold estimates of 2.44 and 2.89 respectively. For these periods, for the sub-sample below the threshold, we obtain positive and significant coefficient estimates for inflation of 1.08 and 0.55 respectively. The coefficient for the *Mid-20th Century* is actually negative, with a point estimate of -0.43, but is very insignificant.

The R-squared estimates indicate that much variability remains unexplained, but we obtain a respectable value of 0.18 below the inflation threshold for the full sample.

The results for sample separation at the 50th percentile are similar. The inflation threshold estimate for the full sample is 2.40, and our F-test confirms that the break is statistically significant at a 1% confidence level. The inflation coefficient below the threshold is similar at 0.33 and is again statistically significant at a 1% confidence level. Above the threshold we obtain a -0.13 inflation coefficient, again significant at a 1% confidence level. For the full sample excluding WWII (1939-1949) and the Great Depression (1929-1939), we again obtain a threshold of 2.40, which is now statistically significant at a 10% confidence level. As in the case of the Hansen splitting method, the coefficient estimates for this sub-sample are smaller in absolute value, at 0.16 and -0.06 respectively, and neither are statistically significant. The goodness of fit measure, here the correlation between the model fit and the data, is again a respectable 0.11 for the sub-sample below the inflation threshold.

The results for the historical sub-samples are similar. We obtain smaller inflation threshold estimates for the earlier periods, 0.57 and 0.62 for the *Before WWII* and *Gold Standard* periods respectively, and higher threshold estimates for the later sub-samples, 4.21 and 5.20 for the *After WWII* and *After BW* sub-samples respectively. The coefficient

estimates for inflation levels below the 50th percentile thresholds are positive and statistically significant for at least a 10% level for all sub-periods except the *After BW* period. For the latter sub-sample the inflation estimate is negative, but insignificant. Above the inflation threshold, the point estimates for inflation tend to be negative, with the exception of the *After BW* period, but are insignificant except for the *Mid-20th Century* sub sample.

Overall, our results strongly support the hypothesis of a positive relationship between inflation and economic growth within the range of low to moderate inflation, and of a negative or insignificant relationship above that threshold. These results appear to be robust to dividing the data into a variety of historical sub-samples with the exceptions noted above, and to either estimating the inflation threshold using the Hansen (2000) method or splitting the sample at its 50th percentile.

5. Inflation volatility

In this section, we examine the robustness of our results to the inclusion of a measure of inflation volatility, measured as the variance of inflation over the five year period. We examine the same specifications as those above with inflation volatility measure added.

Our results are shown in Table 4. Table 4.1 repeats the non-linear specification from Table 2 for the full sample and the sub-sample with the Great Depression (1929) and WWII (1939-1949) periods excluded. It can be seen that our point estimates for the inflation coefficient and the nonlinear term are basically unchanged. The inclusion of a volatility term reduces the coefficient on inflation in levels to 0.20 for the full sample and

to 0.11 excluding WWII and the Great Depression. Inflation volatility enters modestly negatively, but is insignificant.

We add our measure of inflation volatility to the linear specifications with structural breaks in Table 4.2. Our estimates for inflation thresholds using both the Hansen (2000) method or splitting the sample at the 50^{th} percentile are identical to those in Table 3. We again obtain a coefficient estimate of 0.32 for the full sub-sample below the inflation threshold, and of -0.14 for the sub-sample above the threshold. Similarly, when splitting the sample at the 50^{th} percentile we obtain a coefficient estimate of 0.35 for the sub-sample below the inflation threshold and of -0.11 for the sub-sample above the inflation threshold. All of these coefficient estimates are statistically significant for at least a 5% confidence level. Inflation volatility is insignificant throughout. Our results excluding WWII and the Great Depression are also quite similar to those without inflation volatility.

6. Conclusion

This paper reexamines the long-term evidence on inflation and economic performance by allowing for inflation and economic performance to follow a non-linear relationship. We find that for low and negative inflation levels, the correlation between inflation and economic performance is quite strong: Below our estimated 3.25% threshold, our coefficient estimate indicates that a 1% increase in average inflation levels is associated with a 0.31% increase in average annual growth for our full sample. These results are predominantly robust to dividing our sample into various historical sub-samples and the inclusion of a measure of inflation volatility.

We should reiterate Atkeson and Kehoe's warning that there is no causality claim here, but, as in their case, we are just observing the correlations between these two variables. However, our results contrast sharply with those of Atkeson and Kehoe for low and negative inflation levels, over which the raw data does appear to indicate a strong positive link between inflation and economic performance.

