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Inflation thresholds and the finance–growth nexus

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Abstract

The robustness of the cross-sectional relationship between the size of a country's financial sector and its rate of economic growth is by now well established. In this article, we examine whether the strength of this relationship varies with the inflation rate. Using five-year averages of standard measures of financial development, inflation, and growth for 84 countries from 1960 to 1995, a series of rolling panel regressions show that there is an inflation threshold for the finance–growth relationship that lies between 13 and 25 percent. When inflation exceeds the threshold, finance ceases to increase economic growth. We also find that the level of financial depth varies inversely with inflation in low-inflation environments and that disinflation is associated with a positive effect of financial depth on growth.

JEL classification: E31; E44; F36

Keywords: Financial development; Economic growth; Inflation; Financial repression; Cross-country regression

1. Introduction

The last decade saw an explosion in research interest on economic growth and its determinants. There is now a large literature that uses panel data to examine differences in growth rates among countries over long periods of time. One of the outstand-

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ing findings in this literature is a robust empirical relationship between financial sector development and economic growth (Wachtel, 2001 and Levine, 1997 summarize the research). While the hypothesis that financial structure aids growth dates back many years (the emphasis on the role of the financial sector is due to Goldsmith, 1969 and McKinnon, 1973), firm evidence for the relationship did not appear until the 1990s when King and Levine (1993) provided cross-country evidence for the post war period and Wachtel and Rousseau (1995) and Rousseau and Wachtel (1998) provided evidence from long time series for several countries. These studies showed that the depth of financial sector development and greater provision of financial intermediary services are associated with economic growth.[1] However, research so far has not asked whether there are economic conditions that are associated with a stronger or weaker finance–growth relationship. In this paper we examine one such relationship—the way in which the finance–growth relationship varies with the inflation rate.

The negative effect of inflation on growth has been widely studied although the evidence does not always provide clear support. Temple (2000) discusses various arguments for the inflation–growth relationship and surveys the empirical literature. Several influential studies in the early 1990s (e.g., Fischer, 1993; Barro, 1996) provided the empirical basis for the widely supported negative relationship. More recently, Bruno and Easterly (1998) showed that the negative relationship between inflation and growth is due to high inflation episodes, and that the threshold for an inflation effect on growth may be as high as 40 percent per year.

The finding that high inflation episodes are the primary source of the negative inflation–growth relationship is particularly interesting to us because it can have strong implications for the finance–growth relationship as well. The reason for this is that financial intermediation becomes more difficult when inflation rates are very high. The flow of information about investment projects and returns that is used by intermediaries becomes more uncertain and less readily available in an inflationary environment. Furthermore, high inflation can repress financial intermediation by eroding the usefulness of money assets and by leading to policy decisions that distort the financial structure. The channel by which inflation affects growth may run, at least in part, through the financial sector.

To the extent that high inflation disrupts the smooth operation of a nation's financial institutions and markets, it also discourages their integration with the rest of the world. Since high inflation is often variable inflation as well, there will be considerable uncertainty about future prices, interest rates, and exchange rates, and this in turn increases the costs of hedging financial risks among potential trade partners. If inflation also increases the possibility of a devaluation and vulnerability to speculative attacks, hedging instruments will become even more expensive and difficult to price. All of this will discourage trade and inflows of foreign capital.

[1] Additional work has shown that other features of financial development are also associated with higher growth rates such as stock market liquidity (Rousseau and Wachtel, 2000) and improved accounting, bankruptcy and governance procedures (Levine et al., 2000).

Our topic of interest in this paper is how the finance–growth nexus is affected by inflation rates. Specifically, we will show that there is an inflation threshold for the finance–growth relationship. When inflation exceeds the 13 to 25% range, financial deepening ceases to increase economic growth. By clearly identifying this threshold, as well as the point where inflation hampers financial development itself, we extend our earlier work on the subject (Rousseau and Wachtel, 2001), which focused primarily on the effects of high inflation episodes in breaking down the finance–growth relationship. To do this, we will use a cross-section of countries with data averaged over time (five-year averages extending from 1960 to 1995) to estimate a base line growth specification that has become fairly common. To allow analysis across a large number of countries, our financial sector measures will be limited to ones that broadly reflect the depth of intermediary activity.

There are a few other studies that examine the inflation-finance-growth nexus. Andres et al. (1999) point out that the "two strands of the empirical literature [the finance–growth and inflation–growth relationships] have lived separate lives". Their paper brings the two strands together using a data set of mostly industrialized (OECD) countries over a relatively short time span, and obtains rather weak results. The effect of inflation on financial sector development is examined in Boyd et al. (2001) and in Haslag and Koo (1999). Both of these papers show that inflation is associated with financial repression; the financial sector is less developed in higher-inflation environments.[2]

2. Inflation and the finance–growth nexus

There are many reasons why the depth of financial sector development can promote economic growth. To summarize, more intense use of financial intermediaries and increased amounts of intermediation will encourage savings and investment and improve the allocation of savings to investment projects. This in turn encourages a higher level of capital formation and greater efficiency in the allocation of capital.

