UNIT ROOTS AND CYCLES IN THE MAIN MACROECONOMIC VARIABLES FOR ARGENTINA

Jorge CARRERA[*], *Mariano FÉLIZ*[*], *Demian PANIGO*[* #]

CACES – Universidad de Buenos Aires (UBA),
Universidad Nacional de La Plata (UNLP)

Abstract

In this paper we study the integration properties of some of the main macroeconomic series of Argentina.

We present a robust methodology for the analysis of persistence of shocks affecting macroeconomic series and its consequences on the modeling of the cyclical and permanent components.

Our strategy consists on testing the stationarity of the series by using a sequence of indicators in such a way that we can analyze the problem from three converging points of view: Persistence of the series, Unit Root (UR) and UR with a Structural Breaks. In such a way we reach robust results regarding the integration properties of the main 14 Argentinean macroeconomic time series.

Thus, we are able to classify them in four homogenous groups according to its order of integration. This allows us to determine the best strategy for modeling the cyclical component of each variable. For example, we found that the GDP can be robustly considered integrated of order one, I(1). Shocks seem to have permanent effects on the GDP and consequently a stochastic process is the best alternative for modeling its behavior.

Finally, with respect to the date of the structural break relevant for the Argentinean economy, the years 1988-89 concentrate the greatest number of breaks detected endogenously for the series of these work. Thus, we can conclude that the convertibility does not appear to be a point of structural change in the data generating process of the main macroeconomic series of Argentina.

Keywords: Unit Root, Persistence, Cycles, Structural breaks, Argentinean Macroeconomic variables

JEL Classification Numbers: **C3, C5, E3**

---

[*] Centro de Asistencia a las Ciencias Económicas y Sociales - Universidad de Buenos Aires y Universidad Nacional de La Plata. The opinions expressed in this paper do not compromise those of the institutions aforementioned.
E-mail: jcarrera@isis.unlp.edu.ar
[#] Mariano Féliz and Demian Panigo are also members of the CONICET.

UNIT ROOTS AND CYCLES IN THE MAIN MACROECONOMIC VARIABLES FOR ARGENTINA

Jorge CARRERA, Mariano FÉLIZ*, Demian PANIGO* #*

CACES – Universidad de Buenos Aires (UBA),
Universidad Nacional de La Plata (UNLP)

Table of Contents

---

*Centro de Asistencia a las Ciencias Económicas y Sociales - Universidad de Buenos Aires y Universidad Nacional de La Plata. The opinions expressed in this paper do not compromise those of the institutions aforementioned.
E-mail: jcarrera@isis.unlp.edu.ar
Mariano Féliz and Demian Panigo are also members of the CONICET.

1 CYCLE, TREND AND THE DATA GENERATING PROCESS

The cycle is very important for macroeconomic theory and for economic policy. Since the 80s there has existed strong controversy as to whether the Real Business Cycle models are the most appropriate framework to explain the evolution of the economies. Thus there's been dispute as to the role of real and monetary (nominal) shocks in the short and long run economic performance.

This relates to the fact that if shocks are mainly transitory then stabilization policies have a reason to be while if shocks are persistent the most appropriate policies are structural ones.

The questions we consider relevant in this context and that we will try to answer (albeit partially) in this work centering our attention on the Argentinean economy are:

a) What is the importance and size of the cycle in Argentina for the most relevant series?

b) What is the structure of shocks hitting the economy like? Are shocks transitory or permanent? How persistent are they?

c) What is the best strategy to model the cycle in terms of the detrending method to be used?

d) What is the effectiveness of stabilization policies?

e) Was the convertibility a structural change that modified the behavior of the series?

f) How much does shock persistence matter to forecast the future behavior of a series?

For any discussion on the cycle it is central to be able to measure it. That is, it is of great importance to define what is the actual object being studied. Different ways of measuring the cycle will give us very different estimations as regards its importance. As a matter of fact, it is possible that the cycle doesn't exists at all (Cribari-Netto, 1996).

When we extract the cycle from a time series (y_t) a first step is to determine which is the permanent component (y^p_t) of the series and which is the cyclical one (C_t). The permanent component is associated with the trend that the series is supposed to follow in the long run and the cycle with the stationary deviations. Thus the cycle is constructed as follows:

(1) $C_t = y_t - y^p_t$

The fundamental problem appears when we need to establish the characteristics of the permanent component.

Till the appearance of Box and Jenkins (1970) methodology, stationary serially correlated deviations around a deterministic trend where the paradigm. Since then, attention has moved toward ARIMA[1] models that allow to work flexibly with any kind of series, be them stationary or not.

This changed the way of determining and measuring the cycle since it meant moving from the generalized use of deterministic trends (in particular linear trends where the most common assumption when calculating the cycle) to stochastic trend specifications.

[1] Autoregressive model, integrated with moving averages.

To be able to know what the most appropriate trend is, the first thing to do is to go back to the Data Generating Process (DGP). According to the structure of the DGP that best fits each series we'll establish the kind of trend that should be used for each one. The DGP is thus crucial for the decomposition between trend and cycle and thus for the determination of the duration and amplitude of the cyclical fluctuations in each macroeconomic variable.

1.1 DGP and the order of integration

A series that needs to be differentiated k times to acquire stationarity is considered to be integrated of order k: I(k)

For example, a series as follows:

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

given that ε is i.i.d., when $\rho = 1$ is non-stationary. This is known as a Random Walk with drift process[2].

