Unit-roots in spatial unemployment in Argentina.
Testing in the presence of structural breaks

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1. Introduction

The present paper focuses on two major points. The first one is the significant rise in the rate of unemployment which has characterized the Argentine economy during the 1990’s suggesting the presence of a structural change at the beginning of this period. Our second object of concern is to study if there exist substantial regional differences in the behavior of the unemployment rate, with regard, for example, to averages or trends and, in particular, with the presence and timing of structural breaks in the local unemployment series.

A mere examination of the data gathered in the Argentine Permanent Household Surveys suggests the likely presence of a sudden change of regime in the rate of unemployment. This latter series exhibits, in fact, an accelerated upward trend that peaked in May 1995, reaching a historic record of 18.6%.

The international experience available warns us about the possible occurrence of a very somber fact: a very high degree of persistence has been observed in many different countries during the 1980’s and 1990’s. As a consequence, one may observe very high rates of unemployment lasting for very long periods. A crucial question one would like to address in this context concerns the best way to deal with the labor market adjustment. The answer we need is obviously not independent of the pattern in which the unemployment rate is likely to evolve. The most optimistic scenario one could conceive of is that the rate of unemployment will soon return to the much lower levels that used to be characteristic in the Argentine economy. There is, however, a danger that the pessimistic scenario might be the most appropriate one to entertain. In this latter case, it may also be true the case that unemployment in Argentina is affected by a high degree of persistence.

With regard to the spatial or regional features of the unemployment problem, it is certainly interesting to examine whether there are important differences by which one or more regions may have suffered more than others. A piece of statistical evidence may serve to illustrate this point: the standard deviation of the local unemployment rates climbed to 4.7% in 1995 from 2.4% in 1990. In other words, the spatial dispersion of the rates of unemployment nearly doubled within a five-year period. This provides evidence that the spatial nature of the unemployment problem deserves further examination leading to a much richer analysis than the one provided by the examination of the behavior of the rate of unemployment at the aggregate, nation-wide level.

The rest of this paper is organized as follows. Section 2 contains a brief discussion of the main concepts involved in the idea of persistence as an economic phenomenon. It also provides some key elements to interpret the hysteresis hypothesis from an econometric point of view.

Section 3 shows some selected features of the national and local unemployment rates in Argentina. Two main characteristics are highlighted: there appears to be a structural break at the end of the 1980's and there is also a markedly different regional behavior according to the statistical data provided by INDEC’s Permanent Household Survey, hereafter referred to as PHS.

In Section 4 the possible presence of structural breaks in the rate of unemployment series is formally tested for both the national and local levels.

Section 5 discusses some of the results obtained when applying unit-root tests at the nation-wide level for the rate of unemployment.

Section 6 summarizes the main topics addressed in this paper, presents the principal

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conclusions, and gives suggestions for future research.

2. Hysteresis and Persistence. Different Meanings in the Literature

Since the term "persistence" appears to mean different things to different people, an exposition of some of the salient points on the matter is in order.

The first thing to be noted is that there exists a "general" and a more strict or "specific" use of the concept. The former is usually used to mean that the unemployment rate stabilizes at a high level, or the related fact that the unemployment rate at a point of time depends on the past values of the same variable. The latter is associated with the existence of a unit-root in the time series.

2.1 The "general" interpretation of persistence

Layard, Nickell and Jackman, 1997, pose as key facts of unemployment that need to be explained the following:

i) unemployment fluctuates over time.
ii) unemployment varies much more between cycles than within business cycles
iii) the rise in European unemployment has been associated with a massive increase in long-term unemployment
iv) in many countries the level of unemployment has risen sharply relative to the level of vacancies
v) despite all this, unemployment is untrended over the long term
vi) unemployment differs greatly between countries.

Two points that emerge from the discussion are: firstly, that the facts ii) iii) and iv) bear a strong relationship with the "extraordinary persistence" of European unemployment in the 1980's (p 4); secondly, that in the long term "there are very powerful mechanisms at work which have forced the number of jobs to respond to the huge changes that have occurred in the number of people wanting to work ...". (p 5).

Again in Chapter 9, for example, a model for unemployment is presented, where a lagged dependent variable is included. The parameter is called a "hysteresis term", and is directly related to employment inertia (p 403), and certain combinations of parameters are called "measures of hysteresis" (p 407).

Within the context of this broad interpretation they conclude that "Hysteresis is a pervasive phenomenon, being absent only in Japan, the USA and Switzerland. It is a feature of price-setting, since persistence is determined by the sluggish adjustment of factors" (p 408), where "hysteresis" and "persistence" seem to be used by these authors without a sharp distinction between them.

In a similar vein, Schettkat (1992, p 43) states that "hysteresis in unemployment arises if the actual rate of unemployment depends entirely or partly on past rates of unemployment. The three dominant theoretical explanations of hysteresis are based on (1) the disappearance of physical capital, (2) the decay of human capital, and (3) insider-outsider models". He uses again "persistence" and "hysteresis" as related terms when referring to "the theoretical hypotheses about persistent unemployment and mismatch in the labor market can be summarized under the following headings: (1) The wage structure has destroyed incentives for mobility; (2) the pace of structural change has increased; (3) insiders exclude outsiders from employment; (4) employers are reluctant to hire; (5) mismatch and bottlenecks have occurred; and (6) (long-term) unemployment is self-sustaining (hysteresis)." (p 79).