The effect of inflation occurs through a wide variety of direct and indirect channels. Inflation increases transactions and information costs which directly inhibit economic development. For example, economic agents will find planning difficult when inflation makes nominal values uncertain. Firms and individuals will be reluctant to enter contracts when inflation is imperfectly predicted and judgments about absolute and relative prices are uncertain. The reluctance to enter contracts over time

[2] Haslag and Koo also show a positive effect of financial depth on growth and a weak negative effect of inflation on growth with a specification that differs from ours. They examine a cross-section of countries with data averaged over the entire 1960-89 period.

will inhibit investment and entrepreneurship, which will affect resource allocation and economic growth.[3]

Inflation will inhibit the development of the financial sector and result in financial repression. High inflation will also discourage any long term financial contracting and financial intermediaries will tend to maintain very liquid portfolios. Thus, in an inflationary environment intermediaries will be less eager to provide long-term financing for capital formation and growth; both lenders and borrowers will also be less willing to enter long-term nominal contracts. High inflation is often associated with various forms of financial repression as governments take actions to protect certain sectors of the economy. For example, interest rate ceilings and directed credit allocations are common in high inflation environments. Such controls lead to inefficient allocations of capital that inhibit growth. The relationship between financial repression and inflation can also be bi-directional. In some instances, repression is a crude effort to protect certain sectors from inflation. In other instances, financial repression that is introduced to assist the government in financing its own activities is a cause of both inflation and resource misallocation.

Moreover, inflation will have contemporaneous effects on the finance ratios that are used to measure financial sector development. High inflation will increase the opportunity costs of holding money and lead agents to economize on money holdings. Thus, the ratio of money to GDP might decline as a direct consequence of inflation. Further, the ratios of financial assets to GDP might decline in a high inflation environment if nominal debts do not increase as rapidly as GDP. This is particularly likely if the financial repression that is common in high inflation episodes keeps real interest rates low or even negative.

In our earlier paper (Rousseau and Wachtel, 2001) we showed that inflation affects financial depth and has a direct effect on growth as well. In this paper, we will examine a more specific hypothesis. We investigate the effect of inflation on the impact of financial deepening on growth. Inflation reduces the ability of financial intermediaries to improve resource allocations. Thus, we will show that the effect of financial deepening on growth is reduced when inflation is high.

3. Data and methodology

An almost standard empirical framework has emerged since Barro (1991) and Levine and Renelt (1992) introduced cross-section regressions for the study of growth among countries. The base line growth equations include a standard set of explanatory variables that provide robust and widely accepted proxies for growth determinants. King and Levine (1993) extend the framework to include measures of

[3] Inflation effects often arise because inflation increases uncertainty about nominal measures. Thus, theory would suggest that inflation uncertainty be measured directly. However, proxies for inflation uncertainty such as the variance of the inflation rate are usually highly correlated with inflation. Simply speaking, higher inflation rates tend to be more variable and uncertain. Thus, it is hard to distinguish between the effects of inflation and inflation variability channels in empirical work.

financial depth in this robust set. Furthermore, the use of data averaged over a number of years has become a standard approach for analyzing long-term determinants of growth. Our empirical framework draws on this decade-old tradition.

Our data set is constructed as a panel of country observations from the World Bank's *World Development Indicators*, and includes as many as 84 countries over the period 1960–95.[4] Since our interest is the longer-term effects of inflation and finance, we use five-year average data as the frequency of observation.[5] Data are thus available for seven time series observations for each country. Missing data for individual countries in particular five-year periods reduces the total number of observations that are available.[6]

The by now standard specification of the growth equation regresses the average rate of real per capita GDP growth for the five-year period on a set of conditioning variables:

- Initial real GDP has an expected negative sign due to real convergence. Everything else held constant, a high GDP country will have a lower growth rate since gradual convergence is expected.
- The log of the initial secondary school enrollment rate (called SEC in the tables) is used as a proxy for human capital investment and enters with an expected positive sign. School enrollment rates are more widely available than more specific measures of human capital. They are a good overall indicator of the commitment towards investments in human capital.
- Fixed effects for the time periods are included because global business cycle conditions result in variations in growth rates over time that are common to many countries. The fixed effects (dummy variables for the time periods) are always significant as a group. They are retained in all equations although the coefficients are not shown in the tables.
- One of three measures of financial sector depth—the ratio of either M3, M3−M1

[4] The 1999 version of *World Development Indicators* includes 227 countries, but the availability of an adequate array of financial indicators limits the coverage of our sample to 84 countries. These countries are Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Finland, France, Gambia, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Lesotho, Luxembourg, Malawi, Malaysia, Malta, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Trinidad and Tobago, Togo, Turkey, United Kingdom, United States, Uruguay, Venezuela, and Zimbabwe. King and Levine (1993) and Boyd et al. (2001) use similar samples.

[5] The use of time series averages in panel data for cross-country studies has become commonplace. Earlier studies take average data over a decade or even several decades. We prefer the shorter period because it allows for more time variation in the data.

