HYSTERESIS VS NAIRU & CONVERGENCE VS DIVERGENCE: 
THE BEHAVIOR OF REGIONAL UNEMPLOYMENT RATES IN BRAZIL

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Abstract

In this article we examine the Hysteresis effect in the unemployment rates of six metropolitan areas in Brazil - São Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Salvador e Recife - as well as in the aggregate unemployment rate. The validity of the Hysteresis hypothesis is examined through the use of both ADF and unit root break tests. Our results show that the phenomenon occurs in all regions, except in Rio de Janeiro, and in Brazil as a whole. As a consequence, there is a clear rejection of the NAIRU hypothesis. These results indicate a high persistence in the unemployment rates. Therefore, we go one step further and investigate whether the five metropolitan regions, which are characterized by the Hysteresis effect, present stochastic convergence as well. Our findings suggest that only Porto Alegre does not exhibit stochastic convergence.

Keywords: unemployment, NAIRU, Hysteresis, convergence, structural breaks.

JEL Classification: C12, C22, J64

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1. Introduction

There is no doubt unemployment has been a recurrent problem in several countries and it is a much bigger matter nowadays than it used to be some decades ago. As a result, unemployment is now a major source of concern among policymakers and society as a whole. This is not different in Brazil and it even seems to have deeper roots in this country due to, among many other factors, a series of failed economic stabilization plans in the 1980s and in the beginning of the 1990s, the opening of the Brazilian economy as well as a tight conduct of monetary policy towards the end of the 1990s.

Theoretically, there are two main hypotheses related to the explanation of unemployment. The first one is the *non-accelerating-inflation rate of unemployment (NAIRU) hypothesis*, which characterizes unemployment dynamics as a stationary process and, therefore, consistent with a stable inflation rate. In other words, the *NAIRU* states that the unemployment rate should oscillate about a long-run steady state. The second one is the *Hysteresis hypothesis*, which states that movements in unemployment might have a long-term persistence once it is affected permanently by cyclical fluctuations.\(^1\)

The *NAIRU* hypothesis was brought to light by the seminal articles of Phelps (1967) and Friedman (1968) and, over the 1950s and 1960s, it was able to provide sufficient explanation for the behavior of unemployment. However, it began to be questioned in the following decades due to constant movements observed in the unemployment rates around the world. This resulted in the Hysteresis hypothesis, which had one of its first statements in Blanchard and Summers (1986), who were concerned about the phenomenon in Europe.

As the Hysteresis theory evolved, several articles started to empirically test it and compare the results with the *NAIRU* hypothesis. In order to do this, researchers make use of time series econometrics and, more specifically, checking the order of integration of the unemployment rates. The reason is straightforward. The natural rate theory can be supported by level stationarity of the series whereas the presence of a unit root...

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\(^1\) Phelps (1994) describes a third theory of unemployment suggesting that most shocks to unemployment are temporary with occasional (but permanent) changes in the natural rate. As a result, the unemployment rate can be defined as a stationary process around a small number of (permanent) structural breaks (Lee, Strazicich & Tieslau, 2001). In other words, this can be seen as an extension of the *NAIRU* hypothesis as it accounts for the possibility of occasional changes in the long-run steady state unemployment rate. Therefore, the unemployment rate is stationary, as in the traditional version of *NAIRU*, but around a broken trend. In both cases, the unemployment rate does not present a prominent degree of persistence, as opposed to the hysteresis hypothesis. For that reason, in this paper we will refer to the *NAIRU* theory even in the case of structural changes in the unemployment rate.
characterizes the Hysteresis hypothesis. Arestis & Mariscal (1999), Lee, Strazicich & Tieslau (2001) and Camarero and Tamarit (2004) are some of the works that apply this methodology, each one with some peculiarities but all of them for OECD countries, as it will be seen in the next section.

So far, we have talked about a literature that looks at unemployment from a national point of view. However, analyzing the nationwide unemployment rate may hide important disparities amongst regional unemployment rates, particularly in Brazil, which has continental dimensions and significant development differentials among its cities. Indeed, the aggregate unemployment rate in Brazil, released by the National Bureau of Geography and Statistics (IBGE), is a weighted average of the unemployment rates of the six major metropolitan areas (São Paulo, Rio de Janeiro, Belo Horizonte, Recife, Salvador, Porto Alegre), each one with peculiarities that ought to be taken into consideration.

The importance of studying regional unemployment is well discussed in Marston (1985), who gives a clear explanation of the so-called compensation theory and examines unemployment rate differentials among American cities. For the Brazilian case, Oliveira & Carneiro (1999) look for a possibility to establish a long-run relationship between unemployment rates of Brazilian States and the national rate. Corseuil, Gonzaga & Issler (1999) also investigate short run and long run unemployment movements across the already mentioned six metropolitan regions in Brazil.

Given the magnitude of the subject, it is of utmost significance to investigate the unemployment rates in the six major Brazilian metropolitan areas. Therefore, the purpose of this paper is twofold. First of all, we will test the both Hysteresis and NAIRU hypotheses for both the aggregate and regional unemployment rates in Brazil. The econometric methodology applied for testing the validity of the Hysteresis hypothesis is both standard Augmented Dickey-Fuller (ADF) tests as well as the endogenous one and two break LM unit root tests proposed in Lee and Strazicich (1999, 2003). The second aim of the article, which is in line with the regional unemployment literature, is a long run analysis that will enable us to check the convergence hypothesis for the regional unemployment series. The methodology employed is a straightforward extension to the unemployment case of the stochastic convergence proposition put forward by Carlino and Mills (1993), who study income convergence across US regions.