And, again: "(Long-term) unemployment is self-sustaining (hysteresis). High rates of excess labor supply and long-term unemployment may have destroyed the working ability of the unemployed (one cause of hysteresis). This would result in long-term unemployment. Furthermore, the hiring rate (f) from unemployment would be low, but flow ratios from
unemployment into nonparticipation would be high ..." (p.81).

Lastly, he states as one of the characteristics of unemployment in Germany, that "unemployment is self-sustaining (hysteresis). In every business cycle, the duration of unemployment increased and did not return to the preceding levels in Germany. This pattern is certainly an indication of hysteresis" (p.180).

### 2.2 The hysteresis hypothesis as a unit-root process

For the purpose of the present paper we adopt a more specific meaning, as illustrated in the following quotation taken from Lindbeck, 1993.

"In spite of the apparent tendency for the unemployment rate to return to some long-run “normal” level, time series of unemployment rates do suggest unemployment persistence in the sense that the unemployment rate in year t is positively correlated with the unemployment rate in year t-1 (and usually also with the rate in one or a few previous years), \( u_t = au_{t-1} + \varepsilon_t \), in the simplest case with one time lag. The unemployment rate in period t is \( u_t \), and \( \varepsilon_t \) is a random disturbance term (“white noise”) with the expected value zero and constant variance. The coefficient \( a \geq 0 \) expresses the strength of the persistence effect. According to the celebrated “hysteresis hypothesis”, coefficient \( a \) would be unity (the unit root hypothesis), implying that the macroeconomy systematically (that is, except for random disturbances) would tend to be “stuck” at whatever unemployment rate happens to exist (the unemployment rate in this extreme case would be a random walk, that is, the expected value of the unemployment rate in one period would be the actual rate in the period immediately preceding it). In view of the tendency for the unemployment rate to return to some normal interval, the empirical evidence does not suggest that persistence is that strong. Most formal time-series studies of unemployment rates by various authors also seem to contradict the (strong) hysteresis hypothesis (Coe and Gagliardi 1985; Wyplosz 1987; Layard, Nickell, and Jackman 1991b, pp.412-413). It is often argued that the unemployment rate has a stronger tendency to be stuck at extreme peaks than at more modest (“local”) peaks; in other words, the unemployment persistence is particularly pronounced when unemployment is exceptionally high. However, the statistics depicted provide no grounds for asserting that unemployment persistence is stronger at exceptionally high unemployment rates than at more normal rates".

### 2.3 Persistence of the spatial structure of unemployment

There is yet a third meaning attached to the word “persistence” in the economic literature. It is appropriate to mention that “persistence” has been also used by some other authors (see Jimeno, and Bentolila, 1995) not only to describe a property of a single series but also the behavior through time of a group of related regional series of unemployment.

The latter refers to what is called the “persistence of the regional structure of unemployment”. The relative regional unemployment rates at a given point in time display a certain “structure”. The extent to which this structure changes or is maintained along time (that is, “persists”) may be measured by means of correlation coefficients between unemployment rates in different regions for two separate moments over time. In this sense persistence is high in the U.K. The USA shows a low persistence degree although it has a great dispersion between regions; on the contrary Japan, with a low dispersion, shows a high persistence.

### 3. Structural Change and the Unemployment Rate in Argentina

Some stylized facts of unemployment rate behavior in Argentina will be shown,
covering the period 1980-1997 are summarized in Table 3.1. Two features deserve special attention: a) the general trends of national and regional unemployment rates; b) Regional unemployment rates disparities.

On visual inspection, and for the national rate of unemployment, there appears to be a structural break by the end of the eighties. With regard to the series for the local rates of unemployment, there appear to be signs of differing patterns in connection with the presence (or absence) of structural breaks and/or the timing of those breaks. In Section 4 formal tests are carried out to detect the presence of such structural breaks on national and local unemployment rate series.

