Dynamic Relationship

between Inflation and Financial Development

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Abstract

This paper studies the long- and short-run relationship between inflation and financial development. Using the Pooled Mean Group estimator of Pesaran, Shin and Smith (1999) to unbalanced panel data for 87 countries over the 1960-2005 period, we find that a negative long-run relationship between inflation and financial development coexists with a positive short-run relationship. However, when splitting the data into different income or inflation groups, these results can be observed only in low-income or low-inflation economies.

Keywords: Inflation, Financial Development, Pooled Mean Group Estimator
JEL Classification: E31, G21

1. Introduction

An extensive literature in the field of economic development concludes that financial development not only has a significant growth-enhancing effect,[1] but also an inequality-reducing effect.[2] As argued, by alleviating informational asymmetries and transactions costs and disproportionally relaxing financial constraints of the poor, financial development encourages more productive investment in physical and human capital that substantially facilitates economic growth, narrowing the gap between the poor and the rich. Moreover, since credit market frictions can propagate and amplify business cycle fluctuations, financial development helps mitigate macroeconomic volatility.[3] Accordingly, determining what causes financial development is important because of its welfare improvement effects on the most important economic problems faced by a country, especially for a developing country.

On the other hand, substantial theoretical and empirical literature recognizes that high and sustained inflation is detrimental to economic growth, [4] and worsens wealth inequality.[5] As argued in Smith (2003), a possible candidate by which inflation imposes real consequences is through the financial systems, especially, by damaging financial markets or impeding their operations. Therefore, unlike existing literature

[1] Please see Levine (1997, 2005) for an excellent, both theoretical and empirical, survey and references therein.

[2] Banerjee and Newman (1993), Galor and Zeira (1993) and Aghion and Bolton (1997) assert that financial intermediary development reduces income inequality by disproportionately boosting the income of the poor. And Beck, Demirguc-Kunt and Levine (2007), Clarke, Xu and Zou (2006), Honohan (2004) and Li, Squire and Zou (2001) provide empirical evidences of the assertion.

[3] Existing literature implies that finance can affect macroeconomic cycles. More developed financial markets and institutions may more efficiently match savers and investors, allowing the economy to absorb shocks more easily. The financial sector may also facilitate diversification (at both the microeconomic and macroeconomic level) which would reduce risk and volatility. By contrast, financial development may be a proxy for the extent of information asymmetries which may themselves cause an increased volatility. Please see Denizer, Iyigun, and Owen (2002), Braun and Larrain (2005) and Raddatz (2006) for discussions and references therein.

[4] Please see Gillman (2005) for theoretical discussions, and Barro (1995), Bullard and Keating (1995), Bruno and Easterly (1998), Khan and Senhadji (2001), Rousseau and Wachtel (2002) and Bose and Murshid (2008), to name a few, for empirical investigations.

[5] Desai, Olofsgard and Yousef (2005), Cysne, Maldonado and Monteiro (2005) and Albanesi (2007) show that inflation is positively related to inequality, perhaps because higher inflation might worsen capital market frictions or weaken political bargaining power of the poor.

emphasizing institutions rule such as legal environments or globalization as a driving force of a well-functioning financial system,[6] this paper examines whether financial development is associated with the extent of a nation's inflation. The finding of significant impacts of inflation on financial development would have important policy implications for real economic activities. In particular, it would suggest that inflation exerts its influence on economic performance possibly through financial mechanism.

In response, despite considerable studies have devoted to analyzing the inflation-financial development relationship, the exact link between the two variables is still far from uncontroversial. For example, according to Mundell (1963) and Tobin (1965), inflation causes portfolio allocations away from money into capital that leads to lower real returns on capital and higher investment, with positive effects on economic growth. English (1999) takes a step further and argues that a higher inflation leads households to substitute purchased transactions services for money balances, which increases production of financial services and boosts the size of the financial services sector. On the other hand, theoretical models based on imperfect credit markets postulate that when there are information-type credit market frictions whose severity is endogenous, higher rates of inflation create greater credit rationing and distort the flows of information, thereby exacerbating credit market frictions. 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. Thus, an increase in inflation may interfere with the ability of financial sectors to allocate resources, reducing thereby capital accumulation and economic growth. These models also emphasize that only when inflation exceeds some

[6] Please see, La Porta, Lopez-de-Silanes, Shleifer and Vishny (1997, 1998), Levine (2002), Rajan and Zingales (2003, 2004) and Djankov, McLiesh and Shleifer (2007). Also see, Mishkin (2007) for more detailed discussions.

threshold levels do informational frictions necessarily play a substantial role.[7]

At the empirical front, while English (1999) provides cross-country evidence in support of a positive effect of inflation on the size of financial sector, Haslag and Koo (1999), Boyd, Levine and Smith (2001) and Khan, Senhadji and Smith (2006) show a negative and even nonlinear relationship between inflation and financial development. Haslag and Koo (1999) argue that inflation is associated with financial repression and find a negative relationship between inflation and financial development, but the relationship disappears with increases in the inflation rate above a threshold. Boyd, Levine and Smith (2001) reach similar results and show that such an inflation threshold occurs at 15 percent per year. By contrast, Khan, Senhadji and Smith (2006) find that the threshold level of inflation is about 3-6 percent, and for rates of inflation above the threshold level, further increases in inflation have strongly negative effects on financial development.