The series turns into a stationary one when it is differentiated (in the case of equation 2 only once), so the data generating process of this series is said to be a difference-stationary process (DSP).

This kind of series is also said to present stochastic non-stationarity (Charenza, 1997) and can be adequately modeled as a Unit Root process (URP) in the autoregressive terms.

Nelson and Plosser (1982) in their pioneering work for the United States show that 13 of the 14 macroeconomic series they studied present stochastic non-stationarity, specifically that they are I(1), that is they have a stochastic trend and thus are to be modeled as Unit Root processes.

However, when the series is of the kind:

(3) $y_t = \alpha + \delta t + \varepsilon_t$ with ε_i i.i.d.~$N(0,\sigma^2)$

y_t is a stationary series around a deterministic trend. Stationarity is achieved when by subtracting the deterministic component (in equation 3, $\alpha + \delta t$) from y_t. The process behind this kind of series is called a trend-stationary process (TSP). This is an I(0) series, so it doesn't need to be differentiated to make it stationary. This was the traditional way of treating series till Nelson and Plosser's work came around. Maddala and Kim (1998) state that from the numerous empirical works in existence it is evident that the deterministic trend is most common amongst real rather than nominal variables.

In a TSP the effect of shocks vanishes in the long run when t moves farther away from the moment of the shock. With DSP the effect of the shock remains. This is what's behind the idea of persistence of innovations.

A stochastic trend implies that each shock is permanent and changes the long run trend. Since the variance grows without limit, forecasting is made difficult in this kind

---

[2] It should be noted that when y_t is a RW with drift contains a deterministic trend. In *(2)* the constant α can be interpreted as the deterministic trend. Suppose the value $y_t = y_0$ en t = 0; substituting repeatedly:

$$y_t = \alpha t + y_0 + \sum_{i=1}^{t} \varepsilon_i \text{ with } \varepsilon_i \text{ i.i.d.~} N(0,\sigma^2)$$

thus the constant α in this I(1) process represents a linear deterministic trend.

of series, in comparison with trend-deterministic series where the variance is limited by the variance of errors and thus forecasting can be based on the trend.

A similar shock has different effects depending on whether the process is stationary or not; simplifying, I(0) or I(1). Then for a process where $\rho = 1$ in period t we have:

(4) $y_t = y_{t-1} + \varepsilon_t$

in t+1

(5) $y_{t+1} = y_t + \varepsilon_{t+1}$, substituting, we have: $y_{t+1} = y_{t-1} + \varepsilon_t + \varepsilon_{t+1}$

The effect of the shock in ε_t transports and persists in the following sub-periods indefinitely.

If the series is stationary I(0) with $|\rho| < 1$ in period t, we have:

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

in t+1

(7) $y_{t+1} = \rho y_t + \varepsilon_{t+1}$, substituting, we get: $y_{t+1} = \rho^2 y_{t-1} + \rho\varepsilon_t + \varepsilon_{t+1}$

The effect of the shock slowly disappears, with greater velocity the lower the value of ρ. Then, shocks have no persistence so they can be considered transitory.

Another way of expressing the same is to state that the central distinction to determine whether the trend is stochastic or deterministic is to verify if the series returns to its deterministic trend (or mean in the case there is no trend), at least in a reasonable period of time. This, of course, relates to the persistence of innovations. An I(1) series is equivalent to the accumulation of shocks and no underlying force exists in the behavior of the series that will make it return to its mean systematically.

Making a mistake in the determination of the DGP could take to important errors. If the series is a TSP and we differentiate we are over-differentiating the series, and if the original series is a DSP and we treat it as a TSP when running the regression against time we are under-differentiating.

However, Plosser and Schwert (1978) state that the risk of over-differentiating is not as great if we analyze carefully the properties of the residuals of the regression. A central point, made by Nelson and Kang (1981), is that if the true data generating process is a DSP and we extract the trend treating it as a series with a TSP, then the cycle will exhibit spurious periodicity.

1.2 Simple measures of persistence

1.2.1 First order autocorrelation coefficient (FOAC). A recursive and rolling approach.

The recursive methodology derived from Brown, Durbin and Evans (1975) consists in estimating a parameter using sub-samples $t = 1,\ldots,k$, *for* $k = k_0,\ldots,T$, where k_0 is the start–up value and T is the full sample size. Unlike recursive estimation, rolling parameters are computed using sub-samples that are a constant fraction δ_0 of the full sample. In this way we can keep constant the marginal weight of each observation.

Using this methodology we can obtain rolling and recursive estimations of the FOAC for each series y_t which is calculated with the following expression:

$$(8)\quad r_k = \frac{\sum_{t=k+1}^{T} (y_t - \bar{y})(y_{t-k} - \bar{y}_{t-k}) \Big/ (T-k)}{\sum_{t=1}^{T} (y_t - \bar{y})^2 \Big/ T}$$

where T is the rolling or recursive sample size, k is the number of lags (in this case equal to 1), and $\bar{y}_{t-k} = \sum_{t=k+1}^{T} y_{t-k} \Big/ (T-k)$

In this way we can analyze the evolution of this simple measure both to build an ordinal classification of shocks persistence among the series and to evaluate its stability along time for the different cycle calculation methodologies.