Table 3.1
Regional Unemployment Disparities

<table>
<thead>
<tr>
<th></th>
<th>U. National Rate* Unemployment</th>
<th>IRUD**</th>
<th>SIRUD***</th>
<th>Coefficient of Variation</th>
<th>By agglomerates</th>
<th>By regions****</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAX</td>
<td>min</td>
<td>Range</td>
<td>MAX</td>
<td>min</td>
<td>Range</td>
</tr>
<tr>
<td>1980 apr</td>
<td>2.6</td>
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<td>0.27</td>
<td>0.46</td>
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<td>0.9</td>
</tr>
<tr>
<td>oct</td>
<td>2.8</td>
<td>0.55</td>
<td>0.22</td>
<td>0.42</td>
<td>8.3</td>
<td>1.1</td>
</tr>
<tr>
<td>1981 apr</td>
<td>4.2</td>
<td>0.55</td>
<td>0.13</td>
<td>0.43</td>
<td>8.8</td>
<td>2.1</td>
</tr>
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<td>5.3</td>
<td>0.73</td>
<td>0.14</td>
<td>0.36</td>
<td>10.6</td>
<td>2.1</td>
</tr>
<tr>
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<td>6.0</td>
<td>0.94</td>
<td>0.16</td>
<td>0.31</td>
<td>11.0</td>
<td>3.7</td>
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<tr>
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<td>0.31</td>
<td>0.41</td>
<td>9.3</td>
<td>1.4</td>
</tr>
<tr>
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<td>0.35</td>
<td>9.1</td>
<td>1.0</td>
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<tr>
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<td>0.35</td>
<td>7.7</td>
<td>1.7</td>
</tr>
<tr>
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<td>1.09</td>
<td>0.23</td>
<td>0.41</td>
<td>10.6</td>
<td>2.3</td>
</tr>
<tr>
<td>oct</td>
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<td>0.36</td>
<td>0.41</td>
<td>10.6</td>
<td>1.2</td>
</tr>
<tr>
<td>1985 may</td>
<td>6.3</td>
<td>1.47</td>
<td>0.23</td>
<td>0.38</td>
<td>12.1</td>
<td>3.1</td>
</tr>
<tr>
<td>nov</td>
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<td>1.63</td>
<td>0.28</td>
<td>0.44</td>
<td>12.7</td>
<td>2.6</td>
</tr>
<tr>
<td>1986 may</td>
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<td>1.51</td>
<td>0.26</td>
<td>0.40</td>
<td>14.0</td>
<td>2.7</td>
</tr>
<tr>
<td>nov</td>
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<td>1.30</td>
<td>0.25</td>
<td>0.44</td>
<td>12.5</td>
<td>1.9</td>
</tr>
<tr>
<td>1987 apr</td>
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<td>1.33</td>
<td>0.22</td>
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<td>0.25</td>
<td>0.40</td>
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<td>0.35</td>
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<td>3.2</td>
</tr>
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<td>0.40</td>
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<td>3.5</td>
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<tr>
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<td>2.11</td>
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<td>0.35</td>
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<td>3.2</td>
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<td>0.20</td>
<td>0.38</td>
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<td>2.2</td>
</tr>
<tr>
<td>1991 jun</td>
<td>6.9</td>
<td>1.56</td>
<td>0.23</td>
<td>0.44</td>
<td>14.5</td>
<td>2.4</td>
</tr>
<tr>
<td>oct</td>
<td>6.0</td>
<td>1.31</td>
<td>0.22</td>
<td>0.39</td>
<td>11.4</td>
<td>3.2</td>
</tr>
<tr>
<td>1992 may</td>
<td>6.9</td>
<td>1.54</td>
<td>0.22</td>
<td>0.41</td>
<td>12.9</td>
<td>2.4</td>
</tr>
<tr>
<td>oct</td>
<td>7.0</td>
<td>1.60</td>
<td>0.23</td>
<td>0.40</td>
<td>13.9</td>
<td>2.3</td>
</tr>
<tr>
<td>1993 may</td>
<td>9.9</td>
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<td>0.19</td>
<td>0.37</td>
<td>14.8</td>
<td>4.0</td>
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<td>oct</td>
<td>9.3</td>
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<td>0.22</td>
<td>0.38</td>
<td>14.9</td>
<td>3.0</td>
</tr>
<tr>
<td>1994 may</td>
<td>10.7</td>
<td>2.00</td>
<td>0.19</td>
<td>0.36</td>
<td>16.9</td>
<td>2.7</td>
</tr>
<tr>
<td>oct</td>
<td>12.2</td>
<td>2.97</td>
<td>0.24</td>
<td>0.38</td>
<td>21.4</td>
<td>4.6</td>
</tr>
<tr>
<td>1995 may</td>
<td>18.6</td>
<td>4.26</td>
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<td>0.34</td>
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<td>0.18</td>
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</tr>
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<td>1996 may</td>
<td>17.0</td>
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<td>0.31</td>
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<td>7.2</td>
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<tr>
<td>oct</td>
<td>17.4</td>
<td>4.06</td>
<td>0.23</td>
<td>0.35</td>
<td>22.0</td>
<td>6.3</td>
</tr>
</tbody>
</table>

The data are taken from INDEC's PHS.
IRUD: Index of Regional Unemployment Disparities, calculated as the sum of the absolute values of the differences between each local rate and the national average.
SIRUD: based on IRUD by scaling by the national rate of unemployment.

4. Recursive Least Squares Tests of Structural Change

Two kinds of tests were run to detect structural changes in the rate of unemployment at the national and local levels. The period considered goes from April 1980 to October
1997. The periodicity of the data is semi-annual\(^3\).

4.1 Recursive residuals

4.1.1 RRT and OSFT tests.

Two tests that belong to the general kind of tests called “recursive least squares” are performed. In these tests the target equation is estimated repeatedly, using ever-larger subsets of the sample data. The target equation is as follows:

\[ y = X\beta + u \]  

(1)

In equation (1) the following symbols are used: \( \beta \) is a \( k \times 1 \) vector of parameters, \( y \) is an \( n \times 1 \) vector of the dependent variable, \( X \) is an \( n \times k \) matrix of explanatory variables, and \( u \) is an \( n \times 1 \) vector of random disturbances.