Our results show that the hysteresis phenomenon occurs in all regions, except in Rio de Janeiro, and in Brazil as a whole. This result indicates a high persistence in the Brazilian unemployment series, which is a consequence of many factors such as several
failed economic policies. As for the convergence test, our findings suggest that São Paulo, Belo Horizonte, Salvador and Recife present the stochastic convergence, which implies that Porto Alegre’s unemployment rate differential remains in the long-run.

The remainder of the paper is organized as follows. Section 2 revises the literature on *NAIRU* versus Hysteresis hypothesis and describes our econometric methodology on the subject. Section 3 revises the literature on convergence and details the econometric approach on this topic. Section 4 presents the data and its descriptive analysis as well as an overview of the unemployment problem in Brazil. Section 5 describes the results and section 6 concludes.

2. **NAIRU versus Hysteresis: Literature and Econometric Approach**

As mentioned above, Blanchard and Summers (1986) were worried about the hysteresis phenomenon in Europe in the 1980s. The authors argued that anything which increased the actual rate of unemployment for a sufficient length of time - a sustained increase in real interest rates induced by monetary policy, for instance - was likely to affect both the actual and the natural rate of unemployment.

Following this important article, several articles began to make empirical analyses on the subject.² For instance, using the ADF unit root test Neudorfer, Pichelmann & Wagner (1990) examine the Hysteresis hypothesis for Austria and Jaeger & Parkinson (1994) analyze the unemployment rates in the U.K., the USA, Canada and Germany. Both works did not reject the null hypothesis of a unit root and, consequently, the Hysteresis theory. As a benchmark examination, we also apply the ADF using the following specification:

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² To the best of our knowledge there are no articles comparing hysteresis and *NAIRU* hypothesis for the Brazilian case. Some works attempt only to find the Brazilian *NAIRU*: For instance, Portugal & Madalozzo (2000) use two different unemployment rate series, which belong to the *National Bureau of Geography and Statistics* (IBGE) and the *Worker’s Union Bureau of Statistics* (DIEESE), for the period between 1982.3 and 1997.3. For the IBGE’s data they find a *NAIRU* varying from 3.05% in the third quarter of 1986 to 9.21% in the fourth quarter of 1989. The use of DIEESE’s series data results in a constant *NAIRU* of 10.3%. The authors also suggest that the actual rate of unemployment converges to the *NAIRU* in the period 995.3/1997.3, reaching its long-term equilibrium level at some point during that period. Lima (2000) also estimates the Brazilian *NAIRU* using IBGE’s data(1982.1/1999.3). The author works with ARCH residuals and Markov-switching regime and concludes that the estimates of the *NAIRU* are very imprecise. These two works show that hysteresis hypothesis may be the case for the Brazilian data once no result is robust enough to confirm the *NAIRU* hypothesis.
\[ \Delta U_t = \mu + \beta t + \alpha U_{t-1} + \sum_{j=1}^{k} c_j \Delta U_{t-j} + \epsilon_t \]  

(1)

where \( U_t \) is the unemployment rate, \( \mu \) and \( t \) are the constant term and the linear trend, respectively.\(^3\)

However, since Perron (1989), it is well known that ADF tests can fail to reject a false unit root due to misspecification of the deterministic trend. In fact, Perron (1989, 1997) and Zivot and Andrews (1992) extend the ADF test considering an exogenous and an endogenous break in an attempt to avoid this problem. Indeed, Mitchell (1993) performs Perron’s unit root tests and his results also support the unit root hypothesis and hysteresis for several OECD nations. Arrufat et alli. (1999) perform unit root tests with structural breaks, based on Zivot and Andrews’ methodology, for the Argentine rate of unemployment as well as for 24 urban locations. Their results reject the unit root null hypothesis for 15 locations, including the nation-wide rate of unemployment.\(^4\)

Lumsdaine and Papell (1997) extended Zivot and Andrews’s test allowing for two breaks in level and trend. Arestis and Mariscal (1999) apply this methodology for 26 OECD countries and show a rejection of the Hysteresis hypothesis for the majority of the nations. However, these extensions of the ADF test including one or two breaks also have some drawbacks once they derive their critical values assuming no break(s) under the unit root null hypothesis, which lead to a spurious rejection of the null hypothesis in the presence of a unit root with breaks, as discussed by Lee and Strazicich (1999, 2003). In order to avoid such problems, the authors propose an endogenous one/two-break LM unit root tests, whose properties are unaffected by breaks under the null, in contrast to the ADF-type tests. Therefore, in addition to using the ADF test, we apply this LM test, whose methodology is as follows.\(^5\)

According to the LM (score) principle, a unit root test statistic can be obtained from the following regression:

\[ \Delta U_t = d' \Delta Z_t + \phi \tilde{\Delta} S_{t-1} + \sum_{i=1}^{k} \gamma_i \tilde{\Delta} S_{t-i} + \epsilon_t \]  

(2)

Where:

\(^3\) Following Ng and Perron (1995) we define a \( k\)-\textit{max} to choose \( k \) and use the (approximate) 10\% value of the asymptotic normal distribution, 1.645, to assess the significance of the last lag.

\(^4\) For the US case, Staiger, Stock and Watson (1997) suggest that the evidence doesn’t support the Hysteresis hypothesis. They argue that, although there have been some shifts, they have been minor over the last 3 decades.