In addition to long-run effects, short-run considerations may play a role in the relationship. Mankiw (1989) points out that inflation tends to rise in booms and fall in recessions in the absence of identifiable real shocks such as oil price changes. Moreover, since financial development is not only characterized by long-run financial deepening but also by short-run financial instability (Loayza and Ranciere, 2006), and since the risk of bank crises tends to be higher in high inflation environments, higher inflation may foster financial fragility that has short-run implications for real activities (Boyd and Champ, 2003). Accordingly, econometric assessments of the relationship between inflation and financial development should ideally be capable of uncovering the relevant long-run parameters amidst a short-run link between the two variables.

Consequently, to account for theoretically conflicting contributions and advance

[7] Please see discussions in Azariadis and Smith (1996), Schreft and Smith (1997), Huybens and Smith (1998, 1999), Bose (2002), Hung (2003), and Smith (2003).

previous researches, this paper models the inflation-financial development relationship as intrinsically dynamic, using panel techniques that explicitly distinguish between short- and long-run effects of inflation on financial development. This can be accomplished by specifying an autoregressive distributed lag (ARDL) model for each country, pooling them together in a panel, and then testing the cross-equation restriction of a common long-run relationship between the two variables using the Pooled Mean Group (PMG) estimator of Pesaran, Shin and Smith (1999). Such a country-specific ARDL structure allows not only for accommodating cross-country heterogeneity in the degree of credit market imperfections and policy regimes, but also capturing certain interesting time-series relations that cross-sectional analysis cannot deal with. Moreover, this methodology can be applied to either stationary or nonstationary variables and hence does not require the pre-testing of unit roots. This partially circumvents some of problems with cointegration analysis that focuses only on the estimation of long-run relationship among nonstationary variables, and with low power of unit roots tests against plausible alternative. Further, instead of averaging the data per country to isolate trend effects, [8] both long- and short-run relationships are estimated using a panel of data pooling time-series and cross-sectional effects.[9]

Using a panel data pooled from 87 developed and developing countries for the 1960-2005 period, we find evidence of a strong link between inflation and financial

[8] As put forth in Loayza and Ranciere (2006), while averaging clearly induces a loss of information, it is not obvious that averaging over fixed-length intervals effectively eliminates business-cycle fluctuations; averaging eliminates information that may be used to estimate a more flexible model that allow for some parameter heterogeneity across countries. Averaging hides the dynamic relationship between inflation and financial development, particularly, the presence of opposite effects at different time frequencies.

[9] The PMG estimator has been recently applied to measure the effect of exchange rate uncertainty on investment (Byrne and Davis, 2005a, b), to assess the trade effect of real effective exchange rates by (Catao and Solomou, 2005), to estimate the impacts of fiscal deficits on inflation (Catao and Terrones, 2005), to estimate the relationship between financial development and economic growth (Loayza and Ranciere, 2006), and to examine the relationship between inequality and growth (Frank, 2008).

development, irrespective of alternative financial development measures, control variables and inflation uncertainty proxies. Specifically, higher inflation appears to stymie financial development in the long run but stimulate financial activities in the short run. However, when splitting the data into different income or inflation groups, these results can be observed only in low-income countries or low-inflation economies. In addition, the long-run impact is generally much larger than the short-run effect.

The remainder of the paper is organized as follows. Section 2 introduces the PMG estimator proposed by Pesaran, Shin and Smith (1999). Section 3 describes the data and source, and Section 4 reports empirical results and robustness tests. Section 5 concludes the analysis.

2. The Autoregressive Distributed Lag Approach

To examine the long-run effect of inflation on financial development, it is common to estimate the following cross-sectional regression:

$$finance_i = \alpha + \beta\, inflation_i + \omega\, controls_i + \varepsilon_i \qquad (1)$$

where *finance* is the financial development indicators, *inflation* is the inflation index, *controls* is a set of control variables, $i = 1, 2, ..., N$ is the country indicator and ε is the error term.

To allow rich dynamic heterogeneity in the finance-inflation regression over time and across countries, we nest equation (1) in an ARDL specification where the dependent and independent variables enter the right-hand side with lags of order *p* and *q*, respectively:

$$y_{it} = \mu_i + \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}^{'} x_{i,t-j} + \varepsilon_{it} \qquad (2)$$

where $i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$, $y_{it} = finance_{it}$, $x_{it} = (inflation_{it}, controls_{it})$, and μ_i is the fixed effects.

By re-parameterization, equation (2) can be written as

$$\Delta y_{it} = \mu_i + \phi_i y_{i,t-1} + \beta_i^{'} x_{it} + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*'} \Delta x_{i,ij} + \varepsilon_{it} \qquad (3)$$

where $j = 1, 2, \ldots, q-1.$ $\phi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij})$, $\beta_i = \sum_{j=0}^{q} \delta_{ij}$, $\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}$,

and $\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}$.