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Table 1: Summary Statistics

Sample Period	Average Inflation	Average Growth	Inflation Volatility				#obs
	π	$\dot{y}$	σ_π^2	$\rho(\pi, \dot{y})$	$\rho(\pi, \sigma_\pi^2)$	$\rho(\dot{y}, \sigma_\pi^2)$	
Full Sample	3.32	3.10	27.64	0.16	0.19	-0.05	375
Excluding WWII and Great Depression	3.28	3.26	27.02	0.16	0.19	-0.03	337
Before WWII	0.98	2.70	38.78	0.25	0.26	-0.03	194
After WWII	5.40	3.61	12.51	0.05	0.41	0.09	159
Gold Standard	0.72	2.56	30.22	0.24	0.25	-0.04	124
Mid 20th Century	3.65	3.75	36.04	0.11	0.24	-0.18	149
After Bretton Woods	5.98	2.81	12.21	0.25	0.39	0.18	102

Note: Average levels of and correlations ($\rho(x, y)$) between inflation **(π)**, growth **($\dot{y}$),** and inflation volatility **(σ_π^2)**. Definition of inflation volatility is in the text. Cross-country sample of 5-year period averages for 16 countries from 1859 through 2004. Great Depression and WWII periods run from 1929-1934 and 1939-1949 respectively. Sample limited to 5-year episodes with average inflation with absolute inflation values less than 20 percent per year and average growth between -10 and 20 percent per year. Full sample is from 1859-2004. Historical sub-samples include *Ex. WWII and Great Depression,* which excludes the years 1939-1949 and 1929-1934, *Before WWII* (1859-1939), *After WWII* (1950-2004), *Gold Standard* (1959-1914), *Mid-20th Century* (1915-1969), and *After Bretton Woods* (1970-2004).

Table 2: Inflation and Growth

Dependent Variable: Average Income Growth

Sample	π	π^2	# Obs	Correlation of fitted and data		
				Overall	Between	Within
Full Sample	0.21***	-0.01***	375	0.06	0.02	0.06
	(0.06)	(0.00)				
Excluding GD and WWII	0.13**	-0.01*	337	0.03	0.42	0.02
	(0.06)	(0.01)				
Before WWII	0.22***	-0.01	194	0.09	0.35	0.07
	(0.07)	(0.01)				
After WWII	0.15	-0.01	159	0.00	0.35	0.02
	(0.13)	(0.01)				
Mid-20th Century	0.25***	-0.02***	149	0.09	0.02	0.10
	(0.09)	(0.01)				
Gold Standard	0.28**	-0.03**	124	0.08	0.02	0.11
	(0.13)	(0.01)				
Post-Bretton Woods	0.19*	-0.01	102	0.05	0.11	0.05
	(0.10)	(0.01)				

Note: Ordinary least squares estimation with robust standard errors of 5-year period averages of growth on levels of inflation rates and inflation rates squared. Cross-country sample for 16 countries from 1859 through 2004. Great Depression and WWII periods run from 1929-1934 and 1939-1949 respectively. See Table 1 for definitions of historical sub-periods. Sample limited to 5-year episodes with average inflation with absolute inflation values less than 20 percent per year and average growth between -10 and 20 percent per year. Goodness of fit measures report overall, between, and within multivariate correlations of fitted model and data. Constant term and fixed effect coefficient estimates suppressed. *, **, and ***, indicate statistical significance at 10, 5, and 1 percent confidence levels respectively.

