Inflation and financial development: Evidence from Brazil ☆

Manoel Bittencourt *

Department of Economics, University of Pretoria, Lynnwood Road, Pretoria 0002, RSA

ABSTRACT

We examine the impact of inflation on financial development in Brazil, and the data available permit us to cover the period between 1985 and 2004. The results—based initially on time series and then on panel time series and panel data and analyses—suggest that inflation presented deleterious effects on financial development during the period investigated here. The main implication of the results is that poor macroeconomic performance has detrimental effects to financial development, a variable that is important for affecting, (e.g., economic growth and income inequality). Therefore, low and stable inflation, and all that it encompasses, is a necessary first step to achieve a deeper and more active financial sector with all its attached benefits.

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1. Introduction

We investigate the role of inflation for financial development in Brazil using data covering the period between 1985 and 2004 and ten economically diverse regions. This period is particularly interesting because it captures two distinct regimes in terms of macroeconomic performance in Brazil. On the one hand, the period between 1985 and 1994 covers the time when the rates of inflation were notoriously high, reaching an astounding 82.18 percent *per month* in March 1990. On the other hand, from 1995 onwards, the macroeconomic performance has consistently improved, with inflation presenting relatively much lower and stable rates since then.[1]

The evidence, based initially on the time-series variation and then on panel time series and panel data and analyses, indicates that inflation is detrimental to financial development. The evidence is significant and robust for different data sets, different measures of financial development and different estimators. The main *policy* implication of the results is that the high rates of inflation seen in Brazil in the 1980s and the first half of the 1990s had a clear detrimental effect to a variable that is known to play an important role in economic growth and income

inequality. Therefore, low and stable inflation, and all that it encompasses, is a necessary first step to be pursued in Brazil if it is to have a deeper and more active financial sector with all its attached benefits.[2]

What distinguishes this paper from previous studies is that, first, we use, as suggested by Fischer (1993), and Besley and Burgess (2003), national data to construct a more disaggregated sub-national data set, which better pinpoints the importance of inflation on financial development in a country so regionally diverse in terms of economic outcomes. Furthermore, to carry out the study, in addition to the time-series data, we take advantage of panel time series and panel analyses, which deal with important empirical issues—non-stationarity, heterogeneity bias, between-region dependence and endogeneity in panels—most of them not discussed in the previous empirical studies, to get better and more informative estimates.

Additionally, the use of panel time series and panel analyses is particularly important because they do not suffer from the usual criticism applied to cross-sectional data and analysis, (i.e., that since a period of high inflation is usually followed by a period of low inflation, high inflation's detrimental effects would be canceled out by low inflation[3]). Finally, we take into consideration the problem of financial repression seen in Brazil during the high-inflation period and therefore use an extra measure of financial development that, to some extent, accounts for this problem.

[1] Although relatively lower and more stable, inflation rates between 1995 and 2004 were, on the average, at 9.47%, and they even reached double digits in 2003.

[2] For instance, Singh (2006), Singh and Cerisola (2006) and Santiso (2006) highlight the importance of the much improved macroeconomic performance in Latin America in producing better economic outcomes recently. Moreover Carvalho and Chamon (2008) suggest that the growth of real income that took place after the reforms of the 1990s in Brazil has been, for methodological reasons, severely underestimated, which reinforces the role of macroeconomic stability on improved economic welfare.

[3] See Bruno and Easterly (1998).

All in all, we attempt to fill in a gap in the literature by exploring national and sub-national data, with time-series and regional variation, from a developing country that provides a *rich* ground to study and better understand the impact of inflation on financial development. On the one hand, determining what causes financial development in a developing country like Brazil—which has presented historically high inequality and erratic growth rates, and high rates of inflation for a long period of time—is important because financial development can have an incremental effect on growth, and a progressive effect on inequality.[4] On the other hand, inflation—for its nature in Brazil, in particular during the transitional period from dictatorship to democracy—arises as a natural macroeconomic determinant of financial development.[5]

Theoretical studies related to what is done here include Moore (1986), Choi et al. (1996), and Azariadis and Smith (1996). They highlight the fact that if inflation is high enough, returns on savings are reduced—which leads to a reduction in savings and savers alike— the pool of borrowers is swamped, informational frictions become more severe, and therefore credit becomes scarce in such an economy.

Moreover, Schreft and Smith (1997), Boyd and Smith (1998), Huybens and Smith (1998), and Huybens and Smith (1999) explore the idea that economies with higher rates of inflation do not approach or reach the steady state where their capital stocks would be high, (i.e., there are bifurcations and development traps arise in such economies). Furthermore, these economies obviously present less efficient financial markets because of the higher interest rates that follow high rates of inflation. All the same, the Mundell–Tobin effect is reversed in a high-inflation environment.

On the empirical side, Haslag and Koo (1999) and Boyd et al. (2001), using cross-sectional and panel international data from the 1960s to early 1990s, report that moderate inflation has a negative impact on financial development. Moreover, both studies find evidence of nonlinearities, (i.e., after a particular threshold—15 percent per year in Boyd et al. (2001)—higher inflation presents only smaller marginal negative effects on financial development). Furthermore, Dehesa et al. (2007) use a panel of 120 countries between 1997 and 2004 to report that lower inflation increases the amount of credit in their sample. Finally, Zoli (2007), and Andrianaivo and Yartey (2009) report that in panels of emerging European countries between 1995 and 2006 and African countries between 1990 and 2006, inflation presents detrimental effects to financial development.[6]

All in all, we highlight the importance of a stable macroeconomic environment, with consistent monetary and fiscal policies, which is attainable only by the introduction of stronger economic institutions so that a deeper and more active financial sector emerges with all its consequences on crucial variables such as growth and inequality.[7]

The remainder of this paper has the following structure. Section 2 describes the data sets used and also presents some correlations and regression plots of the main variables. Section 3 explains the empirical strategies used and reports the main results. Section 4 concludes the paper: it summarises the importance of the results and their implications in terms of policy, and it suggests future work.

