Inflation, Volatility and Growth*

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Abstract

This paper re-examines the relationship between inflation, inflation volatility and growth using cross-country panel data for the past 30 years. With regard to the level of inflation, we find that in contrast to current findings which are based on cross-sectional time-average regression comparisons, exploiting the time dimension of the data reveals a strong negative correlation between inflation and income growth for all but very low inflation countries. To examine the role of inflation uncertainty on growth, we use intra-year inflation data to construct an annual measure of inflation volatility. Using this measure, we find that inflation volatility is also robustly negatively correlated with growth even after the effect of the level of inflation is controlled for.

KEYWORDS: Inflation, growth, volatility, cross-country panel data

JEL Classification System: C23, N10, O57

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1 Introduction

One of the strongest beliefs held by monetary policy practitioners is that inflation is detrimental to economic growth. Consistent with these beliefs, policy makers in both developed and developing countries have often appeared willing to trade short-run output losses for progress toward price stability. However, the empirical evidence documenting the benefits of low inflation is not very persuasive. Further, the theoretical justification for such benefits seems tenuous at best.[1] Given the absence of both theoretical and empirical evidence of the benefits of price stability, the dedication of many policy makers to the goal of price stability might seem questionable.

The primary objective of this paper is to present some additional empirical evidence on the benefits of the sensibility of price stability as a monetary policy goal. In particular, the evidence presented suggests that both lower levels of inflation and greater stability of inflation appear conducive to economic growth. The evidence for these benefits is both stronger and more robust than that found in earlier studies. While this result does not offer an empirical rationale for absolute price stability, it does suggest that the discussion should at least move beyond questioning the sensibility of the goal per se.

As is well known, data realities and identification problems severely limit the ability of researchers to pin down the causal links between inflation and growth. Single-country studies typically lack the variety of inflation experiences necessary for such undertakings. For example, in the case of most OECD countries, a few key events–including the gyrations of energy prices in the 1970s and 1980s–had a strong influence on two decades of inflation movements. Extending the investigation to cross-country studies introduces the variety of inflation experiences desirable for identifying the relationship between inflation and output growth. However, specifying a sufficiently accurate structural model useful for discussing causality issues while encompassing the characteristics of individual countries remains problematic. As a result, most of the work on this topic collapses to a simple investigation of

[1] As Orphanides and Solow (1990) point out, equally plausible theoretical models regarding the effects of low and steady inflation yield fundamentally different results for growth.

the reduced-form relationship between of inflation and growth.

A separate, but empirically important issue is that it is difficult to separate the level of inflation from the volatility or unpredictability of inflation as the source of the possible negative relation between inflation and growth. As a policy matter, the distinction is important.[2] If inflation volatility is the sole culprit, a high but predictably stable level of inflation achieved through indexation may be preferable to a lower but more volatile inflation resulting from an activist disinflation strategy or a cycle of doomed reform attempts. If, on the other hand, the level of inflation per se negatively affects growth, an activist disinflation strategy may be the only sensible choice. As an empirical matter, however, the long-run average level of inflation is strongly correlated with the inter-year variance of inflation, so separating the two effects is difficult when the data used are time-averages.

In recent years, several authors have employed cross-country growth regressions to examine the correlation between inflation and growth. (See Clark, forthcoming, for a review). For the most part, these studies have concentrated on extensions of a growth-theoretic framework in which the long-run growth experience of a set of countries is explained in terms of a base set of regressors including long-run trends in human and physical capital accumulation and initial income. Macroeconomic factors related to inflation, the budget deficit/debt, trade, the exchange rate, and other variables are then added to the basic specification to determine whether they have a separate effect on growth other than what would be captured already through their effect on the stock of capital. The horizon examined is typically 25 to 30 years, from the 1960s to the early 1990s depending on data availability, and the number of observations is often limited to fewer than 100. Some studies uncover a negative association between the average level of inflation and growth. Using the inter-year standard deviation of inflation or similar proxies for inflation volatility, some authors also report a negative correlation of inflation volatility with growth, though typically not in addition to the association due to the level of inflation. In a robustness examination of such

[2] See Fischer and Modigliani (1978) for a taxonomy of the costs of inflation depending on the volatility of inflation and alternative institutional arrangements.

studies, however, Levine and Renelt (1992), point out that slight variations in the specification of these regressions appear to yield substantially different results for the influence of such variables on growth. They find that in cross-country regressions the only variables that are robustly correlated with growth are the investment to capital ratio proxy of capital accumulation and the initial stage of development. Applying the same methodology to policy variables explicitly, Levine and Zervos (1993) suggest that neither the average level of inflation nor inflation volatility (based on an inter-year proxy) are robustly correlated with growth.

Clark (forthcoming), reaches similar conclusions regarding the effect of both the level and the volatility of inflation by examining the influence of slight changes in the horizon over which growth and inflation are being aggregated, and the influence of the exclusion of a handful of outliers in these regressions.

Despite these criticisms, the results of Barro (1995), Fischer (1993) and Motley (1994) are somewhat more positive. Barro (1995) and Motley (1994), using cross-country data split into the decades of the 1960s, 1970s, and 1980s find that overall the level of inflation is negatively correlated with growth. In addition to cross-country regressions, Fischer suggests that the use of panel regressions preserves the time series variation in the data for individual countries and may thus be more informative than the cross country regression results. In panel regressions covering the period 1960 to 1988, he finds the level of inflation to be individually significantly negatively correlated with growth but is unable to separate the significance of this effect from that of the volatility of inflation.

In this paper, we follow Fischer's lead and examine the correlation between inflation and growth employing both the time-series and the cross-sectional variation in the data. For output, this means concentrating on annual growth data since data on a consistent basis across countries do not appear at a finer frequency. For inflation, the availability of consistent quarterly price data for a large set of countries allows us to construct intra-year measures of inflation volatility rather than the inter-year measures used in previous cross-country work. The proxy we construct for intra-year volatility is a substantial improvement over the inter-year proxies used in cross-country regressions and allows us to examine more accurately the effect of both the level and the volatility of inflation on growth.[3] Importantly, the collinearity problem encountered in cross-sectional studies is mitigated by our use of intra-year volatility.