[6] We compute and use an average for any five-year period in which there are three or more continuous observations for a given variable and country. Our data set includes 72 countries for the first 5-year period (1960–1965) and expands to 84 countries for the final 5-year period (1990–1995).

or Total credit to GDP is included.[7] The broad money supply M3 includes all deposit type assets and is a measure of intermediary activity. As a financial sector becomes more developed and exhibits greater depth, there will be more activity by financial intermediaries. M3 less Ml takes the pure transactions assets out of the ratio (currency and transactions deposits) and focuses on the intermediation activities of depository institutions. Financial depth is also reflected by the activities of non-depository intermediaries and direct finance. The total credit ratio reflects the overall level of financial intermediation in an economy.

In our panel data set, the financial ratios show positive but not terribly large correlations with GDP growth; 0.177 for M3, 0.149 for (M3−M1) and 0.106 for the credit ratio. The negative correlation of inflation (the average annual inflation rate over the five-year period) with growth is −0.189. The financial ratios are correlated amongst themselves and for this reason we will experiment with one at a time. The financial ratios are also highly autocorrelated from one five-year period to the next while the autocorrelation of inflation is only 0.173.

Since coefficients in the base line specification for the GDP growth rate may be influenced by simultaneity between growth and contemporaneous measures of inflation and financial depth, we use instrumental variables to extract their predetermined components in the course of estimation. The instruments used for inflation and financial depth are their values in the starting year of each five-year period. Following Levine and Zervos (1996), we further ameliorate the simultaneous impact of growth on financial depth by using initial values of the ratios of exports plus imports to GDP and government expenditure to GDP, as well as initial values of those financial depth measures not included as regressors as additional instruments.

The inflation rate can be simply added to the basic specification to show a significant negative effect of inflation on growth rates, a direct inflation effect. However, Rousseau and Wachtel (2001) and others have shown that outliers—episodes of very high inflation—largely drive this result. Moreover, our interest is in the way inflation moderates the impact of financial development on growth.

As a result, we will utilize a rolling regression technique to characterize more precisely how inflation affects the influence of finance on growth. We do this by ordering the panel observations by the size of the inflation rate and then estimating the growth equation sequentially starting with the 50 panel observations with either the lowest or highest inflation rates and adding observations ordered by the inflation rate until the full sample is included. A graphical presentation of the evolution of

[7] Beck et al. (2000) have recently constructed a database that includes the ratio of private credit by domestic money banks and other financial institutions to GDP. This measure of intermediary activity is broader than M3 due to its inclusion of the assets of important non-bank intermediaries such as insurance companies, but the country coverage ranges from 54 countries in 1960 to 138 countries in 1997. This imbalance in coverage would weight the results from a cross-country regression too heavily towards the recent past, or require a country coverage that was too narrow. Inconsistencies in the construction of this measure across countries, with some including non-bank intermediaries and some not, also lead us to choose the more traditional and readily available measures of broad money.

the finance coefficient as the sample grows then provides us with a view of the influence of inflation on the finance effects.

4. Base line growth regressions and variations

Instrumental variables estimates of our base line growth equation with the contemporaneous 5-year average inflation rate and a measure of financial depth are shown in Panel A of Table 1. The finance variables are all highly significant. In all equations, the log of the initial secondary school enrollment rate, a measure of human capital investment, has the significant and positive growth effect that theory would predict. Finally, the log of initial GDP has a negative effect consistent with some regression towards the mean or GDP convergence over time. To interpret the magnitude of the effects of finance on growth consider a 10% increase in the financial depth ratio from its mean. The increase in the annual growth rate is about 0.6 to 1.0 percentage points.

We add inflation to the base line growth equation as an explanatory variable in Panel B. The direct inflation effects are numerically small but are about twice their standard errors in each instance. It would take an increase in the inflation rate of more than 300 percentage points to depress the growth rate by 1%. The finance coefficients are only slightly changed by the addition of inflation to the specification, and there is no indication from these full sample regressions that the finance and inflation effects are dependent on one another.

Our earlier paper showed that a few inflation outliers are responsible for the negative inflation effect on growth. Five-year average inflation rates in excess of 500% accounted for about one percent of our observations, and inflation rates over 40% accounted for about 10 percent. This frequency of high inflation observations was sufficient to exert considerable leverage over the slope coefficient on the inflation variable. We also showed that the inflation effect disappears when examining only those observations with inflation rates below the median. Bruno and Easterly (1998) suggested a 40% annual inflation rate as a threshold for the definition of high inflation episodes. They found that growth falls sharply when inflation crosses that threshold and then recovers rapidly when inflation comes down.[8] All of this underscores the elusiveness of direct effects of inflation on growth in the data.