In line with the usual procedures employed in the recursive least squares literature\(^4\) a series of steps are implemented. Because there are \( k \) coefficients to be estimated in the \( \beta \) vector, then the first \( k \) observations are used to form the first estimate of \( \beta \). The next observation is then added to the data set and all \( (k+1) \) observations used to compute the second estimate of \( \beta \). This process is repeated until all the \( n \) sample points have been used (where \( n \) is the number of observations in the regression), yielding \( (n-k) \) estimates of the \( \beta \) vector. At each step the last estimate of \( \beta \) can be used to predict the next value of the dependent variable.

This process will give an estimate of the dependent variable. Then the forecast error is defined as the difference between the current value and the estimated value of the dependent variable \( (y - \hat{y}) \). The recursive residual \( w_t \) is then defined as:

\[ w_t = \frac{y - \hat{y}}{\sigma} \]  

(2)

In equation (2), \( \sigma \) and \( \hat{\sigma} \) are respectively the standard deviation of the original data and that of the forecast error. These residuals can be computed for \( t = k+1, \ldots, n \). Their importance derives from the fact that if the maintained model is valid, the recursive residuals will be independently and normally distributed with zero mean and constant variance. This facilitates tests of serial correlation and heteroskedasticity, but one of the most important applications of recursive residuals is testing for structural change in the model. Two particular tests of this type are performed. The first one is the “recursive residuals test” (RRT), and the second one is the so-called “one-step forecast test” (OSFT).

In what follows the results of both tests are displayed in figures made up of two panels. The upper panel shows the results for the RRT, whereas the lower panel does the same thing for the OSFT.

4.1.2 National Unemployment Rate

i) The recursive residual test (RRT) displays a plot of the recursive residuals \( (w_t) \) about the zero line. Plus and minus two standard errors are also shown at each point of time. Residuals outside the standard error bands suggest instability in the parameters of the equation. In the upper panel of Figure 4.1

\(^3\) It must be noted that the periodicity of the data from the INDEC PHS is not exact, only approximate. Nowadays, the Survey is usually referred to May and October of each year. In the not too distant past it was common practice to obtain the samples in April and October.

\(^4\) Recursive residuals were introduced by Brown, Durbin and Evans, 1975. For a clear summary of the main ideas associated with this approach see, for example, Johnston (1984) or Harvey (1990).
the recursive residuals for a linear trend regression specification and the corresponding two-standard-error bands for the national unemployment rate for Argentina are displayed.

Figure 4.1
Argentina. National Unemployment Rate. Linear Trend Specification
Recursive Residual Test, RRT (upper panel)
One-step Forecast Test, OSFT (lower panel)

ii) The one-step forecast test (OSFT) compares the error from each one-step ahead forecast error that emerges from the application of the recursive residuals procedure, with its standard deviation under the null hypothesis of no structural break in the series under consideration. It tests whether the value of the dependent variable at time \( t \) might have come from the model fitted to all the data up to that point. In the lower panel of Figure 4.1 (also for a linear regression) the probability values (i.e. significance levels) for those sample points where the hypothesis of parameter constancy would be rejected at the 5, 10, or 15 percent levels (larger probabilities are not shown) are displayed. If, for example, a plot is below the 5 percent line the null hypothesis for that observation cannot be rejected at the 5 % significance level.
In Figure 4.1, which corresponds to the linear trend specification, both types of test (RRT and OSFT) suggest that an upward structural break is present for April 1993. Additional significant observations refer to October 1994, April and October 1995 and April 1996, respectively. But for April 1994 only the OSFT suggests the presence of a structural break.

In Figure 4.2, similar calculations are performed using a specification with a linear trend and a quadratic term. The data point corresponding to April 1993 suggests (as is the case with the linear specification) the presence of a structural break. The observations for October 1994 and April 1995 further confirm the outlying character of those points. The data points corresponding to April 1993, October 1994 and April 1995 observations reveal the presence of an upward structural change.

### 4.1.3 Heterogeneity of structural breaks in local unemployment rates series

Since one of the objectives of the present paper is to study the spatial heterogeneity of the rates of unemployment, similar tests to the ones reported above were carried out using the 25 PHS agglomerates available for Argentina. As a first step, a simple count of the total number of "upward structural breaks" found for each observation is calculated. The results obtained are shown in Figure 4.3. It may be seen that for April 1989 a total of thirteen and fifteen cases for the linear and linear-and-quadratic-trend versions, respectively, were detected.

This is an important finding because April 1989 marks the beginning of the period for which the two tests employed seem to detect the greatest number of upward structural changes since April 19805.

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5 It should be stressed that the available evidence also shows signs of structural breaks in April 1982 and April 1986. For more details see Figure 4.3.
Throughout the period October 1994 – April 1997 the statistical tests employed detect a great number of significant observations for which a structural break is present. Most of those observations are located in the vicinity of April 1995, with a total count of 22 for both the linear and the quadratic trend specifications.

It is also the case that a significant observation is detected in April 1993, something which had not happened since April 1989.

An alternative procedure

In Figure 4.4, the vertical scale measures the number of recursive residuals outside the standard error bands, given that a one-lagged observation is not outside the error bands. In this way one can isolate the observations that can more properly be called “structural break”.