These two methodological changes prove quite beneficial in disentangling the effect of the level of inflation on growth from the effect of inflation volatility on growth. The conclusion is straightforward. When full use is made of the panel aspect of standard cross-country datasets, and when intra-year information is employed in measuring inflation volatility, our results suggest that both the level and the volatility of inflation are robustly and significantly negatively correlated with economic growth.

2 Data

We use data from the Heston-Summers dataset, and from the IMF's International Financial Statistics (IFS). The maximum possible coverage is 142 countries and 34 years. For most regressions, the actual sample coverage is 119 countries and 2872 observations. In one set of regressions we also incorporate Judson's (1996) human capital stock growth estimates; this restricts the sample further to 69 countries.

The income variable we use is real per-capita GDP in 1985 international prices from Summers and Heston. We calculate annual growth rates, ZGDPC, as log differences multiplied by 100. (Thus, 5% growth is set to 5.00.) For most countries, the most restrictive data requirement is the existence of the quarterly inflation data we use to construct annual inflation measures and intra-year volatility. We calculate inflation levels and standard deviations from quarterly price index data from International Financial Statistics. In cases where consumer price index (CPI) data were not available, we used inflation data. INFLAT, the level of inflation, is calculated in one of two ways. When CPI data are available, INFLAT, is calculated as one plus the rate of change of the CPI level from the last quarter of the

[3]In the process, we also confirm Barro's suspicion that inter-year proxies are poor measures of inflation volatility. (Barro, 1995, p. 9.)

previous year to the last quarter of the current year. When CPI data are not available but inflation data are, INFLAT is calculated as 1 plus the inflation rate. We use gross inflation so that observations for which inflation is zero or negative can be used in our regressions, which use the log of inflation.

The standard deviation of inflation, SDINFLAT, for each year is computed as the standard deviation of the four quarterly inflation observations for that year. We eliminate observations for which the standard deviation of inflation is exactly zero.[4]

Following Mankiw, Romer, and Weil (1992) and Levine and Renelt (1992) we include the log of the share of investment in GDP in all our regressions as a proxy for capital accumulation. We felt was that it was important to include this variable since it appeared to be the only time series variable which passed the robustness criteria in the cross-country analysis for the determinants of growth by Levine and Renelt (1992). The data are from Heston-Summers, and the variable, IY, is the share of investment in income multiplied by 100.

After compiling all the data, we eliminate countries for which we have fewer than five years of data on investment, income, and inflation. Our sample then includes 119 countries in the dataset and 2872 annual observations for our basic regressions. The first few columns of Table 1 show the sample coverage. For each country in the sample we show the first and last year of data and the number of data points available in the baseline sample, which we call FULL. Following Mankiw, Romer, and Weil (1992), however, in all regressions we also examine three subsamples described in their study and indicated by the NONOIL (N), INTERMED (I), and OECD (O), dummy variables. NONOIL is the FULL sample with oil-exporting countries excluded. In the INTERMED sample, countries given a poor data quality grade in Heston-Summers (1992) are omitted. The OECD sample contains only the 22 member countries of the Organization for Economic Cooperation and Development,

[4] An examination of such data revealed that the zero standard deviation was likely due to backfilling of the quarterly data from an annual series on the IFS data which should have been recorded as missing data. For virtually every country where this problem appeared, only the first few consecutive years of data for the country were affected.

which includes most of the world's largest and most advanced economies. We use these subsamples for two reasons. First, with regard to the NONOIL and INTERMED samples, for data homogeneity and reliability. Since many of the inflation movements in the sample are driven by oil shocks with offsetting productivity implications for oil importers and exporters, it is important to isolate the two groups and treat them separately. But many of the remaining countries have data of questionable quality. Excluding such countries results in the INTERMED sample. Second, with regard to the OECD sample, for assessing the relationship between inflation and growth in developed countries, after eliminating from the data countries at a macroeconomic stage of development vastly different from that of the first world. In all cases, for consistency with earlier results we adopt the country selection criteria directly from Mankiw, Romer, and Weil (1992).

The last four columns of Table 1 and Tables 2 and 3 provide a summary snapshot of the data. Table 1 shows the means of the four variables of interest by country: per-capita GDP growth (ZGDPC), the level of inflation (INFLAT), the standard deviation of inflation (SDINFLAT), and investment as a share of GDP (IY). As such, this would constitute the dataset in a cross-country regression. The wide difference in growth and inflation experiences around the world which makes inter-country analysis useful is evident. Table 2 shows the means of the same variables by year providing a snapshot of the information ignored in cross-country regressions. The usefulness of examining the full panel is already visible from an examination of the information which would enable the identification of a difference in the effects of the level of inflation versus inflation volatility. Even though the two variables are strongly correlated, some differences can be seen even by looking at the annual means. For instance, years such as 1963, 1964 and 1971 are relatively low inflation and high volatility years while years such as 1981 and 1984 appear to be relatively high inflation but low-volatility years. Lastly, Table 3 provides summary statistics of the four key variables and also of natural logarithms of INFLAT, SDINFLAT and IY, named LINFLAT, LSDINFLAT and LIY respectively, for the four alternative samples of countries used in subsequent regressions. Most notable, perhaps, is the relative macroeconomic stability characterizing the OECD sample relative to the three broader samples. Inflation appears lower and more stable on average, while investment and growth appear to be substantially higher. These differences are important in examining later results.

Table 4 displays the correlation between inflation and the intra-year volatility of quarterly inflation for both logs and levels of all four of our samples. We display these correlations simply to point out that the collinearity problems encountered in cross-sectional studies are not nearly as severe in the underlying panel data used here. While, for instance, Levine and Renelt (1992) find that the correlation between the level and inter-year volatility of inflation over a span of two decades is 0.97, the correlation between the level of inflation and intra-year inflation in our annual panel data is substantially lower. Note that although the maximum correlation is 0.90, (corresponding to the OECD subsample for the years 1983-1992) the correlations for most of the country and time period sub-samples shown are between 0.4 and 0.6.