By grouping the variables in levels, equation (3) can be rewritten as

$$\Delta y_{it} = \mu_i + \phi_i (y_{i,t-1} - \theta_i^{'} x_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*'} \Delta x_{i,ij} + \varepsilon_{it}, \qquad (4)$$

where $\theta_i = -(\beta_i / \phi_i)$ defines the long-run or equilibrium relationship among y_{it} and x_{it}. And λ_{ij}^{*} and δ_{ij}^{*} are the short-run coefficients relating financial development to its determinants x_{it}. Finally, ϕ_i measures the speed of adjustment of y_{it} toward its long-run equilibrium following a change in x_{it}, and $\phi_i < 0$ ensures that such a long-run relationship exists. As a result, a significant and negative value of ϕ_i can be treated as evidence in support of cointegration between y_{it} and x_{it}.

As argued in Catao and Solomou (2005) and Catao and Terrones (2005), the ARDL specification in eq. (4), where all explanatory variables enter the regression with lags, not only allows us to mitigate the contemporaneous feedback and reverse causality running from financial development to inflation, but also accommodates the substantial persistence of finance adjustments and captures potentially rich inflation adjustment dynamics. In addition, the model allows for heterogeneity in the relationship between financial development and inflation across countries since the various parameters in eq. (4) are not restricted to be the same across countries. Finally, the ARDL approach allows us to estimate an empirical model that encompasses the

long- and short-run effects of inflation on financial development using a data field composed of a relatively large sample of countries and annual observations.

There are a few existing procedures for estimating the above model. At one extreme, the simple pooled estimator assumes the fully homogeneous-coefficient model in which all slope and intercept parameters are restricted to be identical across countries. At the other extreme, the fully heterogeneous-coefficient model imposes no cross-country coefficients constraints and can be estimated on a country-by-country basis. This is the so-called mean group (MG) estimator introduced by Pesaran and Smith (1995). The approach amounts to estimate separate ARDL regressions for each group and obtain θ and ϕ as simple averages of individual group coefficients θ_i and ϕ_i. In particular, Pesaran and Smith (1995) show that the MG estimator will provide consistent estimates of the average of parameters interested.

In-between these extremes, the dynamic fixed-effect (DFE) method allows the intercepts to differ across groups, but imposes homogeneity of all slope coefficients and error variances. Alternatively, Pesaran, Shin and Smith (1999) propose the pooled mean group (PMG) estimator which restricts the long-run parameters to be identical over the cross section, but allows the intercepts, short-run coefficients (including the speed of adjustment), and error variances to differ across groups on the cross section. If the long-run homogeneity restrictions are valid, it is known that MG estimates will be inefficient. In this case, the maximum likelihood-based PMG approach proposed by Pesaran, Shin and Smith (1999) will yield a more efficient estimator.[10] As shown in Pesaran, Shin and Smith (1999), the validity of a cross-sectional, long-run

[10] The underlying ARDL specification dispenses with unit root pre-testing of the variables. Provided that there is a unique vector defining the long-run relationship among variables involved, and the lag orders *p* and *q* are suitably chosen, MG and PMG estimates of an ARDL regression yield consistent estimates of that vector, no matter whether the variables involved are I(1) or I(0).

homogeneity restriction of the form $\theta_i = \theta, \quad i = 1, 2, ..., N$ (and hence the suitability of the PMG estimator) can be tested by a standard Hausman-type statistic.

In terms of the relationship between inflation and financial development, the PMG estimator offers the best available compromise in the search for consistency and efficiency. This estimator is particularly useful when the long run is given by conditions expected to be homogeneous across countries while the short-run adjustment depends on country characteristics such as monetary and fiscal adjustment mechanisms, capital market imperfections, and relative price and wage flexibility (e.g., Loayza and Ranciere, 2006). Therefore, we use the PMG method to estimate a long-run relationship that is common across countries while allowing for unrestricted country heterogeneity in the adjustment dynamics.

3. Data Descriptions and Sources

Our dataset consists of a panel of 87 countries over the 1960-2005 period and is mainly taken from World Development Indicator (2006) published by World Bank. Data on Financial development are obtained from Financial Structure Database originally compiled by Beck, Demirgüç-Kunt, and Levine (2000). Inflation is calculated as percentage changes in consumer price index (*inf*). We use three bank-based financial development indicators: Private Credit (*lprivo*), Liquidity Liabilities (*llly*), and Bank Assets (*ldby*).[11] Private Credit is the value of credits by financial intermediaries to the private sector divided by GDP. It is Beck, Demirgüç-Kunt, and Levine's (2000) preferred measure because it excludes credit granted to the public sector and credit issued by the central bank and development

[11] We focus on bank-based financial development, instead of stock or bond markets, because the data, in terms both of numbers of countries and length of time periods, are more available for the former than for the latter. In particular, the PMG methodology requires large T and N to address dynamic features in the data.

banks. Liquidity Liabilities is equal to the sum of currency and demand and interest-bearing liabilities of banks and non-bank financial intermediaries, divided by GDP. This is a commonly-used measure of financial depth, although it might involve double counting and it includes liabilities backed by credits to the public sector. And Bank Assets is defined as the domestic assets of deposit money bank as a share of GDP. Thus, Bank Assets measures the degree to which domestic banks allocate society's savings.

