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# Hysteresis in Unemployment: Evidence from Latin America

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**ABSTRACT**

This paper tests the hysteresis hypothesis in unemployment for 13 Latin American countries covering the period 1980-2005. The tests exploit the time series and the cross sectional variation of the series, and allows for cross section dependence and a different number of endogenously determined structural breakpoints. The findings give support to the hysteric dynamic hypothesis for the majority of the countries analyzed. The implications of the results have ramifications regarding macro-stabilization, structural reform, and the design of social safety protection.

*Keywords*: Unemployment hysteresis, unit root test, panel unit root test, cross-section dependence.
*JEL Classification*: C22, C23, E24, J24, J60

## INTRODUCTION

Critical features of Latin America's economic growth are its higher volatility, greater frequency of crisis, and shorter periods of booms than other regions in the world[1]. These features of economic growth raise the question of the characteristics of the region's unemployment dynamics.

From a theoretical point of view, there exist two extreme viewpoints for understanding the business cycle-unemployment dynamics[2]. The first one, the natural rate of unemployment, is that output fluctuations generate cyclical movements in the unemployment rates[3]. This view, characterizes unemployment as a mean reversion process which means that despite cyclical movements, unemployment tends to revert to its equilibrium in the long run. The second one, the "hysteresis" hypothesis, is that cyclical fluctuation will have permanent effects on the level of unemployment and therefore, the level of unemployment can be characterized as a non-stationary process[4]. In between the two extreme viewpoints is the persistence hypothesis. The latter implies a slow speed of adjustment toward long run equilibrium level and hence; it is a special case of the natural rate of unemployment hypothesis since the series show (slow) mean reversion. The immediate policy implication is that there is no permanent effect but rather a temporary one.

Establishing which characterization is empirically relevant for Latin American countries is important for a number of reasons. First, because it has ramifications for macroeconomic stabilization policies, structural reforms -such as labor market reforms- and the design of social protection networks. If hysteresis is the appropriate representation then unemployment could be a long lasting problem after stabilization or a reform. Further, if labor reforms are carried out during rising unemployment and the unemployment process is a hysteric one then the expected positive effect of reforms could be choked of because of a time consistency problem. However, ideal timing from a hysteric characterization of unemployment namely during falling unemployment conflicts with the timing recommendations of the political economy's new orthodoxy that concludes that crisis is necessary for a reform as it makes the politics of reform policy more feasible[5]. Second, it is of particular interest for Latin America as it is a region that has been hit by crises that can be interpreted as relatively large number of

[1]See Berg et al. (2006).
[2]See Karanassou et al. (2007) for a review.
[3]See Layard et al. (1991) for a detailed description.
[4]See Cross (1995) for hysteresis in unemployment and Göke (2002) for a review of the use of hysteresis concept in economics.
[5]For a review of the literature see Drazen (2000) and Alesina et al. (2006).

shocks. Third, there is an extensive literature on this issue for OECD countries and the beginning of empirical work on Transitional Economies[6]. The literature generally supports the hysteresis hypothesis but once controlled for structural change the evidence is less clear-cut. However, as far as we know, there has not been a systematic research to delimit the actual unemployment dynamics in Latin America with regard to the two competing hypothesis of the natural rate and hysteresis.

Conventionally the empirical literature attempted to determine the existence of hysteresis through unit root tests of a given country's unemployment series. The latter exercise, the linear hysteric hypothesis, is an extreme case of a more general hysteresis case. As Cross et al. (1998) pointed out the two defining features of a general hysteric process are remanence and selective memory of past shocks. Remanence implies that two shocks of equal size but in opposite directions do not cancel each other and selective memory refers to the phenomena where only the non- dominated extremum values of the shocks are retained of selective memory where all the shocks are recorded in the memory of the series . The linear hysteric hypothesis, in contrast, does not have dominated extremum values and two consecutive shocks of equal magnitude and opposite direction will cancel each other. However, as Leon-Ledesma et al. (2002) point out, hysteresis interpreted as a unit root is not necessarily a true description of the unemployment data generating process but can be used as a local approximation to the phenomena during the sample period. Thus the statistical tests provide an upper bound of the hysteresis hypothesis.

Further, the literature on unit root and stationarity itself has undergone a huge advance. These advances overcome a number of problems with the traditional approach of testing for unit roots. First, as argued by Bai and Ng (2001), conventional unit root tests have low power against the stationary alternative when the process is near integrated. In this case the evidence in favor of hysteresis would be stronger if simultaneously to the test for the null of a unit root is carried out with the reversal complement of the null of stationarity. Second, conventional unit root test tend to have low power in the presence of structural breaks. In general, the presence of structural breaks might lead to erroneously accepting the hypothesis of unit root. Third, the power of the conventional tests could also be low due to a small sample. The proposed solution to these two latter problems in the recent literature is to exploit the time series and cross section virtues of panel data and to test simultaneously for the nulls of unit root and stationarity and structural stability. The battery of tests used

[6]See Stanely (2005) for a meta-regression analysis review and León-Ledesma (2003).

in this paper suggests that the unemployment process is a hysteric one for most of the Latin American countries studied.

The paper proceeds as follows. The next section describes the stylized facts of unemployment in Latin America. In the third section, the empirical strategy is developed. Finally the fourth section concludes.

## THE STYLIZED FACTS

For heuristic reasons we can view unemployment over the output boom- bust cycle. An additional reason is that often back of the envelope calculations of the unemployment costs of growth fluctuations use the Okun's Law's coefficient that relates unemployment to output growth (see Lang and De Peretti (2006) for OECD countries). Okun's Law implicitly assumes the natural rate hypothesis.

The bust-boom cycle is determined by the method recommended by Harding and Pagan (2006). From the individual country's real GDP and unemployment series are identified for each series separately the following sequence of turning points: peak, trough, and recovery and so on. Once these points are identified is calculated the duration of the cycle (number of periods from peak to trough (the recession phase) plus from trough to the next peak (the expansionary phase). A second calculation is the depth of the cycle i.e. the maximum drop of output from peak or the maximum rise in unemployment from a trough. These authors also suggest the concordance index to judge colinearity of business cycles across countries. The index in table 1 suggests high concordance that could be attributed to common external shocks.