3 Specification and Results

Using panel regressions, we estimate the contemporaneous relationship between growth rates and the level and standard deviation of inflation in a panel of countries over the period 1959 to 1992. We estimate all regressions for four country samples: the full sample (FULL), and the intersection of this sample with the three subsamples used by Mankiw, Romer and Weil (1992): Non-oil producing countries (NONOIL), intermediate data quality countries (INTERMED), and OECD countries (OECD). In each regression, the dependent variable is per-capita income growth and our focus is on the partial correlations between growth and our measures of inflation and inflation volatility.

In addition to the variables of interest, all of the regressions include a set of conditioning variables. First, we include the log of investment's share in income, LIY, a capital accumulation proxy, to control for the effect of physical capital accumulation on growth. In addition, for a restricted sample, we include estimates of human capital investment to control for the effect of human capital accumulation on growth as well. Second, all regressions are estimated with both country and year dummy variables. The country effects provide a crude way of capturing differences in other factors across countries which affect growth but which are not included in the regression, including the initial stage of development. We include year dummy variables in order to remove from the data common factors, such as adverse worldwide productivity shocks or recessions, which might affect growth globally. Removing the effects of such common elements should make the linkages of country specific differences in inflation and inflation volatility to growth much easier to detect. While we cannot claim that the resulting estimated relationship is completely free of the endogeneity problems which make causal interpretations of the uncovered relationships between inflation and growth difficult, a substantial part of the endogeneity problem is controlled for by accounting for the common supply and aggregate demand shocks obtained when the year dummy variables are included in the regression.

As our baseline choice for the specification of the effect of the volatility of inflation we use the logarithm of the standard deviation of inflation, LSDINFLAT. This choice forces our baseline regressions to suggest that the effect of a unit reduction in volatility is larger at low volatility levels than at high volatility levels. However, this restriction proves unimportant empirically as alternative choices yield similar results. Moreover, as discussed below, it allows the nesting of two alternative specifications of the effect of inflation uncertainty on growth.

Our measure of volatility is intended to capture the magnitude of the underlying inflation uncertainty at the annual horizon. By restricting attention to inflation uncertainty at the annual horizon, our results do not address the issue of long-term inflation uncertainty. As previous studies have shown, however, (e.g. Fischer, 1993), multi-year measures of volatility do not seem to be correlated with growth. In principle, the observed volatility of quarterly inflation data could be contaminated by poor measurement, including poor seasonal adjustment methods. Since our dependent variable is the growth of income rather than the level of income, and since it is more likely that data from poor countries rather than from slow growing countries would be most affected by this issue, we do not feel that these effects are not important.

With regard to the specification of the effect of the level of inflation, earlier results based on cross-country studies suggest the strong possibility of a nonlinearity. As a baseline we use the logarithm of one plus the annual rate of inflation, or gross inflation. The choice was driven by two factors. First, our strong prior belief that the effect of a unit reduction in inflation from very high inflation levels is much smaller than the effect of a unit reduction from low to moderate inflation rates. This suggests that the estimated relationship ought to be concave, at least at high inflation rates. Second, joint with the logarithmic specification of volatility, this specification offers the additional advantage of nesting the ratio of the standard deviation of inflation to one plus the rate of inflation, which is the uncertainty specification suggested by the theoretical work of Davis and Kanago (1992).

Our baseline regression results are shown in Table 5. In each of the different panels, the four columns represent estimates of the model for each of the four alternative samples: FULL, NONOIL, INTERMED, and OECD. The top panel includes only the level of inflation variable. As can be seen, in all four samples the panel regression indicates a highly significant negative relationship between the level of inflation and growth, with t-statistics of about 4. This result contrasts sharply with the finding of only a marginal statistical association common in cross-country studies. To be noted also, the point estimate appears larger for the OECD sample suggesting a stronger relationship in first-world countries. The middle panel replaces the level of inflation variable with the inflation volatility variable. Two findings emerge. First, it is evident that using the finer intra-year measures of volatility uncovers a highly significant negative relationship between inflation volatility and growth. Second, comparing the sum of squared residuals in the regressions of the two panels suggests that the fit obtained by using inflation volatility alone as an indicator of the effects of inflation on growth is at least as good as the fit obtained by using the level of inflation alone. This result strongly suggests that concentrating attention in policy discussions relating inflation to growth on the level of inflation while ignoring inflation uncertainty may be misleading.

In the third panel both the level of inflation and its volatility are included in the regression. For both variables, and as expected because of their positive correlation, the individual coefficients are somewhat smaller than the corresponding estimates in the top two panels. Importantly, though, the estimated parameters suggest that both the level and the volatility of inflation are negatively and significantly correlated with growth even when the effect of both is simultaneously obtained from the regression.

Tables 6 through 9 provide the results from the same regressions for alternative time period subsamples. The results appear fairly robust across the alternative time periods shown although the significance of individual coefficient estimates drops substantially as we reduce the sample size to one half or one third of the original. However, the influence of inflation volatility appears increasingly stronger over time with estimates for 1983-92 sample being larger (in absolute value) than the estimates for the 1973-1982 period and those being larger, in turn, than the estimates in the pre-1973 period. A notable exception to this is the estimate for the effect of volatility in the 1973-1982 period for the OECD sample.

