

Inflation and Economic Growth in Latin America: Some Panel Time-Series Evidence*

Manoel Bittencourt[†]

November 2, 2011

Abstract

In this paper we investigate the role of macroeconomic performance, mainly in terms of rates of inflation, in determining economic growth in four Latin American countries which suffered hyperinflationary bursts in the 1980s and early 1990s, but that also differ in terms of development levels. The data set covers the period between 1970 and 2007, and the empirical results, based on panel time-series data and analysis, confirm the anecdotal evidence which suggests that inflation has had a detrimental effect to growth in the region. All in all, we highlight the fact that excessive inflation has clearly offset the Mundell-Tobin effect and consequently the high costs that inflation has had on economic activity in the region.

Keywords: Inflation, Growth, Latin America.

JEL Classification: E31, O11, O42, O54.

*I thank seminar participants at Pretoria, Wits, UCT, Arno X in Göttingen and two referees for comments.

[†]Department of Economics, University of Pretoria, Lynnwood Road, Pretoria 0002, RSA, Email: manoel.bittencourt@up.ac.za.

1 Introduction and Motivation

Latin America has been known for its display of high rates of inflation, and even bursts of hyperinflation, in particular shortly after its political transition to democracy in the 1980s and in the first half of the 1990s, and also for presenting erratic economic growth rates during roughly the same period of time. The countries following this, pathological, pattern include; Argentina, Bolivia, Brazil and Peru. In most of these cases, macroeconomic stabilisation took some time to take root. In fact, stabilisation came only in the middle of the 1990s, in the spirit of Alesina and Drazen (1991), with the implementation of particular economic institutions (inflation targeting and fiscal responsibility laws), when, coincidentally enough, growth rates also started showing a positive trend.

Given this background, we investigate the role of macroeconomic performance, mainly in terms of inflation rates, in determining economic growth in the region. More specifically, we use data from Argentina, Bolivia, Brazil and Peru from 1970 to 2007—a period which captures episodes of reasonably low inflation, rising inflation, high inflation, hyperinflation, and low inflation again—and panel time-series analysis to study whether inflation played any role (either via the Mundell-Tobin effect and its predicted shift from money to financial assets which would drive the interest rates down and consequently increase economic activity, or alternatively via higher macroeconomic uncertainty and volatility, and other distortions which would actually create a hold up problem and possibly offset the Mundell-Tobin effect), in generating growth in Latin America.

Interestingly enough, although the above-mentioned countries differ in terms of economic *and* institutional development (with Argentina and Brazil being reasonably more developed than Bolivia and Peru), all of them suffered severe hyperinflationary bursts sometime after their democratisation processes. Therefore, in the vein of Sargent, Williams and Zha (2009), we pay special attention to these four countries in an attempt to better understand and consequently shed some light on a time period which includes the *infamous* ‘lost decade’ in South America.

The empirical results robustly suggest that, during the period investigated, inflation has not only been the main macroeconomic determinant of growth in the region, but also that its effect has been clearly a negative one

on growth (clearly offsetting the prospective Mundell-Tobin effect). It is therefore fair to say that the lack of certain economic institutions (central-bank independence and a credible fiscal authority), which were implemented in the region only in the second half of the 1990s, combined with the political transitions of the 1980s and some populist tendencies, facilitated the process of generating the easy money used to fund spiralling public transfers, which some would argue led to those hyperinflationary bursts seen in the 1980s and early 1990s, with all their consequences on economic activity, growth and welfare in general¹.

In addition, the importance of acquiring a better understanding of a time period which includes, amongst other things, high inflation and severe hyperinflationary episodes is not only because we recently have had a protracted hyperinflationary event in Zimbabwe, with all its consequences on economic activity, but also because there is an ongoing debate in developing countries like South Africa and Argentina about the role, legitimacy *and* efficacy of independent central banks in conducting monetary policy. For instance, the South African case is interesting in the sense that it is a rather unequal country transitioning to democracy (just like Latin America in the 1980s), in which particular stakeholders heavily lobby for a change in the way the South African Reserve Bank implements inflation targeting. The current Argentinian case, in which the governor of the Banco Central has been recently, and somehow hastily, removed from office, is also interesting given the recurring history of populism and poor macroeconomic performance that this country has experienced in the last 40 years or so. Therefore, it is important to better understand not only the causes, but also the consequences of episodes of macroeconomic mismanagement, so that the mistakes of the past do not happen again.

The contribution of this paper to the literature is that, firstly, we follow the early advice given by Fischer (1993) and Temple (2000), and also the recent analysis by Sargent, Williams and Zha (2009) of the South American hyperinflationary experiences, and restrict our sample to those diverse Latin American countries which transitioned to more democratic regimes in the

¹For instance, Bittencourt (2009) investigates the case of the Brazilian hyperinflation of the 1980s and early 1990s, and he suggests that the high rates of inflation seen at the time contributed to increase earnings inequality. Moreover, Easterly and Fischer (2001) suggest that the poor from 38 countries consider inflation to be a more pressing problem than the rich, which suggests that the poor are the ones suffering more with higher inflation.

1980s and that suffered hyperinflationary episodes in the 1980s and 1990s to conduct a more disaggregated and ‘detailed’ *case study* on the subject.

Secondly, we follow the advice by Durlauf, S. N., Johnson, P. A., and Temple, J. R. W. (2005), and Sirimaneetham and Temple (2009) and make use of principal component analysis to get independent latent variables with more explanatory power in an attempt to reduce *model uncertainty* in growth analysis.

Thirdly, we also follow the early advice given by Bruno and Easterly (1998), and to some extent the recent analysis by Bond, Leblebicioğlu and Schiantarelli (2010), and make use of *annual data*, without the usual averaging which would certainly blur our view on the region, to better pinpoint the effects of some macroeconomic variables on growth.

Finally, we take advantage of *panel time-series analysis*—which deals with empirical issues such as non-stationarity, heterogeneity and endogeneity biases, and cross-section dependence in relatively thin panels—to carry out a more specific study on Latin America, which methodologically differs from the previous large cross-sectional and panel studies that treated Latin America either as a dummy or as an outlier to be removed from the sample. This is believed to provide more informative estimates on the topic, and therefore to deepen our knowledge of the region.

The remainder of the paper is as follows: the next section briefly reviews and inserts this paper within the previous literature. Section Three describes the data and the empirical strategy used, and then reports and discusses the results obtained. Section Four concludes the paper, it summarises the work, and then it suggests some *policy* implications and also possible future work.