To strengthen our empirical results, we also control for conditional variables in the relation between inflation and financial development. The conditional variables include the initial real per-capita GDP (*initial*) to control for a causal link from the income level to financial development, the ratio of government expenditure to GDP (*lgov*) to measure macroeconomic stability, and the sum of exports and imports as a share of GDP (*ltrade*) to account for external shocks.[12]

Table 1 displays a list of countries in the sample, whereas Table 2 provides descriptive statistics and correlations of the variables for the sample countries over the period 1960-2005. It is noticed that inflation and each of three financial intermediary development measures are negatively correlated. Moreover, the correlations between any pair of three financial development measures are positive.

4. Empirical Results

4.1 Basic Results

Table 3 displays the results on specification tests and the estimation of long- and short-run parameters linking inflation and financial development.[13] We emphasize the

[12] All variables in this paper are in natural logarithm.

[13] Loayza and Ranciere (2006) suggest that when the main interest is on the long-run parameters, the lag order of the ARDL can be selected using some consistent information criteria on a country-by-country basis; however, when there is also interest in analyzing and comparing the short-run parameters, it is recommended to impose a common lag structure across countries. Thus, in

results from using the Pooled Mean Group (PMG) estimator, considering its gains in consistency and efficiency over other panel error-correction estimators. For comparison purposes, we also present the results obtained by the Mean Group (MG) and dynamic fixed-effect estimators.

For the existence of a long-run relationship (dynamic stability), the coefficient on the error-correction term should be negative and within the unit circle. As can be seen in Table 3, the pooled error-correction coefficient estimates are significantly negative and fall within the dynamically stable range for PMG, MG and DFE estimators. This gives evidence of mean reversion to a non-spurious long-run relationship and therefore stationary residuals, meaning that inflation and financial development are cointegrated. In addition, the Hausman test does not reject long-run homogeneity restriction, indicating that the PMG estimator is more suitable for the analysis, relative to the MG estimator. These results hold for alternative financial development measures. Accordingly, the following analysis focuses on the PMG approach.

Regarding the estimated parameters of primary interest, we find that long-run coefficient of inflation is negative and significant. It suggests that inflation tends to hinder financial development in the long run. The estimated long-run effect is also economically significant in that a 10 percent increase in inflation will lead financial transactions (relative to GDP) to increase by about 0.1 to 0.3 percent. However, the short-run coefficients on inflation tell a different story. Since the price regimes and capital market frictions vary across countries in the short run, the short-run coefficients are not restricted to be the same across countries, so that we do not have a single pooled estimate for each coefficient. Nevertheless, we can still analyze the

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this paper, we use the latter procedure and set $p = q = 1$, for simplicity. Of course, we have also tried different orders for p and q selected by Akaike information criterion (AIC), Schwarz Bayesian criterion (SBC), and Hannan and Quinn (HQ), respectively. We found qualitatively and quantitatively similar results.

average short-run effect by considering the mean of the corresponding coefficients across countries. As Table 3 shows, the short-run average relationship between financial development and inflation appears to be significantly positive. That is, on average, inflation is a significant driver of financial development.

Thus, comparing the long- and short-run estimates, the inflation-financial development relationship depends on whether their movements are temporary or for a long haul. Moreover, inflation is found to have much stronger effects on financial development in the long run than that in the short run. And, the evidence holds for alternative measures of financial development. Further, the findings of coexistence of positive short-run effects and negative long-run effects imply that while the effect of inflation on the need for financial services is more relevant in the short run, the arguments of imperfect credit markets tend to dominate in the long run.

To further check if the results are sensitive to model specification, we add three control variables into the models: income, government size and trade openness. Table 4 reports the results. The estimation outcome is qualitatively similar to that in Table 3. The signs and statistical significance of both long- and short-run coefficients remain unchanged. Moreover, the pooled error-correction coefficients continue to be significantly negative and within the unit circle, indicating that there is a long run equilibrium relationship among financial development, inflation, and three control variables. Consequently, our findings that inflation has significantly negative effects on financial development in the long run but significantly positive effects in the short run are not driven by common omitted factors. And an interesting finding is that while income and government size seem to have positive and significant influence on financial deepening both in the long and short run, trade openness appears to have a significant positive long-run impact but a negative short-run effect on financial development. Furthermore, for all three control variables, their long-run impacts are

much stronger than those in the short run.

4.2 The Effects of Financial Uncertainty

Recently, Dotsey and Sarte (2000) argue that since inflation and inflation uncertainty are highly correlated, the presence of uncertainty tends to attenuate the negative long-run relationship between inflation and real growth. In terms of the inflation-financial development relationship, as claimed by Lucas (1990) and Fuersy (1992), inflation uncertainty resulting from high and variable inflation affects nominal interest rates and so affects decisions to use money or transaction services to make purchases. However, in Lucas and Stokey (1987) and English (1999), it is mean inflation, not inflation uncertainty, that affects transactions decisions. Thus, as another robustness check, it is interesting to test if there is an independent effect of inflation uncertainty on financial sector and whether the addition of inflation uncertainty changes the relationship between inflation and financial development.