Table 10 presents spline estimates for the relationship between inflation and growth as a means of investigating any non-linearities that may be present. The spline operator generates a piecewise linear regression line. The regressions shown are estimated over the complete sample and are thus directly comparable to the results in the last panel of Table 5. Two noteworthy features of the data emerge. With respect to the level of inflation, the cuts in the splines represent annual inflation rates of 10 and 40 percent. We choose these cutoffs following Fischer (1993).[5] It appears that although the level of inflation is significantly negatively related to growth at levels above 10 percent, the relationship is insignificant for lower inflation levels and, except for the OECD sample is of the wrong sign. However, with respect to the volatility of inflation, the gains to growth associated with added stability are present at both high and low levels of volatility. Thus, these regressions indicate that, in

[5]By comparison, Sarel (1996) presents evidence for a structural break in the relationship between inflation and growth at 8 percent.

low inflation environments, the stability of inflation may be more important than the level of inflation for achieving high growth.

To assess the magnitude of the coefficients, consider the coefficients for the intermediate sample (Column 3) in Table 10. For a low-inflation country, reducing the level of inflation is associated with virtually no change the growth rate. On the other hand, a reduction of the inflation volatility, for example, from swings of 2 percent around 8 percent each quarter (i.e., 6 percent one quarter, 10 percent the next) to swings of only 0.5 percent (i.e., 7.5 percent one quarter, 8.5 percent the next) is associated with an increase of the growth rate by about one-half of one percent.

For moderate-inflation countries, reductions of both the level and the volatility of inflation are associated with gains in growth. A reduction in the rate of inflation from 25 percent to 15 percent, is associated with about a one-half of one percent increase in growth. Reducing swings in inflation from five percent around 25 percent (i.e., 30 percent one quarter, 20 percent the next) to one percent around 25 percent (i.e., 26 percent one quarter, 24 percent the next) is associated with a growth gain of just over two-thirds of a percentage point.

Of course these estimates hold all other factors constant and are based on the average of the experience of many countries over the sample. Thus, there is no guarantee that simply reducing inflation volatility will automatically augment growth in any particular country. But on average, the gain to reducing inflation volatility is substantial at all levels of inflation, and the gain to reducing the level of inflation can be substantial at moderate and high levels of inflation.

To check for the robustness of the results to the inclusion of observations for countries which were at war, in Table 11 we replicate the top panel of Table 5 and compare it with a restricted sample which excludes observations associated with war. (The data for war years are from the Bruno and Easterly (1995) dataset). By draining resources, wars are detrimental to growth and at the same time often result in inflationary and unpredictable fiscal needs, which would boost both the level and volatility of inflation. As a result, we should check whether our results are driven primarily from such observations. As the table makes clear, the impact of both inflation and its volatility on growth are essentially unaffected by the exclusion of these observations, which suggests that our results are not driven by the incidence of war.

Finally, in Table 12 we show results which control—in addition to physical capital accumulation—for human capital accumulation. To that end, we add the variable ZHK to our baseline regressions which represents Judson's (1996) estimates of the growth rate of the per-capita stock of human capital.[6] While measures of both physical and human capital accumulation should in principle be controlled for throughout the analysis, that would require eliminating about half of the observations in our sample due to coverage problems with human capital data. As a result, we chose to provide a comparison of our results with and without controlling for human capital only for our baseline specification. As can be seen by comparing the two panels of the table, the estimates of the impact of inflation and its volatility are not materially different in the two specifications. This result suggests that the influence of human capital on growth is orthogonal to the inflation effects and provides reassurance that our earlier results based on the full sample of 119 countries are unlikely to be influenced by differences in human capital accumulation.

4 Concluding Remarks

In sum, we find that exploiting the time dimension of the data is critical in revealing the links between GDP growth and the level and volatility of inflation. When full use is made of the panel aspect of standard cross-country datasets, and when intra-country inflation volatility data are available, the following conclusions emerge from the data. First, inflation volatility is robustly and significantly negatively correlated with income growth across level of inflation, time, and type of country. Second, the level of inflation is significantly negatively correlated with growth, but apparently only for inflation levels higher than about 10 percent

[6]This variable is defined as the current replacement value of education in PPP dollars, and is interpolated from quinquennial data.

per year. Third, the level and the volatility of inflation appear to have independently significant influences to growth. Combined, these conclusions indicate that, fundamentally, the inclinations of monetary policy makers are correct: High inflation is detrimental for growth, and volatile inflation is associated with lower growth at all levels of inflation.

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Table 1: Sample Coverage and Means by Country

Country	First	Last	N	Sample			Mean of variable			
Name	Year	Year	Obs	N	I	O	ZGDPC	INFLAT	SDINFLAT	IY
ALGERIA	1975	1992	16	1	1	0	0.487	1.131	0.166	23.43
AUSTRAL	1959	1992	34	1	1	1	1.976	1.064	0.024	28.21
AUSTRIA	1959	1992	34	1	1	1	3.163	1.042	0.034	25.60
BAHAMAS	1978	1987	10	0	0	0	4.883	1.067	0.020	9.68
BAHRAIN	1976	1988	13	0	0	0	-0.747	1.055	0.070	35.15
BANGLAD	1975	1992	18	1	1	0	2.470	1.083	0.108	3.00
BARBADOS	1966	1989	24	0	0	0	3.543	1.095	0.058	12.48
BELGIUM	1959	1992	34	1	1	1	2.866	1.046	0.015	23.76
BELIZE	1984	1992	9	0	0	0	2.812	1.028	0.051	17.53
BOLIVIA	1986	1992	7	1	1	0	-0.271	1.251	0.434	5.18
BOTSWANA	1975	1989	15	1	1	0	3.190	1.109	0.056	20.28
BRAZIL	1982	1991	8	1	1	0	0.534	4.113	3.258	15.95
BURKINAF	1960	1992	33	1	0	0	-0.005	1.052	0.172	7.85
BURMA	1959	1989	24	1	1	0	3.560	1.096	0.177	8.74
BURUNDI	1966	1992	27	1	0	0	1.399	1.083	0.104	5.64
CAMEROON	1969	1989	21	1	1	0	2.620	1.092	0.086	10.00
CANADA	1959	1992	34	1	1	1	2.416	1.052	0.016	24.01
CAPEVERD	1985	1992	8	0	0	0	0.969	1.067	0.109	22.55
CENAFREP	1982	1992	11	1	0	0	-2.106	1.024	0.086	5.18
CHAD	1985	1992	8	1	0	0	3.433	0.993	0.254	1.35
CHILE	1976	1992	17	1	1	0	2.901	1.304	0.260	20.17
COLOMBIA	1961	1992	31	1	1	0	2.184	1.204	0.147	15.55
CONGO	1963	1992	30	1	0	0	2.289	1.063	0.082	9.08
COSTARIC	1961	1992	30	1	1	0	1.539	1.140	0.092	16.29
CYPRUS	1959	1992	34	0	0	0	4.445	1.048	0.131	26.92
DENMARK	1959	1992	34	1	1	1	2.599	1.066	0.035	25.34
DOM.REP	1959	1992	34	1	1	0	1.793	1.134	0.137	15.34
ECUADOR	1962	1992	27	1	1	0	1.970	1.251	0.145	21.58
EGYPT	1961	1992	32	1	0	0	2.616	1.105	0.095	4.60
ETHIOPIA	1967	1986	20	1	1	0	0.297	1.068	0.132	4.71
FIJI	1970	1990	21	0	0	0	2.569	1.090	0.066	16.70
FINLAND	1959	1992	34	1	1	1	2.873	1.071	0.030	34.16
FRANCE	1959	1992	34	1	1	1	2.802	1.063	0.018	27.04
GABON	1964	1992	29	0	0	0	1.458	1.066	0.086	21.70
GAMBIA	1962	1990	29	0	0	0	1.207	1.102	0.162	5.17
GHANA	1965	1992	26	0	0	0	-0.030	1.388	0.475	5.43
GREECE	1959	1991	33	1	1	1	3.684	1.117	0.094	24.36
GRENADA	1985	1990	6	0	0	0	7.283	1.025	0.035	18.51
GUATEMAL	1959	1992	34	1	1	0	0.945	1.090	0.089	9.09