2 Related Literature

The literature on inflation and growth has a long and illustrious tradition in economics. De Gregorio (1993) presents some early evidence using a panel of twelve Latin American countries during the 1950-1985 period, and he suggests that inflation is detrimental to economic growth (or that economic agents in general will shift to activities which are ‘not the engines of sustained growth’); and Fischer (1993) presents international cross-sectional and panel data evidence for the period between 1961 and 1988 to suggest that inflation indeed outweighs the Mundell-Tobin effect, or that inflation

reduces the capital stock in the economy. It is worth noting that, given the date of their publication and the periods covered, these two studies do not account for the hyperinflationary episodes in Latin America of the early 1990s, which would certainly reinforce their results.

Furthermore, Barro (1995) suggests that ‘households are thought to perform poorly when inflation is high’ and he makes use of international data covering the period between 1960 and 1990, and cross-sectional analysis, to suggest that the high-inflation countries in his sample, mostly in Latin America, drive the negative effects of inflation on growth; and Bullard and Keating (1995) make use of annual time-series data and VAR analysis to reach a similar conclusion (that in the high-inflation country in their sample, inflation negatively affects growth, or that the Mundell-Tobin effect is offset).

Moreover, Clark (1997) uses a panel of eighty five countries between 1960 and 1985, and different specifications and sub-samples, to confirm the above (that economic agents ‘devote productive resources to dealing with inflation’) and he suggests that there are problems with cross-section regressions—because of the averaging—and that panel analysis might be the way forward. Bruno and Easterly (1998) suggest that, because of the averaging again, there is no long-run relationship between inflation and growth in cross-sectional analysis. Nevertheless, they suggest, using a non-parametric approach and data covering the period between 1961 and 1994 that there is a negative relationship between inflation and growth when inflation reaches their proposed 40% *threshold* (or an inflation crisis).

In addition, Sarel (1996), Gosh and Phillips (1998), and Khan and Senhadji (2001) confirm the above negative relationship between inflation and growth once inflation reaches particular thresholds. Finally, Sirimaneetham and Temple (2009) make use of an index for macroeconomic instability, based on principal component analysis, and Bayesian Model Averaging in an attempt to deal with model uncertainty, and they suggest that macroeconomic stability is a *necessary* condition for economic growth in a panel of 70 developing countries during the period between 1970 and 1999.

Ultimately, the literature suggests that high inflation is detrimental to growth in large cross-section and panel data samples (it either outweighs the Mundell-Tobin effect, or create particular distortions, including increased volatility and uncertainty, which results in a shift to less productive activities

and consequently slower growth rates), and in a region like Latin America—which has suffered from chronic income inequality—high inflation and erratic growth certainly display negative effects on overall economic welfare².

Hence, it is fair to say that this paper is a natural development of the previous literature on the subject (we conduct a case study that attempts to pinpoint in more detail the effects of severe macroeconomic conditions on economic activity; we avoid the averaging and make use of annual data, and panel time-series analysis so that we are able to capture more accurately the role of the poor macroeconomic performance seen in the 1980s and early 1990s in Latin America on growth; and we attempt to reduce model uncertainty via principal component analysis). It is therefore believed that we are able to provide informative estimates so that our knowledge on those historical episodes in a very idiosyncratic, and also diverse within, Latin America is deepened.

3 Empirical Analysis

3.1 A Look at The Data

The data set used covers the period between 1970 and 2007, and four Latin American countries, namely Argentina, Bolivia, Brazil and Peru ($T = 38$ and $N = 4$). To briefly illustrate the importance of these countries in the regional context, these four countries accounted for approximately 70% of the total GDP and population in South America in 2009.

The growth rates of the real gross domestic products per capita (*GROW*) are provided by the Penn World Table (PWT) data set mark 6.3, and the data on inflation (*INFLAT*) come from the Bureaux of Census of the four countries.

The control variables used are rather standard in the literature and include the general government debt share to GDP (*DEBT*), which proxies for governments' abilities in controlling their own finances and captures the fact that governments (particularly in Latin America), tend to increase consumption and expenditure during political transitions (Bittencourt (2011), and

²Other notable contributions include Barro (1998), Fischer (2004) and Easterly (2005), not to mention the growth studies which include inflation as the main proxy for macroeconomic performance. Overall, most of these large cross-section and panel studies reach the conclusion that inflation is detrimental to economic growth. See Temple (2000) for an early survey of the literature.

Brender and Drazen (2007)). It is predicted that highly indebted governments tend to be detrimental to growth (Barro (1995)). This information is provided by the recently released IMF’s Historical Public Debt Database. In addition, we use the ratio of exports and imports to GDP (*OPEN*), a proxy for economic openness which captures the trade liberalisation processes taking place in Latin America in the 1990s and it is expected that more open economies display faster growth rates (Lucas (2009), and Wacziarg and Welch (2008)); and the ratio of investment to real GDP (*INV*), a canonical Solow growth determinant. The data on all these variables are provided by the PWT files. We also use a baseline measure of financial development (the ratio of the liquid liabilities to GDP (*M2*), from the World Bank’s World Development Indicators (WDI) and it is expected that wider access to finance increases economic activity (Levine (2005)).

Moreover, we interact the average years of schooling of those aged 25 and over (from the Barro and Lee data set), with the percentage of the total urban population (from the WDI files), to construct an index for structural development (*DEV*), which is supposed to capture the unified growth theory fact that developing societies tend to be not only more educated (or in the process of educating themselves), but also more urbanised (all these four countries have shifted the emphasis from agriculture to manufacturing and services in their recent history) (see Kuznets (1955) or Galor (2005)).

Furthermore, we construct two latent variables in an attempt to reduce the set of a number of observed variables to a smaller number of indicators which are believed to drive most of the variation in the original data, and that consequently helps to reduce model uncertainty in growth analysis.

Therefore, via spectral decomposition we are able to extract from the standardised data matrix the unobserved common factors of three normalised, and rather popular, Polity IV variables (democracy (*DEMOC*), constraints on the executive (*XCONST*), and political competition (*POLCOMP*)), so that we end up with a proxy for political regime characteristics (*POL*), which contributes to reduce model uncertainty, and that is believed to present more explanatory power. In this particular case, the first principal component—which roughly corresponds to the mean of the series—accounts for 97% of the variation in these three Polity IV variables. All in all, this proxy captures the role of the political transitions from dictatorship to more democratic regimes taking place in Latin America in the 1980s and the pre-

diction is that more constrained executives, or more democratic regimes, tend to implement better policies which are conducive to growth.

Finally, via principal component analysis, we also extract the unobserved common factors amongst the first lag of inflation, government's share to GDP (from the PWT files) and the ratio of external debt to GDP (from the WDI files), to construct an index for macroeconomic stability (*STABIL*) (very much in the vein of Sirimaneetham and Temple (2009)), which contributes to reduce the dimensionality of a set of prospective cyclical macroeconomic variables, and that is supposed to present more explanatory power in determining the poor macroeconomic performance seen in the region in the 1980s and early 1990s³. For instance, in this particular case the first principal component accounts for 52% of the variation in these three cyclical variables and the prediction is that inflation is persistent, bigger governments tend to generate higher inflation as well as highly indebted ones.