Table 3: Samples Split by Inflation						
	Estimated Thresholds (Hansen)			**Samples split at 50th percentile**		
Sample	π^*	$\pi \leq \pi^*$	$\pi > \pi^*$	π^*	$\pi \leq \pi^*$	$\pi > \pi^*$
Full sample	3.25*	0.31***	-0.15**	2.40***	0.33***	-0.13***
P-values and std errors	(0.06)	(0.08)	(0.05)	(0.00)	(0.10)	(0.05)
# Obs		223	152		188	187
Goodness of fit		0.18	0.17		0.11	0.01
Excluding WWII and GD	3.38*	0.143*	-0.12**	2.40*	0.16	-0.06
P-values and std errors	(0.06)	(0.08)	(0.05)	(0.10)	(0.11)	(0.04)
# Obs		209	128		169	168
Goodness of fit		0.13	0.24		0.03	0.00
Before WWII	-1.10**	0.14	0.03	0.57	0.55***	-0.02
P-values and std errors	(0.01)	(0.21)	(0.07)	(0.17)	(0.19)	(0.08)
# Obs		51	143		97	97
Goodness of fit		0.01	0.00		0.11	0.01
After WWII	2.44	1.08***	0.02	4.21**	0.41*	-0.12
P-values and std errors	(0.24)	(0.29)	(0.05)	(0.04)	(0.21)	(0.07)
# Obs		43	116		80	79
Goodness of fit		0.20	0.00		0.07	0.00
Gold Standard	0.684	0.60**	0.17	0.62*	0.69**	-0.01
P-values and std errors	(0.29)	(0.22)	(0.18)	(0.09)	(0.29)	(0.22)
# Obs		64	60		62	62
Goodness of fit		0.17	0.03		0.16	0.03
Mid 20th century	-0.43	0.13	-0.16**	3.24***	0.45***	-0.33***
P-values and std errors	(0.00)	(0.21)	(0.06)	(0.00)	(0.13)	(0.10)
# Obs		32	117		75	74
Goodness of fit		0.02	0.06		0.25	0.06
After BW	2.89	0.55**	0.10	5.20	-0.17	0.02
P-values and std errors	(0.69)	(0.22)	(0.06)	(0.40)	(0.20)	(0.07)
# Obs		36	66		51	51
Goodness of fit		0.13	0.07		0.00	0.01

Note: Ordinary least squares estimation with robust standard errors of 5-year period averages of growth on levels of inflation rates. Cross-country sample of 5-year period averages for 16 countries from 1859 through 2004. Great Depression and WWII periods run from 1929-1934 and 1939-1949 respectively. See Table 1 for definitions of historical sub-periods. Panels split by Hansen (2000) estimation method and by 50^{th} percentile of inflation in sample. Estimation conducted with country-specific fixed effects for full and ex. GD and WWII samples under Hansen estimation, and for all sub-samples for split by percentiles. Fixed effects not included for historical sub-samples under Hansen estimation. Figure in parentheses below π^* reports p-value of not having a threshold at designated π^* using La Grange multiplier and F-statistics for estimated and percentile sample splits respectively. Other figures in parentheses are standard errors of corresponding coefficient estimates. Goodness of fit measures report R-squared statistic for estimated thresholds and multivariate correlations of fitted model and data for samples split by percentiles. Constant term and fixed effect coefficient estimates suppressed. *, **, and ***, indicate statistical significance at 10, 5, and 1 percent confidence levels respectively.

Table 4: Inflation, Growth and Volatility

Dependent Variable: Average Income Growth

I. Non-linear Specification

	π	π^2	σ_π^2	# Obs	Overall Corr	Between Corr	Within Corr
Sample							
Full Sample	0.20***	-0.01***	-0.00	375	0.06	0.00	0.06
	(0.06)	(0.00)	(0.00)				
Excluding GD and WWII	0.11*	-0.01	-0.00	337	0.03	0.00	0.03
	(0.06)	(0.00)	(0.00)				