In Panel C of Table 1 we briefly examine some alternative specifications of the direct inflation effect. Growth equations are shown with the M3/GDP ratio and three change specifications—the change in inflation from one five-year period to the next, a dummy variable for inflation episodes (change in the five-year average of more than 10%) and a dummy variable for substantial disinflation episodes (a reduction

[8] Other studies have shown lower thresholds for the effect of inflation on growth. Khan and Senhadji (2001) summarize the literature and present estimates for a threshold of 1–3% for industrial countries and 7–11% for developing countries.

Table 1
Growth equations, 1960–95

Panel A: Base line growth specification Financial variable:	M3/GDP	(M3−M1)/GDP	Credit/GDP
Constant	−0.370(2.0)	−0.893(1.3)	−1.008(1.4)
Log initial GDP	−0.219(1.7)	−0.283(2.2)	−0.346(2.3)
Log initial SEC	0.832(3.9)	0.853(4.1)	1.057(5.0)
Financial variable	0.025(4.6)	0.035(4.8)	0.023(3.4)
R-bar sqd./SEE	0.231/2.48	0.237/2.47	0.218/2.50
Panel B: Inflation as additional variable Financial variable:	M3/GDP	(M3−M1)/GDP	Credit/GDP
Constant	−1.108(1.6)	−0.784(1.1)	−0.919(1.2)
Log initial GDP	−0.259(2.0)	−0.297(2.3)	−0.338(2.3)
Log initial SEC	0.907(4.0)	0.917(4.3)	1.104(5.2)
Inflation	−0.003(2.5)	−0.003(1.9)	−0.003(2.3)
Financial variable	0.023(4.2)	0.031(4.1)	0.018(2.7)
R-bar sqd./SEE	0.221/2.27	0.245/2.46	0.217/2.50
Panel C: Alternative inflation specifications	Inflation change	Disinflation	Increasing inflation
Constant	−1.312(1.8)	−1.439(2.0)	−0.944(1.3)
Log initial GDP	−0.243(1.8)	−0.239(1.8)	−0.242(2.2)
Log initial SEC	0.821(3.6)	0.812(3.6)	0.942(4.2)
Change in inflation rate	−0.0009(2.7)		
Dummy for disinflation: inflation change $<-5\%$		0.642(1.9)	
Dummy for change in inflation $>10\%$			−1.44(4.0)
Financial variable: M3/GDP	0.026(4.7)	0.027(4.7)	0.023(4.0)
R-bar sqd./SEE	0.240/2.48	0.233/2.49	0.257/2.45

Notes: Absolute values of *t*-statistics are in parentheses following each regression coefficient. Estimation is by instrumental variables. All equations include fixed effects for time periods that are not shown. The sample size is 479 for Panels A and B, and 424 for Panel C.

in the five-year average of more than 5%).[9] These inflation effects have the expected signs, but the coefficient on the dummy variable for inflation acceleration episodes is not very precisely estimated.

In Table 2 we show the finance coefficients from the base line growth equation

[9] The sample size falls in these regressions because we lose at least one time series observation for each country in computing the variables for inflation changes.

Table 2
Finance coefficients from base line growth equations

Sample divided by inflation rate:	M3/GDP	(M3−M1)/GDP	Credit/GDP
<Median	0.033(5.3)	0.040(4.7)	0.026(3.2)
>Median	0.005(0.4)	0.021(1.5)	0.012(1.0)
Sample divided by finance variable	**M3/GDP**	**(M3−M1)/GDP**	**Credit/GDP**
<Median	0.034(0.8)	0.008(0.2)	0.013(0.3)
>Median	0.021(3.2)	0.028(3.3)	0.017(2.0)
Median	35.1%	18.2%	25.2%

Notes: The base line growth equations include the log initial GDP, the log initial secondary school enrollment, fixed effects for each 5-year period, and the finance variable listed in each column heading. Estimation is by instrumental variables. Absolute values of *t*-statistics are in parentheses following each coefficient. The median inflation rate calculated from the full sample is 8.3 %.

when the sample is divided in two. In the upper panel, estimates are shown for the above and below median inflation observations. The positive effect of financial depth on growth is dampened substantially when inflation is high. In the lower panel, the sample is divided between above and below median levels of financial development. In these regressions, finance does not affect growth when the sample is limited to observations with financial depth below the median, but has a positive and significant effect in the groups that lie above the median. Even here, the coefficients are smaller than those obtained for the full sample. This suggests that the basic relationship between finance and growth may to some extent be a result of clustering across observations with low and high values for our financial depth measures. In other words, the finance coefficients for the below and above median samples are within group marginal effects, while the full sample coefficients may have a large between-group component.

All in all, our experiments with direct inflation effects and the mixed results reported in other studies indicate that there might be more complex channels through which inflation and finance affect growth and that thresholds might be difficult to identify. In order to get a fuller understanding of the influence of inflation on the finance coefficients, we present some figures that show their evolution from rolling regressions. With this technique we order all the observations by a variable of interest (either the inflation rate or its change) and estimate regressions by adding observations one at a time. We start with a regression with 50 observations so that the initial regression has a reasonable sample size. We show the evolution of the coefficients on the finance variables when the rolling regressions start with the smallest inflation rates and go up and when they start with the highest inflation rates and go down. In both instances, the last regression will include the entire sample and will be the regressions shown in the tables.