In essence, Durlauf, S. N., Johnson, P. A., and Temple, J. R. W. (2005) in their extensive chapter in the Handbook of Economic Growth list different *groups* of variables that, in one way or another, have already been regressed against growth, which include different definitions of inflation, government, openness to trade, investment, finance, education and democracy. Given data availability, we attempt to not only represent all of these groups without unnecessary duplications in our empirical specifications later on in the analysis, but also to connect them to the recent Latin American history.

For the sake of clarity, in Figure One we plot the data on GDP per capita and inflation rates in Argentina, Bolivia, Brazil and Peru respectively (in clockwise fashion), and what we can see is that, in particular during the hyperinflationary bursts of the 1980s and early 1990s, GDP per capita presented sharp decreases in all four countries, just to recover after the stabilisation of the 1990s. Basically, in this case if a twenty-year average between 1980 and 2000 had been taken, we would not be able to see any negative effect of inflation on economic activity in the region (Bruno and Easterly (1998)).

³It is worth remembering the importance of the external debt, debt rescheduling and default crisis in Latin America, particularly in the 1980s, which coincide with the beginning of the process of high inflation. See Sachs (1985) for a historical overview of the Latin American case.

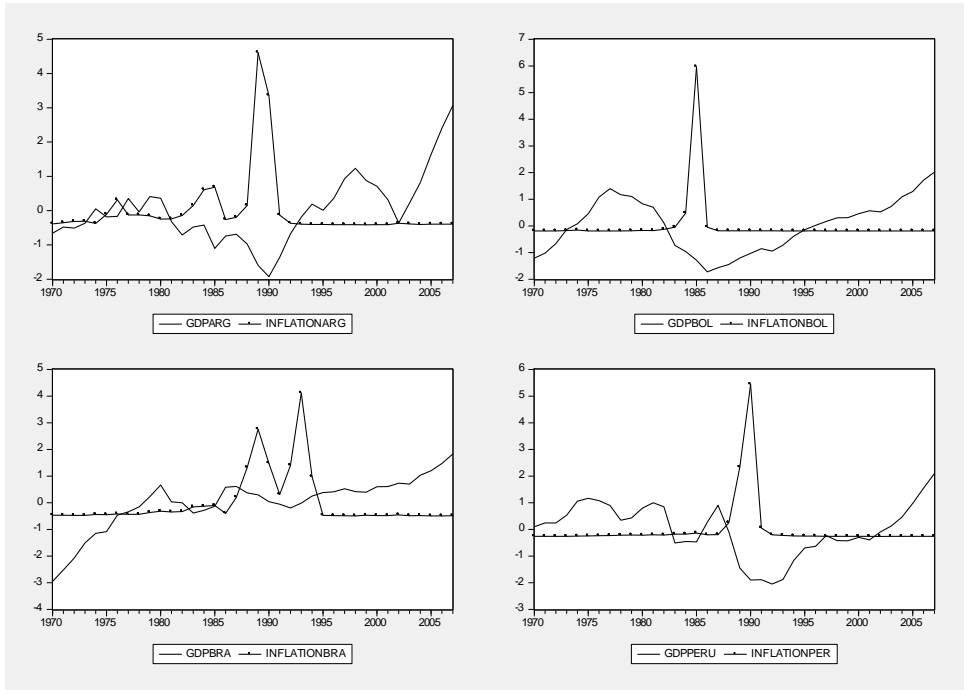


Figure 1: GDP per capita and Inflation, Argentina, Bolivia, Brazil and Peru, 1970-2007. Sources: Penn World Table and Bureaux of Census. *GDP* is the GDP per capita and *Inflation* is the inflation rate.

Moreover, in Table One we present the correlation matrix of the variables used, and inflation and growth present negative and statistically significant correlations to each other. The control variables present the expected signs (government debt is known to be negatively associated with growth (Barro (1995)), more open economies tend to grow faster (Wacziarg and Welch (2008)), investment, for being a canonical Solow growth determinant, is positively correlated to growth (Bond, Leblebicioğlu and Schiantarelli (2010)), and the measure of financial development is positively correlated to growth (Levine (2005)), as well as our measure of development). The variable of political regime characteristics indicates that the implementation of democracy in the region in the 1980s, which is illustrated by a reduction in the index *POL*, was, in fact, associated with slower growth⁴.

⁴Bittencourt (2010) suggests that, because of the distributional conflict and some populist tendencies, some of the Latin American countries that transitioned from dictatorship to democracy in the 1980s suffered from poor macroeconomic performance at the time.

Table 1: The Correlation Matrix: Argentina, Bolivia, Brazil and Peru, 1970-2007.

	GROW	INFLAT	DEBT	OPEN	INV	M2	DEV	POL
GROW	1							
INFLAT	-0.451*	1						
DEBT	-0.173*	0.204*	1					
OPEN	0.044	-0.379*	0.348*	1				
INV	0.244*	-0.118	-0.657*	-0.434*	1			
M2	0.104	-0.299*	0.072	0.368*	-0.277*	1		
DEV	0.017	-0.056	-0.209*	0.077	0.334*	0.019	1	
POL	0.100	-0.142	-0.370*	-0.323*	0.379*	-0.423*	-0.384*	1

Sources: Penn World Table, Bureaux of Census, IMF, World Development Indicators, Barro and Lee, and Polity IV. * represents significance at the 5% level.

Furthermore, in Figure Two we plot the OLS regression line between inflation and growth in Argentina, Bolivia, Brazil and Peru, and the relationship is negative and statistically significant, which indicates that perhaps there is an *economic* relationship between these two variables in the panel.

All in all, this initial inspection of the data, with all its caveats, suggests that the anecdotal evidence of the 1980s and early 1990s of high inflation rates and erratic economic growth in Latin America might be correct (the data plots show the sharp decline in income, particularly during the hyper-inflationary bursts, the statistical correlation between inflation and growth is negative and significant, and finally the OLS regression line indicates a significant negative economic relationship between inflation and growth in the region). Therefore, it can be speculated at this stage that the Mundell-Tobin effect was outweighed (or that there was an increase in macroeconomic volatility or a shift to less productive activities) by the high inflation rates of the 1980s and early 1990s in these Latin American countries.