\(^5\) Due to space limitations we present the two-break case. For the one break test methodology see Lee and Strazicich (1999).
i) \( \Delta S_{i,t}, \ i = 1, \ldots, k \), terms are included as necessary to correct for serial correlation; \(^6\)

ii) \( \tilde{S}_t \) is a de-trended series such that:

\[
\tilde{S}_t = U_t - \tilde{\phi} z - Z_t \tilde{\delta}, \ t = 2, \ldots, T
\]  

(3)

iii) \( \tilde{\delta} \) is a vector of coefficients in the regression of \( \Delta U_t \) on \( \Delta Z_t \);

iv) \( \tilde{\phi} z = U_1 - Z_1 \tilde{\delta} \), where \( Z_t \) is a vector of exogenous variables defined by the data generating process;

v) \( U_1 \) and \( Z_1 \) are the first observations of \( U_t \) and \( Z_t \), respectively;

vi) Considering 2 changes in level and trend \( Z_t \) is described by \( \left[l, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}\right] \), where:

a) \( D_{jt} = 1 \) for \( t \geq T_{B_j} + 1, \ j = 1,2 \), and zero otherwise;  
b) \( DT_{jt} = t \) for \( t \geq T_{B_j} + 1, \ j = 1, 2, \) and zero otherwise;  
c) \( T_{B_j} \) stands for the time period of the breaks. Note that the test regression (2) involves \( \Delta Z_t \) instead of \( Z_t \) so that \( \Delta Z_t \) becomes \( \left[l, B_{1t}, B_{2t}, D_{1t}, D_{2t}\right] \), where \( B_{jt} = \Delta D_{jt} \) and \( D_{jt} = \Delta DT_{jt}, j = 1,2 \).

The unit root null hypothesis is described in equation (2) by \( \phi = 0 \) and the test statistic is defined as given by:  

\[
\bar{\phi} = T \cdot \tilde{\phi},
\]

\[
\bar{t} = t\text{-statistic for the null hypothesis } \phi = 0
\]  

(4)

To endogenously determine the location of the two break points \( T_{B_j} \) in each time series, we use a similar procedure used in the “minimum LM test”, that is, a grid search is utilized to determine the break where the t-test statistic is minimized:

\[
LM_{t} = \inf \bar{t} (\lambda)
\]  

(5)

There is a repeated procedure at each combination of break points \( \left\{\lambda_j = T_{B_j}/T, \ j = 1,2\right\} \) over the time interval \([.1T,.9T]\) where \( T \) is the sample size. As shown in Lee and Strazicich (2003), critical values for this model depend on the location of breaks \( \left\{\lambda_j = T_{B_j}/T, \ j = 1,2\right\} \).

As a result, we utilize critical values that correspond to the location of the breaks.

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\(^6\) See footnote 3.
Finally, Lee, Strazicich & Tieslau (2001) study the validity of the Hysteresis hypothesis with yearly unemployment rate data from 17 OECD countries for the period between 1955 and 1999. The authors employ a panel LM unit root test which allows for heterogeneous structural change and find a strong rejection of the hypothesis. More recently, Camarero and Tamarit (2004) studied a panel of 19 OECD countries and, for that, applied a sequential procedure based on two multivariate ADF test-type panel unit root tests in a SURE framework. Their results strongly reject the joint null of Hysteresis.\footnote{We decided not to apply panel tests because we use only seven cross-section units.}

3. Regional Unemployment and Convergence: Literature and Econometric Approach

Regardless of the integration order of the series, it is imperative to study the regional unemployment series, i.e., it is important to study whether unemployment rates among different regions have got something in common which attracts them in the long run. Indeed, convergence matters especially when the series are integrated. In other words, if the Hysteresis hypothesis is the case, which indicates that there is no mean reversion in the series, they might also present some convergence pattern. For that reason, looking for disparities amongst regional unemployment rates as well as seeing if there is any process of convergence amongst them is a crucial investigation for Brazil once, as mentioned previously, it has got continental dimensions and several peculiarities between regions. Consequently, our study will focus on the unemployment rates of the country’s six major metropolitan areas - São Paulo (SP), Rio de Janeiro (RJ), Belo Horizonte (BH), Recife, Salvador, Porto Alegre (PA).

The importance of studying regional unemployment is well discussed in Marston (1985), who gives a clear explanation of the so-called compensation theory, which predicts that in equilibrium all individuals have the same utility level, and so areas more attractive could have a larger unemployment rate. The author examines unemployment rate differentials among American cities and his findings show that disturbances to the steady-state relationship among unemployment rates of important US metropolitan regions are likely to disappear because of mobility within a particular year. Blanchard and Katz (1992) go one step further and say that when jobless individuals move to other areas to look for work there is an adjustment of the labor market towards a long-run equilibrium, i.e., there will be convergence of regional unemployment rates. The authors analyze the dynamics of
the American regional unemployment but don’t find a strong indication for stationarity of
the rates and attribute the weak results to the tests used.