2. The data

2.1. Description of the data

The data sets used come from the Brazilian Institute of Geography and Statistics (IBGE), which is the Brazilian Census Bureau, the Brazilian Central Bank (BACEN), and the Institute of Applied Economic Research (IPEA) files. The IPEA is an agency of the Brazilian government that, among other activities, compiles primary and provides secondary data from a variety of national sources.

These data sets cover the period between 1985 and 2004 and ten major regions, from North to South: Pará (PA), Ceará (CE), Pernambuco (PE), Bahia (BA), Distrito Federal (DF), Minas Gerais (MG), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR) and Rio Grande do Sul (RS). To briefly illustrate the importance of these regions in the national context, they accounted for 74 percent of the total population and 84 percent of the total gross domestic product in 1995. Moreover, in terms of regional variation, these data sets include a relatively rich southern region like São Paulo, as well as a region like Pará in the relatively poor North of the country, with a gross domestic product equivalent to just 5 percent of the one produced by São Paulo in 1995.

The first data set used to construct the measures of financial development covering the period between 1985 to 2002 are from the BACEN's Monthly Bulletin and IBGE's National Accounts System. The first annualised monetary aggregate used is m2, (i.e., the liquid liabilities). The second monetary aggregate, m3, is defined as m2 plus other financial assets that are more illiquid but with higher rates of nominal and real returns than the ones in m2. Moreover, credit to the private sector (credit) and personal credit (personal) are defined, respectively, as credit provided by public and private financial institutions to firms and to individuals, and to individuals only. These monetary aggregates are deflated by the IBGE's national index of consumer prices (INPC).

The gross domestic products (GDPs) and financial domestic products (FDPs)—which account for the gross domestic product of the financial sector by region—are calculated at market prices and deflated by the IBGE's GDP implicit deflator.

We can then calculate the ratios $m2/GDP$, $m3/GDP$, $credit/GDP$ and $personal/GDP$ at national and regional levels to obtain $M2$, $M3$, $CREDIT$ and $PERSONAL$, respectively. To calculate these measures at the national level, we use the information on the national monetary aggregates over the national GDPs.

However, to construct the above mentioned regional proxies for financial development, we have to take into account the fact that the data covering the period between 1985 and 2002 on monetary aggregates are provided only at the national level. We therefore use the available national data on monetary aggregates divided by the regional gross domestic products and multiplied by the percentage participation of each region in the financial domestic product. The reason for doing so is that otherwise the most developed regions of the South would not appear as financially developed as they actually are. More specifically, with this weighting, the measures of financial development recapture more accurately the regional variation in financial development seen amongst the different regions of Brazil. For example, the Distrito Federal, where the federal capital Brasília is located, São Paulo and Rio de Janeiro, regain their places amongst the most financially developed regions after the weighting.[8]
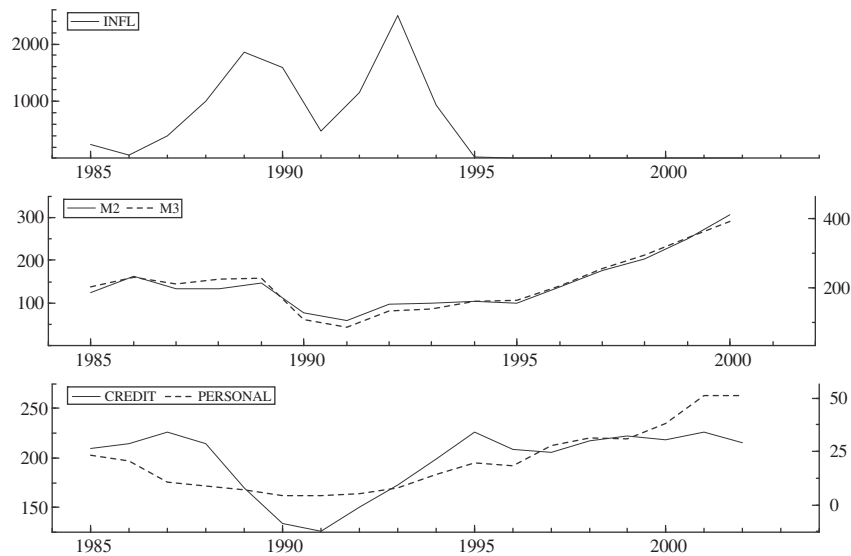
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[4] For instance, King and Levine (1993), Levine and Zervos (1998), Beck et al. (2000), and Beck and Levine (2004) report that financial development has a positive impact on long-run growth. Moreover, Li et al. (1998), Dollar and Kraay (2002), Clarke et al. (2006), Beck et al. (2007) and Bittencourt (2010) report that financial development contributes to reduce inequality.

[5] For instance, Gregorio (1993), Fischer (1993), Barro (1995), Bullard and Keating (1995), Clark (1997), Barro (1998), Bruno and Easterly (1998), and Fischer (2005) confirm the fact that *high* inflation outweighs the Mundell–Tobin effect and therefore presents a detrimental effect to economic growth. Also, Cardoso et al. (1995), Barros et al. (2000), Ferreira and Litchfield (2001), and Bittencourt (2009) report that the *high* rates of inflation seen in Brazil in the 1980s and the first half of the 1990s were significantly regressive on income inequality.

[6] In addition, Choi et al. (1996) use national data from different countries, e.g., U.S., Chile, Korea and Taiwan, to report that inflation presents a negative impact on stock-market development.

[7] Singh (2006) reports that the Brazilian authorities have started to implement sounder federal and regional fiscal rules and also inflation targeting from the late 1990s onwards. Nevertheless, Carstens and Jácome (2005) report that Brazil still has one of the *least* independent central banks in Latin America, which is always a cause for concern.

[8] Honohan (2004) and Silva (2002) explore further the role of using the financial domestic product as a proxy for financial development.

Fig. 1. Inflation and financial development, 1985–2002. Source: IBGE, BACEN, IPEA and author's own calculations. *INFL* accounts for inflation and the measures of financial development are *M2*, *M3*, private credit (*CREDIT*) and personal credit (*PERSONAL*).