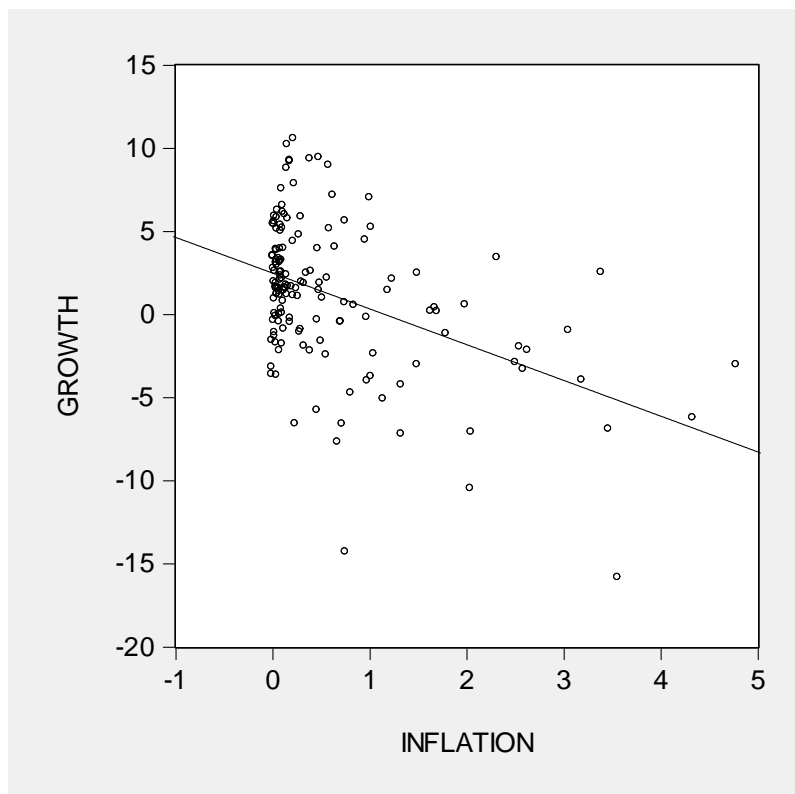


Figure 2: OLS Regression Line between GDP Growth and Inflation, Argentina, Bolivia, Brazil and Peru, 1970-2007. Sources: Penn World Table and Bureaux of Census. *Growth* is the GDP growth rate and *Inflation* is the inflation rate.

3.2 Empirical Strategy

In terms of econometric modelling, since we have a $T > N$ data set, the empirical strategy used is based on panel time-series analysis. This is interesting in itself because panel time-series allows us not only to deal with important econometric issues in relatively thin panels—non-stationarity, heterogeneity and endogeneity biases, and between-country dependence—but also to specifically further our knowledge of Latin America without having to incur in the usual removal of Latin American countries from large cross-sectional or panel data analyses. All in all, with panel time-series we can specifically analyse Latin America, with all its idiosyncrasies and differences within, without treating it either as an outlier or as a dummy, and therefore disaggregate the analysis further so that a clearer picture of the region

emerges.

Firstly, although some of the variables are either ratios or indices, and therefore bounded within closed intervals, for *non-stationarity* in the country time-series we use the Im, Pesaran and Shin (IPS (2003)) test, which allows for *heterogeneous* parameters and serial correlation. The IPS test consists of an augmented Dickey-Fuller (ADF) regression for each variable of each country, and these are then averaged. The moments of the mean and variance of the average \bar{t} are -1.46 and .63 respectively⁵.

Secondly, the issue of statistical endogeneity (the unobserved individual effects which are nested in the error term might be correlated to the regressors), and heterogeneity of intercepts are dealt with by the Fixed Effects (FE), or the within estimator, which provides consistent estimates in dynamic models when $T \rightarrow \infty$, indeed the case at hand here. Thirdly, *heterogeneity* bias in *dynamic* $T > N$ panels, which is caused because, with wrongly assumed homogeneity of the slopes, the disturbance term is serially correlated and the explanatory variables x_s are not independent of the lagged dependent variable y_{t-1} , is dealt with by the Swamy's (1970) Random Coefficients (RC) estimator, which assumes heterogeneity of intercepts *and* slopes, and it gives consistent estimates of the expected values as $T \rightarrow \infty$. Basically, the RC estimator, 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 ⁶.

⁵An alternative to IPS (2003) is the test by Levin, Lin and Chu (2002). However, this test assumes parameter *homogeneity*, and therefore does not consider a possible heterogeneity bias present in the data. Moreover, given that these countries shared some poor macroeconomic characteristics in the 1980s and early 1990s, some would argue that there is between-country dependence present. An alternative that considers the existence of between-country dependence is proposed by Pesaran (2007), the cross-section IPS (CIPS) test. However, CIPS assumes that $N > 10$ and we have $N = 4$ in our data set. In addition, one would argue that, given the structure of the data, structural breaks are a possibility. The test proposed by Im, Lee and Tieslau (2005) takes that into account, however this test also assumes large N , which is not entirely the case here. Other alternatives that consider particular commonalities and breaks in the data include Bai and Ng (2004) in which they propose the PANIC attack on unit roots in large panels ($N = 40, T = 100$), and Bai and Carrion-I-Silvestre (2009) which also consider reasonably large panels ($N = 20, T = 100$), none applicable to our case though. 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.

⁶The Mean Group estimator, proposed by Pesaran and Smith (1995), is also an alternative. However, this estimator is sensitive to outliers, a problem not faced by the RC estimator. In addition, Bond (2002) argues that GMM-type estimators are *not* an

Essentially, although these countries shared some poor macroeconomic characteristics in the 1980s and early 1990s, these two pooled estimators account for important econometric issues in dynamic $T > N$ panels, statistical endogeneity and heterogeneity biases (not to mention a reduction in the Nickell bias as $T \rightarrow \infty$), or for the fact that some of these countries do indeed present different levels of economic development and sophistication (e.g., Brazil and Argentina are known to be relatively more developed than Peru and Bolivia), and could have been affected by inflation differentially.

Furthermore, some would argue that there is *reverse causality*, or economic endogeneity, present (that higher growth is actually generating higher inflation and not the inverse). We therefore use the Fixed Effects with Instrumental Variables (FE-IV) two-stage Least Squares estimator, and we firstly follow Barro (1995 and 1998) and make use of the first lag of inflation as a baseline instrument and secondly we use the composite index *STABIL* as our identifying instrument for inflation. Essentially, if we assume that the observed data are generated by a small number of *unobserved* factors, then *STABIL*, for not being represented in the original specification, is a valid instrument and it is supposed to capture the role of the unobserved common factors amongst the first lag of inflation, government size and external debt in, actually, predicting inflation⁷. The estimates provided by the FE-IV estimator are asymptotically consistent and efficient as $T \rightarrow \infty$, and it retains the time series consistency even if the instrument set is only predetermined.

