Economics Bulletin

Volume 29, Issue 2

A note on finance, inflation, and economic growth

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Abstract

This paper examines the impact of inflation on the relationship between financial development and economic growth. Using panel-data techniques applied to observations from more than seventy-five countries, we find that the positive effect of financial development on economic growth diminishes as inflation increases.

Citation: Daniel Giedeman and Ryan Compton, (2009) "A note on finance, inflation, and economic growth", *Economics Bulletin*, Vol. 29 no.2 pp. 749-759.
Submitted: Dec 02 2008. **Published:** April 30, 2009.

1. Introduction

Over the past few decades, economists have devoted enormous attention to empirically studying the causes of economic growth. One substantial area of this work examines the impact of financial factors on economic growth. The general findings of this literature indicate that the financial sector has a significant and positive impact on growth (cf Levine *et al*. 2000, Demetriades and Andrianova 2004, Levine 2005, or Ang 2008). A second area of research investigates what connection, if any, there is between inflation and growth. The literature on this topic however is more mixed, with some finding a significant negative relationship (Briault 1995 surveys this literature), while others find a negative relationship only with high levels of inflation, and still other authors find little or no evidence of a connection between inflation and growth (cf Barro 1995, Bullard and Keating 1995, Bruno and Easterly 1998, or Temple 2000).

As discussed below in more detail, a new line of investigation has begun to connect these two streams of research to investigate the possibility that finance's impact on economic growth may be influenced by inflation. In general, this literature finds that high inflation reduces the positive effect that financial development has on economic growth. Our paper applies an alternative empirical technique to address this topic, and our findings are supportive of the existing literature.

The remainder of the paper is organized as follows: Section 2 outlines the relevant literature on this topic while Section 3 details the data and empirical approaches used in this study. Section 4 then presents the empirical results and Section 5 concludes.

2. Links between Finance, Inflation, and Growth

The purpose of this paper is to examine the influence that inflation may play on the link between financial development and economic growth. There are several channels through which this influence might occur. For instance, inflation may distort information about the real returns from investment projects and exacerbate credit frictions thus resulting in diminished financial intermediation (see Boyd, Levine and Smith 2001). Further, inflation may also repress financial development or induce other forms of financial repression such as interest rate ceilings, etc. which could in turn cause lower economic growth (cf Haslag and Koo 1999 or Rousseau and Wachtel 2002).

Empirically, the most important paper on this topic is Rousseau and Wachtel (2002), which considers the impact of finance on growth under different levels of inflation using a rolling regressions technique. The authors find that the positive relationship between finance and growth disappears when inflation is above a 13-25% threshold. Similarly, in their study of Japan and Taiwan, Lee and Wong (2005) find that the positive influence of financial development on economic growth exists only when inflation is below certain thresholds (7.25% for Taiwan and 9.66% for Japan). Gillman and Harris (2004) and Gillman, Harris and Kejak (2006) develop and then empirically test theoretical endogenous growth models, finding evidence of a negative interaction effect between inflation and financial development on economic growth. More recently, Rousseau and Yilmazkuday (2008) employ a three-dimensional graphical approach to examine the trilateral relationship between finance, inflation and growth. They find the impact

of inflation on the connection between financial development and economic growth is negative at moderate inflation levels (although when inflation exceeds 14%, growth is low at all levels of financial development).

3. Data and Empirical Approach

To investigate the link between finance, inflation and economic growth we utilize a World Bank dataset compiled by Levine *et al*. (2000). This popular dataset consists of observations for more than seventy-five countries from 1960-1995. For robustness purposes, we consider three different measures for financial development (which more specifically are three bank related measures). Our first measure is *Private Credit*, which measures the amount of outstanding credit issued by non-central bank financial intermediaries to the private sector as a proportion of GDP. Private credit is among the most widely used measures of banking development in the finance and growth literature. Our second measure of financial development is *Liquid Liabilities* which measures the liquid liabilities of the financial system (currency plus financial intermediaries' demand and interest-bearing liabilities) relative to GDP. Liquid liabilities is among the broader measures of financial intermediation within an economy, and again is commonly used in the finance and growth literature. Our final financial variable, *Com-Cen Bank*, measures the importance of commercial banks relative to the economy's overall banking system. Specifically, it is deposit money banks' assets divided by the sum of deposit money banks' assets plus central bank assets. This variable measures the extent to which private banks versus the central bank allocates credit in the economy. Our other variable of interest, inflation, is measured as the log-difference of the Consumer Price Index.