Definitions 1 and 2 illustrate the national (FD_t) and the regional (FD_{it}) measures of financial development, respectively.

$$FD_t = mon.aggregates_t / GDP_t \qquad (1)$$

$$FD_{it} = (mon.aggregates_t / GDP_{it})FDP_{it}. \qquad (2)$$

Furthermore, the reason for using *M3* in addition to *M2* is because during the high-inflation period Brazil presented the problem of financial repression—the government kept the basic nominal interest rates artificially low, generating negative real interest rates—and therefore a low *M2*.[9] Additionally, the proxy *PERSONAL* captures credit being allocated to individuals who might lack the collateral available to, (e.g. firms and captured by *CREDIT*).[10]

Moreover, we use a new regional data set provided by the BACEN on credit provided by private and public financial institutions covering the period between 1995 and 2004 and the same ten regions as before. Definition 3 illustrates this regional measure of financial development:

$$CREDIT_{it} = credit_{it} / GDP_{it}. \qquad (3)$$

That said, the data on the rates of inflation (*INFL*) come from the IBGE's regional consumer price indexes (IPCs) and the national INPC. The IPCs cover the already mentioned ten regions. This regional information is then compiled and aggregated by the IBGE, using the resident population in each region as weight, to form the national INPC itself.[11]

The macroeconomic control variables used are the regional government expenditure over the regional GDPs (*GOV*) and the regional financial domestic product (*FDP*), which accounts for the gross domestic product of the financial sector in each region. *GOV* captures all expenditure on current public services provided, including education and health, by regional governments. The expenditure by the regional governments is deflated by the IBGE's INPC and the data come from the IPEA files.

Table 1
Correlation matrix, financial development and inflation, 1985–2002.

Variables	M2	M3	Credit	Personal	INFL
M2	1				
M3	0.983**	1			
CREDIT	0.596**	0.691**	1		
PERSONAL	-.857**	0.853**	0.648**	1	
INFL	− 0.481*	− 0.505**	− 0.635**	− 0.664**	1

Source: BACEN, IBGE, IPEA and author's own calculations. *INFL* accounts for inflation and the measures of financial development are *M2*, *M3*, private credit (*CREDIT*) and personal credit (*PERSONAL*). **Significant at the 5 percent level and *Significant at the 10 percent level.

2.2. Behaviour of the data

The rates of inflation were notoriously high during the 1980s and the first half of the 1990s in Brazil. The two most visible hyperinflationary bursts happened in 1989–1990—1,863 percent in 1989, and 82 percent in March 1990—and then again in 1993, 2,489 percent. However, after July 1994, with the implementation of the Real Plan, inflation has been relatively more stable and much lower than previously.[12]

With regard to financial development, on the one hand, it can be said that all measures presented sharp reductions right before, during and after the first hyperinflationary burst of 1989–1990—and then again, although less sharply than before—during and after the second burst of hyperinflation in 1993–1994. On the other hand, after the stabilisation of 1994–1995, all measures have experienced a constant increase in size. Fig. 1 illustrates the above using the national time-series variation in the data covering the period 1985–2002.

Furthermore, Table 1 provides the correlations between the measures of financial development and inflation using the national time-series variation between 1985 and 2002. First, it is seen that all measures of financial development are positively correlated with each other and all correlations are statistically significant at the 5 percent level. Second, all measures are negatively correlated with inflation, with *CREDIT*, *PERSONAL* and *M3* being significant at the 5 percent level, and *M2* being significant at the 10 percent level.

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[9] Agénor and Montiel (2008), and Easterly (2002) cover the issue of financial repression in developing countries in general.
[10] For more on financial development measures, see Beck et al. (2001).
[11] For more on these price indexes, see Corseuil and Foguel (2002).

[12] The Real Plan was gradually implemented during the first half of 1994. The Real (R$) itself was introduced in July 1994. See Agénor and Montiel (2008).
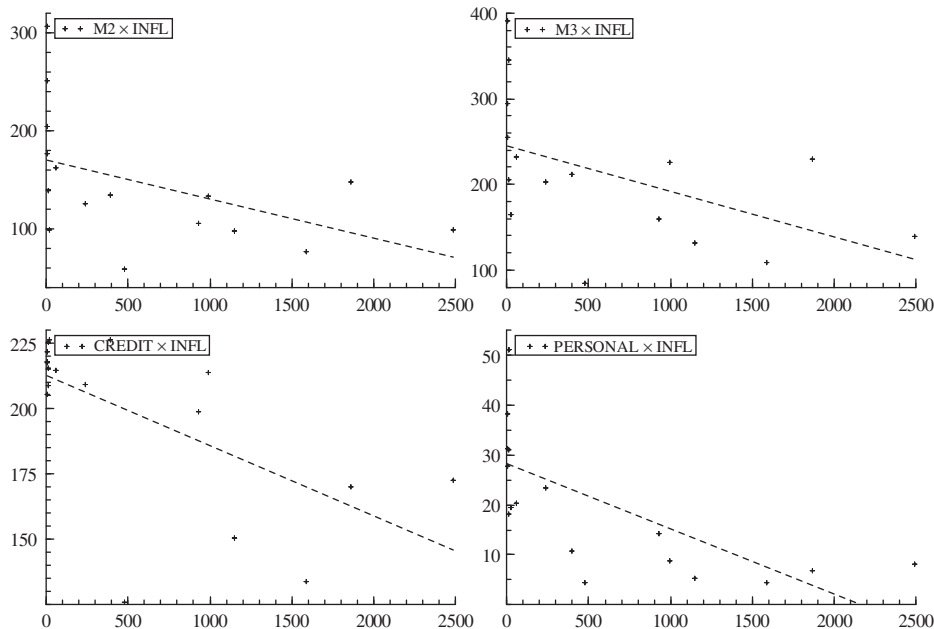
Fig. 2. OLS regression lines, financial development and inflation, 1985–2002. Source: BACEN, IBGE, IPEA and authors own calculations. INFL accounts for inflation and the measures of financial development are M2, M3, private credit (CREDIT) and personal credit (PERSONAL). All estimates are statistically significant at the 5 percent level.