Jimeno & Bentolila (1998) look at the Spanish regional unemployment persistence. They show that regional wages, and relative unemployment and participation rates, are very persistent in Spain, while employment growth rates are not. Wu (2003) studies the Chinese regional unemployment persistence through a panel data approach. According to the author, three empirical findings are suggested. Firstly, provincial relative unemployment shows a greater persistence when compared to the nationwide unemployment rate. Secondly, total unemployment is more persistent than youth unemployment. Thirdly, the region with the highest provincial unemployment rate is the one with the lowest persistence of regional unemployment. Finally, the author finds out that Chinese jobseekers are usually driven to the private sector, which has helped reduce unemployment persistence. Bayer & Juessen (2004) analyze West German Regional Unemployment Rates and also apply unit-root tests that allow for structural breaks. For three of the ten federal states, and for Germany as a whole, the null hypothesis of a random walk cannot be rejected. The authors also find a strong evidence for convergence and that the speed of this convergence is very high.

As for the analysis of provincial unemployment in Brazil, Corseuil, Gonzaga & Issler (1999) investigate short run and long run unemployment movements across the mentioned six metropolitan regions in Brazil. The authors find evidence that, with an exception for the Recife metro area, aggregate components are relevant for regional unemployment rates. They also categorize short and long run comovements among the other five unemployment rates and the national unemployment rate. In addition to that, the article makes a decomposition of the unemployment series on permanent and temporary elements. The former follows very closely the respective unemployment rates, which is an indication of high persistence of the disturbances that influence the regional unemployment rates.

Oliveira & Carneiro (2001) also look for a possibility to establish a long-run relationship between states and national rates of unemployment. Two econometric techniques are used: The Engle-Granger cointegration analysis and the Unrestricted Error Correction Model. Their findings suggest that, in general, the states and the nation-wide unemployment rates have similar dynamics, but with permanent differences in the long run. If we suppose that the states have different attractiveness level, this result is consistent
with Marston (1985) prediction that in equilibrium all individuals have the same utility level, and so areas more attractive could have a larger unemployment rate.

If this is the case, it is important to examine this topic for our data set. Therefore, besides examining the Hysteresis hypothesis for Brazil, this paper makes use of the stochastic convergence concept, developed by Carlino and Mills (1993), and studies the progression of provincial discrepancies in unemployment rates within Brazil. Carlino and Mills’ (1993) approach, which was originally developed to study per capita income convergence among US regions, is based on the following idea: If per capita income of different regions is converging, then their income should not diverge arbitrarily and, consequently, the relative income – the \((ln)\) ratio of region “\(i\)” income and the mean income – should be stationary, which can be test by a unit root test.\(^8\)

In other words, the aim is to extend the authors’ approach and apply it to the relative unemployment of those regions that present hysteresis. Thus, the first step consists in defining the relative unemployment rate of region \(i\), \(u_{it}\), as the \((ln)\) ratio of unemployment rate \(U_i\) and the average unemployment rate of the regions, such that,

\[
u_{it} = \ln \left[ \frac{U_i}{\left( \sum_{i=1}^{I} U_i / I \right)} \right]
\]

(6)

Stochastic convergence is defined as the \((ln)\) of the unemployment rate from one region relative to the region’s average, \(u_{it}\), being stationary. In other words, under stochastic convergence, shocks to a region’s relative unemployment are temporary. For each area, we examine the null hypothesis that unemployment is diverging by testing for a unit root in \(u_{it}\). Failure to reject the unit root’s null hypothesis indicates evidence against stochastic convergence. The stochastic convergence is examined using the same unit root procedure applied to the hysteresis hypothesis, i.e., ADF tests and Lee and Strazicich’s (1999, 2003) framework, whose methodology has already been described previously.

4 Data, Overview, and Descriptive Analysis

In this section the aim is to present the data used in the article. After that, there will be an overview of the unemployment dynamics in Brazil in the 1980s, 1990s and

\(^8\) While Carlino and Mills apply unit root tests with a exogenous break, Loewy and Papell (1996), Tomljanovich and Vogelsang (2002) and Strazicich et al. (2004) refine their approach using endogenous break unit root tests.
beginning of the present decade. Finally, a descriptive analysis of the series will be outlined.

4.1 Data

The data used in the analysis are the seasonally adjusted monthly rates of open unemployment for the six major Brazilian metropolitan areas (São Paulo, Rio de Janeiro, Belo Horizonte, Recife, Salvador e Porto Alegre) and the nation-wide rate as well. The source is the Monthly Employment Survey (Pesquisa Mensal de Emprego) from the National Bureau of Geography and Statistics (IBGE), from 1981:01 to 2002:12, totaling 264 observations. It should be remarked that the aggregate rate of unemployment for Brazil corresponds to the weighted average of the regional rates, relative to the economically active population of each metropolitan region.

4.2 Overview of the Brazilian Unemployment

The beginning of the 1980’s definitely represents a turning point in the Brazilian economy. The so-called “economic miracle” of the 1970s had come to an end with negative consequences to the GDP growth as well as the unemployment rates. From then on, GDP growth rates have oscillated significantly about much lower values than the preceding decades. On the other hand, the unemployment rates increased slightly after the second half of the 1980s and considerably in the 1990s. As a result of the economic problems, the years analyzed here are marked by two periods of recession (1981-83 and 1990-92).