Figure 1 shows rolling estimates of the instrumental variables specifications reported in Panel A of Table 1. The left-hand side of the figure includes the coefficients and standard errors for our three measures of financial development as we add observations of increasing inflation to the sample.[10] On the right-hand side of the figure, we order the observations starting with the high inflation episodes and expand to include lower inflation observations.[11] The left side shows that the relationship between financial depth and growth is largest among countries with inflation rates of 8–10 percent, but that these effects become smaller and far less variable as higher inflation observations are added to the sample. The right side shows more clearly where the inflation thresholds lie. In the upper right panel, for example, the coefficient on M3/GDP is negative but not significant for inflation rates larger than 13.4 percent, but is positive at lower inflation rates and becomes statistically significant at the 5 percent level when inflation is less than 6.5 percent. This suggests a threshold inflation rate of somewhere between 6.5 and 13.4 percent—only when inflation is beneath the threshold is it low enough for M3/GDP to affect growth.

The center right and lower right panels, which repeat the sequential regressions with (M3−M1)/GDP and Total credit/GDP serving as the financial measure, indicate respective thresholds between 13.4 and 15.9 percent, and between 8.1 and 25.1 percent. Financial depth appears to need a reasonably low inflation environment to promote long-run growth effectively.[12]

Although it is difficult to identify specific inflation channels, the rolling regression technique can be used to shed light on important possibilities. Figure 1 reveals that low inflation improves the influence of financial depth on growth. We can also use the rolling regression approach to examine the impact of inflation outbursts and disinflation episodes on the effects of finance. In Fig. 2 we show estimates of the finance coefficients from the base line regressions with the sample ordered by the change in the inflation rate.

The left hand side of Fig. 2 shows that disinflation (negative change) is associated with a very strong and positive effect of finance on growth when we use M3 and (M3−M1) as the finance measures. The results with the total credit ratio are negative although insignificantly different from zero. The panels on the right hand side show that very large increases in inflation are associated with strong finance effects. However, these finance effects are much smaller when inflation increases are between

[10] In the left-hand sides of Figs 1–3, we stop reporting the coeffcient estimates at the point where they stabilize as higher-inflation observations are added. This allows us to focus more closely on the ranges of inflation in which the important fluctuations and thresholds appear.

[11] The scaling of the left and right sides of Fig. 1 differ to allow a clearer view of fluctuations in the coefficients on the financial variable as the sample grows. The scaling of the left and right sides also differs in Fig. 3.

[12] Another way of looking at the relationship between finance and inflation effects is to use the rolling regressions to examine how the direct inflation effect on growth varies with financial depth. Rolling regression estimates of the equations in Panel B of Table 1, which we do not present here but are available from the authors upon request, suggest that the negative direct effects of inflation on growth are present at all levels of financial development.