Additionally, we run univariate OLS time-series regressions based on the national data to further investigate the statistical *and* economic relationship seen between inflation and financial development between 1985 and 2002. Fig. 2 shows how the four measures of financial development fared against inflation, and the clear and statistically significant results from these regressions are that inflation presents negative effects on all measures of financial development.

Moreover, it is important to mention the effect of inflation on *M*3, since it presents larger correlations and estimates than *M*2. This result is particularly worrying because during crisis—in which a process of financial adaptation would take place for those with access to financial markets—*M*3 would be the monetary aggregate presenting the public with assets with more instruments of deferring payment (i.e., a reduction in *M*3 would deprive the general public of an important tool against high inflation[13]).

In summary, first, the above preliminary visual evidence briefly illustrates the behaviour of the national time-series data during the period between 1985 and 2002, particularly the fact that during the hyperinflationary bursts, the measures of financial development presented considerable reductions. More intuitively, one could argue that the high inflation seen during the transitional period between 1985 and 1994 created a sense of uncertainty in terms of expectations of a drastic disinflationary policy that would come at some point with all its costs. This uncertainty, combined with the restrictive stabilisation plans themselves, played a central role in reducing the amount of financial resources available in the economy at the time.[14, 15]

On the other hand, the shorter visual evidence covering the period between 1995 and 2002 suggests that financial development presented a clear increase at the time, which points to the importance of a more stable macroeconomic environment for a deeper and more active financial sector and, hence, for higher savings and credit in the economy. However, since the series is shorter, this effect is still not being picked up by the initial correlations or the OLS regression lines.

Second—and complementary to the above result—the statistical correlations among the variables indicate a significant negative statistical relationship between inflation and financial development. Furthermore, the univariate OLS time-series regressions, to a large extent, confirm the visual and descriptive evidence presented and suggest that there is a negative economic relationship between inflation and financial development in Brazil.

3. Empirical strategies and results

3.1. Strategies

The data sets we explore in this section present time-series T combined with panel N variation. The first data set consists of $T = 18$ years, and the panel of $N = 10$ regions covers the period between 1985 and 2002. Therefore, the empirical strategy used is based on

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[13] For more on financial adaptation and velocity of money, see Erosa and Ventura (2002), and Moore (1986).

[14] For instance, not only was the Collor Plan implemented in 1990 a stabilisation attempt based on restrictive monetary policies, but it also confiscated from the public a huge fraction of financial assets in the economy. Furthermore, the populist Cruzado Plan implemented in 1986 relied heavily on interventionist price controls to curb high inflation. It is therefore thought that both plans only added to the macroeconomic uncertainty at the time. See Agénor and Montiel (2008) or Kiguel and Liviatan (1992) for more on these plans.

[15] In addition, dollarisation was never fully implemented as an instrument against inflation in Brazil; therefore, it can be argued that there was never a run of resources from the financial institutions towards U.S. dollars as a form of protection against inflation; see Singh (2006).

Table 2
Panel unit-root tests.

Variables	IPS Statistics
M2	−2.58
M3	−2.83
CREDIT	−2.64
PERSONAL	−3.16
INFL	−3.51
GOV	−2.09
FDP	−1.92

The moments of the mean E and variance *var* of the average $\bar{t}$ are respectively: −1.349 and 0.565. Source: Im et al. (2003) and author's own calculations.

Table 3
Dynamic estimates of inflation on financial development, 1985–2002.

	FE			
	M2	M3	CREDIT	PERSONAL
INFL	-0.300 (-2.04)	-0.424 (-2.03)	-0.116 (-0.81)	-0.044 (-2.73)
GOV	2.083 (2.04)	2.466 (1.70)	2.199 (2.49)	.330 (3.29)
FDP	1.007 (1.61)	1.674 (1.88)	1.724 (2.85)	.032 (.486)
$M2_{t-1}$	0.338 (5.76)			
$M3_{t-1}$		0.425 (7.18)		
$CREDIT_{t-1}$			0.701 (12.91)	
$PERSONAL_{t-1}$				0.503 (11.84)
R^2	0.89	0.90	0.93	0.89
F test	94.80	102.53	186.65	110.43
LR test	54.89	42.78	12.94	30.68
	RC			
INFL	− 0.274 (-1.84)	− 0.397 (-2.14)	− 0.186 (-2.83)	− 0.038 (−1.38)
GOV	1.845 (1.87)	1.749 (1.41)	0.853 (0.64)	0.447 (4.03)
FDP	0.775 (1.44)	1.176 (1.66)	0.819 (1.97)	0.075 (1.38)
$M2_{t-1}$	0.436 (4.60)			
$M3_{t-1}$		0.493 (5.17)		
$CREDIT_{t-1}$			0.419 (4.53)	
$PERSONAL_{t-1}$				0.495 (4.93)
R^2	0.69	0.72	0.65	0.83
Wald test	34.53	44.72	49.47	63.87
LR test	189.32	235.00	279.70	299.74

T-ratios in parentheses, the number of observations: $NT = 180$. The estimated equation is $FD_{it} = \alpha_i + \beta_i INFL_{it} + \gamma_i GOV_{it} + \delta_i FDP_{it} + \epsilon_i FD_{it-1} + u_{it,}$, where FD is the proxy of financial development being used, $INFL$ is the inflation rate, GOV is the government expenditure and FDP is the financial domestic product. FE is the fixed effects and RC is the random coefficients estimators, respectively. Source: Author's own calculations.

the relatively novel panel time-series $T>N$ analysis. This sort of analysis allows us to deal with issues such as non-stationarity, heterogeneity bias and between-region dependence in relatively thin panels.

Although some of the variables are stationary by default, for non-stationarity in the regional time series, we use the Im et al. (2003) test, which allows for heterogeneous parameters and serial correlation, and for sufficiently large T converges in probability to a standard normal distribution. The IPS test is based on an augmented Dickey–Fuller (ADF) regression for each region of each variable, which are then averaged. The moments of the mean E and variance var of the average $\bar{t}$ to be plugged into the IPS test are taken from IPS (2003) and, in this case, are −1.349 and 0.565 respectively.[16] Eqs. (4) and (5) illustrate the regional ADF equations of a particular variable y and the IPS test, respectively.