We therefore estimate static and dynamic models with different pooled estimators (the benchmark Pooled Ordinary Least Squares (POLS), FE, RC and FE-IV estimators), so that different econometric issues are dealt with and more reliable estimates provided. The estimated heterogeneous dynamic equation is therefore as follows,

$$\begin{aligned} GROW_{it} = & \alpha_i + \beta_i INFLAT_{it} + \gamma_i DEBT_{it} + \delta_i OPEN_{it} + \epsilon_i INV_{it} \\ & + \varepsilon_i M2_{it} + \zeta_i DEV_{it} + \eta_i POL_{it} + \theta_i GROW_{it-1} + v_{it}, \quad (1) \end{aligned}$$

in which *GROW* are the growth rates of the domestic GDPs, *INFLAT* are the inflation rates, *DEBT* is the share of government debt to GDP, *OPEN*

alternative under $T > N$ for the overfitting problem.

⁷It is important to stress the fact that none of the variables which make this index up are in the original estimated equation, therefore this variable is a valid instrument by definition.

is a measure of economic openness, INV is the share of investment to GDP, $M2$ is the share of the liquid liabilities to GDP, DEV is the interaction between education and urbanisation, and POL is the political regime variable which consists of the unobserved common factors of $DEMOC$, $XCONST$ and $POLCOMP$.

In addition, and given that some poor macroeconomic characteristics are shared by those countries in the 1980s, we deal with *between-country dependence*, which is believed to happen through the disturbances being $E(v_{it}v_{jt}) \neq 0$. Given the nature of the data, $T > N$, we make use of Zellner's (1962) Seemingly Unrelated Regressions (SUR) estimator, which presents greater efficiency, the greater the correlation amongst the disturbances. The SUR estimates different country time series, which are then weighted by the covariance matrix of the disturbances⁸. Moreover, this estimator provides rather insightful estimates because it disaggregates the analysis further than the pooled analysis, so that we can have a more in-depth view of the effects of the inflationary processes on growth in the region⁹. Equation Two illustrates the dynamic equation estimated for each country,

$$GROW_t = \alpha_t + \beta INFLAT_t + \gamma DEBT_t + \delta OPEN_t + \epsilon INV_t + \varepsilon M2_t + \zeta DEV_t + \eta POL_t + \theta GROW_{t-1} + v_t. \quad (2)$$

3.3 Results

In terms of results, firstly, we report the IPS statistics— $GROW$ is -3.24, $INFLAT$ is -2.87, $OPEN$ is -2.51, INV is -2.41, $M2$ is -2.04, DEV is -2.18 and POL is -2.26—and they suggest that we can reject the null hypothesis of unit roots and accept in favour of the alternative that at least *one* country of each variable is, in fact, stationary. With that in mind, we do not have to incur in any further data transformation, nor pursue panel-cointegration analysis¹⁰.

⁸An alternative to SUR is the Common Effects Estimator proposed by Pesaran (2006). However, N is assumed to be large and in our data set $N = 4$. Furthermore, Kapoor, M., H. H. Kelejian, *et al.* (2007) propose an estimator that also works best under the $N \rightarrow \infty$ assumption.

⁹For a more thorough discussion about panel time-series analysis in general, see Smith and Fuertes (2008) or Lee, Pesaran and Smith (1998) for a more applied to growth analysis.

¹⁰In addition, in terms of possible cointegration between growth and inflation, the Levin, Lin and Chu statistics for growth and inflation are respectively -3.33 and -3.92, and the Fisher test proposed by Maddala and Wu (1999) provides values of 31.24 and 24.21. These

Secondly, in Table Two we report the static and dynamic estimates of *INFLAT* on *GROW* using the POLS, FE and RC estimators respectively. Most *INFLAT* estimates are negative and statistically significant against *GROW*, suggesting that the severe macroeconomic conditions of the 1980s and early 1990s indeed contributed to distort the pace of overall economic activity. For instance, using the dynamic FE estimate in column (3), every percentage increase in inflation would reduce growth in .15% per year, which given the nature of inflation in those countries in the 1980s and early 1990s, would be a considerable detrimental effect.

INV, as expected, presents positive and mostly significant effects on *GROW*. The other control variables do not present clear-cut estimates in this instance. Moreover, the F* tests indicate that there is some evidence of country fixed effects and the Likelihood Ratio (LR) test suggests heterogeneity of intercepts *and* slopes in the dynamic case.

somehow corroborate the IPS statistics reported above which indicates that these series are stationary.

Table 2: POLS, FE and RC Estimates of Inflation on Economic Growth, 1970-2007.

GROW	Static and Dynamic Models			
	POLS (1)	FE (2)	FE (3)	RC (4)
INFLAT	-1.926 (-4.32)	-1.769 (-3.94)	-1.59 (-3.41)	-2.243 (-1.60)
DEBT	-0.001 (-.08)	-0.006 (-.44)	-0.005 (-.36)	-0.076 (-.96)
OPEN	0.009 (.34)	0.123 (1.53)	0.089 (1.09)	-0.131 (-.58)
INV	0.235 (2.10)	0.255 (2.19)	0.250 (2.01)	0.483 (1.06)
M2	-0.005 (-.16)	-0.052 (-1.35)	-0.053 (-1.36)	-0.247 (-1.13)
DEV	-0.002 (-.84)	-0.006 (-.75)	-0.002 (-.32)	0.016 (1.48)
POL	-0.432 (-1.55)	-0.476 (-1.48)	-0.413 (-1.28)	-0.857 (-1.61)
GROW ₋₁			0.107 (1.19)	-0.104 (-.78)
F test	5.66	6.50	6.11	
F test*		1.90	1.68	
R ²	0.22	0.14		
LR test				55.66
Wald test				24.91

T-ratios in parentheses. Number of observations: $NT = 152$. The basic estimated equation is $GROW_{it} = \alpha_i + \beta_i INFLAT_{it} + \gamma_i DEBT_{it} + \delta_i OPEN_{it} + \epsilon_i INV_{it} + \varepsilon_i M2_{it} + \zeta_i DEV_{it} + \eta_i POL_{it} + \theta_i GROW_{it-1} + v_{it}$, in which $GROW$ is the growth rate of the real GDP, $INFLAT$ is the inflation rate, $DEBT$ is the government's debt share to GDP, $OPEN$ is a measure of economic openness, INV is the investment ratio to GDP, $M2$ is the liquid liabilities ratio to GDP, DEV is the interaction of schooling and urbanisation, and POL is a proxy for political regime characteristics. POLS is the Pooled Ordinary Least Squares, FE is the Fixed Effects and RC the Random Coefficients estimators.