**Table 1. Concordance Index for Unemployment Rates**

| | Argentina | Brazil | Chile | Colombia | Costa Rica | Ecuador | Mexico | Nicaragua | Panama | Paraguay | Peru | Uruguay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | 1.000 | | | | | | | | | | | |
| Brazil | 0.248* | 1.000 | | | | | | | | | | |
| Chile | -0.552* | -0.045 | 1.000 | | | | | | | | | |
| Colombia | 0.439* | 0.165* | -0.001 | 1.000 | | | | | | | | |
| Costa Rica | -0.065 | 0.282* | 0.169* | 0.007 | 1.000 | | | | | | | |
| Ecuador | 0.362* | 0.189* | -0.134 | 0.410* | -0.081 | 1.000 | | | | | | |
| Mexico | 0.025 | 0.111 | 0.035* | 0.002 | 0.190* | 0.005 | 1.000 | | | | | |
| Nicaragua | 0.627* | -0.002 | -0.771* | -0.076 | -0.201* | 0.130* | -0.020 | 1.000 | | | | |
| Panama | 0.134 | -0.050 | -0.245* | -0.027 | -0.053* | -0.005 | -0.024* | 0.169* | 1.000 | | | |
| Paraguay | 0.441* | 0.635* | -0.028 | 0.285 | 0.040 | 0.365* | 0.047 | 0.059 | 0.012 | 1.000 | | |
| Peru | 0.215* | 0.305* | -0.121 | 0.105* | -0.111 | 0.308* | 0.027 | 0.162* | 0.013 | 0.320* | 1.000 | |
| Uruguay | 0.442* | 0.241* | 0.263 | 0.619* | 0.072 | 0.298* | 0.042* | -0.091 | -0.078 | 0.396* | 0.209* | 1.000 |
| Venezuela | 0.591* | 0.276* | -0.033 | 0.747* | 0.010 | 0.538* | 0.026 | 0.004 | 0.028 | 0.441* | 0.219* | 0.798* |

**Note:** significant coefficients (at 5% significance level) are denoted by a *

The evolution of unemployment in each Latin American country is presented in Figure 1. Moreover, the calculations we just discussed are presented in Table 2. They show that the duration of output from peak to recovery is on average about

3 years while the duration of unemployment is double, 6 years. On recovery of pre-crisis unemployment rates output was 13% higher in that year relative to the previous low of unemployment rates. The average depth is 6.4% for output and 3.7% for unemployment.