Table 1 (continued)

Country	First	Last	N	Sample			Mean of variable			
Name	Year	Year	Obs	N	I	O	ZGDPC	INFLAT	SDINFLAT	IY
GUINEA.B	1987	1992	6	0	0	0	0.185	1.666	0.814	17.60
GUYANA	1960	1990	31	0	0	0	-0.845	1.100	0.092	24.25
HAITI	1961	1989	29	1	1	0	-0.353	1.066	0.145	5.25
HONDURAS	1959	1992	34	1	1	0	0.806	1.067	0.062	13.83
HUNGARY	1977	1992	16	0	0	0	0.079	1.125	0.110	25.87
ICELAND	1963	1992	21	0	0	0	2.908	1.343	0.647	27.30
INDIA	1959	1992	34	1	1	0	1.705	1.078	0.088	13.63
INDONESI	1969	1992	24	1	1	0	4.928	1.121	0.094	20.91
IRAN	1959	1992	31	0	0	0	1.923	1.103	0.154	15.23
IRELAND	1959	1992	34	1	1	1	3.477	1.079	0.044	24.22
ISRAEL	1980	1992	13	1	1	0	2.032	2.004	1.161	20.75
ITALY	1959	1992	34	1	1	1	3.424	1.086	0.026	27.89
IVORYCST	1961	1992	32	1	1	0	-0.044	1.069	0.115	10.83
JAMAICA	1959	1991	33	1	1	0	1.120	1.144	0.082	21.85
JAPAN	1959	1992	34	1	1	1	5.366	1.052	0.037	34.08
JORDAN	1977	1990	14	0	0	0	1.066	1.085	0.113	16.93
KENYA	1960	1992	33	1	1	0	1.265	1.096	0.062	15.09
KUWAIT	1981	1989	9	0	0	0	-8.012	1.029	0.026	19.71
LESOTHO	1974	1992	19	0	0	0	2.089	1.142	0.070	17.30
LIBERIA	1968	1986	19	1	0	0	-0.797	1.074	0.091	8.90
LUXEMBRG	1959	1992	34	0	0	0	2.280	1.042	0.019	30.23
MADAGASC	1965	1992	28	1	1	0	-2.181	1.112	0.117	1.43
MALAWI	1981	1992	12	1	1	0	-0.921	1.170	0.145	7.45
MALAYSIA	1959	1992	34	1	1	0	4.509	1.032	0.032	23.12
MALTA	1959	1989	31	0	0	0	5.187	1.034	0.050	23.39
MAURITAN	1986	1992	7	1	0	0	0.223	1.085	0.087	13.62
MAURITUS	1963	1992	30	1	0	0	2.384	1.089	0.087	10.44
MEXICO	1971	1992	18	1	1	0	1.745	1.541	0.870	16.51
MOROCCO	1959	1992	34	1	1	0	2.906	1.058	0.072	8.90
NAMIBIA	1988	1992	5	0	0	0	-0.321	1.137	0.050	8.22
NEPAL	1964	1986	23	1	0	0	1.889	1.085	0.142	5.78
NETHLNDS	1959	1992	34	1	1	1	2.667	1.044	0.032	24.42
NIGER	1969	1989	21	1	0	0	-1.921	1.070	0.184	8.54
NIGERIA	1961	1992	32	1	1	0	1.703	1.156	0.179	12.37
NORWAY	1959	1992	33	1	1	1	3.141	1.064	0.031	30.35
NZEALAND	1959	1992	34	1	1	1	1.456	1.081	0.032	24.53
PAKISTAN	1959	1992	34	1	1	0	2.663	1.078	0.069	10.50
PANAMA	1960	1992	25	1	1	0	2.515	1.042	0.044	20.69
PAPUANG	1972	1992	21	1	0	0	-0.902	1.072	0.053	14.68

Table 1 (continued)