1.2.2 Relative persistence measure (RPM)

This measure of persistence results from comparing the sum of the first six autocorrelation coefficient of the series with the ones of a series obtained as the average of 2000 Monte Carlo Simulation of random walk series without drift.

$$(9)\quad RPM = 1 - \left(\frac{\sum_{k=1}^{6} r_k^{RW} - \sum_{k=1}^{6} r_k^{Xi}}{\sum_{k=1}^{6} r_k^{RW}} \right)$$

where RW is an artificial random walk series, Xi is the i[th] series (in log., stochastic cycle and deterministic cycle), r_k^{RW} and r_k^{Xi} are the k order autocorrelation coefficient for the RW and Xi respectively.

If RPM indicator for a selected series are close to unity, no significant difference between this series and a I(1) variable exists.

When RPM>1, the series presents bigger shock's persistence than a unit root process, so it is possible that it is an I(2) variable.

On the other hand, a RPM significatively lower than one is usually found in stationary variables.

1.3 Test of Unit Roots

Nelson and Plosser (1982) demonstrated that a time series has a stochastic trend if and only if it has a Unit Rood (UR) in the autoregressive component. In such a way, testing for the number of UR is equivalent to testing the existence of a stochastic trend.

Based on the fact that the parameter *d* in an ARIMA (*p,d,q*) [3] representation is equal to the number of Unit Roots, Dickey and Fuller constructed a test on the null hypothesis of UR. This is the so called Dickey-Fuller (DF) test. Since it is based on the restrictive assumption of independent and identically distributed (i.i.d.) errors, several modifications of the test where developed allowing for some heterogeneity and serial correlation in errors. The most known and used is the Augmented Dickey-Fuller (ADF) test and the semi-parametric alternative of the (Modified) Phillips-Perron

[3] *p* indicates the order of integration of the autoregressive component, *q* is the moving average component and *d* the number of times the variable has been differentiated to reach stationarity.

test (Phillips and Perron, 1988, for the original test and Perron and Ng, 1996, for the modified version of the test).

These tests, in the line of the original DF test, were used by Nelson and Plosser. Sargan and Bhargava (1983) postulate a different approach presenting their test in a Durbin-Watson framework.

Basically, the idea of the DF test is to check the null hypothesis of $\rho = 1$ in the following equation:

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

The mechanism consists on testing the null of ξ=0 in the Ordinary Least Squares (OLS) regression in the following equation, which is equivalent to (10):

(11) $\Delta y_t = \alpha + \xi y_{t-1} + \varepsilon_t$

where $\xi = \rho - 1$.

Rejection of the hypothesis $\xi = 0$ in favor of the alternative $\xi < 0$ implies that $\rho < 1$ and that y_t is integrated of order zero (0).

If we cannot reject $\xi = 0$, then we should repeat the test using Δy_t in place of y_t. The Dickey-Fuller equation changes to:

(12) $\Delta\Delta y_t = \xi\Delta y_{t-1} + \varepsilon_t$

The tests based on the DF have different distributions for the null and alternative hypothesis. If y_t is I(1), as indicated by the null hypothesis, then equation (11) represents a regression of an I(0) variable on an I(1) one. In this case there is no *limiting normal distribution*. The distribution used is known as the *Dickey-Fuller t distribution*. Fuller (1976) tabulated the original critical values. MacKinnon (1991) and Cheung and Lai (1995) modified the critical values to take into account the effect of different sample sizes and number of lags.

For an acute critic on some of the problems of the tests based on the DF methodology see Maddala and Kim (1998).

One weakness of the DF test is that it doesn't take into account the possible autocorrelation between errors ε_t. If this was the case, the OLS estimations in equation (11) or its substitutes would not be efficient. The solution, implemented by Dickey and Fuller(1981), was to include as explanatory variable de lagged dependent variable. This solution is know as the Augmented Dickey-Fuller test (ADF).

Then, an equivalent equation to equation (11) is:

(13) $\Delta y_t = \xi y_{t-1} + \sum_{i=1}^{k} \xi_i \Delta y_{t-1} + \varepsilon_t$

The testing procedure is the same one as before and it is based on the t corresponding to the ξ. The critical values are the same ones as those for the DF test.

Phillips (1987) and Phillips and Perron (1988) proposed a new test using a non-parametric correction for the presence of serial correlation. The objective was to eliminate the nuisance parameters on the asymptotic distribution caused by the presence of serial correlation in the errors ε_t.

This statistics are know as Z_ρ and Z_t. For the case of an AR(1) without drift[4].

---

[4] For the cases of an AR(1) with a drift, and with a drift and a linear trend see Maddala and Kim (1998).

(14) $Z_{\rho} = T(\hat{\rho}-1) - \frac{1}{2}\frac{(s^2 - s_e^2)}{T^{-2}\Sigma_1^T y_{t-1}^2}$

(15) $Z_t = \frac{S_e}{s} t_{\hat{\rho}} - \frac{1}{2}\frac{(s^2 - s_e^2)}{s(T^{-2}\Sigma_1^T y_{t-1}^2)^{1/2}}$

Cochrane (1991) remarked the low power of the Unit Root tests as well as of any other test where a null hypothesis of $\rho=\rho_0$ against the alternative $\rho_{0-\kappa}$ with κ small for reduced samples. Although the difference between ρ_0 *y* $\rho_{0-\kappa}$ could be reduced and even insignificant from the economic point of view, this is especially problematic in the case of Unit Root tests for there exists a discontinuity in the theory of distribution in vicinity of the unit root. Thus, in such cases, these tests would not answer the question of which is the most appropriate distribution for small samples.