**Figure 1: Unemployment Rates in Latin American in %**

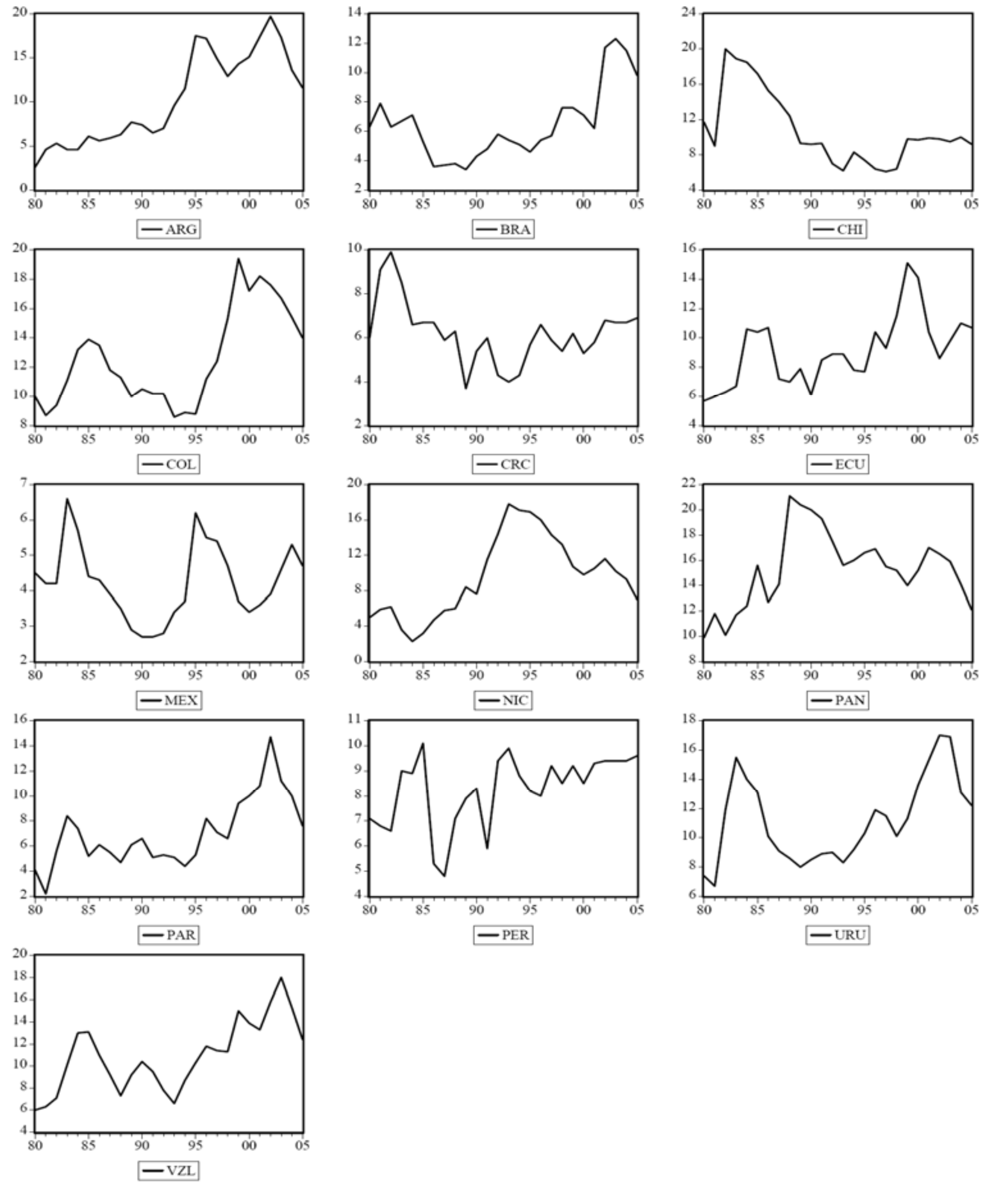

**Table 2: Crisis Episodes: GDP and Unemployment**

| Country/Period | Num of years to recover GDP | ΔUnemployment at the recovery point | Unemployment Depth | GDP Depth | Num of years to recover pre-crisis level of unemployment | ΔGDP by the unemployment recovery |
|---|---|---|---|---|---|---|
| Arg_87/92 | 5.0 | 1.1 | 1.8 | 12.0 | Not Yet | NA |
| Arg_94/96 | 2.0 | 5.7 | 6.0 | 2.8 | 11.0 | 121.8 |
| Arg_98/05 | 7.0 | -1.3 | 6.8 | 18.4 | 7.0 | 105.8 |
| Bar_00-04 | 4.0 | 0.6 | 1.8 | 2.6 | 5.0 | 107.5 |
| Bra_89-93 | 4.0 | 2.0 | 2.4 | 4.3 | Not Yet | NA |
| Chi_98-00 | 2.0 | 3.3 | 3.4 | 0.8 | Not Yet | N/A |
| Col_98-01 | 3.0 | 2.9 | 4.1 | 4.2 | 6.0 | 111.0 |
| Ecu_98-02 | 4.0 | -2.9 | 3.6 | 6.3 | 3.0 | 101.5 |
| Mex_94-97 | 3.0 | 1.7 | 2.5 | 6.2 | 5.0 | 114.7 |
| Mex_00-02 | 2.0 | 0.5 | 0.5 | 0.2 | Not Yet | N/A |
| Nic_92-94 | 2.0 | 2.7 | 3.4 | 0.4 | 5.0 | 120.5 |
| Pan 86-91 | 5.0 | 6.6 | 8.4 | 14.9 | Not Yet | N/A |
| Par_98-03 | 5.0 | 4.6 | 8.1 | 4.8 | Not Yet | N/A |
| Per_87/96 | 9.0 | 3.2 | 5.1 | 23.5 | Not Yet | N/A |
| Per-97/99 | 2.0 | 0.0 | 0.0 | 0.7 | 2.0 | 100.3 |
| Uru_94-96 | 2.0 | 2.7 | 2.7 | 1.4 | Not Yet | N/A |
| Uru_98-05 | 7.0 | 2.1 | 6.9 | 17.7 | Not Yet | N/A |
| Ven_88-91 | 3.0 | 2.2 | 3.1 | 8.6 | 5.0 | 113.6 |
| Ven_93-95 | 2.0 | 3.7 | 3.7 | 2.3 | Not Yet | N/A |
| AVERAGE | 3.6 | 2.1 | 3.8 | 6.6 | 6.0 | 113.3 |

**Note:** 22 crisis episodes are considered; Δ denoted a changed in the variable

However, for some crisis, unemployment rates have still not fallen to pre-crisis levels although output has recovered. This holds for ten crises in eight countries. For four countries' crisis episodes (Argentina 1987-92, Peru 1987-96, Uruguay 1994-95, and Venezuela 1993-95) unemployment was hit with a subsequent crisis but for five countries despite no subsequent crisis (Brazil 2000-04, Brazil 1989-93, Mexico 2000-02, Panama 1986-91, Paraguay 1998-91) unemployment has not fallen to pre-crisis levels despite output recovering its pre-crisis levels.

The descriptive data calculations reveal that Okun's coefficient suffers change over the cycle with jobless growth during the upturn in economic activity. Further, it also suggests that a quick reversal to the mean of unemployment does not generally hold, this in turn suggests that unemployment may be either a slow mean reversion or a hysteric process.

## EMPIRICAL STRATEGY

### 1. Data Description

The unemployment rate data is from the national statistical institutes of each country considered in this paper. Only a few countries have quarterly data and most of them only from mid nineties. Thus, to maximize the time period and the number of countries covered, we use annual data from 1980-2005 for Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

### 2- Theoretical Justification

Before detailing the various tests and their results it is useful to slightly formalize the issue under the linear hysteric hypothesis. Consider that unemployment, $y_t$ , follows an AR (1) process as:

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t \qquad (1)$$

where $\varepsilon_t$ is $iid(o, \sigma_\varepsilon^2)$ .

Then if under the natural rate hypothesis, $H_0 : \rho < 1$ holds then the natural-mean-equilibrium rate to which unemployment reverts to is $\overline{y} = \frac{\alpha}{1-\rho}$. Under the hysteresis hypothesis, the unit root test has as the null $H_0 : \rho = 1$ with the one sided alternative of $H_1 : \rho < 1$ . The complementary stationarity test has as the null $H_0 : \rho < 1$ with the alternative $H_1 : \rho = 1$ . If the former is not rejected and the latter is rejected then one can assert that the unemployment follows a hysteric process.

### 3- Time Series Tests

Linearly hysteric behavior of unemployment hypothesis is carried out separately for a sample of 13 individual country's annual unemployment series from 1980 to 2005. The tests used were the Augmented Dickey-Fuller (ADF) with the null of a unit root and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) Langrage Multiplier test for the null of stationarity. Regarding the ADF test, one of the key issues in this procedure is the number of lags to include in the auxiliary regression. The critical values associated with the ADF test were generated in the absence of serial autocorrelation in the error term. Hence, the test requires a sufficient number of lag terms of the dependent variable such that the error term is white noise. However, when more lag terms are introduced, the power of the test falls. This implies that the choice of the number of lags is a key element when using ADF tests. It is standard in the literature to use the Akaike information criteria (AIC) and Schwartz information criteria (BIC) to select the number of lags.

For the ADF test, three possible models are considered:

$$y_t = \rho_a y_{t-1} + u_t,$$

$$y_t = \mu_b + \rho_b y_{t-1} + u_t,$$

$$y_t = \mu_c + \gamma_c t + \rho_c y_{t-1} + u_t$$

where the null hypothesis is that $\rho_i = 1$ for $i = a, b, c$.