In addition to our variables of interest, we also include several commonly used control variables. In all models we include two basic controls consisting of the log of initial GDP per capita as well as the mean years of secondary schooling among adults. Beyond our *basic* regressions we also include three "policy" variables for our *full* regressions. These additional variables are the black market premium on foreign exchange (i.e. the ratio of the black market exchange rate to the official exchange rate), government spending as a proportion of GDP, and trade (measured as the sum of imports and exports) as proportion of GDP. Following common practice in the literature, we use five-year averages of the variables rather than annual observations to reduce the influence of short-term fluctuations in growth resulting from the business cycle.

In order to capture the extent that inflation impacts the finance-growth relationship, we include in our regressions an interaction between inflation and the financial development variable of interest. The use of interaction terms to capture conditional relationship is increasingly common in the growth literature and the use of an interaction term to look specifically at finance, inflation, and growth has been employed by Gillman and Harris (2004) and Gillman, Harris and Kejak (2006). Given the work of Gillman and coauthors, we should point out four key distinctions between the empirical analysis in those papers and the analysis in this paper. Because these papers also include investment as an explanatory variable, their sample-sizes are limited relative to the country coverage included in our paper. Second, as discussed in more detail below, we not only consider the sign and significance of the interaction term, but also take into account the covariance between coefficients when calculating the standard errors surrounding the overall

marginal effect of finance on growth conditional on the rate of inflation. Third, while the above papers use a variety of statistical techniques for their analysis, including difference GMM to handle endogeneity, we use a newer, increasingly popular technique in this paper. Specifically, the regression framework we employ for our empirical tests is the System-GMM dynamic panel analysis developed by Arellano and Bover (1995) and Blundell and Bond (1998).[1] Finally, as will be seen in what follows, while, in general, Gillman and coauthors find the effect of finance on growth is insignificant, we find evidence of positive effects of finance on growth which diminish with the level of inflation.

In terms of the panel growth equation we estimate, it can be expressed as:

$$(1) \qquad \Delta y_{it} = \alpha + \beta_1 y_{i\,t-1,} + \beta_2 F_{it} + \beta_3 I_{it} + \beta_4 F_{it} \cdot I_{it} + \gamma' X_{it} + \eta_i + \varepsilon_{it}$$

where for country i at time t, Δy_{it} is the five-year average log difference of real GDP per capita, y_{it-1} is the logarithm of real GDP per capita at the start of each five-year period, F_{it} is the five-year average of our financial variable for the period, I_{it} is the five-year average of inflation for the period, $F_{it} \cdot I_{it}$ is the interaction of finance with inflation, X_{it} is the set of control variables measured at the beginning of each five-year period or averaged over the period, η_i is an unobserved country-specific fixed-effect, and ε_{it} is the error term. We estimate four specifications of this model: (1) a baseline model without interaction term or policy control variables; (2) a model with the interaction term, but without the policy variables; (3) a model with the policy variables but without the interaction term; and (4) a full model with the policy control variables and the interaction term.

We are interested in how the amount of inflation may affect the marginal effect of finance on growth. In most studies using interactions, the standard approach to interpret this effect would be to simply examine the $\hat{\beta}_2$ and $\hat{\beta}_4$ coefficients in equation (1), focusing in particular on the sign and significance of the interaction term $\hat{\beta}_4$. However, as discussed in Brambor *et al*. (2006), this approach fails to take into account the covariance between $\hat{\beta}_2$ and $\hat{\beta}_4$ and thus may provide misleading results in terms of significance. Therefore we take into account the covariance between $\hat{\beta}_2$ and $\hat{\beta}_4$ which allows for the correct calculation of the standard errors surrounding the overall marginal effect of finance on growth conditional on the rate of inflation. More specifically we are interested in $\frac{\partial \Delta Y}{\partial F} = \hat{\beta}_2 + \hat{\beta}_4 I$ with standard error bands derived from $\hat{\sigma}_{\frac{\partial \Delta Y}{\partial F}} = \sqrt{\text{var}(\hat{\beta}_2) + I^2 \text{ var}(\hat{\beta}_4) + 2I \text{ cov}(\hat{\beta}_2 \hat{\beta}_4)}$. As a result, for the regression models with full control sets, in addition to the standard empirical estimates presented in table format, we also include

[1] Because of its ability to mitigate problems caused by endogeneity and omitted variable bias due to heterogeneity, System-GMM has become very popular in the recent growth literature. However, as Roodman (2008) details, one potential problem with System-GMM is that it may generate "false positive" results in which the results appear valid, but are in fact invalid due to endogeneity. The problem results from the proliferation of instruments in System-GMM which causes tests of instrument validity to often fail to indicate situations in which the instruments are not valid. To mitigate this problem, we have limited the number of instruments in our regressions such that only one instrument is created for each variable and lag distance as opposed to generating a full instrument set for each variable, time period and lag distance. (For more information on this technique, see Roodman 2006.)

graphs which show how the marginal effect of finance on growth depends on the amount of inflation (again with correct standard error bands included).