To do so, following tradition, we use conditional variances derived from exponential GARCH (EGARCH) and component GARCH (CGARCH) to proxy for inflation uncertainty, and denoted as h_{it}^{eg} and h_{it}^{cg}, respectively.[14] The PMG estimation results when controlling for inflation uncertainty are summarized in Table 5. As indicated, the inclusion of inflation uncertainty does not change our previous exercises. The pooled error-correction coefficient keeps significantly negative and falls within the unit circle, supporting long-run equilibrium relationship among financial development, inflation, inflation uncertainty and other control variables. Moreover, the significant negative long-run impacts coexist with significant positive short-run effects, meaning that inflation has direct impacts on financial development both in the short and long run. Also, as expected, inflation appears to have stronger

[14] The detailed specifications for EGARCH and CGARCH are presented in Appendix.

influence in the long run than in the short run.

Note that the long-run coefficient estimate of inflation uncertainty is significant and positive, while the short-run estimate is insignificant, except for that of Δh_{it}^{eg} on *llly*. It implies that inflation uncertainty affects financial development in a positive fashion in the long run but tends to have an insignificant effect in the short run. The evidence supports the hypothesis that increasing inflation risk encourages precautionary saving that is beneficial for the financial sector expansion. It helps explain that the Dotsey and Sarte (2000) finding of a positive growth-improving effect of inflation uncertainty works possibly through the financial channel.

4.3 The Effects of Economic Development

Literature on the finance-growth nexus postulates that the growth-enhancing effects of finance are nonlinear, and even non-monotonic, depending on the stage of economic development. De Gregorio and Guidotti (1995) and Rioja and Valev (2004) , for example, report that positive effects between banking development and economic growth are particularly strong in middle- and high-income countries. Deidda and Fattouh (2002) also reach the similar results. By contrast, Wachtel (2003), Calderon and Liu (2003) and Masten, Coricelli and Masten (2008) provide strong evidence that the bank-growth link is not as strong among developed countries as it is among less developed ones. It is thus interesting to explore whether such nonlinearity can be attributed to differential responses of finance to inflation. On this point, English (1999) puts forth that since countries with higher per-capita income generally have larger financial sectors, it seems likely that the effect of inflation on financial sectors is larger in high income countries as well. His cross-country investigation supports this idea. By contrast, Dotsey and Sarte (2000) assert that sustained inflation should not be expected to yield significant growth effects for industrialized countries that appear to

have high degree of financial sophistication. Since our data show that higher initial real GDP per capita seems to have positive impacts on financial depth, this section examines whether the inflation-financial development relationship differs along with economic development.

To test the empirical relevance of real development in the relationship, we divide countries into three equal-sized country subsamples, i.e., high-, middle- and low-income groups, depending on the relative ranking of their real income per capita in the middle of the sample period, and redo the estimation for each country subsample. As claimed in Rioja and Valev (2004), separating countries into three roughly equal-size groups is fairly mechanical and may leave the positioning of some countries open to skepticism. However, it has the advantage of avoiding subjective judgments on how to group the countries. The estimated heterogeneous responses of financial development to inflation are depicted in Table 6.

As can be seen, the pooled error-correction coefficients continue to be significantly negative and within the unit circle in each income group, indicating that there is long-run cointegrating relationship among financial development, inflation and other control variables. However, our finding that a positive short-run effect coexists with a negative long-run impact can only be observed in the low-income countries. It suggests that the relationship between inflation and financial development indeed varies with economic development. In particular, the short-run coefficient estimates of inflation appear to be insignificant for the middle- and high-income countries but significantly positive for the low-income countries. By contrast, the long-run coefficient estimates of inflation appear to be significantly negative for all three income subsamples (except for the case of *ldby* in high-income countries). The data also reveal that the long-run effect of inflation increases with economic development. Finally, as expected, the long-run impact is found to be larger

than the short-run effect for each income group.

4.4 The Effects of the Inflation Level

Theory suggests that inflation matters because it affects the severity of credit market frictions. And since credit market rationing may not occur in the environment with low rates of inflation, and since, with higher rates of inflation, endogenous rationing of credit worsens information frictions, the relationship between inflation and financial development should be better characterized by nonlinearity with thresholds. Moreover, as suggested by Khan, Senhadji and Smith (2006), the potential threshold level of inflation is about 3 to 6 percent per year below which inflation has positive effect, but above which the effect turns negative. Also, as put forth by Boyd, Levine and Smith (2001), the inflation threshold is about 15 percent per year above which inflation has limited effects on financial activities. These two observations imply that there might be two thresholds with three regimes in the inflation-financial development link.

Accordingly, in this section, we reinvestigate the issue by dividing countries into high-, medium- and low-inflation country groups and redo the estimation for each country group. In particular, countries with annual inflation rates above 15 percent are classified as high-inflation countries, while those with inflation rates below 6 percent are grouped as low-inflation countries. Others are middle-inflation countries. The results of differential effects of inflation on financial development are reported in Table 7.