**Table 3: ADF Results**

| | Argentina | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -3.0914 | -4.3942 | -3.6118 | -3.2418 | Do not reject |
| $t_m$ | -1.6169 | -3.7343 | -2.9907 | -2.6348 | Do not reject |
| $t$ | -0.4169 | -2.6648 | -1.9559 | -1.6231 | Do not reject |
| Lags (BIC) | 1 | | | | |

| | Nicaragua | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | 0.102 | -4.7315 | -3.7611 | -3.3228 | Do not reject |
| $t_m$ | -3.5617 | -3.9635 | -3.0818 | -2.6829 | Reject |
| $t$ | -0.3881 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Brazil | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -0.0784 | -4.7315 | -3.7611 | -3.3228 | Do not reject |
| $t_m$ | 1.4377 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | 1.2184 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Panama | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -1.0527 | -4.7315 | -3.7611 | -3.3228 | Do not reject |
| $t_m$ | 0.6289 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | -0.8937 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Chile | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -4.4953 | -4.7315 | -3.7611 | -3.3228 | Reject |
| $t_m$ | -1.3741 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | -0.0976 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Paraguay | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -7.5502 | -4.7315 | -3.7611 | -3.3228 | Reject |
| $t_m$ | -8.2783 | -3.9635 | -3.0818 | -2.6829 | Reject |
| $t$ | 0.3812 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Colombia | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | 0.1076 | -4.7315 | -3.7611 | -3.3228 | Do not reject |
| $t_m$ | 3.0068 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | 1.6701 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Peru | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -1.4233 | -4.6712 | -3.7347 | -3.3086 | Do not reject |
| $t_m$ | -1.7988 | -3.9228 | -3.0659 | -2.6745 | Do not reject |
| $t$ | 2.5534 | -2.7274 | -1.9642 | -1.6269 | Reject |
| Lags (BIC) | 9 | | | | |

| | Costa Rica | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -1.6537 | -4.6712 | -3.7347 | -3.3086 | Do not reject |
| $t_m$ | -1.6485 | -3.9228 | -3.0659 | -2.6745 | Do not reject |
| $t$ | 1.256 | -2.7274 | -1.9642 | -1.6269 | Do not reject |
| Lags (BIC) | 9 | | | | |

| | Uruguay | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -3.6022 | -4.7315 | -3.7611 | -3.3228 | Do not reject |
| $t_m$ | 0.1885 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | 1.847 | -2.741 | -1.9658 | -1.6277 | Do not reject |
| Lags (BIC) | 10 | | | | |

| | Ecuador | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -2.9329 | -4.6193 | -3.7119 | -3.2964 | Do not reject |
| $t_m$ | -0.5849 | -3.8877 | -3.0521 | -2.6672 | Do not reject |
| $t$ | 0.4303 | -2.7157 | -1.9627 | -1.6262 | Do not reject |
| Lags (BIC) | 8 | | | | |

| | Venezuela | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -5.4573 | -4.7315 | -3.7611 | -3.3228 | Reject |
| $t_m$ | -0.9986 | -3.9635 | -3.0818 | -2.6829 | Do not reject |
| $t$ | 2.0544 | -2.741 | -1.9658 | -1.6277 | Reject |
| Lags (BIC) | 10 | | | | |

| | Mexico | Critical Values | | | Conclusion |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | |
| $t_t$ | -3.5559 | -4.4415 | -3.633 | -3.2535 | Do not reject |
| $t_m$ | -3.7253 | -3.7667 | -3.0038 | -2.6417 | Reject |
| $t$ | -1.0128 | -2.6756 | -1.9574 | -1.6238 | Do not reject |
| Lags (BIC) | 3 | | | | |

MacKinnon (1991) critical values

Notes:

$t_t$ : model with a trend and a constant term

$t_m$ : model with a constant term

$t$ : model with no constant and no trend

Table 3 above summarizes the test statistics for the three models. Despite the heterogeneity of GDP and unemployment experiences across different crises in the same country and across countries, the results of the ADF are that for almost all the countries -with the exceptions of Paraguay and Venezuela- the unit root null hypothesis cannot be rejected. These results, based on an univariate analysis of unemployment, support the hypothesis of a hysteric behavior in unemployment.

**Table 4. KPSS Results**

| | Num. of lags | Statistic | Conclusion |
|---|---|---|---|
| Argentina | 2 | 0.903 | Reject |
| Brazil | 2 | 0.515 | Reject |
| Chile | 2 | 0.553 | Reject |
| Colombia | 2 | 0.513 | Reject |
| Costa Rica | 2 | 0.295 | Do not reject |
| Ecuador | 2 | 0.529 | Reject |
| Mexico | 2 | 0.097 | Do not reject |
| Nicaragua | 2 | 0.499 | Reject |
| Panama | 2 | 0.266 | Do not reject |
| Paraguay | 2 | 0.633 | Reject |
| Peru | 2 | 0.519 | Reject |
| Uruguay | 2 | 0.353 | Do not reject |
| Venezuela | 2 | 0.612 | Reject |
| Critical Values | | | |
| 1% | 5% | 10% | |
| 0.739 | 0.463 | 0.347 | |

**Notes:**
1. The autocovariance function was weighted by the quadratic spectral kernel rather than the Barlett kernel.
2. The automatic bandwidth selection procedure proposed by Newey and West (1994) as described by Hobijn et al. (1998) is used to determine the number of lags used.

Table 4 above presents the results of the KPSS test using the optimal bandwidth selection procedure to determine the number of lags. The KPSS test assumes that the series $y_t$ is trend stationary under the null. The KPSS statistic is based on the residuals from the OLS regression of $y_t$ on the exogenous variables $x_t$ :

$$y_t = x_t'\delta + u_t \qquad (2)$$

The LM statistic is then defined as

$$LM = \sum_t \frac{S(t)^2}{T^2 f_0}$$

where , $f_0$ is an estimator of the residual spectrum at frequency zero and where $S(t)$ is a cumulative residual function

$$S(t) = \sum_{r=1}^{t} \widehat{u}r$$

based on the residuals $\widehat{u}_t = y_t - x_t \widehat{\delta}(0)$.