1.4 Rolling and Recursive ADF test for Unit Root

Another alternative to test unit root consists in evaluating the shifting root hypothesis. For this purpose the recursive and rolling developed by Banerjee, Lumsdaine and Stock (1992) provides a complete set of analysis.

Applied to the Unit Root Hypothesis, the procedure consists in estimating rolling and recursively[5] the maximum and minimum ADF t statistics and comparing them with the 5% asymptotic critical values. In addition, we analyze the difference between the maximum and minimum ADF statistics which can be associated with a measure of shifting root or root volatility.

1.5 Variance ratio measurement (VR)

An alternative non-parametric instrument to evaluate the presence of a unit root is to measure the degree of persistence. Such alternative was proposed by Cochrane (1988).

Using Beveridge and Nelson's (1981) decomposition we can see that each series can be modeled as a combination of a non-stationary random walk (RW) and a stationary component. However, the RW can have an arbitrarily low variance, so that the power of the UR tests is arbitrarily low for small samples.

Cochrane (1991) highlights the importance of measuring the size of the RW component through the degree of persistence of the shocks in the levels of the series.

The measurement presented by Cochrane (1988) is as follows:

(16) $VR_k = \frac{V_k}{V_1} = \frac{\mathrm{var}(y_t - y_{t-k})}{k.\mathrm{var}(y_t - y_{t-1})}$

If y_t is stationary, then $\lim_{k \to \infty} VR_k=0$ and if y_t is a RW, $VR_k=1$ for any lag size.

A direct estimation for VR is the following:

(17) $\hat{VR}_k = \frac{\hat{\sigma}_k^2}{\hat{\sigma}_1^2}$

---

[5] As was explained in the section 1.2.1 for the recursive and rolling estimation of the FOAC.

In practice, several values for VR_k are considered and the null is rejected if at least one of the VR_k generates evidence against it (Maddala and Kim, 1998).

1.6 Unit Root under the hypothesis of a Structural Break

The idea of a structural break is associated with changes in the parameters in a regression. Discussions on the constancy of parameters have been very rich in econometrics, with a great number of test developed with respect to the matter (for a review and classification see Maddala and Kim, 1998).

The point that we are interested in focusing on for this study is how structural changes can affect the results for the Unit Root tests.

A pioneering article on the subject was one by Perron (1989) where he argues that, in general, shocks are transitory and the series are sporadically hit by extraordinary (not regular) events. Since its probability distribution is different to that of other regular shocks, he proposes changing them from the *noise component* to the deterministic trend of the series.

In other words, innovations are transitory (and so stationary) around a deterministic trend that can sporadically suffer changes of different kind (in the constant, in the slope, or both). Perron's proposal is very strong and puts back into discussion what had consolidated as the dominant framework in the 80s on the existence of a stochastic trend in the majority of the economic time series. That is, that they were generated by a DSP.

For example, the existence of a structural break represented by a change in the value of the mean in a series could make the conventional analysis conclude that there exists a unit root when in reality none exists. It is just that the series was and is still stationary, but now around a new mean. Charenza and Deadman (1997) indicates that the most simple case of a stationary series I(0) that suffers a jump (structural break) in the mean in the middle of the sample could be described by a random walk with drift of the kind:

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

with $\rho = 1$[6].

The conclusion is that the autoregressive equation could bias ρ towards 1. In this case, in the presence of a structural break, the tests of the Dickey-Fuller kind tend to accept the null hypothesis of a Unit Root when actually the process is stationary to both sides of the structural break.

Perron applies the test to Nelson and Plosser's series and find that the hypothesis of Unit Root must be rejected in all of the series with the exception of the Consumer Price Index, the velocity of money and the nominal interest rate. For that reason, he considers that the majority of the series have a segmented linear trend.

From Perron's work on, there has been a long sequence of tests that gained in complexity. In Perron (1989) he proposes a modified DF test for Unit Root in the *noise function* with three different alternatives for the deterministic trend function of the series (DT_t).

In the first one he allows for a structural change reflected in the intercept (*crash model*).

(19) Model A: $DT_t = \alpha + \beta DU_t + \delta_t$

[6] Recall that a random walk with drift contains a deterministic trend.

where a) DU_t= 1 if t> T_b; 0 otherwise.

The second model only allows for a change in the slope (*changing growth model*).

(20) Model B: $DT_t = \alpha + \delta_0 t + \delta_1 DT^*_t$

where b) DT^*_t= t-T_b if t> T_b; 0 otherwise.

The third model gives place to changes both in the intercept and the slope.

(21) Model C: $DT_t = \alpha + \beta DU_t + \delta_0 t + \delta_1 DT^*_t$

The strategy followed by Perron is to first detrend the series and then analyze the behavior of the residuals. Perron then obtains the limit distribution with the Ordinary Least Squares of the normalized estimators of $\hat{\rho}$ and the corresponding *t-statistics* of the following regression:

(22) $y_t^i = \rho_i y_{t-1} + \varepsilon_t$

where: y_t^i with i = A, B, C being the residuals of the regression of y_t corresponding to each of the models.