Country	First	Last	N	Sample			Mean of variable			
Name	Year	Year	Obs	N	I	O	ZGDPC	INFLAT	SDINFLAT	IY
PARAGUAY	1959	1992	31	1	1	0	1.569	1.145	0.126	13.78
PERU	1985	1992	5	1	1	0	2.427	1.951	2.402	16.58
PHILIPP	1959	1992	34	1	1	0	1.353	1.114	0.087	15.20
POLAND	1981	1992	12	0	0	0	-1.200	2.013	2.957	23.89
PORTUGAL	1959	1990	30	1	1	1	4.678	1.135	0.078	22.58
RWANDA	1966	1992	27	1	0	0	2.881	1.082	0.087	4.30
SALVADOR	1959	1992	33	1	1	0	0.755	1.104	0.063	8.24
SARABIA	1972	1989	18	0	0	0	-1.335	1.067	0.086	12.51
SENEGAL	1969	1991	23	1	1	0	-0.193	1.071	0.146	4.95
SEYCHELL	1970	1990	21	0	0	0	4.683	1.097	0.129	20.47
SINGAPOR	1967	1992	26	1	1	0	7.079	1.041	0.037	34.85
SKOREA	1971	1991	21	1	1	0	6.963	1.113	0.060	28.35
SLEONE	1964	1992	18	1	0	0	-1.883	1.622	1.168	1.32
SOLOMONI	1981	1988	8	0	0	0	3.363	1.113	0.093	15.43
SOMALIA	1964	1988	25	1	0	0	-1.672	1.248	0.247	8.98
SPAIN	1959	1992	34	1	1	1	3.486	1.096	0.047	25.29
SRILANKA	1959	1992	34	1	1	0	1.897	1.079	0.050	9.14
SUDAN	1971	1991	19	1	0	0	0.031	1.326	0.447	13.43
SURINAME	1961	1989	29	0	0	0	0.750	1.090	0.121	17.73
SWAZILND	1966	1989	24	0	0	0	1.677	1.107	0.070	12.88
SWEDEN	1959	1992	34	1	1	1	2.023	1.066	0.034	23.33
SWITZ	1959	1992	34	1	1	1	1.936	1.038	0.020	29.36
SYRIA	1961	1991	29	1	1	0	2.798	1.109	0.211	14.90
S.AFRICA	1960	1992	33	1	1	0	0.988	1.095	0.031	17.94
S.KITTSN	1984	1992	9	0	0	0	4.963	1.025	0.030	29.54
TANZANIA	1970	1988	19	1	1	0	1.276	1.209	0.184	11.77
THAILAND	1966	1992	27	1	1	0	4.608	1.061	0.039	19.17
TOGO	1971	1992	22	1	0	0	-0.698	1.066	0.148	17.28
TRTOBAGO	1959	1991	33	1	1	0	1.550	1.085	0.048	12.43
TUNISIA	1988	1992	5	1	1	0	2.475	1.069	0.029	10.30
TURKEY	1970	1992	23	1	1	1	2.458	1.418	0.231	21.97
UGANDA	1982	1992	11	1	0	0	-4.445	1.891	0.809	1.83
UK	1959	1992	34	1	1	1	2.049	1.075	0.044	17.96
URUGUAY	1976	1992	17	1	1	0	1.087	1.649	0.815	14.75
USA	1959	1992	34	1	1	1	1.911	1.048	0.013	21.30
VANUATU	1984	1990	7	0	0	0	-0.144	1.068	0.037	18.44
VENEZUEL	1959	1992	32	1	1	0	0.108	1.134	0.094	17.95
WGERMANY	1959	1992	34	1	1	1	2.763	1.033	0.019	27.86
WSAMOA	1980	1990	11	0	0	0	0.061	1.124	0.104	19.41
ZAMBIA	1962	1991	25	1	1	0	-2.453	1.327	0.305	18.78
ZIMBABWE	1979	1992	14	1	1	0	-0.036	1.172	0.086	12.82

Table 2: Means of key variables by year

	Year	N	ZGDPC	INFLAT	SDINFLAT	IY
1	1959	40	3.136	1.022	0.061	19.35
2	1960	43	4.148	1.022	0.054	19.87
3	1961	52	2.240	1.031	0.086	18.76
4	1962	53	3.876	1.028	0.084	18.63
5	1963	55	2.610	1.054	0.215	18.77
6	1964	61	3.885	1.057	0.211	18.54
7	1965	60	2.506	1.039	0.078	18.46
8	1966	65	2.682	1.038	0.077	17.96
9	1967	65	2.434	1.026	0.069	17.83
10	1968	68	3.529	1.035	0.071	17.79
11	1969	73	4.005	1.047	0.094	17.54
12	1970	76	4.192	1.045	0.075	17.96
13	1971	81	3.556	1.070	0.177	17.57
14	1972	84	2.163	1.071	0.098	17.31
15	1973	84	2.816	1.142	0.125	18.40
16	1974	86	2.713	1.191	0.179	18.79
17	1975	90	1.119	1.132	0.129	18.25
18	1976	93	4.044	1.132	0.191	18.22
19	1977	96	3.440	1.142	0.170	18.45
20	1978	95	3.254	1.114	0.102	18.08
21	1979	97	2.384	1.156	0.125	17.93
22	1980	100	0.796	1.175	0.178	18.52
23	1981	104	0.320	1.158	0.132	18.20
24	1982	106	-1.240	1.158	0.171	17.22
25	1983	106	-1.588	1.174	0.152	16.29
26	1984	110	-0.163	1.189	0.133	16.08
27	1985	114	0.885	1.170	0.187	15.84
28	1986	115	1.535	1.146	0.152	15.54
29	1987	112	0.756	1.196	0.166	15.76
30	1988	110	2.046	1.243	0.177	16.04
31	1989	109	1.632	1.204	0.261	16.33
32	1990	96	0.724	1.200	0.255	16.99
33	1991	91	0.725	1.229	0.213	16.69
34	1992	82	0.278	1.137	0.086	16.73