As indicated, since the pooled error-correction coefficient estimate remains significantly negative and lies inside dynamically stable range for each inflation group, there exists a long-run equilibrium relationship among financial development, inflation and other control variables. However, our finding of coexistence of a positive short-run and negative long-run effect can only be observed for low-inflation

countries. Specifically, the short-run coefficient estimate of inflation is positive and significant in low-inflation countries but tends to be insignificant both in the middle- and high-inflation countries. Moreover, such positive short-run effects of inflation tend to decrease as inflation goes up. On the other hand, the long-run estimate is significant and positive in all three subsamples, except for that of inflation on *ldby* in low-inflation countries. In addition, we find an inverted U-shaped long-run link between inflation and financial development in that positive influence of inflation first increases and then decreases as inflation heightens.

5. Conclusions

In their recent important paper, Dortsey and Sarte (2000) postulate that inflation and growth may be negatively related in the long run while positively related at cyclical frequencies. Moreover, since financial development is characterized by long-run financial deepening and by short-run financial instability, this paper investigates whether the heterogeneous responses of growth to inflation work possibly through financial systems. Specifically, we assess whether the impacts of inflation on financial development differ in the short versus long run.

Using the Pooled Mean Group estimation to a panel of data consisting 87 countries over 1960-2005, we find evidence for the coexistence of negative long-run effects and positive short-run effects of inflation on financial development. The findings are robust to alternative financial development indicators, conditioning variables and even controlling for inflation uncertainty. However, dividing the sample into different income or inflation groups yields some interesting insights. We find that the inflation-financial development link indeed varies with the levels of economic development. While a negative long-run effect coexists with a positive short-run effect of inflation in low-income countries, inflation tends to have negative long-run

and insignificant short-run effects on financial development in higher-income countries. Finally, the data suggest that the inflation-financial development link is nonlinear. While the negative short-run impacts of inflation on financial depth seem to decrease with inflation, the positive long-run link between inflation and financial development appears to be inverted U-shaped.

Appendix: Deriving inflation volatility

In order to estimate the effect of inflation uncertainty on financial development, we need a measure for inflation uncertainty. This is obtained via the GARCH-type models to generate conditional variance as a proxy for inflation uncertainty. Specifically, suppose that inflation follows a pure ARIMA model:

$$\pi_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \pi_{t-i} + \sum_{j=1}^{q} \varphi_j \varepsilon_{t-j} \tag{6}$$

where ε_t is a white noise and π_t is the rate of inflation. Also in order to allow for conditional heteroskedasticity, we assume that $\varepsilon_t \middle| \Omega_{t-1} = h_t^{\frac{1}{2}} \eta_t$ and $h_t \sim NID(0,1)$. In the study, two alternative specifications of the conditional variance h_t are considered for each country. The first one is exponential GARCH (EGARCH) process proposed by Nelson (1991) that takes account of the asymmetric effects of negative and positive shocks. The specification can be written as

$$\ln(h_t) = a_0 + a_1 \ln(h_{t-1}) + b_1 \left| \varepsilon_{t-1} \Big/ \sqrt{h_{t-1}} \right| + c_1 \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \tag{7}$$

The second model for the conditional variance is an extension of the basic GARCH model. Engle and Lee (1999) represent the GARCH(1,1) model as characterized by reversion to a constant mean $\overline{\mu}$, i.e.,

$$h_t = \overline{\mu} + a_1 (h_{t-1} - \overline{\mu}) + b_1 (\varepsilon_{t-1}^2 - \overline{\mu}) \tag{8}$$

In contrast, their component GARCH (CGARCH) process allowing reversion to a time varying mean m_t is modeled as

$$\begin{aligned} h_t - m_t &= \overline{\mu} + a_1 (h_{t-1} - \overline{\mu}) + b_1 (\varepsilon_{t-1}^2 - \overline{\mu}) \\ m_t &= \mu + \rho (m_{t-1} - \mu) + \varsigma (\varepsilon_{t-1}^2 - h_{t-1}) \end{aligned} \tag{9}$$

We follow conventional applications such as Asteriou and Price (2005) and

Byrne and Davis (2005a, 2005b) to proxy inflation uncertainty by the logarithm of the fitted (conditional) volatility values from equations (7) and (9), respectively. The corresponding inflation uncertainty measures are denoted as h_{it}^{eg} and h_{it}^{cg}.

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Table 1: A list of Sample Countries by Inflation

High-inflation countries	Haiti	**Low-inflation countries**
Bolivia	Honduras	Australia
Chile	Hungary	Austria
Ecuador	India	Belgium
Ghana	Iran	Belize
Iceland	Ireland	Burkina Faso
Indonesia	Italy	Canada
Israel	Jordan	Central African
Jamaica	Kenya	Chad
Malawi	Korea, Rep.	Cyprus
Mexico	Madagascar	Denmark
Nigeria	Mauritius	Dominica
Sierra Leone	Nepal	Finland
Suriname	New Zealand	France
Uganda	Pakistan	Germany
Uruguay	Paraguay	Japan
Venezuela, RB	Philippines	Luxembourg
Zambia	Portugal	Malaysia
Middle-inflation countries	Rwanda	Morocco
Burundi	Seychelles	Netherlands
Costa Rica	South Africa	Niger
Ctte d'Ivoire	Spain	Norway
Dominican Republic	Sri Lanka	Panama
Egypt	St. Lucia	Senegal
Ethiopia	Swaziland	St. Kitts and Nevis
Fiji	Syrian Arab Republic	St. Vincent and the Grenadines
Gambia, The	Togo	Sweden
Greece	Tonga	Switzerland
Grenada	Trinidad and Tobago	Thailand
Guatemala	United Kingdom	United States

Note: Countries with inflation averaged over the sample period of 15% and above are classifies as high-inflation countries, those with inflation between 6% and 15% middle-inflation countries, and those with inflation of 6% and below low-inflation countries.