The test by Perron is a conditional test for a given structural break point, which is defined ex-ante. For this reason, it is criticized for the possibility of *pre-testing bias*.

Since this proposal, there have been several attempts to give endogeneity to the structural breaks by using recursive, rolling and sequential tests. The first two take sub-samples, from the general sample, that may grow or remain fixed (with a constant marginal weight for the new data points); meanwhile, the sequential test progressively increase the date of the hypothetical break by using different *dummy* variables.

The endogeneization of the structural break generated several papers that reverted previous Perron results, but when the existence of more than one endogenous structural break is allowed, the number of rejections of the UR hypothesis once again increases.

Perron (1993, 1994a, 1994b) and Volgelsang and Perron (1994) propose two models to allow for endogenous structural changes: *Additive outliers (AO) model and Innovational outliers (IO) model*.

The difference between the two models is in the way they understand the change. In the AO model the change is abrupt while in the IO change is gradual and is affected by the behavior of the *noise function* since it moves in a similar way as the shocks that affect this function (Cati, 1997).

For AO models the three kinds of structural changes seen before (A, B and C) are applicable, while for the IO models only A and C are.

The AO model is performed using a two step regression procedure, for the case of change in the slope of the trend function when the segments are joined at the time break. The point is to test the t-statistics of ρ =1. Let DT_t = t – T_b if t>T_b; and 0 otherwise with T_b the time of break. The first step consists on estimating the following regression:

(23) $y_t = \mu + \beta t + \gamma DT_t + \tilde{y}_t$

Later, the error term ($\tilde{y}_t$) is modeled as follows:

(24) $\tilde{y}_t = \rho \tilde{y}_{t-1} + \sum_{j=1}^{k} c_j \Delta \tilde{y}_{t-j} + \varepsilon_t$

To obtain the IO model we must test the t-statistics of ρ=1 in the following regression:

Let DU_t = 1 if t> T_b and 0 otherwise, and DT as specified above and $D(T_b)_t$ =1 if T_b +1 and 0 otherwise.

$$(25)\quad y_t = \mu + \beta t + \theta DU_t + \gamma DT^*_t + dD(T_b)_t + \rho y_{t-1} + \sum_{j=1}^{k} c_j \Delta y_{t-j} + \varepsilon_t$$

1.7 A synthesis of the different views

Table 1 presents a synthesis of the existing views with respect to the trend that is characteristic of a series, its relationship with the shocks and its effect on the cycles.

Table 1

Origin of the shocks	Duration of the shocks	Persistence	Order of Integration of the series	Trend	Kind of Trend	Cycle
Not real	Transitory	Low	I (O)	Deterministic	Linear, exponential.	Greater amplitude
Real	Permanent	High	I(k) with k ≥ 1	Stochastic	ARIMA models (RW, etc.).	Very small or not existent
Not real	Transitory and a few permanent	Low	I(O)	Segmented deterministic	One or several breaks	Greater amplitude

A stochastic trend implies that each shock is permanent and for that reason is usually called a real shock. In this case, the series present high persistence coefficients.

A deterministic trend, on the other hand, implies that shocks that hit the economy do not deviate it permanently from its long run path. Thus, every shocks is transitory.

Assuming a segmented trend implies that the majority of the shocks are transitory and that only one (or a few) are permanent. This are the structural breaks, that hit the economy very sporadically. For the case of Argentina, this could be associated with events such as the debt crisis, the convertibility, the Mercosur, the return of democracy or the hyperinflation.

The restitution of the deterministic trend, even though segmented, to the center of the scene has great implications with respect to the role of shocks and of stabilization policies. Accordingly, it's been the source of great controversies, giving place to a set of comparative studies on previous works on Unit Root and allowing the possibility of gaining greater precision in the specification and knowledge of the macroeconomic time series.

Clearly, these improvements in the analysis of the data generating process (DGP) should allow for greater precision in the search for the cycle and its features.

1.8 The methodology

The objective of this paper is to combine a battery of complementary tools to determine the best approximation to the cycle of some of the most relevant macroeconomic time series for Argentina.

Here we present a procedure (that we will follow in the rest of paper) to check for the existence of stationarity or not in the series (and the influence of this fact in the cycle of the variables), as well as for comparing the differences between the cycle assuming a linear trend and a purely stochastic trend (first differences).

Our methodology consists on the following steps:

1. Analyze the first order autocorrelation coefficient of the series (of the cycle of those series) including a recursive and rolling version. The goal is to obtain a first vision of the level of persistence of the series and of the possible changes in the intra-sample behavior.

2. Compare the persistence of the series with respect to that of an artificial series constructed as the average of 2000 Monte Carlo simulations of RW processes. This will allow us to build a Relative Persistence Measure (RPM).

3. Analyze for the hypothesis of Unit Root for the sample as a whole with the Augmented Dickey-Fuller (ADF).

4. Perform the analysis of the hypothesis of Unit Root for the whole sample with the Phillips-Perron (PP) test.

5. Analyze of the hypothesis of Unit Root for the sub-samples with a recursive ADF, obtaining the maximum and minimum.

6. Evaluate the hypothesis of Unit Root for the sub-samples with a rolling ADF, obtaining the maximum and minimum.

7. Perform of the Variance Ratio (VR) for a sequence of k that is sufficiently long.

8. Analyze of the hypothesis of Unit Rood in the presence of structural break: Perron's test with exogenous selection of the break date.