The KPSS test points in the same direction as the ADF test: for almost all the countries the hypothesis of stationary is rejected. In other words, hysteresis, as evidenced by the ADF and the KPSS tests, seems a plausible hypothesis to describe the unemployment dynamics of Latin American countries. Still, the caveat here is that the tests' findings might be affected by the low power of the tests due to the small sample used and the non-tested hypothesis of possible structural breaks. To overcome these problems we turn to panel data techniques that overcome the small sample problem by exploiting both cross- sectional and time-series dimensions of the data, and by using techniques that test for structural breaks.

**4- Panel Data Tests**

To test for the null of a unit root with panel data we use the Im, Pesaran and Shin (2003) (IPS) test. This test is essentially a panel data equivalent of the ADF single series test. Note that the test is designed for a heterogeneous panel in which each cross-section is estimated separately and not pooled. Further, the process does not impose the same speed of mean reversion in the different countries thus allows for heterogeneity across countries. In addition, to take into account that different cross-sections are not distributed independently, we also report the demeaned version of the test; i.e. we subtract cross section averages from the individual country's series. The IPS test is based on the following regression equation:

$$\Delta y_{it} = \alpha_{mi} d_{mt} + \delta_i y_{it-1} + \sum_{k=1}^{p} \gamma_k \Delta y_{it-k} + \varepsilon_{it} \qquad (3)$$

with $t = 1, \ldots, T,$ $i = 1, \ldots, N,$ where $d_{mt}$ denotes the deterministic component. The null hypothesis is given by $H_0 \ : \ \delta_i = 0; \forall i = 1, \ldots, N$ whereas the alternative hypothesis is $H_1 \ : \ \delta_i < 0 \quad i = 1, \ldots, N_1; \delta_i = 0$ $i = N_1 + 1, \ldots, N_1$ Therefore; the null is rejected if there is a subset $N_1$ of stationary individuals. As a result, the unit root hypothesis testing can be conducted allowing for a higher degree of heterogeneity provided that under the alternative hypothesis it is not required a common autoregressive parameter. The test statistic used by IPS is the standardized group-mean $t$ bar test statistic - the

$\Psi_{\bar{t}}$ test:

$$\Psi_{\bar{t}} = \frac{\sqrt{N}\left[t_i - N^{-1}\sum_{i=1}^{N} E(t_i)\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(t_i)}} \quad (4)$$

where $t_i$ denotes the individual pseudo t-ratio for testing $\delta_i = 0$ in (3). This test assumes cross-sectional independence among panel units, but allow for heterogeneity of the form of individual deterministic effects (constant and/or linear time trend) and heterogeneous serial correlation structure of the error terms.

Since the null hypothesis of this test assumes that all the series considered are non stationary, making it very sensitive to the marginal addition of subtraction of countries. Initially, we conducted the test for the 13 Latin American countries where data was available for the complete period 1980-2005. We also considered a sub sample of 7 countries. The results are summarized in Annex 1.

**Table 5. IPS Results**

| | Observations | Lags | Trend | Demeaned | t-bar | cv 10% | cv 5% | cv 1% | W[t-bar] | P-value | Conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All countries | 325 | 0 | No | Yes | -2.025 | -1.82 | -1.9 | -2.05 | -2.026 | 0.021 | Reject |
| Big 7 | 175 | 0 | No | Yes | -2.016 | -1.95 | -2.07 | -2.31 | -1.459 | 0.072 | Do not reject |
| All countries | 312 | 1 | No | Yes | -2.423 | -1.82 | -1.9 | -2.05 | -3.575 | 0.000 | Reject |
| Big 7 | 170 | 1 | No | Yes | -2.162 | -1.95 | -2.07 | -2.31 | -1.866 | 0.031 | Reject |
| All countries | 299 | 2 | No | Yes | -2.238 | -1.82 | -1.9 | -2.05 | -3.017 | 0.001 | Reject |
| Big 7 | 165 | 2 | No | Yes | -2.327 | -1.95 | -2.07 | -2.31 | -2.467 | 0.007 | Reject |
| All countries | 325 | 0 | No | No | -1.898 | -1.82 | -1.9 | -2.05 | -1.508 | 0.066 | Reject |
| Big 7 | 175 | 0 | No | No | -1.842 | -1.95 | -2.07 | -2.31 | -0.941 | 0.173 | Do not reject |
| All countries | 312 | 1 | No | No | -2.187 | -1.82 | -1.9 | -2.05 | -2.641 | 0.004 | Reject |
| Big 7 | 170 | 1 | No | No | -1.945 | -1.95 | -2.07 | -2.31 | -1.236 | 0.108 | Do not reject |
| All countries | 299 | 2 | No | No | -2.004 | -1.82 | -1.9 | -2.05 | -2.109 | 0.017 | Reject |
| Big 7 | 165 | 2 | No | No | -2.117 | -1.95 | -2.07 | -2.31 | -1.87 | 0.031 | Reject |
| All countries | 325 | 0 | Yes | Yes | -2.151 | -2.45 | -2.53 | -2.68 | 0.09 | 0.536 | Do not reject |
| Big 7 | 175 | 0 | Yes | Yes | -2.185 | -2.57 | -2.69 | -2.93 | -0.041 | 0.484 | Do not reject |
| All countries | 312 | 1 | Yes | Yes | -2.686 | -2.45 | -2.53 | -2.68 | -2.159 | 0.015 | Reject |
| Big 7 | 170 | 1 | Yes | Yes | -2.692 | -2.57 | -2.69 | -2.93 | -1.602 | 0.055 | Reject |
| All countries | 299 | 2 | Yes | Yes | -2.205 | -2.45 | -2.53 | -2.68 | -0.454 | 0.325 | Do not reject |
| Big 7 | 165 | 2 | Yes | Yes | -2.257 | -2.57 | -2.69 | -2.93 | -0.493 | 0.311 | Do not reject |
| All countries | 325 | 0 | Yes | No | -1.999 | -2.45 | -2.53 | -2.68 | 0.749 | 0.773 | Do not reject |
| Big 7 | 175 | 0 | Yes | No | -2.084 | -2.57 | -2.69 | -2.93 | 0.281 | 0.611 | Do not reject |
| All countries | 312 | 1 | Yes | No | -2.531 | -2.45 | -2.53 | -2.68 | -1.508 | 0.066 | Reject |
| Big 7 | 170 | 1 | Yes | No | -2.546 | -2.57 | -2.69 | -2.93 | -1.153 | 0.124 | Do not reject |
| All countries | 299 | 2 | Yes | No | -2.175 | -2.45 | -2.53 | -2.68 | -0.333 | 0.369 | Do not reject |
| Big 7 | 165 | 2 | Yes | No | -2.336 | -2.57 | -2.69 | -2.93 | -0.732 | 0.232 | Do not reject |