This must be done because frequently the test finds a sequence of residuals outside the standard error bands in consecutive observations. The observations for which an “structural change” occurs are, more intuitively those which have a residual outside the SE bands and do not have a one-lagged observation also with a residual outside the SE bands. In this sense, April 1989 is undoubtedly a period of time of generalized structural breaks in the INDEC-PHS agglomerates. A second point with generalized structural breaks at the local level is April 1995.

A second feature worth noting from Figures 4.3 and 4.4 is that the pattern of local structural breaks is far from being homogeneous. This fact corroborates the previously mentioned spatial heterogeneity of unemployment in Argentina in the period under study. The pattern of differential local structural breaks in unemployment series is a “fact” to be explained.
Figure 4.4
Argentina. number of Structural breaks in local unemployment series
(recursive residuals outside the standard error bands, given that a one-lagged
observation is not outside the error bands)

Heterogeneity

Note that if the movements of the unemployment rate were identical for all the INDEC
agglomerates during a given time period, a structural change would happen in all of them at
the same time. Figures 4.3 and 4.4 clearly show a general picture where it shall be noted
that: a) there is not such an homogeneous behavior, and, b) the structural changes tend to
be concentrated in a few points of time.

The next step is to ask if groups of agglomerates which belong to a same “region” or
“bloc” are more likely to have coincident structural breaks than groups of agglomerates
chosen at random. As a first approximation, a cluster analysis was performed to find
agglomerates which are the “most similar” or “closest” from an statistical point of view. The
objective is to select representative agglomerates from each of these groups, in order to
compare the properties of local unemployment time series. More specifically we are
interested in testing for unit-roots.
### Table 4.5

**Argentina - Summary Statistics of Unemployment - INDEC Agglomerates**

**Cluster Analysis; 1984-1997; Variables: Rates of Unemployment**

<table>
<thead>
<tr>
<th>Region</th>
<th>Agglomerate</th>
<th>Average</th>
<th>Std. Dev.</th>
<th>Coef. of Var</th>
<th>Agglomerate</th>
<th>Average</th>
<th>Std. Dev.</th>
<th>Coef. of Var</th>
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<td><strong>NORESTE</strong></td>
<td>SGO. ESTERO</td>
<td>5.5</td>
<td>3.08</td>
<td>0.56</td>
<td>STAROSA</td>
<td>5.3</td>
<td>2.85</td>
<td>0.54</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>MENDOZA</td>
<td>4.9</td>
<td>1.33</td>
<td>0.27</td>
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<tr>
<td><strong>ARGENTINO</strong></td>
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<td>JUJUY</td>
<td>8.2</td>
<td>3.78</td>
<td>0.46</td>
<td>SANLUIS</td>
<td>6.4</td>
<td>2.82</td>
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<td>4.1</td>
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<td>2.71</td>
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<td>LARIOJA</td>
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<td>7.8</td>
<td>0.46</td>
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<td>7.8</td>
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<td>0.06</td>
</tr>
<tr>
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<td>6.4</td>
<td>2.82</td>
<td>0.44</td>
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<td>4.9</td>
<td>1.33</td>
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<tr>
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<td>MENDOZA</td>
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<td>1.33</td>
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<td>11.8</td>
<td>5.07</td>
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<td>10.1</td>
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<td>11.1</td>
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<td>3.90</td>
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<tr>
<td></td>
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<td>3.80</td>
<td>0.38</td>
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<td></td>
<td>11.1</td>
<td>4.26</td>
<td>0.38</td>
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<tr>
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<td>6.5</td>
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<td></td>
<td>10.1</td>
<td>3.80</td>
<td>0.38</td>
</tr>
<tr>
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<td>ROSARIO</td>
<td>11.1</td>
<td>4.26</td>
<td>0.38</td>
<td></td>
<td>8.8</td>
<td>1.39</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>CONJURBANO</td>
<td>8.3</td>
<td>2.49</td>
<td>0.30</td>
<td></td>
<td>10.1</td>
<td>3.80</td>
<td>0.38</td>
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<td><strong>PATAGONICA</strong></td>
<td>NEUQUEN</td>
<td>8.5</td>
<td>3.91</td>
<td>0.46</td>
<td></td>
<td>13.1</td>
<td>3.90</td>
<td>0.30</td>
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<td></td>
<td>RIO GALLEGOS</td>
<td>9.9</td>
<td>3.73</td>
<td>0.38</td>
<td></td>
<td>9.6</td>
<td>2.17</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>USHUAIA*</td>
<td>9.6</td>
<td>2.17</td>
<td>0.23</td>
<td></td>
<td>8.0</td>
<td>2.67</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Note: Numbers in italics are for the average and dispersion statistics for each cluster.

*Ushuaia statistics are for the period 1981-1997.*
As a further check of the said heterogeneity, Table 4.5 displays some summary statistics. The left-hand-side panel reports the relevant data for the urban agglomerates. Notice that the agglomerates are grouped in accordance with INDEC's usual practices. By way of contrast, in the other three panels, the local data are grouped following the results obtained through the use of cluster analysis. (This is a piece of research work conducted by the authors of the present paper, which is currently in progress).

The most striking feature emerging from Table 4.5 is the very significant drop in the values of the various indicators of spatial dispersion. This is not altogether surprising because cluster analysis is a technique specifically designed to minimize the within-groups distance and maximize between-groups distance.