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{j=1}^{k} \gamma_{ij} \Delta y_{i,t-j} + \delta_i t + u_{it} \quad (4)$$

$$IPS = \frac{\sqrt{N}(\bar{t} - E(\bar{t}))}{\sqrt{var(\bar{t})}} \quad (5)$$

in which α_i is the heterogeneous intercept, $\delta_i t$ the time trend, u_{it} the residuals and N the number of regions.

When dynamic models are estimated, the fixed-effects (FE) estimator provides consistent estimates when $T \to \infty$ and N is fixed, but only when the slopes are *homogeneous*. When *heterogeneous* slopes are present, the estimates provided by the FE estimator become rather inconsistent, even for large T. Basically, the explanatory x_s will not be independent of the lagged dependent variable y. The

indiscriminate use of the FE estimator in this case is to be seen with caution, since it possibly contains a heterogeneity bias problem, and this bias might be severe.

An alternative is the mean group (MG) estimator, which consists of a simple average of the time-series estimates. However, the MG is sensitive to outliers, a problem not faced by the random coefficients (RC) estimator proposed by Swamy (1970). Another alternative is the instrumental variable estimator; however, an instrument uncorrelated with the residuals is also uncorrelated with the explanatory variable and is therefore not a valid instrument.[17] Moreover, in this $T>N$ case, GMM-type estimators are not an option either due to overfitting.[18]

Therefore, we estimate our dynamic equations using the benchmark FE estimator and then the RC estimator, which allows for heterogeneous intercepts *and* slopes, and it gives consistent estimates of the expected values. The RC, which can also be interpreted as a generalised least squares estimator, consists of a weighted average of $\hat{\alpha}_i$ and $\hat{\beta}_i$, and the weight contains a modified variance–covariance matrix of the heterogeneous α_i and β_i.

Furthermore, although these regions obviously share some common characteristics, the FE and RC estimators account for the fact that some of these regions indeed present different levels of economic development because of particular idiosyncrasies present in different regions (i.e., the regions of the Northeast, namely, Pernambuco and Bahia, are known to be much poorer than the ones in the more developed South). Eq. (6) illustrates the dynamic heterogeneous equation estimated:

$$FD_{it} = \alpha_i + \beta_i INFL_{it} + \gamma_i GOV_{it} + \delta_i FDP_{it} + \epsilon_i FD_{it-1} + u_{it,} \quad (6)$$

in which FD_{it} is the particular proxy of financial development being estimated, α_i the heterogeneous intercept, $INFL_{it}$ are the rates of inflation and then the control variables [i.e., government expenditure (GOV_{it}) and the financial gross domestic product (FDP_{it}), and u_{it} the independent normal error term]. The FD_{it-1} term is the first lag of the proxy of financial development being used. The use of the first lag of

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[16] An alternative to IPS (2003) is the test by Levin et al. (2002). However, this test assumes parameter *homogeneity* and therefore does not consider a possible heterogeneity bias present in the data. In addition, some would argue that, given the structure of the data, structural breaks are a possibility. The test proposed by Im et al. (2005) takes that into account; however, this test assumes large N, which is not entirely the case here. Basically the IPS test is probably slightly biased; however, it presents more flexibility in terms of sample size and asymptotics and is therefore informative and probably the best alternative available at this stage.

[17] See Pesaran and Smith (1995) for more on heterogeneity bias in dynamic panels, or alternatively, Smith and Fuertes (2008).
[18] See Bond (2002).

Table 4
Dynamic sur estimates of inflation on financial development, 1985–2002.

	SUR				
	PA	CE	PE	BA	DF
M2					
INFL	−0.058 (−2.03)	−0.289 (−4.74)	−0.134 (−2.07)	−0.150 (−2.85)	−1.336 (−1.84)
GOV	0.512 (2.80)	0.244 (0.72)	1.061 (2.28)	0.757 (1.95)	5.271 (1.57)
FDP	0.154 (1.18)	1.001 (3.56)	0.838 (3.22)	0.495 (2.64)	5.467 (2.49)
$M2_{t-1}$	0.908 (10.87)	0.790 (8.24)	1.368 (7.47)	0.755 (11.33)	0.555 (3.79)
LM test	253.94				
M3					
INFL	−0.076 (−2.03)	−0.384 (−5.24)	−0.176 (−2.17)	−0.142 (−2.27)	−1.618 (−1.51)
GOV	0.768 (3.20)	0.631 (1.88)	1.650 (2.88)	1.534 (3.18)	7.584 (1.45)
FDP	0.158 (.95)	1.440 (4.36)	1.261 (3.68)	0.540 (2.42)	7.291 (2.19)
$M3_{t-1}$	0.855 (11.47)	0.754 (10.83)	1.400 (8.07)	0.739 (12.26)	0.676 (4.56)
LM test	221.33				
	MG	RJ	SP	PR	RS
M2					
INFL	−0.247 (−5.06)	−0.680 (−8.71)	−0.409 (−4.46)	−0.178 (−2.06)	−0.165 (−5.11)
GOV	0.580 (−2.47)	−1.636 (−3.63)	−0.207 (−0.31)	1.832 (2.44)	0.141 (0.37)
FDP	0.614 (3.54)	1.666 (5.82)	1.158 (3.34)	0.707 (2.52)	0.397 (2.05)
$M2_{t-1}$	0.857 (9.55)	0.802 (14.82)	0.875 (8.66)	0.639 (4.66)	1.036 (23.07)
LM test	253.94				
M3					
INFL	−0.368 (−6.36)	−1.031 (−10.47)	−0.571 (−5.46)	−0.200 (-1.98)	−0.258 (−6.46)
GOV	−1.112 (−3.71)	−2.458 (−4.39)	−0.715 (−1.98)	3.135 (3.56)	0.372 (0.87)
FDP	0.923 (4.19)	2.687 (7.18)	1.575 (3.72)	1.012 (3.23)	0.855 (3.52)
$M3_{t-1}$	0.847 (10.84)	0.817 (18.76)	0.854 (9.59)	0.524 (5.24)	0.958 (23.03)
LM test	221.33				

T-ratios in parentheses, number of observations: $NT = 180$. The estimated equation is $FD_t = \alpha_t + \beta INFL_t + \gamma GOV_t + \delta FDP_t + \epsilon FD_{t-1} + u_t$, where *FD* is the proxy of financial development being used, *INFL* is the inflation rate, *GOV* is the government expenditure and *FDP* the financial domestic product. SUR is the seemingly unrelated regressions estimator. Source: Author's own calculations.

the dependent variable is important not only because it accounts for the dynamics of financial development over time but also because it works as a proxy for possible omitted variables.