The opening years of the 1980s were the worst of all decade. They were followed by an inconsistent recovery but, with all the failed economic plans aimed at stabilizing the country’s inflation, the improvement of the economic growth did not sustain. During the course of the 1980s, the alleged “lost decade” by economists, there was a sharp fall in wages and an increase in the informal sector. In other words, there was a clear deterioration of the labor market with a widespread expansion of the underground

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9 Two reminders: i) In June and July/1992, there were no data available for the metropolitan regions once the survey was not performed due to workers’ strike. In these cases, the procedure adopted was a linear interpolation. ii) IBGE did not stop releasing unemployment data after 2002:12. However, there was an important change in methodology, which prevents us from going beyond that period. The main methodological changes followed recommendations of the International Labor Organization and refer to the geographic coverage, population at an active age, collection instruments, expansion of the sample, etc.
The economy in Brazil, which absorbed an increasing quantity of individuals who could not be employed by the formal segments of the economy. Even so, in spite of a 4% decline in GDP, the national unemployment rate was only 4.3% in 1990, as opposed to about 8% in 1981.

In the 1990s, the situation worsened and unemployment turned into one of the major distresses of Brazilian society. The opening up of the economy in the beginning of the decade, which resulted in more foreign competition, as well as a deep recession in the period, aggravated the labor market, especially the industrial employment. Between 1990 and 1992, there was a 1.3% annual decline in GDP and an increase in the overall unemployment rate (3.4% in 1989, 4.3% in 1990, 4.2% in 1991, 5.8% in 1992). The informal economy continued to expand and became even more perceptible.

Right after the implementation of the *Real Plan*, in 1994, unemployment started to recover from the stagnation observed in the early years of the decade. The stabilization plan lowered the inflation rate and, as a result, produced an economic stability which caused a sharp increase in the purchase power, due to the end of the inflationary tax. The fixed exchange rate, together with the opening up of the Brazilian borders, made consumption increase considerably and, as a consequence, caused a growing trade imbalance due to an explosive rise in imported products. Keeping a fixed exchange rate from the middle of 1994 up to the beginning of 1999 made the country highly dependent on the inflow of international capital and, as a result, made it highly vulnerable to external shocks. This weakness was confirmed when important crises hit the country (Mexico in 1994, Asia in 1997 and Russia 1998) and made Brazil lose a high volume of foreign reserves given, as mentioned before, the switch in the international market. In this period, the government implemented a restrictive monetary policy seeking to restore the trade balance by cooling down the economy and attracting short-term capital. The continuous resistance to devaluate the exchange rate had considerable social costs in terms of unemployment. Needless to say, the currency had to be devalued in the beginning of 1999. The flexible exchange rate gave the policymakers more freedom to conduct the Brazilian monetary policy. However, in order to maintain inflation under control, the policymakers have been keeping high interest rates that prevent the country from growing steadily and the unemployment rates from decreasing.

But the monetary policy is not the only variable responsible for the deterioration of the Brazilian labor market. There are some other issues which are worth mentioning: i) the
lack of necessary investments in infrastructure; \textit{ii}) severe deficiencies in the Brazilian education system; \textit{iii}) demographic changes.

4.3 Descriptive Analysis

The overview outlined above can be better seen in the light of a graphical of the deseasonalized series. Figure 1 reports the evolution of regional unemployment rates for Brazil, Greater São Paulo (SP) and Greater Rio de Janeiro (RJ). Firstly, one can notice the presence of two peaks in the beginning of the 1980s, both because of sharp economic recessions, as previously stated. Also, it can be seen that the dispersion of unemployment rates has increased considerably since the beginning of the 1990s, and this is due primarily, as mentioned by Blanchard & Summers (1987), to tight economic policies, especially monetary policy. As a result of these two facts, the graphic analysis suggests the existence of two structural breaks: the first one in the beginning of the 1980’s and the second one after the \textit{Real} stabilization plan. It is also worth mentioning a close similarity between the unemployment rates of São Paulo and Brazil, which may be caused by the fact that the former is Brazil’s most populated Brazilian metropolitan region. As for Greater Rio de Janeiro, the vertical axis shows a lower unemployment rate series, which can be a first indication that Rio de Janeiro area has a distinct behavior.
The dynamics of the regional unemployment rates for Greater Belo Horizonte (BH) and Greater Porto Alegre (PA) is plotted in Figure 2, together with the national unemployment rate. Again, the evolution of the series is quite analogous to the previous figure, with a high level of unemployment observed in the beginning and in the end of the sample. As before, this pattern suggests the existence of two structural breaks: early years of the 1980’s and after the Real Plan.

**Figure 2 - The Evolution of Regional Unemployment**

Figure 3 reports the evolution of regional unemployment rates for Greater Salvador, Greater Recife and, once more, the Brazilian unemployment rate. Despite following the same progression of the preceding figures, there are some details related to Salvador and Recife that need mentioning. Unlike the other series, the two metropolitan areas present a peak in 1992/1993, which is more prominent for Greater Recife. This could be an explanation for the results reported by Corseuil, Gonzaga & Issler (1999). In their article the authors suggest that, for the Recife metropolitan area, aggregate components are not too relevant. In fact, it is not apparent whether the two-break pattern described for the other regions and for Brazil as a whole applies to Recife.
Apart from a graphic analysis, it is also important to study whether there can be persistent differences among regional unemployment rates in Brazil. The descriptive statistics and the correlation analysis, depicted in Tables 1 and 2, may serve to analyze this point. We notice that Recife presents the highest mean, followed by Salvador, which has the second highest standard deviation. However, this doesn’t look like a structural factor underlying the series. It seems that these high values are more related to an isolated period within the sample. For Recife, this period goes from 1992 to 1994 whereas for Salvador the year 2000 may be the case. Also, as opposed to the other regions, both cities do not have unemployment rates below 3.4%. This can be an indication of substantial and persistent differences in the unemployment rates in Brazil. In addition to that, one can notice that Salvador, Rio de Janeiro and Recife have, respectively, the highest maximum values. Again, the series for Salvador and Recife evidently don’t show stable differentials when compared to the other regions and also to the nation-wide unemployment rate.