**Note:** Big 7 = Argentina, Brazil, Chile, Colombia, Mexico, Peru and Uruguay

When considering both the demeaned and non-demeaned versions with no trend, the null hypothesis is rejected for both samples while introducing a trend the unit root hypothesis cannot be rejected. The latter case, this is giving evidence of a potential hysteric behavior of unemployment. Still, the small sample and the cross section independence hypothesis may be an issue in the performance of this test. As shown by several authors (including O'Connell, 1998, Banerjee, Marcellino, and Osbat, 2004a, 2004b), the assumption of cross-sectional independence on which the asymptotic results of the IPS's procedure relies (as actually most panel data unit root tests of "the first generation" including Maddala, and Wu, 1999; Levin, Lin and Chu 1993, 2002,) is often unrealistic and can be at odds with economic theory and empirical results. Besides, as shown in two simulation studies by Banerjee et al. (2004a, 2004b) if panel members are cross-correlated, all these tests experience strong size distortions and limited power. This is analytically confirmed by Lyhagen (2000) and Pedroni and Urbain (2001).

For this reason, panel unit root tests relaxing the assumption of cross sectional independence have recently been proposed in the literature by Choi (2002), Bai and Ng (2003), Moon and Perron (2003), Pesaran (2003) and Phillips and Sul (2003). We decided to investigate the presence of a unit-root using the tests proposed by Choi (2002) and Pesaran (2003). Choi (2002) uses an error-component model to handle cross sectional dependence. In particular, to let cross-sections units respond homogeneously to a single common factor $f_t$ the model is:

$$z_{it} = \alpha_i + f_t + z_{it}^0$$
$$z_{it}^0 = \rho_i z_{it-1}^0 + \varepsilon_{it}$$

The first step is to obtain a cross-sectionally independent series. For that purpose Choi (2002) first demeans the data by GLS and then takes cross-sectional means to obtain a new variable $z_{it}^{\mu} \cong z_{it}^0 - z_{i1}^0$ which is independent in the cross-sectional dimension as both $n$ and $T$ goes to infinity. Finally Choi (2002) combines p-values from individual ADF tests using three statistics:

$$P_m = -\frac{1}{\sqrt{n}}\sum_{i=1}^{n}\left[\ln(p_i)+1\right]$$

$$Z = \frac{1}{\sqrt{n}}\sum_{i=1}^{n}\Phi^{-1}(p_i)$$

$$L^* = -\frac{1}{\sqrt{\pi^2 n/3}}\sum_{i=1}^{n}\ln\left(\frac{p_i}{1-p_i}\right)$$

where $\Phi$ is the *cdf* for a standard normal variable. All of these three statistics have a standard normal distribution as $n \to \infty$ and $T \to \infty$. As a general rule, the test based on the $P_m$ statistic rejects the null hypothesis for large positive values of the statistic, while the other two tests reject for large negative values of the statistic.

Table 6 shows the results for the Choi (2002) test. The evidence found suggest that when considering cross section independence the null hypothesis of unit root is rejected, but once we allow for cross section correlation the conclusion is reversed and we cannot reject the hypothesis of nonstationarity. Hence, the evidence supports the hysteresis hypothesis.

**Table 6. Choi (2001) and Choi(2002) Panel Unit Root Test**

| Cross-sectional dependence | | |
|---|---|---|
| | Unemployment | Conclusion |
| Z (inverse normal) | -2.694 | Do not reject |
| Pm (modified inverse chi-square) | 3.212 | Reject |
| L* (modified logit) | -2.772 | Do not reject |
| No cross-sectional dependence | | |
| | Unemployment | Conclusion |
| Z (inverse normal) | -1.453 | Reject |
| Pm (modified inverse chi-square) | 1.016 | Reject |
| L* (modified logit) | -1.42 | Reject |
| T | 26 | |
| N | 13 | |

**Notes:**

1. Annual data for the sampling period 1980-2005 were used.
2. The Dickey--Fuller-GLSt test coupled with BIC lag selection was used as and underlying unit root test for time series.
3. (*): significant at the 5% level.
4. The Pm test is a modification of Fisher's (1932) inverse chi-square tests and rejects the null hypothesis of unit root for positive large values of the statistics.
5. The L* is a logit test.
6. The tests Z and L* reject the null for large negative values of the statistics.
7. The P, Z and L* tests converge under the null to a standard normal distribution as (N,T g 1).

Pesaran (2003) provides an extension of the Im, Pesaran and Shin (2003) test to allow for one stationary factor with heterogeneous loadings. This last test in particular, seems to show "good size and power for different values of $n$ and $T$ and model specifications". In particular, to account for the possible small sample bias from the Choi (2002) test, we perform the Pesaran (2003) test which seems to have a better performance in small samples. Moreover Pesaran (2003) propose a simple alternative test where the standard ADF regressions are augmented with the cross section averages of lagged levels and first-differences of the individual series and shows that the cross sectionally augmented panel unit root tests have satisfactory size and power even for relatively small values of $n$ and $T$. This is particularly true of cross sectionally augmented and truncated versions of the simple average t-test of Im, Pesaran and Shin (2003) and Choi's (2002) inverse normal combination test. The limiting distribution of this test is non-standard and tables with critical values are given in Pesaran (2003). The test is given by

$$CIPS(n,T) = \frac{1}{n}\sum_{i=1}^{n} t_i(n,T)$$

where $CIPS$ is the cross-sectionally Augmented IPS and $t_i(n,T)$ is the cross-sectionally augmented Dickey-Fuller statistic for the $i^{th}$ cross section unit. Table 7 presents the results. In most cases we now cannot reject the null hypothesis of nonstationarity and hence take this as evidence of the presence of a unit root process in the panel structure.