Moreover, since our data set presents $T > N$, between-region dependence is believed to be through the disturbances being $E(u_{it}u_{jt}) \neq 0$. In this case, the covariance matrix of the residuals of the time-series regressions can be estimated and used as a weight so that the between-region dependence is captured. Therefore, the seemingly unrelated regression (SUR) estimator is used, and its estimates are based on the regional time series, which are, in turn, weighted by the covariance matrix of the residuals, and the more correlated the residuals are, the more efficient the SUR is.[19] Eq. (7) illustrates the dynamic equation estimated:

$$F D_t = \alpha_t + \beta\, INFL_t + \gamma\, GOV_t + \delta\, FDP_t + \epsilon\, FD_{t-1} + u_t, \qquad (7)$$

in which all variables account for the regional time series of each variable.

The second data set we use, which covers the period between 1995 and 2004, consists of a panel $N = 10$ and $T = 10$, (i.e., $N \geq T$). The dynamic panel data estimators we use in this case are the benchmarks Anderson and Hsiao (1981, 1982) first difference (DF) estimator, the difference generalised method of moments (DIF–GMM) proposed by Arellano and Bond (1991), and then the system generalised method of moments (SYS–GMM) proposed by Blundell and Bond (1998).

The DF estimator as well as DIF–GMM and SYS–GMM—which remove the unobserved individual effects—are based on the assumption of sequential exogeneity, (i.e., the lagged levels of the endogenous explanatory variable are valid identifying instruments for the equations in first differences). Moreover, DIF–GMM makes optimal use of these moment conditions, as well as SYS–GMM. Furthermore, the extended SYS–GMM goes a step further and makes use of lagged differences as instruments for the extra equations in levels, and it is understood to perform better than DIF–GMM when the series are believed to be persistent. Basically, the differences are good instruments for the levels, and it explains the levels well, irrespective of the fact that the parameter being estimated is approaching unit. Needless to say that these extra moment conditions that SYS–GMM makes use of should be tested using the Hansen test. Eq. (8) illustrates the dynamic equation estimated:

$$\Delta CREDIT_{it} = \beta\Delta INFL_{it} + \gamma\Delta GOV_{it} + \delta\Delta FDP_{it} + \epsilon\Delta CREDIT_{it-1} + \Delta u_{it}, \qquad (8)$$

in which all variables account for the differenced panel variation of each variable.

Given the review above, it can be said that we attempt to deal with some of the most important empirical issues facing data sets, which present $T \geq N$ and $N \geq T$ variations. This is important in itself because dealing with these issues implies that we are able to deliver better and more informative estimates. All the same, the panel time series and panel analyses used provide enough tools that cater for different issues, and also avoids the usual criticism that the cross-country analysis of this subject tends to suffer.[20]

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[19] An alternative to SUR–FGLS is the correlated common effects estimator (CCE) proposed by Pesaran (2006). However, for CCE to work best, *N* is assumed to be large, and in our data set, $N = 10$. Furthemore, Kapoor et al. (2007) propose a FGLS estimator that also works best under the $N \to \infty$ assumption.

[20] See also Clark (1997) for some of the criticism of the cross-sectional analysis from an economic point of view.

Table 5
Dynamic SUR estimates of inflation on financial development, 1985–2002.

	SUR				
	PA	CE	PE	BA	DF
CREDIT					
INFL	−0.165 (−3.42)	−0.150 (−2.19)	−0.144 (−2.03)	−0.199 (−2.85)	−0.122 (−0.13)
GOV	0.025 (0.09)	1.459 (4.92)	1.034 (3.08)	0.956 (2.05)	14.244 (2.54)
FDP	0.422 (2.03)	1.083 (3.21)	0.995 (3.35)	0.966 (3.91)	5.723 (1.72)
$CREDIT_{t-1}$	0.362 (2.90)	0.603 (6.54)	0.264 (2.06)	0.185 (1.27)	0.686 (4.27)
LM test	187.57				
PERSONAL					
INFL	−0.016 (−3.48)	−0.038 (−2.80)	−0.015 (−1.67)	0.000 (0.07)	−0.239 (−3.52)
GOV	0.062 (1.93)	0.125 (2.30)	0.225 (3.87)	0.387 (4.97)	0.744 (2.27)
FDP	0.033 (1.63)	0.136 (2.28)	0.073 (2.14)	0.012 (0.33)	0.321 (1.62)
$PERSONAL_{t-1}$	0.616 (9.00)	0.877 (9.37)	0.762 (8.48)	0.677 (7.56)	0.509 (5.53)
LM test	176.86				
	MG	RJ	SP	PR	RS
CREDIT					
INFL	−0.224 (−3.99)	−0.729 (−7.54)	−0.311 (−3.24)	−0.368 (−4.01)	−0.215 (−3.39)
GOV	0.410 (1.40)	−0.217 (−0.42)	1.379 (1.96)	0.671 (1.37)	1.797 (2.78)
FDP	1.227 (5.70)	3.084 (8.34)	1.701 (4.49)	2.032 (5.92)	1.362 (4.53)
$CREDIT_{t-1}$	0.558 (5.69)	0.608 (9.58)	0.611 (5.93)	0.271 (2.63)	0.397 (3.72)
LM test	187.57				
PERSONAL					
INFL	−0.016 (−1.60)	−0.067 (−4.57)	−0.051 (−2.16)	−0.032 (−2.30)	−0.031 (−3.29)
GOV	0.204 (3.71)	0.142 (1.80)	0.249 (1.33)	0.198 (2.28)	0.041 (.36)
FDP	0.069 (1.88)	0.170 (3.46)	0.122 (1.30)	0.074 (1.42)	0.128 (2.66)
$PERSONAL_{t-1}$	0.862 (10.06)	0.701 (8.70)	0.776 (7.77)	0.644 (6.50)	0.947 (9.90)
LM test	176.86				