Table 2 shows that Greater São Paulo has the highest correlation with Brazil, which is expected once São Paulo is Brazil’s biggest metropolitan region. It is also clear that Rio has the lowest mean, which indicates something very peculiar. As well as that, it can be perceived that Greater Recife has the lowest correlation, followed by Greater Salvador, as pointed out by Corseuil, Gonzaga & Issler (1999). Again, the reason for such finding is because Recife had very high unemployment rates between 1992 and 1994 and Salvador had a similar pattern around year 2000. Therefore, both the descriptive and correlation analyses provide support that the regional behavior of the unemployment in Brazil needs to be assessed carefully and this evaluation will unquestionably lead to a better understanding.
of the problem when compared to the examination provided by the study of the national unemployment rate.

Table 1 - Descriptive Statistics: monthly unemployment rates

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Brazil</th>
<th>São Paulo</th>
<th>Rio de Janeiro</th>
<th>Belo Horizonte</th>
<th>Porto Alegre</th>
<th>Salvador</th>
<th>Recife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.631</td>
<td>5.942</td>
<td>4.597</td>
<td>5.670</td>
<td>5.187</td>
<td>6.844</td>
<td>6.932</td>
</tr>
<tr>
<td>Median</td>
<td>5.498</td>
<td>6.028</td>
<td>4.113</td>
<td>5.047</td>
<td>5.239</td>
<td>6.730</td>
<td>6.914</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.763</td>
<td>2.370</td>
<td>2.400</td>
<td>2.656</td>
<td>2.027</td>
<td>3.413</td>
<td>3.633</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.461</td>
<td>1.644</td>
<td>1.508</td>
<td>1.844</td>
<td>1.418</td>
<td>1.841</td>
<td>1.570</td>
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<tr>
<td>Observations</td>
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<td>264</td>
<td>264</td>
<td>264</td>
<td>264</td>
<td>264</td>
</tr>
</tbody>
</table>

Table 2 - Correlation: monthly unemployment rates

<table>
<thead>
<tr>
<th></th>
<th>Brazil</th>
<th>São Paulo</th>
<th>Rio de Janeiro</th>
<th>Belo Horizonte</th>
<th>Porto Alegre</th>
<th>Salvador</th>
<th>Recife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>São Paulo</td>
<td>0.943</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>0.835</td>
<td>0.640</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>0.912</td>
<td>0.770</td>
<td>0.866</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porto Alegre</td>
<td>0.869</td>
<td>0.844</td>
<td>0.640</td>
<td>0.798</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvador</td>
<td>0.826</td>
<td>0.802</td>
<td>0.554</td>
<td>0.698</td>
<td>0.724</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Recife</td>
<td>0.786</td>
<td>0.709</td>
<td>0.672</td>
<td>0.720</td>
<td>0.635</td>
<td>0.611</td>
<td>1.000</td>
</tr>
</tbody>
</table>

5. Econometric results

The benchmark ADF test was started with a maximum length of $k \ (k_{max})$ equal to 8 and, as Table 3 reports. The unit root null hypothesis is not rejected for Brazil as a whole and for all regions, except Rio de Janeiro, at a 5% level of significance. In other words, the Hysteresis phenomenon is found in the Brazilian aggregated data and also in 5 metropolitan areas. Indeed, this distinct behavior of Rio de Janeiro area had been noticed in the graphic analysis, which showed that Greater Rio de Janeiro consistently had lower unemployment rates than the others after 1990. As for Greater Recife, the null hypothesis is also rejected at a 10% level of significance, but this needs to be checked more deeply.
Table 3 - Regional Unemployment ADF Test

<table>
<thead>
<tr>
<th>Region</th>
<th>Specification</th>
<th>Test Statistic</th>
<th>Critical Values</th>
<th>Reject H₀ (Unit Root)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$k$</td>
<td>Constant</td>
<td>Trend</td>
<td>Test Statistic</td>
</tr>
<tr>
<td>Brazil</td>
<td>6</td>
<td>Yes</td>
<td>Yes</td>
<td>-2.799</td>
</tr>
<tr>
<td>São Paulo</td>
<td>6</td>
<td>Yes</td>
<td>Yes</td>
<td>-2.838</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>8</td>
<td>Yes</td>
<td>No</td>
<td>-3.453</td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>1</td>
<td>Yes</td>
<td>No</td>
<td>-2.102</td>
</tr>
<tr>
<td>Porto Alegre</td>
<td>1</td>
<td>Yes</td>
<td>No</td>
<td>-2.299</td>
</tr>
<tr>
<td>Salvador</td>
<td>2</td>
<td>Yes</td>
<td>Yes</td>
<td>-3.025</td>
</tr>
<tr>
<td>Recife</td>
<td>7</td>
<td>Yes</td>
<td>No</td>
<td>-2.729</td>
</tr>
</tbody>
</table>

Note: The constant and the linear term where included when they were significant at 10%. The critical values for the ADF unit root test are from MacKinnon (1996).