9. Check the hypothesis of Unit Root in the presence of structural break: Perron's test with endogenous selection of the break date: *additive outliers* (AO).

10. Analyze the hypothesis of Unit Root in the presence of structural break: Perron's test with endogenous selection of the break date: *innovation outliers* (IO).

11. Evaluate of the information from the tests on the characteristics of the DGP and thus the best specification for the permanent component of the series.

Following this sequence of growing complexity we begin with the eye inspection of the correlograms, then move to the traditional Unit Root tests, double checking with the indicators of persistence, later controlling for the existence of structural breaks and finally analyzing if there are changes in the order of integration of the series under the hypothesis of structural break and eventually determine when they occurred.

We believe that this is an important contribution since as far as we know such an integral analysis does not exist. We've found as an immediate antecedent, though partially related to our work, the important paper by Sosa-Escudero (1997). However, the interest there falls exclusively on the GDP. Additionally the series only reaches the year 1992. Another work, also partially related to ours, is that of Ahumada (1992) on cointegration in nominal variables. Sturzenegger (1989) analyzes the kind of shocks affecting Argentina's GDP using Blanchard and Quah (1989) decomposition. For more recent sources that include most of the convertibility period (which begun in

91:2) Carrera, Féliz and Panigo (1998a, b) present the results for the GDP and inflation in the first paper and on the real exchange rate in the second one[7].

1.9 The data

For this paper we use the data provided by the Argentinean Government's Statistical Office (INDEC) and the Ministry of the Economy and Public Works for the period 1980:1 to 1998:4.

The data was provided by its source in quarterly periodicity in every case with the exception of the unemployment rate, the participation rate and employment rate which are of semi-annual periodicity.

The data was transformed by seasonally adjusting it using the X-11 ARIMA methodology, except for the semi-annual variables. We then applied the logarithm function to the series, with the exceptions of the nominal interest rate, the trade balance, M1 growth, inflation and the semi-annual variables which were left untouched because they are all expressed in percentages. We use the software package RATS 4.2.

The real exchange rate was calculated from the nominal exchange rate of the Peso to the American dollar, correcting it by the evolution of Argentina's and American's consumer price index (CPI).

We analyze separately M1 and M1 growth, the CPI and inflation (CPI growth) because the log approximation of growth for these series is not applicable due they present strong oscillation in this sample period.

The identification code of each series are presented in Table 2 in the Appendix at the end of the paper.

2 MEASURES OF THE PERSISTENCE OF THE MACROECONOMIC SERIES IN ARGENTINA

2.1 The cycle

The most traditional (and most often used) way of extracting the cycle relies in a linear deterministic trend such as the one presented in Figure 1a. The result is what's called a deterministic cycle indicated by the thick trace in Figure 1b. There we can identify 5 cycles that allow us to interpret the most relevant moments for the macro-economy in Argentina since the 80s.

[7] However, no one has followed an integral approach such as the one presented in this paper.

Figure 1a

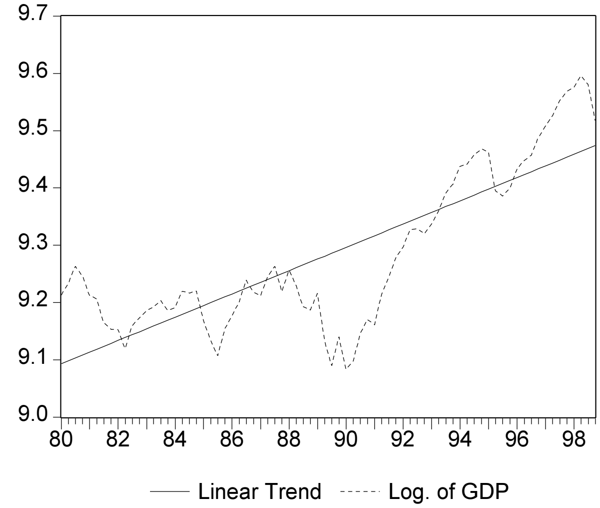
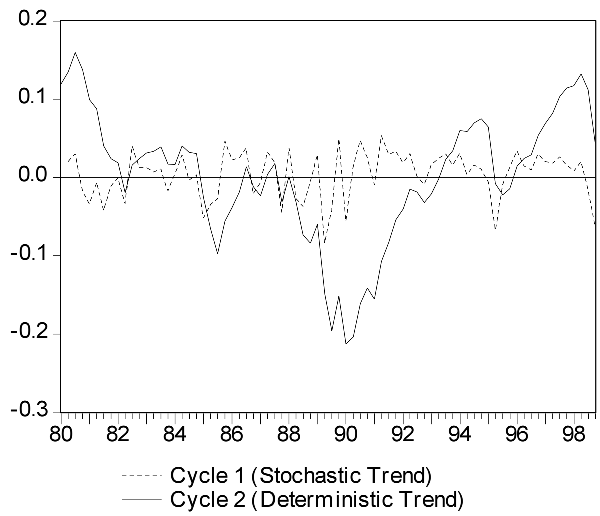


Figure 1b



The first one, ending in 1982, shows the end of the military government. It is dominated mainly by the surge and decadence of the monetarist stabilization plan (which begun in 1978) based on an pre-announced rate of devaluation that resulted to the unsustainable appreciation of the currency (the Peso) and later in a huge financial crisis.