**Table 7. Pesaran Results**

| | Observations | Lags | Trend | Demeaned | t-bar | cv 10% | cv 5% | cv 1% | W[t-bar] | P-value | Conclusion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| All countries | 325 | 0 | No | Yes | -2.236 | -2.14 | -2.25 | -2.45 | -1.731 | 0.042 | Reject |
| Big 7 | 175 | 0 | No | Yes | -2.143 | -2.21 | -2.33 | -2.57 | -1.046 | 0.148 | Do not reject |
| All countries | 312 | 1 | No | Yes | -2.315 | -2.14 | -2.25 | -2.45 | -2.026 | 0.021 | Reject |
| Big 7 | 168 | 1 | No | Yes | -2.365 | -2.21 | -2.33 | -2.57 | -1.651 | 0.049 | Reject |
| All countries | 299 | 2 | No | Yes | -2.12 | -2.14 | -2.25 | -2.45 | -1.299 | 0.097 | Do not reject |
| Big 7 | 161 | 2 | No | Yes | -2.406 | -2.21 | -2.33 | -2.57 | -1.763 | 0.039 | Reject |
| All countries | 325 | 0 | No | No | -2.236 | -2.14 | -2.25 | -2.45 | -1.731 | 0.042 | Reject |
| Big 7 | 175 | 0 | No | No | -2.143 | -2.21 | -2.33 | -2.57 | -1.046 | 0.148 | Do not reject |
| All countries | 312 | 1 | No | No | -2.315 | -2.14 | -2.25 | -2.45 | -2.026 | 0.021 | Reject |
| Big 7 | 168 | 1 | No | No | -2.365 | -2.21 | -2.33 | -2.57 | -1.651 | 0.049 | Reject |
| All countries | 299 | 2 | No | No | -2.12 | -2.14 | -2.25 | -2.45 | -1.299 | 0.097 | Do not reject |
| Big 7 | 161 | 2 | No | No | -2.406 | -2.21 | -2.33 | -2.57 | -1.763 | 0.039 | Reject |
| All countries | 325 | 0 | Yes | Yes | -2.535 | -2.66 | -2.76 | -2.96 | -0.834 | 0.202 | Do not reject |
| Big 7 | 175 | 0 | Yes | Yes | -2.65 | -2.73 | -2.86 | -3.1 | -0.968 | 0.167 | Do not reject |
| All countries | 312 | 1 | Yes | Yes | -2.762 | -2.66 | -2.76 | -2.96 | -1.712 | 0.043 | Reject |
| Big 7 | 168 | 1 | Yes | Yes | -3.614 | -2.73 | -2.86 | -3.1 | -3.709 | 0.000 | Reject |
| All countries | 299 | 2 | Yes | Yes | -2.415 | -2.66 | -2.76 | -2.96 | -0.37 | 0.356 | Do not reject |
| Big 7 | 161 | 2 | Yes | Yes | -2.906 | -2.73 | -2.86 | -3.1 | -1.695 | 0.045 | Reject |
| All countries | 325 | 0 | Yes | No | -2.535 | -2.66 | -2.76 | -2.96 | -0.834 | 0.202 | Do not reject |
| Big 7 | 175 | 0 | Yes | No | -2.65 | -2.73 | -2.86 | -3.1 | -0.968 | 0.167 | Do not reject |
| All countries | 312 | 1 | Yes | No | -2.762 | -2.66 | -2.76 | -2.96 | -1.712 | 0.043 | Reject |
| Big 7 | 168 | 1 | Yes | No | -3.614 | -2.73 | -2.86 | -3.1 | -3.709 | 0.000 | Reject |
| All countries | 299 | 2 | Yes | No | -2.415 | -2.66 | -2.76 | -2.96 | -0.37 | 0.356 | Do not reject |
| Big 7 | 161 | 2 | Yes | No | -2.906 | -2.73 | -2.86 | -3.1 | -1.695 | 0.045 | Reject |

**Note:**
Big 7 = Argentina, Brazil, Chile, Colombia, Mexico, Peru and Uruguay
Based on Pesaran (2003)

Finally, to account for the possibility of structural breaks we apply the Carrion-i-Silvestre et al. (2005) test. This is a null stationarity test a la KPSS extended to panel data by Hardi (2000) and further extended by Carrion et al. (2005) to simultaneously consider the possibility of structural breaks. The test allows for heterogeneity and multiple structural breaks at different unknown dates and different number of breaks for each country that are determined endogenously.

The basic setup of the test is as follows. Let $y_{it}$ be a stochastic process such that:

$$y_{it} = \alpha_{it} + \beta_i t + \varepsilon_{it} \tag{5}$$

$$\alpha_{it} = \sum_{k=1}^{m_i} \theta_{ik} DT_{bkt}^{i} + \sum_{k=1}^{m_i} \gamma_{ik} DU_{ikt} + \alpha_{it-1} + v_{it} \tag{6}$$

where $v_{it} \sim iid(o, \sigma_{vi}^2)$ and $\alpha_{i0}$ is a constant with $i = \{1, \ldots, n\}$ individuals and $t = \{1, \ldots, T\}$ time periods. The dummy variables are defined as

$$DT^{i}_{bkt}=\begin{cases}1 & t=T^{i}_{bk}+1\\ 0 & elsewhere\end{cases}$$

and

$$DU_{ikt}=\begin{cases}1 & t>T^{i}_{bk}\\ 0 & elsewhere\end{cases}$$

where $T^{i}_{bk}$ denotes the $k^{th}$ date of the break for the $i^{th}$ individual with $k=\{1,\ldots,m\}$. Hence the data generating process given by (5) and (6) can be defined under the null hypothesis of stationarity as

$$y_{it}=\alpha_{it-1}+\sum_{k=1}^{m_i}\theta_{ik}DT^{*}_{ikt}+\beta_i t+\sum_{k=1}^{m_i}\gamma_{ik}DU_{ikt}+\alpha_{it-1}+\varepsilon_{it} \tag{7}$$

where $\{\varepsilon_{it}\}$ is a sequence of mixingales[7] and

$$DT^{*}_{ikt}=\begin{cases}t-T^{i}_{bk} & t>T^{i}_{bk}\\ 0 & elsewhere\end{cases}$$