The most important lesson to be learnt from this analysis is that it seems a far better practice to group agglomerates into regions by looking at similarities and disparities of the relevant labor market indicators rather than simply grouping agglomerates on the basis of notions of mere geographical proximity.

5. Testing for unit-roots in the rate of unemployment

In this section, Augmented Dickey-Fuller (hereafeter ADF) tests are carried out in order to ascertain whether the nation-wide rate of unemployment for Argentina can be characterized by a unit root process, including an intercept and a time trend. The test is implemented for the period 1980-1997, for which there are 36 observations available. In all cases, the data employed in the analysis come from the Permanent Household Survey. This Survey is conducted twice a year, during May and October, in present day practice. In older days, which are relevant for the first part of the sample data, the months chosen were April and October. It is clear that the observations relating to May and October are placed exactly six months apart. This is, however, not the case for the observations relating to May and October. In this latter case, 5 months are elapsed from May to October, while 7 months separate October from the following May. The problems which this feature of the only source of data available might pose have been ignored. Consequently, the econometric analysis which follows has been conducted on the assumption that all data points are evenly spaced in time.

It is well known in the literature (see, for example, Perron (1989)), that the ADF type of unit root tests is highly sensitive to the presence of structural breaks in the series under consideration. In the previous section, it was established that the rate of unemployment exhibits such structural breaks. It is, therefore, advisable to guard against the danger of concluding in favor of the presence of a unit root in the data generation process when no unit root is, in fact, present. It is for this reason that a series of Augmented Dickey-Fuller tests are carried out for the nation-wide rate of unemployment, by first running the test for the period 1980-1989, that is, for a total of 20 observations. Two more observations are added at each stage, until the full sample of 36 data points are used. Nine tables are presented, labelled from 5.1 to 5.9, covering the periods indicated in each one of them. The reason underlying the present procedure is that it was considered important to bring out the different structure of the observations following the end of the eighties. This is best illustrated by the fact that different conclusions, with regard to the presence or absence of a unit root in the rate of unemployment series, are obtained as the exercise proceeds.

The main results obtained are briefly presented here. With regard to the period 1980-1989, for which there are 20 observations available, the ADF test assumes a value of –3.679. As shown in Table 5.1 this result leads to the rejection of the null hypothesis of the presence of a unit root at the 5% level.

The results presented in Table 5.2 lead to the same conclusion: the null hypothesis is rejected, but this time the estimated ADF test statistic is equal to –4.026, which is also...
significant at the 5% level.

Similar conclusions are obtained in Tables 5.3, 5.4 and 5.5. On the contrary, the results displayed in the remaining Tables, 5.6 to 5.9 point to the non-rejection of the null hypothesis of a unit root.

Table 5.1

Augmented Dickey-Fuller Unit Root Test on TDESEM Period: 1980-1989

<table>
<thead>
<tr>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.679493</td>
<td>-4.5348</td>
<td>-3.6746</td>
<td>-3.2762</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98 Time: 18:48
Sample (adjusted): 2 20
Included observations: 19 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDESEM(-1)</td>
<td>-0.873428</td>
<td>0.237377</td>
<td>-3.679493</td>
<td>0.0020</td>
</tr>
<tr>
<td>C</td>
<td>3.369087</td>
<td>0.908777</td>
<td>3.707275</td>
<td>0.0019</td>
</tr>
<tr>
<td>@TREND(1)</td>
<td>0.147399</td>
<td>0.058071</td>
<td>2.538236</td>
<td>0.0219</td>
</tr>
</tbody>
</table>

R-squared            0.462182    Mean dependent var 0.238757
Adjusted R-squared   0.394955    S.D. dependent var 1.138150
S.E. of regression   0.885306    Akaike info criter-0.099704
Sum squared resid    12.54027    Schwarz criterion  0.049418
Log likelihood      -23.01264    F-statistic        6.874920
Durbin-Watson stat   2.132616    Prob(F-statistic)  0.007000

Table 5.2

Augmented Dickey-Fuller Unit Root Test on TDESEM Period: 1980-1990

<table>
<thead>
<tr>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4.026021</td>
<td>-4.4691</td>
<td>-3.6454</td>
<td>-3.2602</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98 Time: 18:48
Sample (adjusted): 2 22
Included observations: 21 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDESEM(-1)</td>
<td>-0.971397</td>
<td>0.241280</td>
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<tr>
<td>C</td>
<td>3.713763</td>
<td>0.897363</td>
<td>4.138529</td>
<td>0.0006</td>
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<tr>
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<td>0.164930</td>
<td>0.059409</td>
<td>2.776178</td>
<td>0.0125</td>
</tr>
</tbody>
</table>

R-squared            0.487544    Mean dependent var 0.172132
Adjusted R-squared   0.430604    S.D. dependent var 1.237219
Table 5.3