The 1982-85 cycle is the result of the shutting down of the international financial markets after the Mexican default, the change in the political mood with the reinstitution of democratic rule, the statization of the private external debt and several intents of wages and salaries recomposition in the transition to democracy.

The third cycle accompanies the stabilization plan know as Plan Austral which include a monetary reform, a fixed nominal exchange rate, and an incomes policy (amongst other instruments). This plan had an initial successful stage associated with the reduction in the inflation rate. The deep recession in the years following the failure of the plan, are associated with the progressive loss of macroeconomic instruments that derived in a number of (ever) shorter and more ineffective programs that ended up in hyperinflation in 1989. With the change of government, also in 1989, we observe a small cycle that coincides with the first stabilization plan tried during Menem's government which was based on exchange rate fixation with almost no international reserves. This led the economy to its lowest level in the period in the first quarter of 1990. To grasp the depth of this recession, see, for example, that the GDP at that time was 10% lower in real terms than it was in 1980 (and more than 20% below its long-run deterministic trend).

The fourth cycle starts with a new program based in a floating exchange rate. One of the most drastic credibility measures was taken: to change all of the State's short term debt and people's bank deposits, that generated the Central Bank's huge deficit, into long run debt (nominated in dollars). The program couldn't avoid a new hyperinflationary shock but it help recover much of the Central Bank's foreign reserves. This would be key for the move to a new exchange rate fixation where full convertibility of local currency is assumed and the Central Bank's reserves covered the full monetary base (currency board regime). Known as the Convertibility Plan, this has been the most successful experience as regards a stabilization plan. Together with the effectiveness of the instruments used, the program took advantage of the newly re-opened international financial markets and the important reduction in the international interest rate. In fact, this phase of the cycle with strong growth was interrupted by the recessive crisis resulting from Mexico's devaluation in 1994 (known as the Tequila effect).

The last cycle identifies with the expansion that begun in 1996, resulting from the reduction in the international interest rate and the fact that the convertibility resisted the previous negative external shock. The new turning point is associated with the international crisis following the crisis in South East Asia.

2.2 What cycle?

When we use a deterministic linear trend such as that in Figure 1a, the cycle we obtain is much wider than the one we could get from a stochastic trend. There exists multiple possible stochastic trends. Following the criterion of using the most simple model, we calculated the stochastic cycle as first differences of the logarithm of the series (which for small changes approximate the rates of growth of GDP). In Figure 1b we see the different behavior of the two cycles. In what follows we'll call Cycle 1 to the one coming from the stochastic trend and Cycle 2 to the other one, resulting from the deterministic trend.

From the comparison, it is evident the different variance in both cycles. Cycle 1 is more homogeneous than Cycle 2 (which shows a behavior with the shape of a V resulting from the deep recession of 1988-89 and the two expansions of the nineties. Defining which kind of cycle is the relevant one has important implications as regards associating economic policies to objectives. Intuitively, we could think that such a point is showing a very strong structural break, especially when from the analysis of the facts it appears as a point of economic change due to the hyperinflationary shock and the change of government. We'll leave for the end of this paper the formal test for this possibility in an ad-hoc manner as well as endogenously to the data generating process.

The problem that appears with the GDP, is also apparent with the rest of the variables so we'll follow our sequential methodology to try to establish what is the most appropriate DGP for each one.

2.3 Simple measures of persistence

2.3.1 First order autocorrelation coefficients (FOAC)

Following the methodology described in section 1, we obtain the first order autocorrelation coefficients (FOAC), recursive and rolling, for each variable which are presented in figure 2 in the appendix. We find as a common fact that the recursive coefficient in almost all variables grows towards the end of the sample. Amongst the nominal variables such as nominal interest rate (TN), M1 growth (DM) and inflation there's an abrupt fall in the levels of autocorrelation when we include to the sub-sample the data for the year 1988. In the labor market series it stands out the increasing autocorrelation of the unemployment series.

The rolling coefficients show different results only at the end of the sample, that is, when we introduce the years 1996-98. For the real exchange rate, however, we detected great stability in the coefficient. Meanwhile, the employment in the period 1989-93 shows a transitory, but abrupt, drop in the coefficient.

For the cycles, the results indicate a highly uniform behavior between the series. Cycle 1 (Stochastic trend) has low autocorrelation, rapidly reverting to its mean, while Cycle 2 (Deterministic trend) presents autocorrelation coefficients of around 0.9 for the majority of the series. For the case of the GDP, and complementing what has already been seen in Figure 1b, the FOAC of Cycle 1 is zero while for cycle 2 is 0.9.

In the nominal variables its important to highlight the structural change that is apparent with the inclusion of the year 1988 (the last stabilization plan of the Radical government). The nominal interest rate, M1 growth and inflation show coefficients that fall to half its value, in cycle 2, or even become negative, in cycle 1 (Stochastic trend).

2.3.2 Relative persistence measure (RPM)

From Table 2 we find patterns of behavior that can be divided into 3 different groups and which are highly stable when we evaluate the series in levels as well as when we evaluate the cycles.