Table 3: Summary statistics by subsample

Variable	Mean	Std Dev	Minimum	Maximum
FULL sample, N=2872				
ZGDPC	1.861	6.160	-64.240	33.033
INFLAT	1.132	0.309	0.827	10.124
SDINFLAT	0.147	0.609	0.00010	17.127
IY	17.462	9.114	0.400	48.000
LINFLAT	0.108	0.153	-0.189	2.314
LSDINFLAT	-2.795	1.148	-9.210	2.840
LIY	2.665	0.716	-0.916	3.871
NONOIL sample, N=2307				
ZGDPC	1.887	5.621	-64.240	33.033
INFLAT	1.132	0.311	0.827	10.124
SDINFLAT	0.135	0.459	0.00010	7.500
IY	17.039	9.113	0.400	42.200
LINFLAT	0.108	0.154	-0.189	2.314
LSDINFLAT	-2.821	1.141	-9.210	2.014
LIY	2.630	0.734	-0.916	3.742
INTERMED sample, N=1923				
ZGDPC	2.173	4.868	-23.197	31.880
INFLAT	1.130	0.320	0.827	10.124
SDINFLAT	0.121	0.455	0.00010	7.500
IY	18.820	8.681	1.100	42.200
LINFLAT	0.106	0.150	-0.189	2.314
LSDINFLAT	-2.952	1.127	-9.210	2.014
LIY	2.784	0.626	0.095	3.742
OECD sample, N=731				
ZGDPC	2.868	3.004	-10.457	12.869
INFLAT	1.078	0.091	0.977	1.920
SDINFLAT	0.040	0.055	0.00010	0.990
IY	25.875	4.995	14.200	42.200
LINFLAT	0.072	0.073	-0.022	0.652
LSDINFLAT	-3.617	0.956	-9.210	-0.009
LIY	3.234	0.192	2.653	3.742

Table 4: Correlations

Correlations of INFLAT and SDINFLAT

Time	Country subsample			
subsample	FULL	NONOIL	INTERMED	OECD
ALL YEARS	0.46	0.39	0.38	0.76
PRE 1973	0.80	0.76	0.70	0.38
1973-1982	0.54	0.57	0.58	0.80
POST 1982	0.45	0.38	0.37	0.90
POST 1972	0.45	0.39	0.38	0.81

Correlations of LINFLAT and LSDINFLAT

Time	Country subsample			
subsample	FULL	NONOIL	INTERMED	OECD
ALL YEARS	0.58	0.57	0.57	0.52
PRE 1973	0.34	0.29	0.25	0.26
1973-1982	0.57	0.56	0.59	0.64
POST 1982	0.69	0.69	0.71	0.72
POST 1972	0.64	0.63	0.65	0.69

Table 5: Panel regressions for 1959-1992

Variable	FULL	NONOIL	INTERMED	OECD
LIY	1.822	3.080	2.968	4.461
	4.59	7.27	6.56	5.34
LINFLAT	-4.201	-4.655	-4.662	-9.120
	-3.89	-4.16	-4.31	-4.42
SSR	90873.7	59219.7	35060.7	3663.2
LIY	1.874	3.198	3.127	4.535
	4.72	7.56	6.94	5.38
LSDINFLAT	-0.583	-0.631	-0.594	-0.360
	-4.02	-4.18	-4.31	-2.88
SSR	90839.9	59213.8	35059.4	3723.4
LIY	1.839	3.131	3.006	4.550
	4.63	7.40	6.66	5.45
LINFLAT	-2.896	-3.332	-3.390	-8.051
	-2.44	-2.74	-2.91	-3.73
LSDINFLAT	-0.421	-0.455	-0.433	-0.217
	-2.64	-2.78	-2.92	-1.67
SSR	90640.8	59010.5	34896.7	3647.9
Total N	2872	2307	1923	731
Countries	119	88	70	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.

Table 6: Panel regressions for 1959-1972

Variable	FULL	NONOIL	INTERMED	OECD
LIY	3.218	3.236	3.034	8.815
	2.70	2.54	2.13	4.71
LINFLAT	-5.690	-9.492	2.011	-14.442
	-1.14	-1.76	0.36	-1.87
SSR	23316.2	17870.3	12624.2	1315.0
LIY	3.200	3.155	3.094	8.603
	2.69	2.47	2.18	4.61
LSDINFLAT	-0.234	-0.200	-0.227	-0.321
	-0.85	-0.69	-0.84	-2.01
SSR	23333.8	17941.6	12611.7	1312.3
LIY	3.250	3.249	3.065	8.758
	2.73	2.55	2.15	4.70
LINFLAT	-5.172	-9.168	2.575	-11.712
	-1.03	-1.69	0.46	-1.49
LSDINFLAT	-0.191	-0.138	-0.241	-0.271
	-0.69	-0.47	-0.88	-1.66
SSR	23302.0	17864.2	12607.1	1301.0
Total N	872	742	652	294
Countries	83	69	57	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.

Table 7: Panel regressions for 1973-1982

Variable	FULL	NONOIL	INTERMED	OECD
LIY	1.529	2.959	4.272	10.447
	1.56	2.79	4.11	5.73
LINFLAT	-5.707	-10.573	-7.608	-15.252
	-2.03	-3.83	-3.11	-4.47
SSR	31758.8	18406.8	9309.5	950.8
LIY	1.611	3.125	4.572	10.537
	1.65	2.93	4.39	5.44
LSDINFLAT	-0.712	-0.787	-0.615	-0.267
	-2.32	-2.66	-2.44	-0.95
SSR	31711.7	18613.7	9373.1	1047.7
LIY	1.570	3.031	4.352	10.171
	1.61	2.86	4.18	5.51
LINFLAT	-3.586	-9.074	-6.170	-16.758
	-1.16	-2.95	-2.27	-4.46
LSDINFLAT	-0.544	-0.362	-0.336	0.283
	-1.60	-1.11	-1.20	0.96
SSR	31660.7	18372.8	9284.7	946.1
Total N	948	757	620	220
Countries	104	80	66	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.