T-ratios in parentheses, number of observations: $NT = 180$. The estimated equation is $FD_t = \alpha_t + \beta INFL_t + \gamma GOV_t + \delta FDP_t + \epsilon FD_{t-1} + u_t$, where FD is the proxy of financial development being used, $INFL$ is the inflation rate, GOV is the government expenditure and FDP the financial domestic product. SUR is the seemingly unrelated regressions estimator. Source: Author's own calculations.

3.2. Results

First, in this section, we report the results covering the period between 1985 and 2002, which makes use of dynamic panel time-series analysis.

The IPS statistics suggest that we can reject the null hypothesis in favour of the alternative that at least *one* region of each variable is, in fact, stationary.[21] Table 2 reports the results.

The dynamic equations are estimated by the FE and RC estimators, respectively. The first panel of Table 3 reports the estimates provided by the FE estimator. Inflation presents negative effects on financial development and most estimates are statistically significant. The controls GOV and FDP suggest that regional government expenditure—including education and health—is conducive to economic development, and an increase in FDP is associated with more financial development in the economy. The lags of the financial development proxies present positive effects on themselves. The likelihood ratio (LR) tests for the homogeneity of intercepts suggest that we cannot accept the null of homogeneity, confirming that there are fixed effects in the sample, which justifies the use of the FE estimator here.

The second panel of the table presents the estimates provided by the RC estimator. The effects caused by all variables on financial development follow the same pattern (i.e., negative effects of inflation and positive effects caused by GOV and FDP). Moreover, M3 and CREDIT suffer particularly large effects, stressing the importance of inflation in negatively affecting a variable that is, by definition, broader than M2 and would not be much affected by financial repression—which highlights that inflation curtails the provision of payment-deferring instruments that

play a crucial role during crisis—and also reducing the amount of credit in the economy, with all its deleterious effects on longer and shorter gestation projects. Furthermore, the LR tests for homogeneity of intercepts and slopes suggest that the coefficients are *heterogeneous*, which makes the RC the most appropriate estimator in this dynamic setting.

Between-region dependence is dealt with by the SUR estimator. The more disaggregated and weighted dynamic time-series equations confirm the results provided above by the pooled estimators. The impact of inflation on M2 and M3 is negative and significant in most regions. Inflation presents larger estimates against M3 than M2, and the regions most affected by inflation are the ones located in the more developed South [i.e., Distrito Federal (DF), São Paulo (SP), Rio de Janeiro (RJ), Minas Gerais (MG), and Rio Grande do Sul (RS)]. This condition is quite intuitive because, although regional inflation follows the same national trend over time, the richest regions are the ones with more advanced financial sectors and, therefore, more prone to be affected by inflation. On the other hand, the poorest regions of the North and Northeast do not possess a well-structured financial sector to be affected by inflation in the first place. The controls GOV and FDP present the same sort of positive impact as before on financial development, with most estimates being significant. The Lagrange multiplier (LM) tests suggest that we cannot accept the null of independence across regions.[22] Table 4 reports the results.

Moreover, when the proxies used are CREDIT and PERSONAL, the impact of inflation on financial development is negative and mostly statistically significant. The proxy CREDIT suffers larger detrimental effects than PERSONAL, and the regions most affected by inflation are the ones

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[21] As an aside, Phillips and Moon (1999) argue that spurious regressions are less of a problem in large panels. This is because the pooled estimators average over the regions and the noise is attenuated, and therefore, the estimates are consistent. Furthermore, Smith and Fuertes (2008) suggest that, under certain conditions, the above prediction holds even when between-region dependence is present.

[22] The IPS test reported in Table 2 above assumes the existence of between-region *independence*. An alternative that considers the existence of between-region dependence is proposed by Pesaran (2007), the cross-section IPS (CIPS) test. However, CIPS assumes that $N > 10$, and we have $N = 10$ in our data set. It is therefore thought that the IPS test in this case is slightly biased; nevertheless, it is still informative. See Baltagi et al. (2007) for more on panel unit-root tests and between-region dependence.

with better developed financial sectors in the more developed South. The controls *GOV* and *FDP* confirm their roles of being conducive to financial development, and most estimates are significant. The LM tests reject the null of independence across the regions, therefore suggesting that the SUR is an appropriate estimator in this case. Table 5 reports the results.

Given the above evidence, we can say that the impact of inflation on a range of financial development proxies is negative and statistically significant. Moreover, the pooled evidence, based on the FE and RC estimators, clearly points to the fact that *M*3 and *CREDIT* are the proxies being affected most by inflation. This condition is particularly worrying since *M*3 and *CREDIT* include respectively financial assets that would not be so heavily affected by financial repression and therefore important during crisis; and assets that are important for the formation of capital—physical and human—in an economy. For example, using the dynamic RC estimates of *INFL* against *M*3, this measure would be reduced in roughly 4 percent *per year* to every ten percent increase in inflation, which is considerable given the nature of inflation in Brazil until 1994.

Furthermore, the more disaggregated time-series evidence based on SUR not only confirms the pooled evidence but also pinpoints which regions are prone to be more affected by inflation. It is the more financially developed and dynamic regions which are the ones suffering most with poor macroeconomic performance, therefore depriving the country as a whole of an important engine for economic development. For instance, using the SUR estimates of *INFL* against *CREDIT* in São Paulo, it can be seen that this measure would be reduced by 3 percent *per year* to every ten percent increase in inflation.