Table 2: Descriptive statistics 1960-2005

Panel A: summary statistics							
	inf	*lprivo*	*ldby*	*llly*	*initial*	*lgov*	*ltrade*
Mean	15.6337	3.3272	3.4400	3.6154	7.6207	2.6466	4.0382
Std.	199.9059	0.9436	0.8497	0.6337	1.6359	0.3799	0.5712
Min.	-13.0566	-0.3071	0.3447	1.5327	4.4242	0.9502	1.8438
Max.	11749.6400	5.8438	5.5546	5.8236	10.8305	3.9985	5.6832
Panel B: correlation matrix							
inf	1.0000						
lprivo	-0.0628	1.0000					
ldby	-0.0782	0.9155	1.0000				
llly	-0.0873	0.8364	0.8983	1.0000			
initial	-0.0209	0.7551	0.7405	0.6859	1.0000		
lgov	-0.0184	0.4129	0.4859	0.4345	0.4496	1.0000	
ltrade	-0.0163	0.2784	0.3439	0.3246	0.2384	0.3717	1.0000

Table 3: The Effect of Inflation on Financial Development

Panel A: *lprivo*	PMG	MG	Hausman Test	DFE
Long-Run Coefficients				
Inflation	-0.0256***	-0.0153	0.1512	0.0004
	(0.0026)	(0.0267)	[0.6974]	(0.0003)
Error Correction				
Phi	-0.0637***	-0.0763***		-0.0546***
	(0.0073)	(0.0099)		(0.0046)
Short-Run Coefficients				
△ Inflation	0.0015***	0.0015***		0.0000***
	(0.0005)	(0.0005)		(0.0000)
Constant	0.2435***	0.2806***		
	(0.0276)	(0.0353)		
Panel B: *ldby*	PMG	MG	Hausman Test	DFE
Long-Run Coefficients				
Inflation	-0.0237***	0.0120	0.6020	0.0007**
	(0.0024)	(0.0460)	[0.4378]	(0.0003)
Error Correction				
Phi	-0.0553***	-0.0706***		-0.0487***
	(0.0075)	(0.0108)		(0.0045)
Short-Run Coefficients				
△ Inflation	0.0009**	0.0008*		-0.0001***
	(0.0004)	(0.0005)		(0.0000)
Constant	0.2197***	0.2765***		
	(0.0306)	(0.0440)		
Panel C: *llly*	PMG	MG	Hausman Test	DFE
Long-Run Coefficients				
Inflation	-0.0122***	-0.0060	0.1192	-0.0004*
	(0.0015)	(0.0181)	[0.7299]	(0.0002)
Error Correction				
Phi	-0.0763***	-0.0961***		-0.0513***
	(0.0089)	(0.0120)		(0.0052)
Short-Run Coefficients				
△ Inflation	0.0010*	0.0011*		0.0000***
	(0.0006)	(0.0006)		(0.0000)
Constant	0.3057***	0.3859***		
	(0.0368)	(0.0469)		

Note: The values in the parentheses (bracket) are the standard errors (p-value) of corresponding coefficient estimates. ***, ** and * indicate significant at 1%, 5% and 10 % level, respectively.

Table 4: The PMG results--Robustness Tests

	Financial Development indicator		
	lprivo	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0271***	-0.0308***	-0.0130***
	(0.0031)	(0.0034)	(0.0014)
Income	1.8578***	2.0460***	0.6547***
	(0.1194)	(0.1229)	(0.0170)
Government	0.6142***	-0.4106***	0.5007***
	(0.0943)	(0.0957)	(0.0278)
Trade	0.3328***	0.3639***	0.4797***
	(0.1053)	(0.0998)	(0.0353)
Error Correction			
Phi	-0.0607***	-0.0516***	-0.1053***
	(0.0080)	(0.0081)	(0.0125)
Short-Run Coefficients			
△ Inflation	0.0013**	0.0015***	0.0018**
	(0.0006)	(0.0005)	(0.0008)
△Income	0.4505***	0.1689**	0.0520
	(0.0772)	(0.0781)	(0.0918)
△Government	0.1698***	0.1916***	0.1331***
	(0.0379)	(0.0360)	(0.0408)
△Trade	-0.0462**	-0.0539**	-0.0684***
	(0.0254)	(0.0260)	(0.0221)
Constant	-0.7617***	-0.5926***	-0.4497***
	(0.1130)	(0.1054)	(0.0602)

Note: The values in the parentheses are the standard errors of corresponding coefficient estimates. ***, ** and * indicate significant at 1%, 5% and 10% level, respectively.