Finally, the test is formulated as in Hardi (2000), that is, as the average of the individual KPSS statistic. The general expression takes the form:

$$LM(\lambda)=\frac{1}{n}\sum_{i=1}^{n}\left(\omega^{-2}T^{-2}\sum_{i=1}^{T}S^{2}_{it}\right) \tag{8}$$

where $S_{it}=\sum_{j=1}^{t}\widehat{\varepsilon}_{ij}$ denotes the partial sum process obtained from the OLS residual of (7) and $\widehat{W}^{2}=\frac{1}{n}\sum_{j=1}^{t}\widehat{W}_{i}^{2}$ where $\widehat{W}_{i}^{2}$ is a consistent estimate of the long-run variance of $\varepsilon_{it}$. The parameter $\lambda$ from equation (8) denotes the dependence of the test on the dates of the break. In particular, $\lambda_i=\left(\lambda_{i1},\ldots,\lambda_{im_i}\right)'=\left(T^{i}_{b1}/T,\ldots,T^{i}_{bm_i}/T\right)'$ denotes the relative positions of the dates of the breaks on the time period $T$. Finally, the normalized test statistic converges to a standard normal distribution.

[7]Actually, $\{\varepsilon_{it}\}$ and $\{v_{it}\}$ are mutually independent across the two dimensions of the panel.

**Table 8: Unemployment rate panel data set**

Panel A: Estimation of the number of structural breaks

| | Indiv. test | Num.of breaks | Break dates * |
|---|---|---|---|
| Argentina | 0.1055 | 2 | 1984; 1992 |
| Brazil | 0.0993 | 4 | 1984; 1990; 1997; 2001 |
| Chile | 0.1596 | 1 | 1988 |
| Colombia | 0.0401 | 1 | 1997 |
| Costa Rica | 0.1286 | 2 | 1986; 1994 |
| Ecuador | 0.0960 | 3 | 1983; 1986; 1995 |
| Mexico | 0.0421 | 2 | 1984; 1987 |
| Nicaragua | 0.0671 | 4 | 1982; 1985; 1988; 1990 |
| Panama | 0.2224 | 3 | 1984; 1987; 1991 |
| Paraguay | 0.0733 | 2 | 1995; 1998 |
| Peru | 0.1012 | 1 | 1991 |
| Uruguay | 0.1164 | 1 | 1999 |
| Venezuela | 0.1299 | 2 | 1982; 1995 |

Panel B: Stationarity panel data tests

| | Test | P-value | Conclusion |
|---|---|---|---|
| Homogeneous | 1.474 | 0.070 | Reject |
| Heterogenous | 2.620 | 0.004 | Reject |

*Bootstrap distribution (allowing for cross-section dependence)*

| | 1.0% | 2.5% | 5.0% | 10.0% | 90.0% | 95.0% | 97.5% | 99.0% |
|---|---|---|---|---|---|---|---|---|
| Homogeneous | -0.406 | -0.154 | 0.020 | 0.225 | 2.593 | 3.027 | 3.424 | 3.901 |
| Heterogenous | 0.604 | 0.843 | 1.125 | 1.414 | 4.492 | 4.978 | 5.748 | 6.263 |

**Note:** * Only in the cases of Costa Rica and Panama the null hypothesis is not rejected using a 1% critical in the other cases is at a 5% and a 10%. Allowing for 5 structural breaks

To compute the test we allow for up to 5 breaks, $m^{\max} = 5,$ where the number of breaks has been selected using the sequential procedure in Bai and Perron (1998). This procedure consists of specifying a maximum number of breaks $\left(m^{\max}\right)$, estimating their position for each $m_i \le m^{\max}$, $i = \{1, \ldots, n\},$ testing for the significance of the breaks and, then, obtaining their optimum number and position for each series[8]. Table 8 above presents the results.

Panel A in the table offers the individual information, the number of breaks and their position. In general, at least one structural break was detected by the sequential procedure in all the countries considered. If we now combine the

[8] Carrion-i-Silvestre et al. (2005) suggest estimating the dates of the breaks choosing the argument that minimizes the sequence of individual $SSR$. In particular, first the dates for possible breaks are estimated and then the number of optimal structural breaks is selected for each $i$. The selection criterion used is the modified Schwarz information criterion (LWZ) of Liu, Wu and Zidek (1997) suggested by Bai and Perron (2003) since the model includes trending regressors.

individual information to compute the test statistic in Panel B, we realize that the null hypothesis of stationarity is rejected both for the homogeneous and the heterogeneous long-run variance. However, this conclusion is reversed when cross-section dependence is taken into account. In particular, the critical values drawn from the bootstrap distribution indicate that the null hypothesis cannot be rejected at the 5% level. From this test, the evidence points to the absence of hysteresis in unemployment. However, we need to interpret this result with caution since we have a small sample that is affecting the bootstrap distribution and hence may be biasing the conclusion. To overcome this problem, more data points should be considered; an option not available at this time. Hence, a *non-testable* hypothesis is that the results are sensitive to longer time series and or higher frequency data but neither is available for the majority of the countries studied in this paper.

## CONCLUDING REMARKS

In this paper we undertook a systematic empirical analysis of the dynamic behavior of unemployment in Latin American countries. Specifically, we applied a battery of statistical tests on single and panel data series to determine if there were hysteric features in Latin America's labor markets.

We found, from both unit root and stationarity test approaches, that for most Latin American countries their aggregate unemployment can best be described as a hysteric dynamic. The confidence attached to this assertion is highest for Latin America's seven largest economies.

The degree that the hysteretic feature of labor markets is due to, individually or their interaction, labor market inflexibility, pro-cyclical monetary and fiscal policy or decreasing capital stock is beyond the scope of this paper. However, a research agenda focusing exclusively on labor market inflexibility (due to minimum wages, unions, and employment protection) may be misplaced as labor protection policies are either weak or generally not fully enforced. Meanwhile there is growing evidence that monetary and fiscal policy is pro-cyclical and, although to a lesser extent, that pro-market structural reform has not resulted in an increase in private investment over and above the decline in public investment; suggesting the possibility of a decline in capital stock. The why of hysteresis is a topic for a subsequent study. The why of hysteresis, a topic for a subsequent study, is important for drawing out the policy ramifications of the findings; that is, whether labor market reform or macroeconomic policy should be used for smoothing as required.

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