In order to double check the above results, we perform the LM unit root test for the series, considering the unknown structural break(s). We implement Strazicich’s et. alii. (2004) procedure, viz. we estimate the test equation including two break dates and, if the level ($B_t$) and the trend ($D_t$) dummies coefficients are not significant at 10% for one break date, we re-estimate the test equation with just one break date. The results are reported in Table 4. Only Salvador presents one break and the unit root null hypothesis is rejected for Rio de Janeiro, at 5% and 10%.

Table 4 - Regional Unemployment Two-Break LM Test

<table>
<thead>
<tr>
<th>Region</th>
<th>$k$</th>
<th>Test statistic</th>
<th>Break dates $T_{B1}$ ($\lambda_1$)</th>
<th>$T_{B2}$ ($\lambda_2$)</th>
<th>Reject H₀: Unit Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>8</td>
<td>-4.936</td>
<td>1985:07 (0.2)</td>
<td>1998:03 (0.8)</td>
<td>No</td>
</tr>
<tr>
<td>São Paulo</td>
<td>6</td>
<td>-4.529</td>
<td>1985:07 (0.2)</td>
<td>1998:01 (0.8)</td>
<td>No</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td>8</td>
<td>-6.333</td>
<td>1986:05 (0.2)</td>
<td>1997:10 (0.8)</td>
<td>Yes</td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>1</td>
<td>-5.178</td>
<td>1985:03 (0.2)</td>
<td>1998:02 (0.8)</td>
<td>No</td>
</tr>
<tr>
<td>Porto Alegre</td>
<td>1</td>
<td>-4.541</td>
<td>1986:03 (0.2)</td>
<td>1998:05 (0.8)</td>
<td>No</td>
</tr>
<tr>
<td>Salvador</td>
<td>2</td>
<td>-3.966</td>
<td>1989:10 (0.4)</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Recife</td>
<td>7</td>
<td>-4.479</td>
<td>1991:06 (0.5)</td>
<td>1994:12 (0.6)</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Critical values from Lee and Strazicich (1999) and Lee and Strazicich (2003), as a function of the location of the break(s), are reported in appendix.

These results confirm the hypothesis of full Hysteresis for the other series, which means that not only do shocks observed in the Brazilian economy cause deviations around
a deterministic trend but they also affect the national unemployment rate employment permanently. This influence is then spread to the regional unemployment rates and only Rio de Janeiro manages to deter such pressure. There are several speculations for Rio’s peculiarity: i) its population grows slower than the other metropolitan areas; ii) it seems that youngsters have opted, more than the other regions, to qualify themselves prior to getting into the labor market; iii) self-employment has been efficient and formal employment has fallen less than in other metro areas; iv) public sector jobs have been created in the three levels of government (Federal, State, Municipal).

Figure 4
To visualize our empirical findings, we superimpose the break points identified by the two-break tests and plot the unemployment series for the all the series. They are displayed in Figure 4. We perform a trend estimation, via ordinary least squares, in order to connect the break points. There is clear evidence that, in general, the series have two significant shifts in unemployment. For all the series containing two breaks, with the exception of one only, the first break falls into the period of 1985/march – 1986/May. As for the second break, it falls into the period of 1997/October – 1999/February, for all series, except one. Table 4 shows that the exception is Greater Recife, as it is also shown in Figure 4. An economic interpretation for the breaks might be the following. As mentioned in section 4, there were two periods of recession in the past decades: 1981-83 and 1990-92. The recovery from the first recession can be the explanation for the first break. After this downturn, there was a revitalization of the unemployment rates in the following years, i.e., they went from higher to lower levels and the break happened around 1986. The Recife
metro area didn’t deal well with the second recession and this is the reason why its two breaks are located in the beginning and in the end of the downturn. The second break coincides with the fixed exchange rate crisis around 1998.

5.1 Convergence Tests

First, we inspect the occurrence of stochastic convergence by means of the ADF test and report them on Table 5. We notice that the unit root null hypothesis is rejected in three cases (at 10% significance level): São Paulo, Porto Alegre and Salvador. This is a first indication of evidence against stochastic convergence.

Table 5 - Regional Unemployment Stochastic Convergence: ADF test

<table>
<thead>
<tr>
<th>Region</th>
<th>Specification</th>
<th>Test Statistic</th>
<th>Critical Values</th>
<th>Reject H0: Unit Root</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K  Constant</td>
<td>Trend</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>São Paulo</td>
<td>1  Yes</td>
<td>Yes</td>
<td>-4,523</td>
<td>-3,428 -3,137</td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>8  No</td>
<td>No</td>
<td>-1,036</td>
<td>-1,942 -1,616</td>
</tr>
<tr>
<td>Porto Alegre</td>
<td>6  Yes</td>
<td>No</td>
<td>-3,107</td>
<td>-2,873 -2,573</td>
</tr>
<tr>
<td>Salvador</td>
<td>4  Yes</td>
<td>Yes</td>
<td>-3,323</td>
<td>-3,428 -3,137</td>
</tr>
<tr>
<td>Recife</td>
<td>4  Yes</td>
<td>No</td>
<td>-2,377</td>
<td>-2,873 -2,573</td>
</tr>
</tbody>
</table>

Note: The constant and the linear term were included when they were significant at 10%. The critical values for the ADF unit root test are from MacKinnon (1996).