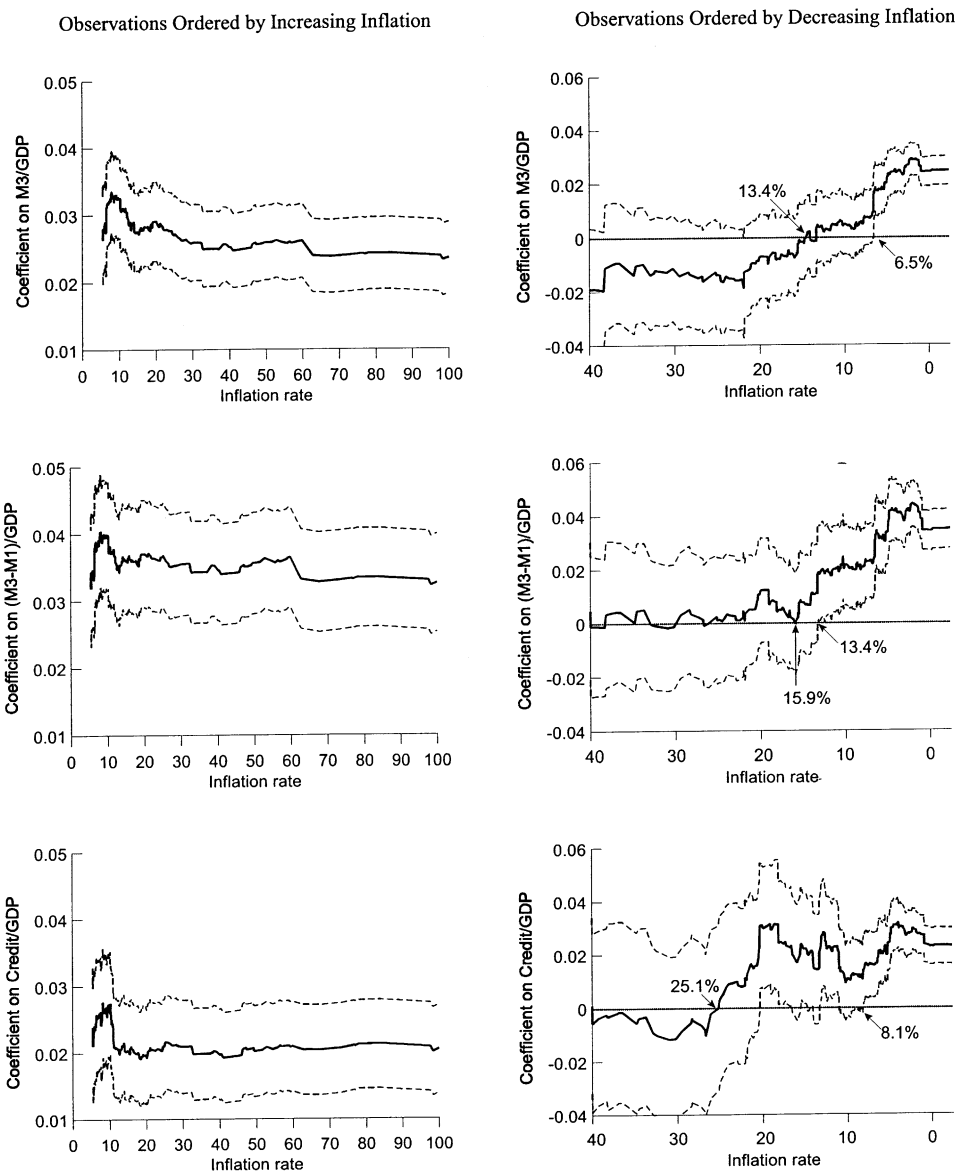

Fig. 1. Evolution of coefficients on financial variables in cross-country 5-year growth regressions as the sample size increases, 1960–95.

about 5 and 20 percent. Once inflation increases fall below 5 percent and enter the disinflation range, the finance impact increases.

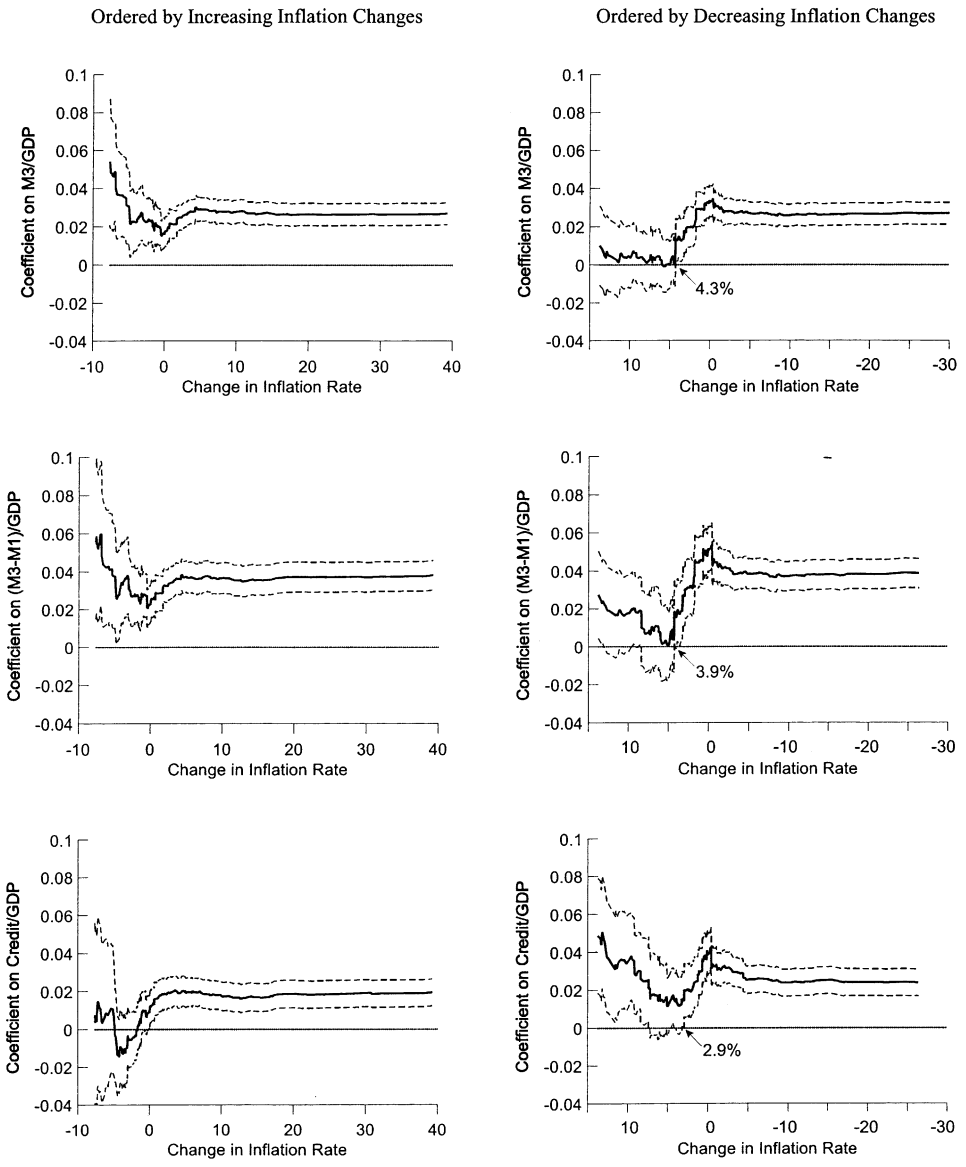

Fig. 2. Evolution of coefficients on financial variables in cross-country 5-year growth regressions as the sample size increases, 1960–95.