Table 5: The PMG Results when considering inflation Uncertainty

	Conditioning Information Set		
Panel A: Inflation uncertainty measured by E-GARCH Model	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0427***	-0.0414***	-0.0262***
	(0.0048)	(0.0044)	(0.0024)
Inflation Uncertainty, h_{it}^{eg}	0.1891***	0.2915***	0.1731***
	(0.0413)	(0.0491)	(0.0294)
Error Correction			
Phi	-0.0593***	-0.0682***	-0.0930***
	(0.0078)	(0.0070)	(0.0089)
Short-Run Coefficients			
△ Inflation	0.0021***	0.0026***	0.0021***
	(0.0006)	(0.0005)	(0.0006)
△ Inflation Uncertainty, Δh_{it}^{eg}	0.0001	0.0014	-0.0101**
	(0.0076)	(0.0122)	(0.0040)
Panel B: Inflation Uncertainty measured by Component-GARCH Model	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0219***	-0.0207***	-0.0171***
	(0.0032)	(0.0023)	(0.0018)
Inflation Uncertainty, h_{it}^{cg}	0.0928**	0.0473	0.0547*
	(0.0415)	(0.0334)	(0.0294)
Error Correction			
Phi	-0.0820***	-0.0919***	-0.1061***
	(0.0097)	(0.0091)	(0.0099)
Short-Run Coefficients			
△ Inflation	0.0014**	0.0015***	0.0017***
	(0.0007)	(0.0006)	(0.0006)
△ Inflation Uncertainty, Δh_{it}^{cg}	0.0073	0.0086	-0.0051
	(0.0200)	(0.0136)	(0.0099)

Note: The estimates on control variables are omitted for brevity. The values in the parenthesis are the standard errors of corresponding coefficient estimates. ***, ** and * indicate significant at 1%, 5% and 10% level, respectively.

Table 6: The PMG Results for Different Income Country subsamples

	Conditioning Information Set		
Panel A: High-income countries	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0914***	0.0000	-0.0353***
	(0.0168)	(0.0008)	(0.0064)
Error Correction			
Phi	-0.0236***	-0.0749***	-0.0455***
	(0.0083)	(0.0147)	(0.0111)
Short-Run Coefficients			
△ Inflation	0.0010	0.0008	0.0016
	(0.0012)	(0.0012)	(0.0022)
Panel B: Middle-income countries	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0213***	-0.0123***	-0.0114***
	(0.0041)	(0.0012)	(0.0026)
Error Correction			
Phi	-0.0942***	-0.0967***	-0.0599***
	(0.0162)	(0.0244)	(0.0221)
Short-Run Coefficients			
△ Inflation	0.0011	0.0010	0.0012**
	(0.0010)	(0.0006)	(0.0006)
Panel C: Low-income countries	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0083***	-0.0131***	-0.0085***
	(0.0011)	(0.0025)	(0.0012)
Error Correction			
Phi	-0.1347***	-0.1170***	-0.1412***
	(0.0210)	(0.0122)	(0.0211)
Short-Run Coefficients			
△ Inflation	0.0022***	0.0021***	0.0021***
	(0.0006)	(0.0005)	(0.0004)

Note: The estimates on control variables are omitted for brevity. The values in the parenthesis are the standard errors of corresponding coefficient estimates. ***, ** and * indicate significant at 1%, 5% and 10% level, respectively.

Table 7: The PMG Results for Different Inflation Country subsamples

	Conditioning Information Set		
Panel A: High-inflation countries with inflation >15% (17 countries)	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0123***	-0.0145***	-0.0105***
	(0.0017)	(0.0016)	(0.0012)
Error Correction			
Phi	-0.1087***	-0.0945***	-0.1433***
	(0.0272)	(0.0292)	(0.0204)
Short-Run Coefficients			
△ Inflation	0.0007	0.0003	0.0008***
	(0.0006)	(0.0003)	(0.0003)
Panel B: Middle-inflation countries with inflation about 6%-15% (41 countries)	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0256***	-0.0245***	-0.0149***
	(0.0044)	(0.0038)	(0.0039)
Error Correction			
Phi	-0.0860***	-0.0916***	-0.0498***
	(0.0112)	(0.0103)	(0.0150)
Short-Run Coefficients			
△ Inflation	0.0011	0.0018***	0.0009
	(0.0008)	(0.0006)	(0.0007)
Panel C: Low-inflation countries with inflation <6% (29 countries)	*lprivo*	*ldby*	*llly*
Long-Run Coefficients			
Inflation	-0.0101*	-0.0008	-0.0149**
	(0.0055)	(0.0045)	(0.0064)
Error Correction			
Phi	-0.0712***	-0.0360***	-0.0524**
	(0.0153)	(0.0121)	(0.0247)
Short-Run Coefficients			
△ Inflation	0.0023**	0.0022**	0.0029**
	(0.0010)	(0.0009)	(0.0015)

Note: The estimates on control variables are omitted for brevity. The values in the parenthesis are the standard errors of corresponding coefficient estimates. ***, ** and * indicate significant at 1%, 5% and 10% level, respectively.