Augmented Dickey-Fuller Unit Root Test on TDESEM
==================================================================================================
ADF Test Statistic  -3.814952  1% Critical Value*-4.4167
                     5% Critical Value -3.6219
                     10% Critical Value -3.2474
==================================================================================================
*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98   Time: 18:48
Sample(adjusted): 2 24
Included observations: 23 after adjusting endpoints
==================================================================================================
Variable      CoefficienStd. Error t-Statistic  Prob.
==================================================================================================
TDESEM(-1)     -0.865146   0.226778  -3.814952   0.0011
C           3.538284   0.890011   3.975553   0.0007
@TREND(1)       0.121487   0.049836   2.437740   0.0242
==================================================================================================
R-squared            0.438888    Mean dependent var 0.147838
Adjusted R-squared   0.382777    S.D. dependent var 1.204504
S.E. of regression   0.946301    Akaike info criter 0.010718
Sum squared resid    17.90970    Schwarz criterion  0.158826
Log likelihood      -29.75884    F-statistic        7.821758
Durbin-Watson stat   2.085250    Prob(F-statistic)  0.003094
==================================================================================================

Table 5.4

Augmented Dickey-Fuller Unit Root Test on TDESEM
Period: 1980-1992
==================================================================================================
ADF Test Statistic  -4.103325    1% Critical Value*-4.3738
                     5% Critical Value -3.6027
                     10% Critical Value -3.2367
==================================================================================================
*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98   Time: 18:48
Sample(adjusted): 2 26
Included observations: 25 after adjusting endpoints
==================================================================================================
Variable      CoefficienStd. Error t-Statistic  Prob.
==================================================================================================
TDESEM(-1)     -0.826251   0.201361  -4.103325   0.0005
C           3.457639   0.831772   4.156955   0.0004
@TREND(1)       0.108158   0.039710   2.723678   0.0124
==================================================================================================
R-squared            0.440771    Mean dependent var 0.177649
Adjusted R-squared   0.389932    S.D. dependent var 1.162231
S.E. of regression   0.907782    Akaike info criter-0.081335

S.E. of regression  0.933585    Akaike info criter-0.005884
Sum squared resid  15.68844    Schwarz criterion  0.143334
Log likelihood    -26.73593    F-statistic        8.562466
Durbin-Watson stat  2.011494    Prob(F-statistic)  0.002437
<table>
<thead>
<tr>
<th>Sum squared resid</th>
<th>18.12951</th>
<th>Schwarz criterion</th>
<th>0.064931</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log likelihood</td>
<td>-31.45678</td>
<td>F-statistic</td>
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</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>2.204560</td>
<td>Prob(F-statistic)</td>
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<table>
<thead>
<tr>
<th>Table 5.5</th>
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<tbody>
<tr>
<td>Augmented Dickey-Fuller Unit Root Test on TDESEM</td>
</tr>
<tr>
<td>Period: 1980-1993</td>
</tr>
<tr>
<td>ADF Test Statistic</td>
</tr>
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</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98   Time: 18:48
Sample(adjusted): 2 28
Included observations: 27 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
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<tr>
<td>TDESEM(-1)</td>
<td>-0.818066</td>
<td>0.199311</td>
<td>-4.104478</td>
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<tr>
<td>C</td>
<td>3.184460</td>
<td>0.813198</td>
<td>3.915973</td>
<td>0.0007</td>
</tr>
<tr>
<td>@TREND(1)</td>
<td>0.133689</td>
<td>0.041036</td>
<td>3.257868</td>
<td>0.0033</td>
</tr>
</tbody>
</table>

R-squared       | 0.412476    | Mean dependent var | 0.245563 |
Adjusted R-squared | 0.363515   | S.D. dependent var  | 1.245633 |
S.E. of regression | 0.993766   | Akaike info criter  | 0.091931 |
Sum squared resid | 23.70168   | Schwarz criterion  | 0.235913 |
Log likelihood   | -36.55241   | F-statistic        | 8.426492 |
Durbin-Watson stat | 2.088889   | Prob(F-statistic)  | 0.001692 |

<table>
<thead>
<tr>
<th>Table 5.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller Unit Root Test on TDESEM</td>
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<tr>
<td>ADF Test Statistic</td>
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<tr>
<td></td>
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</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98   Time: 18:48
Sample(adjusted): 2 30
Included observations: 29 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDESEM(-1)</td>
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</tr>
<tr>
<td>C</td>
<td>2.025467</td>
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<td>2.506606</td>
<td>0.0188</td>
</tr>
<tr>
<td>@TREND(1)</td>
<td>0.122989</td>
<td>0.045583</td>
<td>2.683210</td>
<td>0.0125</td>
</tr>
</tbody>
</table>

R-squared       | 0.240412    | Mean dependent var | 0.328966 |
Adjusted R-squared | 0.181983   | S.D. dependent var  | 1.240178 |
S.E. of regression | 1.121670   | Akaike info criter  | 0.327335 |
Sum squared resid | 32.71174   | Schwarz criterion  | 0.468779 |
Log likelihood   | -42.89557   | F-statistic        | 4.114551 |
Durbin-Watson stat | 2.102283   | Prob(F-statistic)  | 0.028023 |
### Table 5.7