Again, the LM unit root break test is implemented following Strazicich’s et. alli. (2004) procedure described beforehand. This approach is particularly important in this context because, in the previous section, we observed that the unemployment series have similar break dates. Thus, some of these breaks may disappear when we build the relative unemployment series. In fact, as Table 6 reports, São Paulo and Porto Alegre present two breaks whereas the other cities present no more than one break. Furthermore, the stochastic convergence hypothesis is rejected only for Porto Alegre, at both 5% and 10% significance level. A plausible explanation for this peculiar behavior found in Porto Alegre’s unemployment rate might be due to the fact that jobless workers from other regions, because of distance and regional factors, do not tend to migrate to Porto Alegre in order to find work. In other words, Porto Alegre does not attract many job seekers and, as a result, it has lower levels of unemployment, as suggested by the compensation theory. This characteristic helps us to notice that Porto Alegre follows its own pattern and it is not influenced much by the other regions. On the other hand, the other metropolitan regions seem to be more linked and the distance between them is not a problem. This is clearly seen
by the frequent migration of northeast people to the southeast of Brazil, which could be an explanation for the convergence of the series. This is also in line with the regional unemployment literature discussed above.

**Table 6 -Regional Unemployment Stochastic Convergence: two-break LM test**

<table>
<thead>
<tr>
<th>Region</th>
<th>k</th>
<th>Test statistic</th>
<th>Break dates</th>
<th>Reject H₀: Unit Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>São Paulo</td>
<td>0</td>
<td>-6.692</td>
<td>1987:01 (0.3) 2000:02 (0.9)</td>
<td>Yes Yes</td>
</tr>
<tr>
<td>Belo Horizonte</td>
<td>0</td>
<td>-11.444</td>
<td>1995:01 (0.6) -</td>
<td>Yes Yes</td>
</tr>
<tr>
<td>Porto Alegre</td>
<td>1</td>
<td>-5.197</td>
<td>1986:08 (0.3) 1995:06 (0.7)</td>
<td>No No</td>
</tr>
<tr>
<td>Salvador</td>
<td>1</td>
<td>-5.448</td>
<td>1983:10 (0.1) -</td>
<td>Yes Yes</td>
</tr>
<tr>
<td>Recife</td>
<td>1</td>
<td>-5.457</td>
<td>1994:01 (0.6) -</td>
<td>Yes Yes</td>
</tr>
</tbody>
</table>

Note: Critical values from Lee and Strazicich (1999) and Lee and Strazicich (2003), as a function of the location of the break(s), are reported in appendix.

Here, we can also visualize our empirical findings. For that, we superimpose the break points identified by the two-break tests and plot the unemployment rates for the all the series, which are displayed in Figure 5. In order to connect the break points, the trend is estimated via ordinary least squares. For Belo Horizonte, Salvador and Recife, we notice that the one-break trend is able to replicate the relative unemployment behavior. On the other hand, São Paulo and Porto Alegre demand the two-break trend function.

**Figure 5**
6. Conclusion

The purpose of the paper was twofold. Firstly, we tested Hysteresis effect in unemployment for the six major metropolitan areas in Brazil and compared them with the nationwide unemployment rate. In order to do this, we applied a standard unit root test and also unit root tests that allowed for breaks in the trend function of the rates of unemployment. Our results showed that the unit root null hypothesis could not be rejected for all series, except for Rio de Janeiro. Therefore, the Hysteresis hypothesis was able to explain more properly the behavior of unemployment as opposed to the NAIRU hypothesis.

Secondly, as there was clear evidence of high persistence in the unemployment behavior of the most important cities in Brazil, the article also investigated the occurrence of stochastic convergence among the five metropolitan regions characterized by the Hysteresis effect. Our findings suggested that only Porto Alegre did not exhibit
convergence, which was an indication that this region had some peculiarities not found in the rest of the country.

As a result, our findings show that regardless of Rio de Janeiro and Porto Alegre having the two lowest averages, which would mean less attractiveness in Marston’s (1985) sense, these two cities have got some important aspects. Rio de Janeiro is able to keep its unemployment rates low whereas the other metropolitan areas do not manage to do the same. Porto Alegre has the second lowest mean but does not manage to get rid of the Hysteresis effect. Thus, we can infer that the other metropolitan regions converge to a higher level of unemployment once unemployment rates in Porto Alegre are relatively low. Therefore, the other cities will have problems in bringing their unemployment rates down.

Summing up, the results are extremely important in terms of economic policy as they can be used by policymakers to make crucial decisions related to mitigating unemployment and improve social standards of the Brazilian population.
References


## Appendix

### Table A1 - LM unit root test with one/two breaks critical values

<table>
<thead>
<tr>
<th>Break points</th>
<th>One-Break Test</th>
<th>Two-Break Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical Values</td>
<td>Break points</td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>( \lambda = (0.1) )</td>
<td>-4.50</td>
<td>-4.21</td>
</tr>
<tr>
<td>( \lambda = (0.2) )</td>
<td>-4.47</td>
<td>-4.20</td>
</tr>
<tr>
<td>( \lambda = (0.3) )</td>
<td>-4.45</td>
<td>-4.18</td>
</tr>
<tr>
<td>( \lambda = (0.4) )</td>
<td>-4.50</td>
<td>-4.18</td>
</tr>
<tr>
<td>( \lambda = (0.5) )</td>
<td>-4.51</td>
<td>-4.17</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Critical values from Lee and Strazicich (1999, 2003) for one-break and two-break LM unit root test (Model C), respectively. The critical values depend on the location of the break(s), \( \lambda \), and are symmetric around \( \lambda \) and 1-\( \lambda \). Critical values at additional break points can be interpolated.