4. Results and Analysis

Table 1 presents the results of our estimates where private credit is the finance variable of interest, while Figure 1 plots out the marginal effect of private credit on growth conditional on the level of inflation from the full model with all control variables (regression IV). The solid center line in the graph indicates the marginal coefficient of private credit associated with that level of inflation and the dashed lines provide the associated 90% confidence intervals.

Before interpreting the results, let us first discuss the expected signs of the coefficients. Based upon existing finance and growth literature, we would expect a positive coefficient on our finance variable, in this case, private credit. That is, higher levels of financial development should contribute positively to economic growth. With respect to inflation, however, given the somewhat varied findings in the existing literature on the subject, it is not clear what relationship, if any, should be expected between inflation and economic growth. Concerning the interaction term, given the work of Rousseau and Wachtel (2002) we would expect that financial systems do not perform as effectively in the presence of high inflation. Therefore we would expect that the coefficient on the interaction term is negative (implying that the effect of financial development on growth falls as inflation increases). A zero or insignificant interaction would indicate that the effects of finance and inflation on growth are independent. Again for our purposes, this would mean that the effect of financial development on growth is not influenced by a country's level of inflation.

Looking at regressions I and III (those without an interaction) we see that private credit proves to be positive and statistically significant, as expected from the finance and growth literature, while inflation is not statistically different from zero. Including the interaction of private credit and inflation as seen in regressions II and IV, we see in II the interaction is negative and near significant, while in IV the interaction is again negative but now meets standard significance tests. This confirms what we might expect, that while the effect of private credit on growth is positive, as inflation increases, the effect of finance on growth diminishes.[2] This can also be seen graphically in Figure 1.

In Figure 1, the effect of private credit on growth at low levels of inflation is positive and significant, but as the level of inflation increases, private credit's affect on growth diminishes, such that at rates of inflation 25% and higher, the effect of private credit on growth is not significantly different from zero.

[2] To help with the interpretation of these results, recall that we are interested in $\frac{\partial \Delta Y}{\partial F} = \hat{\beta}_2 + \hat{\beta}_4 I$. Taking regression IV, the estimated coefficient on private credit (2.716) captures the effect of finance on growth when inflation is 0, while the interaction (-6.132) is capturing the degree that the effect of finance (held constant) changes as inflation (not constant) moves away from zero.

In Table 2 we present the results of our estimates with liquid liabilities as the finance variable of interest, while. Figure 2 uses the results of regression IV to plot out the marginal effect of liquid liabilities on growth conditional on the level of inflation. As with private credit, we would expect that the coefficient for liquid liabilities would be positive (again indicating that financial development leads to higher economic growth). In general, this prediction holds true in our findings, where in I and III (no interaction) the effect of liquid liabilities on growth is positive and significant (or near significant in the case of regression I), while in II and IV (with the interaction) the effect of liquid liabilities on growth is again positive and significant when inflation is zero, and this effect diminishes as inflation increases (as seen by the negative and significant interaction terms).

Visually we see the moderating effect of inflation on the liquid liabilities-growth link in Figure 2, however it seems much higher levels of inflation (close to 50%) are required to fully eliminate the positive finance effect on growth.

Lastly, Table 3 presents the results of our estimates with Com-Cen Bank as the finance variable, and Figure 3 plots out the marginal effect of Com-Cen Bank on growth conditional on the level of inflation from the full model. It is important to note that Com-Cen Bank differs from the two previous financial measures in that it corresponds not to the overall depth of financial development, but rather the composition of assets within the banking system. Specifically it reflects the extent to which commercial banks allocate credit relative to the central bank in the economy. The intuition behind this measure is that private banks are better at allocating funds to growth enhancing projects than central banks and so higher values of the Com-Cen Bank variable would indicate "better finance" and ultimately higher growth.

Our findings indicate that there is not a significantly positive effect on growth resulting from a higher share of overall credit being extended by commercial banks relative to central banks. Likewise, while the interaction is negative, it is insignificant, and as we see in Figure 3, there is little indication that higher inflation significantly reduces any impact that the allocation of credit by commercial banks relative to central banks might have on growth.