5. Inflation effects on financial depth

Our main results suggest that the inflationary environment is an important determinant of the degree to which finance affects growth. An interesting related issue is whether inflation itself affects financial sector development. The two tests are not

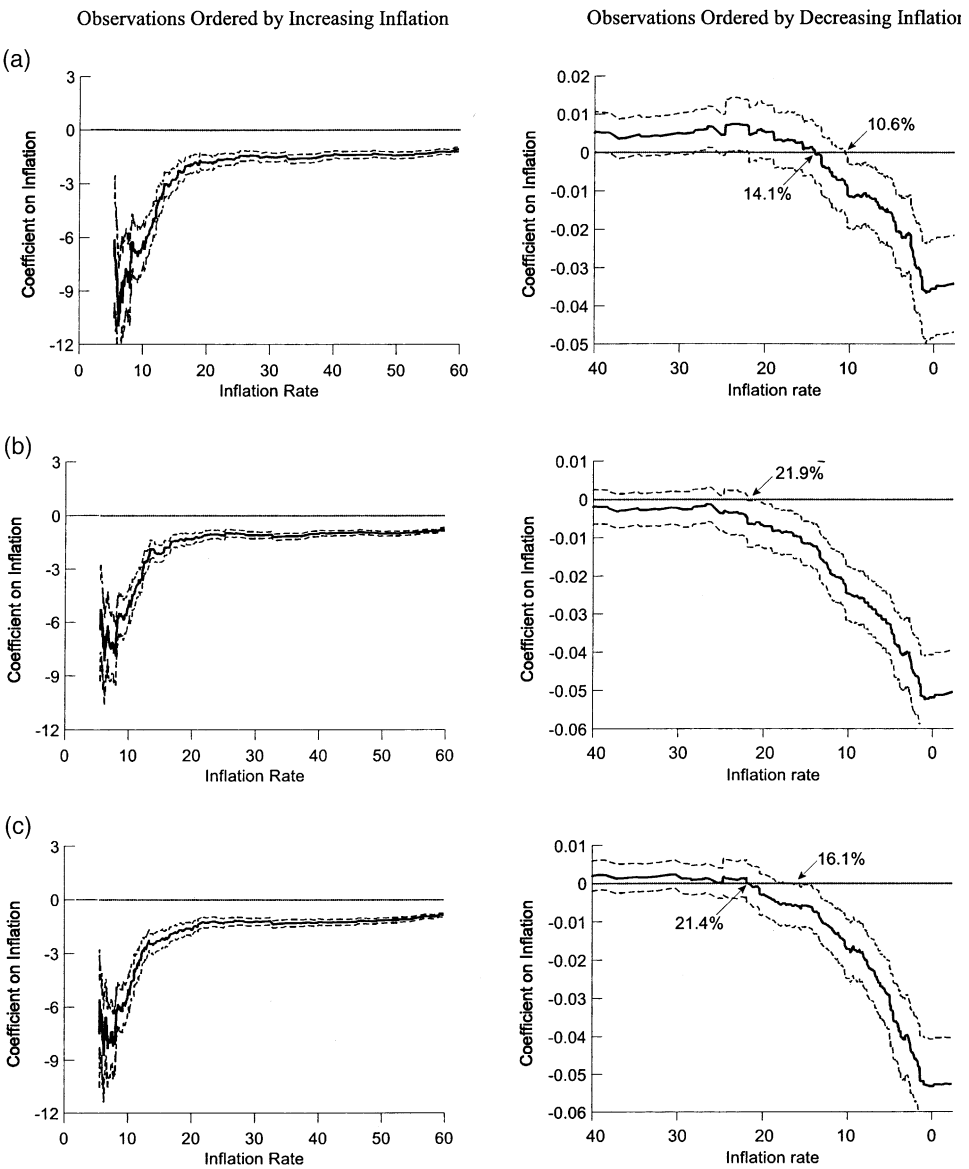

Fig. 3. Evolution of coefficients on inflation in cross-country 5-year regressions with finance as dependent variable as the sample size increases, 1960–95. (a) Dependent variable: M3 as a percent of GDP; (b) dependent variable: (M3−M1) as a percent of GDP; (b) dependent variable: total domestic credit as a percent of GDP;

the same. The former addresses whether inflation inhibits the smooth operation of the financial sector regardless of its size. The latter can shed light on the presence of financial repression, or the tendency for inflation to dampen or reverse financial development.