On the other hand, it can be said that the poorer regions of the North and the Northeast are not *so* affected by inflation because they already have a rather small financial sector (i.e., there is a smaller marginal negative effect of inflation on financial development in those regions). All the same, although the regional rates of inflation follow a very similar trend over time, the SUR estimates provide an insightful analysis into the fact that inflation affects regions with different levels of development differentially.

Second, we explore the new data set covering the more stable period between 1995 and 2004, which makes use of dynamic panel data analysis.

The first column of Table 6 reports the FD estimates, and inflation presents a negative effect on *CREDIT*, although not entirely significant. The second column presents the DIF–GMM estimates, without all available moment conditions so that we avoid overidentification, and with robust standard errors provided by the Windmeijer (2005) correction.[23] Inflation again presents a negative effect on *CREDIT* and this time the estimate is statistically significant. The Hansen test suggests that the instruments are not correlated with the error term, and the Arellano and Bond test for second-order correlation *m*2 suggests no auto correlation. Finally, the third column reports the SYS–GMM estimates and inflation presents the, by now expected, negative and significant effect on *CREDIT*. The Hansen test indicates that the instruments are not correlated with the error term, and the Arellano and Bond *m*2 test for second-order correlation suggests no second-order autocorrelation.

The dynamic panel data evidence above is interesting in itself, since it covers the period in which inflation rates were much lower, although not as low as in developed countries.[24] The size of the estimates and inflation effects reflect that, (e.g. according to SYS-GMM *CREDIT* would be reduced by 0.55 percent *per year* to every ten percent increase in inflation, which is lower than the panel time-series effects above). This result illustrates that inflation was lower and consequently generated less uncertainty and therefore have smaller effects on *CREDIT*, but perhaps not low enough since it still presents detrimental effects to *CREDIT*.

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[23] See Roodman (2009) for more on the issue of 'too many instruments.'
[24] For instance, inflation rates reached 10.38% in Brazil in 2003.

Table 6
Dynamic panel data estimates of inflation on credit, 1995–2004.

	DIF	DIF–GMM	SYS–GMM
INFL	− 0.092 (-1.60)	− 0.062 (−2.62)	− 0.055 (−1.84)
GOV	− 0.060 (-1.49)	− 0.005 (−0.19)	− 0.070 (−1.63)
FDP	− 0.094 (-0.21)	− 0.246 (−2.00)	− 0.003(−0.21)
CREDIT$_{t-1}$	0.479 (2.91)	0.499 (4.21)	0.144 (1.44)
F test	1.39	15.61	33.70
Hansen test (p-value)		.96	0.95
m2 (p-value)		.23	.55

T-ratios in parentheses, number of observations: $NT = 100$. The estimated equation is $\Delta CREDIT_{it} = \beta \Delta INFL_{it} + \gamma \Delta GOV_{it} + \delta \Delta FDP_{it} + \epsilon \Delta CREDIT_{it-1} + \Delta u_{it}$, where *CREDIT* is private credit, *INFL* is the inflation rate, *GOV* is the government expenditure and *FDP* the financial domestic product. DIF is the Anderson and Hsiao, DIF–GMM the Arellano and Bond, and SYS–GMM the Blundell and Bond estimators, respectively. Source: Author's own calculations.

All in all, the body of evidence presented in this section is economically feasible [e.g., it goes along the lines of Boyd et al. (2001)] and statistically sound, and it confirms the one presented in Section 2 above, which reinforces the significance of the results.

4. Concluding remarks

We have examined the relationship between inflation and financial development in Brazil from 1985 to 2004. The results—based on different data sets, and on a range of estimators and financial development measures—suggest that inflation reduced financial development in Brazil at the time.

The relevance of understanding the macroeconomic determinants of financial development lies in the fact that a deeper and more active financial sector is of crucial importance for key economic variables—i.e., economic growth and income inequality—high in the agenda of any developing country, in particular Brazil. Moreover, given the sort of macroeconomic performance seen at the time of transition from dictatorship to democracy in Brazil, inflation arises naturally as a proxy for macroeconomic performance and, hence, as a factor that is to have an impact on financial development.

The importance of the results presented is mainly because we explore not only the time-series variation but also the panel time series and panel dimensions present in the data. Hence, we carry out a study based on national and sub-national data, which, first, is believed to more accurately pinpoint the effects of inflation on financial development, and second, at least to our knowledge, is believed to be the first time that such a study has been done with Brazilian data.

Furthermore, we employ a range of estimators that deal with the empirical issues present in different sorts of panels to get better and more informative estimates. The analyses also, first, avoid the criticism that the cross-sectional analysis usually suffers (e.g., that periods of different macroeconomic performance end up cancelling each other out), and second, highlights the advantages of pooling, SUR and SYS–GMM analyses when the variables are expected to be $I(1)$ and regionally dependent. Moreover, we use financial development measures that, first, take into account the problem of financial repression and, second, consider the allocation of credit at a more individual and disaggregated level.

Complementary to the above discussion, the results confirm the theoretical prediction [e.g., Choi et al. (1996) and Azariadis and Smith (1996) to mention a few] that high rates of inflation are detrimental to financial development and hence reverse the Mundell–Tobin effect.

Therefore, the main *policy* implication of the results is that for a developing country to have a deeper and more active financial sector with all its attached benefits, the rates of inflation have to be low and consistently under control. Poor macroeconomic performance only brings deleterious effects to a developing economy (i.e., high

inequality, erratic growth and, most importantly here, a restrictive financial sector). Therefore, for a financial sector to become deeper and more active it is important also to stress the importance of having stronger economic institutions like an independent central bank and a sound fiscal authority.

A possible extension of this work would be an investigation of how inflation and financial development affected economic growth in Brazil during the troubled 1980s and 1990s. The main question to be asked would be: Did financial development compensate for the detrimental effects of inflation to economic growth? Presumably not, because as seen above, financial development was significantly reduced during the period of crisis. Another possibility is to extend the regional data set to keep analysing the relationship not only between finance and inflation but also between finance and growth during the period of macroeconomic stability.

All in all, the research agenda is rich and the use of sub-national data is promising to be insightful.

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