5. Conclusion

This paper examines the impact of the interaction of financial sector development and inflation on economic growth. We utilize a broader sample than previous studies that employ interaction terms, use System GMM while limiting the number of instruments in order to mitigate problems of endogeneity, and follow Brambor *et al* (2006) to interpret our interaction terms. What we find is strong evidence that while financial development is associated with economic growth, its positive effects are diminished as inflation becomes higher. These results are consistent with previous studies on this topic that used other empirical methods to examine this relationship.

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Table 1: Private Credit, Inflation, and Growth

	I	II	III	IV
Private Credit[1]	2.462**	2.045*	1.912**	2.716**
	(0.046)	(0.065)	(0.030)	(0.007)
Inflation	1.504	10.692	2.477	19.460**
	(0.595)	(0.206)	(0.364)	(0.048)
Initial GDP[1]	1.788	1.412	0.682	-0.093
	(0.213)	(0.283)	(0.485)	(0.927)
Education	-3.129*	-1.597	-1.253	-0.186
	(0.081)	(0.293)	(0.303)	(0.879)
Black Mkt. Premium[2]			-1.760**	-2.157**
			(0.004)	(0.021)
Gov. Spending[1]			-1.097	-0.948
			(0.497)	(0.500)
Trade[1]			-0.886	-0.681
			(0.506)	(0.566)
Private Credit[1]*Inflation		-3.860		-6.132**
		(0.118)		(0.038)
AB Test for AR(1)	0.000	0.000	0.000	0.000
AB Test for AR(2)	0.804	0.787	0.944	0.503
Hansen Test	0.201	0.188	0.108	0.203
# of Instruments	33	39	51	57
# of Observations	464	464	445	445

Notes: p-values based on robust standard errors are in parentheses; * indicates significance at the 10% level, ** indicates significance at the 5% level; 1 indicates ln(variable), 2 indicates ln(1+variable); time dummies included but not reported