Thirdly, in Table Three we report the static and dynamic estimates of $INFLAT$ on $GROW$ using the FE-IV estimator, and all $INFLAT$ estimates instrumented with the index $STABIL$ confirm that the poor macro-economic performance of the 1980s and early 1990s somehow contributed to significantly reduce economic activity in this case too. More specifically, in columns (1) and (2) we make use of lagged inflation as the baseline instrument for inflation, and in columns (3) and (4) we use the composite index $STABIL$ as the identifying instrument, and according to the dynamic estimate in column (4), for every percentage increase in inflation, growth would be reduced in .28% per year.

In addition, *INV* confirms its positive and significant effect on growth, and the other controls do not present clear-cut effects this time either. Furthermore, in the first-stage regressions (available on request), the F tests for overall significance indicate that we can reject the null hypothesis and the identifying instruments, lagged inflation and *STABIL*, are positive and statistically significant, which minimises the possibility of weak instruments.

Table 3: FE-IV Estimates of Inflation on Economic Growth, 1970-2007.

GROW	Static and Dynamic Models			
	FE-IV (1)	FE-IV (2)	FE-IV (3)	FE-IV (4)
INFLAT	-0.918 (-1.33)	-0.406 (-.53)	-2.91 (-2.57)	-2.82 (-2.07)
DEBT	-0.011 (-.75)	-0.010 (-.70)	0.000 (.03)	0.000 (.01)
OPEN	0.167 (1.93)	0.136 (1.55)	0.065 (.67)	0.041 (.42)
INV	0.265 (2.23)	0.237 (1.85)	0.242 (2.00)	0.264 (2.05)
M2	-0.044 (-1.13)	-0.040 (-1.00)	-0.063 (-1.54)	-0.066 (-1.57)
DEV	-0.005 (-.69)	-0.001 (-.20)	-0.006 (-.80)	-0.003 (-.43)
POL	-0.332 (-.98)	-0.199 (-.57)	-0.678 (-1.80)	-0.642 (-1.58)
GROW ₋₁		0.174 (1.78)		0.036 (.31)
IV	INFLAT ₋₁	INFLAT ₋₁	STABIL	STABIL
F test*	2.24	1.84	1.19	1.38
R ²	0.10	0.15	0.18	0.22

T-ratios in parentheses. Number of observations: $NT = 152$. The basic estimated equation is $GROW_{it} = \alpha_i + \beta INFLAT_{it} + \gamma DEBT_{it} + \delta OPEN_{it} + \epsilon INV_{it} + \varepsilon M2_{it} + \zeta DEV_{it} + \eta POL_{it} + \theta GROW_{it-1} + v_{it}$, in which *GROW* is the growth rate of the real GDP, *INFLAT* is the inflation rate, *DEBT* is the government's debt share to GDP, *OPEN* is a measure of economic openness, *INV* is the investment ratio to GDP, *M2* is the liquid liabilities ratio to GDP, *DEV* is the interaction of schooling and urbanisation, and *POL* is a proxy for political regime characteristics. The identifying instruments are the first lag of inflation, columns (1) and (2), and the index *STABIL*, columns (3) and (4). FE-IV is the Fixed Effects with Instrumental Variables estimator.

Finally, when we disaggregate the analysis further and make use of the SUR estimator that takes into account any between-country dependence present in the data, the story the data are telling us does not change much. In the first panel of Table Four *INFLAT* presents negative signs on growth and most of the static estimates are statistically significant, as well as in the

second panel which presents the dynamic *INFLAT* estimates. For instance, using the dynamic estimate for Argentina (first column in the bottom panel), for every percent increase in inflation, growth would decrease in .23% per year. The Lagrange Multiplier (LM) tests of independence suggest that we can not accept the null hypothesis of between-countries independence, which validates the use of the SUR estimator in this analysis.

It is also worth saying that Bolivia does not present statistically significant *INFLAT* estimates against growth in this more disaggregated analysis. Using the information contained in Figure One above, this is perhaps because GDP per capita and growth rates in Bolivia were already experiencing negative trends from the late 1970s onwards, before the hyperinflationary episodes of the 1980s, probably because of the excessive political instability seen towards the end of the 1970s in that country. Nevertheless, during the hyperinflationary events of the 1980s income and growth suffered even sharper reductions than in the 1970s. On the other hand, Brazil does not present clear-cut *INFLAT* estimates either. This is possibly because Brazil already had a fairly sophisticated indexation mechanism back in the 1980s, which could have played a role in minimising the deleterious effects of inflation on growth.

In essence, although all four countries shared poor macroeconomic performance in the 1980s and early 1990s, the SUR analysis highlights the fact that the countries in the sample indeed have different economic characteristics and could have been affected by inflation differentially. Nevertheless, inflation kept its detrimental effect to growth not only in a less developed country like Peru, but also to a fairly sophisticated economy like Argentina.

Table 4: SUR Estimates of Inflation on Economic Growth, 1970-2007.

GROW	SUR			
	ARGENTINA	BOLIVIA	BRAZIL	PERU
INFLAT	-2.13 (-1.69)	-0.576 (-.94)	-0.258 (-.30)	-2.99 (-2.89)
DEBT	0.066 (2.62)	-0.035 (-1.22)	-0.140 (-2.41)	-0.215 (-1.20)
OPEN	0.304 (.73)	0.056 (.57)	-0.639 (-1.24)	-0.055 (-.24)
INV	1.19 (2.41)	-0.049 (-.33)	0.312 (.72)	0.011 (.03)
M2	-0.789 (-3.70)	-0.100 (-1.43)	0.283 (3.24)	-0.469 (-2.48)
DEV	-0.005 (-.13)	0.019 (.72)	0.017 (.34)	0.031 (1.92)
POL	-1.39 (-2.34)	-0.203 (-.54)	-1.27 (-1.78)	-0.732 (-.85)
LM test	18.60			
INFLAT	-2.31 (-2.24)	-0.631 (-.99)	-0.161 (-.19)	-4.51 (-4.00)
DEBT	0.085 (4.00)	-0.024 (-.69)	-0.165 (-2.97)	-4.64 (-2.70)
OPEN	0.382 (1.13)	0.035 (.36)	-1.04 (-2.09)	-0.115 (-.50)
INV	1.90 (4.08)	-0.010 (-.07)	0.750 (1.67)	-0.376 (-.97)
M2	-0.940 (-5.43)	-0.085 (-1.18)	0.255 (3.07)	-0.660 (-3.64)
DEV	-0.006 (-.20)	0.023 (.84)	0.068 (1.31)	0.044 (2.76)
POL	-2.05 (-3.86)	-0.107 (-.28)	-1.20 (-1.68)	-0.541 (-.70)
GROW ₋₁	-0.520 (-4.34)	0.093 (.53)	-.212 (-1.44)	-0.370 (-2.51)
LM test	18.02			

T-ratios in parentheses. Number of observations: $NT = 152$. The basic estimated equation is $GROW_t = \alpha_t + \beta INFLAT_t + \gamma DEBT_t + \delta OPEN_t + \epsilon INV_t + \varepsilon M2_t + \zeta DEV_t + \eta POL_t + \theta GROW_{t-1} + v_t$, in which $GROW$ is the growth rate of the real GDP, $INFLAT$ is the inflation rate, $DEBT$ is the government's debt share to GDP, $OPEN$ is a measure of economic openness, INV is the investment ratio to GDP, $M2$ is the liquid liabilities ratio to GDP, DEV is the interaction of schooling and urbanisation, and POL is a proxy for political regime characteristics. SUR is the Seemingly Unrelated Regressions estimator.