II. Samples Split by Inflation

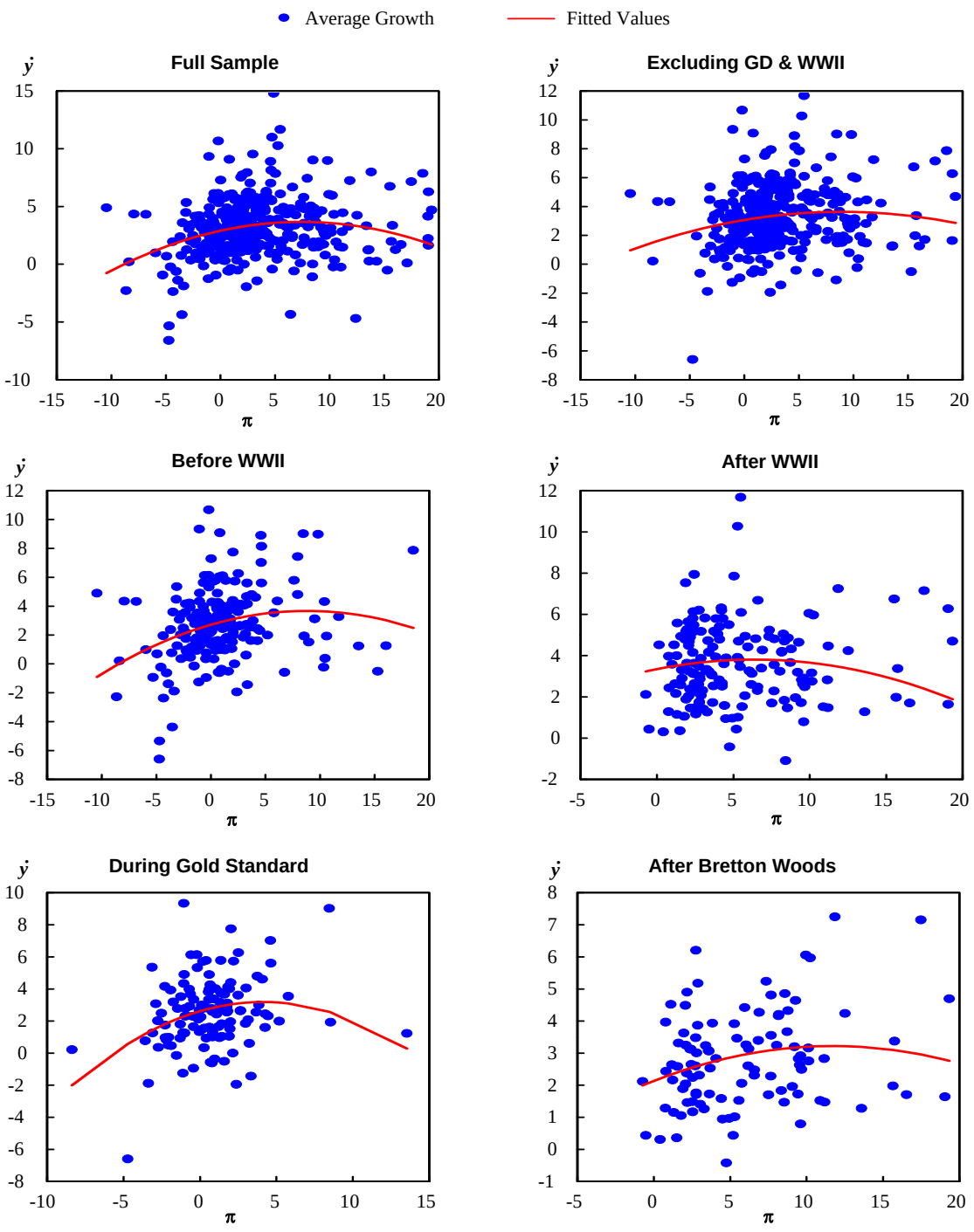
Dependent Variable: Average Income Growth

	Estimated Thresholds		Samples split at 50th percentile	
	$\pi \leq \pi^*$	$\pi > \pi^*$	$\pi \leq \pi^*$	$\pi > \pi^*$
Full Sample				
π	0.32***	-0.14**	0.35***	-0.11**
	(0.09)	(0.05)	(0.11)	(0.05)
σ_π^2	0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
π^*	3.25*		2.40***	
P-value	(0.07)		(0.00)	
# Observations	223	152	188	187
Goodness of fit	0.18	0.18	0.11	0.01
Excluding GD and WWII				
π	0.14*	-0.10*	0.15	-0.04
	(0.09)	(0.05)	(0.12)	(0.05)
σ_π^2	-0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
π^*	3.38		2.40	
P-value	(0.18)		(0.17)	
# Observations	209	128	169	168
Goodness of fit	0.12	0.24	0.03	0.00

Note: Ordinary least squares estimation with robust standard errors of 5-year period averages of growth. Non-linear specification reports regression of growth on levels of inflation rates, inflation rates squared, and estimated inflation volatility. Split sample estimation reports regression of growth on levels of inflation and estimated inflation volatility. Country fixed effects are included in all specification. Panels split by Hansen (2000) estimation method and by 50th percentile of inflation in sample. Cross-country sample for 16 countries from 1859 through 2004. Great Depression and WWII periods run from 1929-1934 and 1939-1949 respectively. See Table 1 for definitions of historical sub-periods. Sample limited to 5-year episodes

with average inflation with absolute inflation values less than 20 percent per year and average growth between -10 and 20 percent per year. Goodness of fit measures report overall, between, and within multivariate correlations of fitted model and data for nonlinear specification, and R-squared statistic for estimated thresholds and multivariate correlations of fitted model and data for samples split by percentiles. Constant term and fixed effect coefficient estimates suppressed. *, **, and ***, indicate statistical significance at 10, 5, and 1 percent confidence levels respectively.

Figure 1: Inflation and Growth



Note: Cross-country sample for 16 countries from 1859 through 2004. Great Depression and WWII periods run from 1929-1934 and 1939-1949 respectively. Fitted line corresponds to point estimates in nonlinear specification in Table 1. See Table 1 for definitions of historical sub-periods. Sample limited to 5-year episodes with average inflation with absolute inflation values less than 20 percent per year and average growth between -10 and 20 percent per year.