Figure 1: Private Credit, Inflation, and Growth

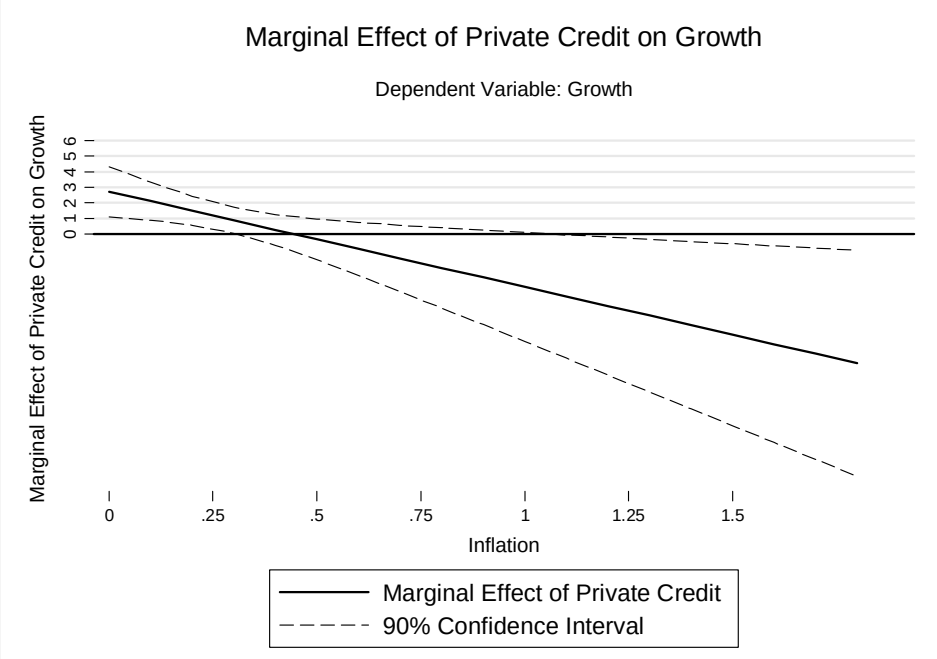

Table 2: Liquid Liabilities, Inflation, and Growth

	I	II	III	IV
Liquid Liabilities[1]	2.358	3.561**	3.581**	4.597**
	0.130	(0.012)	(0.003)	(0.000)
Inflation	-0.487	21.109*	4.311	19.867*
	0.840	(0.071)	(0.110)	(0.055)
Initial GDP[1]	2.656*	2.206*	0.858	0.410
	0.077	(0.075)	(0.416)	(0.685)
Education	-3.718*	-2.753*	-2.125	-1.598
	0.078	(0.077)	(0.133)	(0.206)
Black Mkt. Premium[2]			-2.855**	-2.609**
			(0.000)	(0.000)
Gov. Spending[1]			0.905	-0.791
			(0.647)	(0.678)
Trade[1]			-0.664	-0.687
			(0.589)	(0.600)
Liquid Liabilities[1]*Inflation		-6.654**		-4.949*
		(0.045)		(0.094)
AB Test for AR(1)	0.000	0.000	0.000	0.000
AB Test for AR(2)	0.984	0.920	0.941	0.737
Hansen Test	0.220	0.692	0.245	0.255
# of Instruments	33	39	51	57
# of Observations	464	464	445	445

Notes: p-values based on robust standard errors are in parentheses; * indicates significance at the 10% level, ** indicates significance at the 5% level; 1 indicates ln(variable), 2 indicates ln(1+variable); time dummies included but not reported

Figure 2: Liquid Liabilities, Inflation, and Growth

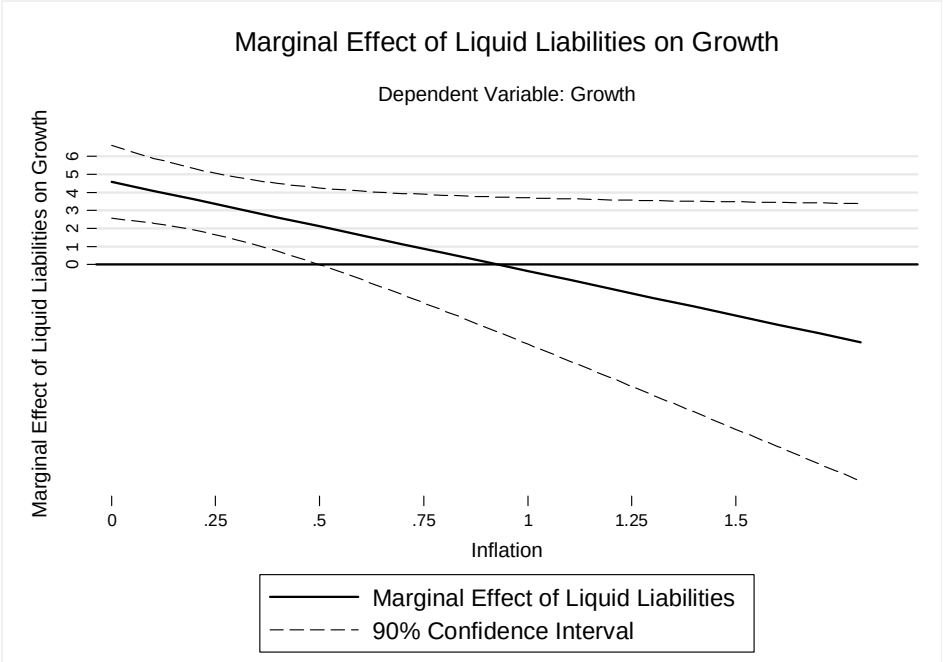

Table 3: Commercial-Central Bank, Inflation, and Growth

	I	II	III	IV
Com-Cen Bank[1]	1.591	2.345	2.939	5.554
	(0.623)	(0.451)	(0.207)	(0.153)
Inflation	-1.237	26.504	0.900	51.670
	(0.641)	(0.365)	(0.675)	(0.272)
Initial GDP[1]	3.326**	3.361**	0.899	0.513
	(0.020)	(0.044)	(0.358)	(0.626)
Education	-3.510*	-3.399	-0.699	-0.289
	(0.079)	(0.109)	(0.549)	(0.787)
Black Mkt. Premium[2]			-1.256*	-1.639**
			(0.096)	(0.035)
Gov. Spending[1]			-0.900	-0.527
			(0.695)	(0.784)
Trade[1]			-0.263	-0.974
			(0.871)	(0.564)
Com-Cen Bank[1]*Inflation		-6.830		-12.311
		(0.315)		(0.269)
AB Test for AR(1)	0.000	0.000	0.000	0.000
AB Test for AR(2)	0.860	0.747	0.697	0.496
Hansen Test	0.173	0.306	0.091	0.136
# of Instruments	33	39	51	57
# of Observations	464	464	445	445

Notes: p-values based on robust standard errors are in parentheses; * indicates significance at the 10% level, ** indicates significance at the 5% level; 1 indicates ln(variable), 2 indicates ln(1+variable); time dummies included but not reported

Figure 3: Commercial-Central Bank, Inflation, and Growth