Several previous studies have addressed the second issue by inverting the base line growth equation to make the financial variable the dependent variable (Boyd et al., 2001; Haslag and Koo, 1999). Although the growth specification is firmly based in growth theory, the inverted equation provides an ad hoc specification for financial development that is similar to a money demand equation.[13] Nevertheless, we will proceed with this approach in order to make comparisons with other results.

There are several channels for the effect of inflation on financial depth. The effect that we are looking for is the financial repression that comes when inflation inhibits the development of financial intermediation. In addition, there can be a similarly negative short run effect (particularly on the M3/GDP ratio) in developed economies when inflation increases the opportunity costs of holding nominal assets and leads to reduced money demand. Finally, with the longer run average data we use here, inflation will either be caused by money growth or accommodated by money growth. As a result nominal assets will grow more rapidly than GDP and inflation may be positively related to financial depth.

Table 3 shows the inflation coefficients in equations for each of the financial ratios. The equations include all of the variables included in our growth model—log initial GDP, log secondary school enrollment, fixed effects for time periods and our inflation variable (the average inflation rate for the 5-year period); the equations are estimated with instruments for inflation. The inflation effects are negative for the full sample and in two of three cases for observations below the median inflation rate. Not surprisingly (given the discussion in the previous paragraph), the estimates with this ad hoc specification for financial development are only weakly significant and variable.

However, we would like to compare these results with those of Boyd et al. (2001),

Table 3
Effect of inflation on finance variables, 1960–95

Coefficients on inflation	M3/GDP	(M3−M1)/GDP	Credit/GDP
Full sample	−0.023(1.7)	−0.021(2.2)	0.006(0.5)
<Median inflation	−2.162(1.3)	−2.154(1.8)	1.056(0.8)
>Median inflation	0.009(1.0)	0.000(0.0)	0.017(2.0)

Notes: The equations include all variables in the base line growth equations. Estimation is by instrumental variables. Absolute values of *t*-statistics are in parentheses following each coefficient. The median inflation rate calculated from the full sample is 8.3 %.

[13] M3/GDP in particular is the inverse of broad money velocity.

p. 246, who specify a threshold of "about 15 percent" for the disappearance of the effect of inflation on financial depth. In order to do so, we use the rolling regression technique to show the evolution of the inflation effect on the finance ratios as inflation changes. The plots on the right-hand side of Fig. 3, which start with the high inflation observations, show that inflation has a significant and negative effect on M3/GDP, (M3−M1)/GDP, and Credit/GDP at respective inflation rates of 10.6, 21.9, and 16.1 percent, but that inflation does not affect financial depth in higher inflation environments. The plots on the left-hand side of Fig. 3, which start with the low inflation observations, imply a similar story—when inflation is "low", small differences in inflation rates seem related to wide variations in financial depth in the cross-section, whereas these effects vary far less when inflation becomes high enough to inhibit contracting.

6. Caveats

Although cross-section studies of growth have led to some important research conclusions, they must be interpreted with care. The financial ratios might be imperfect measures of financial development, particularly at high inflation levels. We use these ratios as measures of the depth of financial intermediation or the development of the intermediary sector. However, changes in inflation can alter the ratios significantly without conveying any information about the performance of the financial sector. In some instances credit may grow faster than GDP and in some instances GDP may grow faster. Thus, changes in the financial ratios may be uninformative, particularly in high inflation environments. Although our averaging of the financial measures across five-year periods ameliorates these effects to some degree, further work with more refined measures of financial sector development is needed to distinguish the various effects on growth.

The finance–growth relationship has been found to be very robust. Nevertheless, the observed relationship between growth and financial development in cross-country studies does not necessarily imply causality. Causality from finance to growth is indicated by additional work that explicitly identifies finance mechanisms and by statistical tests with time series data (e.g., Rousseau and Wachtel, 1998, 2000; Bell and Rousseau, 2001).

Finally, the inferences drawn from these cross-country comparisons might not be prescriptive for the development of a particular country (Wachtel, 2001). The observation that higher growth is associated with disinflation and financial depth is strong enough to argue that countries should pursue such goals. However, our understanding of the dynamics of change is not sufficient to allow us to predict specific outcomes.

7. Conclusion and summary

Recent literature has shown the finance–growth relationship to be strong, significant and robust. The consensus regarding the inflation–growth relationship is not as

strong because it apparently relies on threshold effects that are hard to pinpoint. In this paper we introduce a rolling regression technique to help shed light on the complex interactions between financial development and inflation that affect economic growth.

Our examination of the evolution of inflation effects on the finance–growth relationships shows that:

- Financial depth has a positive effect on growth only when inflation falls below a threshold that varies between a five-year average inflation rate of 13% to 25% depending on the measure of financial depth. The effects become significantly positive when inflation falls below a threshold of about 6% to 8%.
- Disinflations are associated with strong positive effects of finance on growth with most measures of financial depth.
- Inflation has a negative effect on financial depth when the five-year average inflation rate is below about 15% to 20%.

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