In a nutshell, the estimates reported above indicate that the inflation rates clearly and robustly presented detrimental effects to economic growth in those Latin American countries which experienced not only high rates of inflation, but also bursts of hyperinflation shortly after their political transitions in the 1980s and early 1990s. It is also worth highlighting that the only cyclical and structural variable presenting clear-cut effects on growth was, in fact, inflation, which suggests that macroeconomic performance, given its

extreme nature, was the main driving force behind economic activity at the time in the region. Furthermore, although these countries stabilised their economies in the 1990s, the analysis conducted here highlights the negative effects of inflation on growth over the entire period. Finally, inflation did not discriminate between more and less developed economies in the region (*most* countries in the sample experienced the deleterious effects of inflation on economic activity)¹¹.

Ultimately, the above is potentially important in terms of economic welfare, the poor macroeconomic performance seen in the 1980s and early 1990s in the region contributed to reduce growth, which usually has a first- and second-order impact on the poor via higher unemployment, and subsequently increased poverty and inequality.

4 Concluding Observations

Using a data set covering the period between 1970 and 2007, we investigated in this paper the role of macroeconomic performance, mainly in terms of inflation rates, in determining economic growth in a panel of Latin American countries that experienced hyperinflationary episodes in the 1980s (Argentina, Bolivia and Brazil) and early 1990s (Brazil and Peru). The results, based on panel time-series analysis, suggest that inflation was indeed detrimental to growth in the region.

More specifically, amongst the cyclical and structural variables used in the analysis, inflation proved to be the only one presenting clear-cut effects against growth, which highlights its central role in determining economic activity in the region. Moreover, although inflation has been under control in Latin America for some time, overall it still presents detrimental effects to economic activity, it outweighs the Mundell-Tobin effect (or alternatively speaking, inflation has increased macroeconomic uncertainty or induced agents to shift to less productive activities), which highlights the importance of those hyperinflationary bursts in contributing to distort economic activity in a diverse region that already suffers from, amongst other things, chronic income inequality. Finally, growth in the sample was, in one way or another, affected by inflation (inflation did not discriminate between

¹¹When we run alternative regressions with lagged GDP per capita on the RHS, the *INFLAT* estimates keep their signs and significance. Available on request.

more and less developed countries in the panel).

The quality of the evidence presented is, to a certain extent, boosted not only because we focus on those countries which at some point in time suffered from hyperinflation in Latin America, but also because we use a proxy for macroeconomic stability based on principal component analysis, which is believed to reduce model uncertainty and has more explanatory power. Moreover, we avoid the averages and take advantage of panel time-series analysis, which deals with important empirical issues not covered by the previous studies, such as heterogeneity bias in dynamic panels, endogeneity and between-country dependence in relatively thin panels. This analysis is important because it allows us to specifically study Latin America, instead of treating the region either as a dummy or as an outlier to be removed from the sample. It is therefore believed that the analysis conducted here represents a step forward in terms of achieving insightful estimates, and in improving our knowledge on the subject in Latin America.

Regarding future work, on the one hand the issue of a smooth transition to a different macroeconomic regime, hyperinflation in this case, can be investigated. On the other hand, with larger panels of high-inflation countries presenting cointegrating relationships *and* particular commonalities, the use of new estimation methods like DOLS, and CupBC and CupFM proposed respectively by Kao and Chiang (2000), and Bai, Kao and Ng (2009) is a real possibility for further research.

To conclude, the Latin American hyperinflationary experience is informative because it exemplifies an interesting pattern seen in a number of countries at the time. Those Latin American societies that went through political transitions and which still did not have particular economic institutions such as an independent central bank conducting sound monetary policy and a credible fiscal authority in place, ended up experiencing traumatic episodes of hyperinflation, which tend to affect, in one way or another, mainly the welfare of the poor. Moreover, coincidentally enough, macroeconomic stabilisation came only when those countries matured politically, and introduced central bank independence, inflation targeting and fiscal responsibility laws in the 1990s¹². Therefore, perhaps in times in which Chavez,

¹²For instance, Singh (2006), Singh and Cerisola (2006) and Santiso (2006) highlight the importance of the much improved macroeconomic performance in Latin America recently to produce better economic outcomes from the 1990s onwards. Nevertheless, Carstens and Jácome (2005) warn that Brazil still has one of the *least* independent central banks

the Kirchners, Morales, Garcia and Correa are exercising their persuasive populist credentials, the lessons of past macroeconomic mismanagement episodes and their effects on economic activity must be not only learned and well understood, but also kept in the minds of policy makers and other stakeholders, so that the mistakes of the past are not repeated again.

Ultimately, the lesson here is that political liberalisation processes in developing countries should be accompanied not only by well-constrained executives, but also by the implementation of the right economic institutions (central bank independence and fiscal responsibility laws), so that the cost of generating high inflation is increased in the first place and macroeconomic factors do not become impediments to economic growth and prosperity.

References

- [1] Abbas, S.M. Ali, Nazim Belhocine, Asmaa El-Ganainy and Mark Horton. 2010. A Historical Public Debt Database. In IMF Working Paper WP/10/245.
- [2] Alesina, Alberto, and Allan Drazen. 1991. Why are stabilizations delayed? *American Economic Review* 81 (5).
- [3] Bai, Jushan, and Josep Lluís Carrion-I-Silvestre. 2009. Structural changes, common stochastic trends, and unit roots in panel data. *The Review of Economic Studies* 76:471-501.
- [4] Bai, Jushan, Chihwa Kao, and Serena Ng. 2009. Panel cointegration with global stochastic trends. *Journal of Econometrics* 149:82-99.
- [5] Bai, Jushan, and Serena Ng. 2004. A Panic attack on unit roots and cointegration. *Econometrica* 72 (4):1127-1177.
- [6] Barro, Robert J. 1998. *Determinants of Economic Growth: A Cross-country Empirical Study*. The MIT Press.
- [7] Barro, Robert J. 1995. Inflation and Economic Growth. In NBER Working Paper Series.

in Latin America, which is always a cause for concern.