Augmented Dickey-Fuller Unit Root Test on TDESEM  
Period: 1980-1995

<table>
<thead>
<tr>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.584839</td>
<td>-4.2826</td>
<td>-3.5614</td>
<td>-3.2138</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation  
LS // Dependent Variable is D(TDESEM)  
Date: 05/14/98  Time: 18:48  
Sample (adjusted): 2 32  
Included observations: 31 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDESEM(-1)</td>
<td>-0.248366</td>
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<tr>
<td>C</td>
<td>0.575001</td>
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<td>0.802941</td>
<td>0.4288</td>
</tr>
<tr>
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<td>0.096630</td>
<td>0.052107</td>
<td>1.854468</td>
<td>0.0742</td>
</tr>
</tbody>
</table>

R-squared: 0.110622, Mean dependent var: 0.445398  
Adjusted R-squared: 0.047095, S.D. dependent var: 1.647442  
S.E. of regression: 1.608181, Akaike info criter: 1.041973  
Sum squared resid: 72.41485, Schwarz criterion: 1.180745  
Log likelihood: -57.13767, F-statistic: 1.741341  
Durbin-Watson stat: 2.299091, Prob(F-statistic): 0.193735

### Table 5.8

Augmented Dickey-Fuller Unit Root Test on TDESEM  
Period: 1980-1996

<table>
<thead>
<tr>
<th>ADF Test Statistic</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.562129</td>
<td>-4.2605</td>
<td>-3.5514</td>
<td>-3.2081</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation  
LS // Dependent Variable is D(TDESEM)  
Date: 05/14/98  Time: 18:48  
Sample (adjusted): 2 34  
Included observations: 33 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDESEM(-1)</td>
<td>-0.196332</td>
<td>0.156714</td>
<td>-1.562129</td>
<td>0.1287</td>
</tr>
<tr>
<td>C</td>
<td>0.369064</td>
<td>0.716119</td>
<td>0.608092</td>
<td>0.5477</td>
</tr>
<tr>
<td>@TREND(1)</td>
<td>0.096630</td>
<td>0.052107</td>
<td>1.854468</td>
<td>0.0742</td>
</tr>
</tbody>
</table>

R-squared: 0.110622, Mean dependent var: 0.445398  
Adjusted R-squared: 0.047095, S.D. dependent var: 1.647442  
S.E. of regression: 1.608181, Akaike info criter: 1.041973  
Sum squared resid: 72.41485, Schwarz criterion: 1.180745  
Log likelihood: -57.13767, F-statistic: 1.741341  
Durbin-Watson stat: 2.299091, Prob(F-statistic): 0.193735

### Table 5.9
Augmented Dickey-Fuller Unit Root Test on TDESEM

============================================================
ADF Test Statistic -2.179599 1% Critical Value* -4.2412
5% Critical Value -3.5426
10% Critical Value -3.2032

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(TDESEM)
Date: 05/14/98   Time: 18:48
Sample(adjusted): 2 36
Included observations: 35 after adjusting endpoints

Variable      CoefficienStd. Errort-Statistic  Prob.

TDESEM(-1)     -0.257704   0.118235  -2.179599   0.0368
C           0.685834   0.574870   1.193025   0.2416
@TREND(1)       0.092405   0.049562   1.864443   0.0715

R-squared            0.129307    Mean dependent var 0.316814
Adjusted R-squared   0.074889    S.D. dependent var 1.644892
S.E. of regression   1.582102    Akaike info criter 0.999325
Sum squared resid    80.09745    Schwarz criterion  1.132640
Log likelihood      -64.15103    F-statistic        2.376172
Durbin-Watson stat   2.167019    Prob(F-statistic)  0.109104

6. SUMMARY AND CONCLUSIONS

In Section 2, the paper first reviewed some of the meanings usually attached in the economic literature to the word hysteresis. For the purposes of the present research, however, the third meaning, associated with the presence of a unit root in the data generation process for the rate of unemployment, was adopted. Section 3, in turn, highlighted some of the most important characteristics of the labor market, including local labor markets indicators as well as national ones. Various measures of heterogeneity were also presented and proposals made for a new way of grouping urban agglomerates into homogeneous regions, based on some preliminary results obtained by the authors though the use of cluster analysis.

Tests based on the calculations of recursive residuals were presented in Section 4 in order to test for the presence of structural breaks for the rates of unemployment in Argentina, covering the period April 1989 to October 1997. The test reported provided evidence that there has been a break in the series, although some heterogeneity at the local level exists. In Section 5, ADF tests were implemented to determine whether or not the national rate of unemployment contains a unit root. The results of the tests were mixed because the ADF tests pointed towards the rejection of the unit root hypothesis when the analysis covered the period 1980 to 1993. However, when the tests were implemented including observations for 1994 and the remaining years up to 1997, the results did not show evidence to reject the presence of a unit root. Our interpretation of these conflicting findings rests on results quoted in the literature (see Perron (1989), for example). It is for this reason that in our opinion the series does not, in fact, contain a unit root and it is the mere presence of new observations after a structural break after 1993 which accounts for this result.

Suggestions for future research include the extension of the ADF tests to the local rates of unemployment and the implementation of the Zivot-Andrews (1992) and the Ben-David-Papell (1997) approaches.
References


Díaz Cafferata, Alberto and Alberto Figueras, 1997. "Regional Unemployment under Open and Closed Trade Regime in Argentina". In Recalde de Bernardi, M.L. (Ed), *Structural transformation in Latin America and Europe. Learning from each other’s experience*, Ed.Eudecor, Córdoba.