Table 8: Panel regressions for 1983-1992

Variable	FULL	NONOIL	INTERMED	OECD
LIY	3.475	4.385	2.842	2.771
	4.32	5.18	2.95	1.74
LINFLAT	-3.909	-3.177	-4.394	-13.995
	-2.94	-2.23	-3.32	-3.00
SSR	31359.7	20421.5	11386.9	1033.3
LIY	3.467	4.478	3.095	3.701
	4.32	5.35	3.24	2.33
LSDINFLAT	-0.918	-1.061	-1.100	-1.209
	-3.89	-4.09	-4.65	-4.18
SSR	31163.1	20121.1	11203.0	994.1
LIY	3.434	4.458	2.994	3.653
	4.28	5.30	3.13	2.31
LINFLAT	-1.733	-0.484	-1.952	-8.370
	-1.12	-0.30	-1.31	-1.73
LSDINFLAT	-0.761	-1.018	-0.935	-1.025
	-2.78	-3.43	-3.48	-3.34
SSR	31124.4	20118.8	11172.7	979.7
Total N	1151	885	716	239
Countries	119	88	70	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.

Table 9: Panel regressions for 1973-1992

Variable	FULL	NONOIL	INTERMED	OECD
LIY	1.726	3.062	3.128	4.896
	3.40	5.66	5.29	4.81
LINFLAT	-4.528	-5.116	-5.194	-9.686
	-3.94	-4.38	-4.71	-4.17
SSR	66427.4	40529.2	22269.9	2114.4
LIY	1.788	3.256	3.469	5.245
	3.52	6.03	5.91	5.03
LSDINFLAT	-0.735	-0.878	-0.815	-0.530
	-4.13	-4.82	-4.96	-2.71
SSR	66375.3	40423.0	22226.1	2164.5
LIY	1.734	3.150	3.244	5.081
	3.42	5.83	5.49	4.92
LINFLAT	-2.916	-3.186	-3.397	-8.509
	-2.22	-2.42	-2.74	-3.32
LSDINFLAT	-0.517	-0.646	-0.582	-0.232
	-2.55	-3.14	-3.16	-1.09
SSR	66206.1	40267.9	22091.3	2108.4
Total N	2080	1631	1326	459
Countries	119	88	70	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.

Table 10: Panel regressions for 1959-1992 with splines

Variable	FULL	NONOIL	INTERMED	OECD
LIY	1.759	3.067	2.903	4.650
	4.41	7.20	6.38	5.53
LINFLATL	5.875	1.022	0.619	-0.343
	1.41	0.25	0.15	-0.06
LINFLATM	-7.979	-7.617	-5.701	-13.087
	-2.82	-2.65	-2.11	-3.41
LINFLATH	-3.473	-4.291	-5.237	-9.173
	-1.65	-1.99	-2.44	-2.00
LSDINFLATL	-0.402	-0.398	-0.365	-0.241
	-2.35	-2.27	-2.30	-1.70
LSDINFLATM	-0.409	-0.425	-0.369	-0.252
	-2.05	-2.08	-1.98	-1.43
LSDINFLATH	-0.424	-0.352	-0.246	-0.178
	-1.83	-1.49	-1.14	-0.77
Total N	2872	2307	1923	731
Countries	119	88	70	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level in a year and LSDINFLAT the log of the standard deviation of quarterly intra-year inflation. LINFLAT and LSDINFLAT are broken into three regions identified by the letters L (low), M (medium), and H (high). Cuts for inflation are 1.10 and 1.40 Cuts for the standard deviation of inflation are 0.05 and 0.10. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates.

Table 11: Panel regressions for 1959-1992 excluding war years

Variable	FULL	NONOIL	INTERMED	OECD
Excluding war years				
LIY	1.388	2.552	2.773	4.572
	3.41	5.81	5.84	5.38
LINFLAT	-2.625	-2.997	-3.004	-10.258
	-2.14	-2.37	-2.53	-3.47
LSDINFLAT	-0.331	-0.430	-0.464	-0.282
	-2.04	-2.57	-3.03	-2.11
Total N	2610	2059	1706	697
Countries	118	87	69	22
Including war years (from Table 5)				
LIY	1.839	3.131	3.006	4.550
	4.63	7.40	6.66	5.45
LINFLAT	-2.896	-3.332	-3.390	-8.051
	-2.44	-2.74	-2.91	-3.73
LSDINFLAT	-0.421	-0.455	-0.433	-0.217
	-2.64	-2.78	-2.92	-1.67
Total N	2872	2307	1923	731
Countries	119	88	70	22

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates.

Table 12: Panel regressions for 1959-1992
controlling for human capital growth

Variable	FULL	NONOIL	INTERMED	OECD
Controlling for human capital growth				
LIY	2.926	2.948	2.755	6.031
	5.02	5.15	4.73	5.53
ZHK	3.310	3.004	1.972	12.333
	1.62	1.49	1.00	5.00
LINFLAT	-2.838	-4.600	-4.518	-10.454
	-1.95	-3.08	-3.11	-4.13
LSDINFLAT	-0.551	-0.345	-0.307	-0.135
	-2.93	-1.87	-1.71	-0.85
SSR	27572.2	23856.2	21036.9	2149.4
Without controlling for human capital growth				
LIY	3.002	3.022	2.813	5.403
	5.17	5.30	4.86	4.87
LINFLAT	-2.901	-4.633	-4.542	-9.313
	-1.99	-3.11	-3.13	-3.60
LSDINFLAT	-0.549	-0.344	-0.305	-0.112
	-2.92	-1.86	-1.70	-0.68
SSR	27625.8	23897.8	21054.0	2266.1
Total N	1451	1382	1317	516
Countries	67	64	60	20

Notes: The dependent variable in all regressions is per capita growth, ZGDPC, in percent. LIY is the log of investment as a percent of capital. ZHK is the growth rate of per-capita human capital. LINFLAT is the log of one plus the rate of change in the price level and LSDINFLAT the log of standard deviation of quarterly intra-year inflation. All regressions are estimated with country and year effects. t-statistics are shown below the parameter estimates. SSR is the sum of square errors.