- [8] Bittencourt, Manoel. 2010. Democracy, Populism and Hyperinflation/s/: Some Evidence from Latin America. In Proceedings of the German Development Economics Conference.
- [9] Bittencourt, Manoel. 2009. Macroeconomic Performance and Inequality: Brazil, 1983-94. *The Developing Economies* 47 (1):30-52.
- [10] Bond, Stephen R. 2002. Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice. *Portuguese Economic Journal* 1 (2):141-62.
- [11] Bond, Stephen, Asli Leblebicioğlu, and Fabio Schiantarelli. 2010. Capital Accumulation and Growth: a New Look at the Empirical Evidence. *Journal of Applied Econometrics* 25:1073-1099.
- [12] Bruno, Michael, and William Easterly. 1998. Inflation crises and long-run growth. *Journal of Monetary Economics* 41:3-26.
- [13] Bullard, James, and John W. Keating. 1995. The long-run relationship between inflation and output in postwar economies. *Journal of Monetary Economics* 36:477-496.
- [14] Clark, Todd E. 1997. Cross-country evidence on long-run growth and inflation. *Economic Inquiry* XXXV:70-81.
- [15] Durlauf, S. N., Johnson, P. A., and Temple, J. R. W. 2005. Growth econometrics. In P. Aghion and S. N. Durlauf (eds.) *Handbook of Economic Growth*, Volume 1A, North-Holland: Amsterdam.
- [16] Easterly, William. 2005. National Policies and Economic Growth: A Reappraisal. In *Handbook of Economic Growth*, edited by P. Aghion and S. N. Durlauf: Elsevier.
- [17] Easterly, William, and Stanley Fischer. 2001. Inflation and the Poor. *Journal of Money, Credit and Banking* 33 (2):160-178.
- [18] Fischer, Stanley. 1993. The role of macroeconomic factors in growth. *Journal of Monetary Economics* 32:485-512.
- [19] Fischer, Stanley. 2005. *IMF Essays from a Time of Crisis. The International Financial System, Stabilization, and Development*: The MIT Press.

- [20] Galor, Oded. 2005. From Stagnation to Growth: Unified Growth Theory. In *Handbook of Economic Growth*, edited by P. Aghion and S. Durlauf. Amsterdam: Elsevier North-Holland.
- [21] Ghosh, Atish, and Steven Phillips. 1998. Warning: Inflation May Be Harmful to Your Growth. *IMF Staff Papers* 45 (4):672-710.
- [22] Gregorio, José De. 1993. Inflation, taxation, and long-run growth. *Journal of Monetary Economics* 31:271-298.
- [23] Im, K., J. Lee, et al. 2005. Panel LM Unit-root Tests with Level Shifts. *Oxford Bulletin of Economics and Statistics* 67(3).
- [24] Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin. 2003. Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics* 115 (1):53-74.
- [25] Kapoor, Mudit, Harry H. Kelejian, and Ingmar R. Prucha. 2007. Panel Data Models with Spatially Correlated Error Components. *Journal of Econometrics* 140 (1):97-130.
- [26] Kao, Chihwa, and Min-Hsien Chiang. 2000. On the estimation and inference of a cointegrated regression in panel data. *Advances in Econometrics Volume 15*:179-222.
- [27] Khan, Mohsin S., and Abdelhak S. Senhadji. 2001. Threshold Effects in the Relationship Between Inflation and Growth. *IMF Staff Papers* 48 (1):1-21.
- [28] Kuznets, Simon. 1955. Economic growth and income inequality. *American Economic Review* 45 (1).
- [29] Lee, Kevin, H. Pesaran, and R.P. Smith. 1998. Growth empirics: a panel data approach - a comment. *Quarterly Journal of Economics* 113:319-323.
- [30] Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu. 2002. Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics* 108 (1):1-24.

- [31] Levine, Ross. 2005. Finance and Growth: Theory and Evidence. In Handbook of Economic Growth, edited by P. Aghion and S. Durlauf. Amsterdam: North-Holland.
- [32] Lucas, Robert. 2009. Trade and the diffusion of the industrial revolution. *American Economic Journal: Macroeconomics* 1:1.
- [33] Maddala, G.S., and Shaowen Wu. 1999. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics* Special issue.
- [34] Pesaran, M. Hashem. 2006. Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. *Econometrica* 74 (4):967-1012.
- [35] Pesaran, M. Hashem. 2007. A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. *Journal of Applied Econometrics* 27.
- [36] Pesaran, M. Hashem, and Ron Smith. 1995. Estimating Long-Run Relationships from Dynamic Heterogeneous Panels. *Journal of Econometrics* 68 (1):79-113.
- [37] Sachs, Jeffrey. 1985. External Debt and Macroeconomic Performance in Latin America and East Asia. *Brookings Papers on Economic Activity* 1985 (2).
- [38] Santiso, Javier 2006. *Latin America's Political Economy of the Possible*. Cambridge, MA, The MIT Press.
- [39] Sarel, Michael. 1996. Nonlinear Effects of Inflation on Economic Growth. *IMF Staff Papers* 43 (1):199-215.
- [40] Sargent, Thomas, Noah Williams, and Tao Zha. 2009. The Conquest of South American Inflation. *Journal of Political Economy* 117 (2).
- [41] Singh, A. 2006. *Macroeconomic Volatility: The Policy Lessons from Latin America*. IMF Working Paper.
- [42] Singh, A., and M. Cerisola 2006. *Sustaining Latin America's Resurgence: Some Historical Perspectives*. IMF Working Paper.

- [43] Sirimaneetham, Vatcharin, and Jonathan R. W. Temple. 2009. Macroeconomic Stability and the Distribution of Growth Rates. *World Bank Economic Review* 23 (3):443-479.
- [44] Smith, Ron, and Ana-Maria Fuertes. 2008. Panel Time-Series. In London: Centre for Microdata Methods and Practice. Institute for Fiscal Studies.
- [45] Swamy, P.A.V.B. 1970. Efficient Inference in a Random Coefficient Regression Model. *Econometrica* 38 (2):311-323.
- [46] Temple, Jonathan. 2000. Inflation and Growth: Stories Short and Tall. *Journal of Economic Surveys* 14 (4):395-426.
- [47] Wacziarg, Romain, and Karen Welch. 2008. Trade liberalisation and growth: new evidence. *World Bank Economic Review*, 22: 2.
- [48] Zellner, Arnold. 1962. An Efficient Method of Estimating Seemingly Unrelated Regressions and Test for Aggregation Bias. *Journal of the American Statistical Association* 57 (298):348-68.