Nominal wages, M1 and the Consumer Price Index (CPI) all show the highest coefficients, them being potentially I(1) and even maybe I(2) series.

In the other extreme, there's the group of the least persistent series: the nominal interest rate, the growth in M1, inflation and employment. This group even show negative coefficients for the stochastic trend process. For the stochastic cycle we should also include in the lowest persistence group the real wages, unemployment and the participation rate.

Finally, in the intermediate group we have the GDP, investment, the trade balance and the real exchange rate and, except for the stochastic cycle, the real wages, unemployment and the participation rate.

As we can see from this indicator there is a remarkable stability in the composition of the groups across the different specifications (levels, cycle 1 and cycle 2). However, we should highlight the fact that the value of this indicator (like the FOAC) is strongly affected by the detrending methodology. For example, the GDP shows values of 0.91, 0.02 and 0.73 for levels, cycle 1 and cycle 2, respectively.

The different detrending methodologies show strongly contradictory results and for this reason it is necessary to search deeper into the structure of the data generating process (DGP) for each series. In the following section we'll check for the existence of Unit Root in the autoregressive component of the series using the conventional tests.

2.4 Unit root tests

2.4.1 Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)

These are the most often used tests in international papers on Unit Root, and thus most useful for international comparisons, even though several criticisms could be expressed about them as we've seen in section 1.

For choosing the number of lags in the ADF test we followed the "General to Specific" methodology. Beginning with 6 lags we established for each series the adequate number of lags for the logarithms of the levels as well as for the first differences of the series. The greatest number of lags was used for the GDP and the real wages and the lowest for the real exchange rate.

For the Phillips-Perron test (PP) we established a uniform number of lags following the Newey-West (1994) criterion that suggests three lags for quarterly series.

With respect the structure of the test as regards what kind of deterministic regressors to use we checked in each case the significativity of using a constant (C), a constant and a trend (C, T) or none of them (NDR). In almost all cases for the first differences we used no deterministic regressors.

The critical values used are those from MacKinnon (1991). The results of the tests are shown in Tables 3 and 4.

With respect to the results of the tests, we found that almost all the series are I(1) under both tests with a conservative hypothesis of 5% significativity.

Concentrating in the discrepancies of the tests, we found that these are most common in nominal variables (as we found in the measures of persistence in the previous section).

Firstly, we see the series that present mixed evidence as regards being I(1).

One of them is the nominal interest rate for the PP test which results I(0) for any alternative critical value while it appears to be I(1) for the ADF test, also under any critical value. It is interesting to note that this difference appears even though the deterministic regressors are the identical in both cases.

The growth in M1 (dM1) results consistently stationary I(0) in both tests for almost all critical values. Only for the ADF test at 1% the series appears to be I(1). Inflation is another series considered I(0) for both tests at 5%.

M1 (the log level) is an I(2) series for both tests, something which is consistent with the fact that at 1% dM1 was I(1). Only at 10% does M1 appear to be I(1) in the PP test.

The consumer price level (CPI) is an additional series showing strong discrepancies between the tests. For the ADF test it is I(2) while for the PP test it is an I(1) series. In the case of the ADF the result is consistent with the fact that inflation is I(1) at 1%, while the result for the CPI with the PP test is consistent with inflation being I(0) in that test. It is probable that the test are capturing the problems of the hyperinflationary shocks to the economy in different ways.

With respect to the I(1) series it is striking the number of them that fall in this category: not only the GDP and investment, but also variables such as the real exchange rate and the trade balance. The indicators from the labor market are also I(1) without exception, from wages (nominal and real) to variables such us the unemployment, employment and the participation rate.

With such strong results we should begin questioning whether this characteristic is caused by the existence of a Unit Root or is just the result of a structural shock that biased the ρ coefficient towards 1. This problem will be looked at more deeply in the following steps of the paper.

2.4.2 Recursive and Rolling Augmented Dickey-Fuller

Recursive and rolling estimation of ADF t statistics was developed taking $k_0 = \delta_0 = 28$ observations for quarterly data and $k_0 = \delta_0 = 20$ observations for semiannual data.

The stochastic and deterministic regressors for the rolling and recursive equation are taken from ADF test for the entire sample. The estimated statistics are presented in the Tables 5 to 6 and in the Figure 3 of the appendix. The tabulated 5% critical values are taken form Banerjee et al (1992). In the Figure 3 we present both the Banerjee et al (1992) and the Cheung and Lai (1995) 5% critical values for the minimum ADF t statistic.

We can summarize these results as follows:

The null hypothesis of unit root can not be rejected for any of the variables when recursive methodology and Banerjee's 5% critical values are used.

If we take the Cheung and Lai's 5% critical values for the minimum recursive ADF t statistic, M1 growth and inflation become I(0) in the nineties (the only roots that shift with this methodology).

In the rolling estimation the main result is the strong root volatility. For more than 50% of the variables the difference between the maximum and minimum rolling ADF t statistic is bigger than the tabulated critical value. This can be taken as a partial evidence of the existence of structural breaks.

Except for real wages, all prices and monetary variables present a stationary period at the end of the sample (of variable duration[8]). However this result might be a consequence of the disappearance of the effects of hyperinflation since at the end of the sample, the rolling methodology does not take into account the observations of that period. The question is if the I(0) behavior is the consequence of ouliers from the hyperinflation period or the result of the change of regime with the convertibility.

Finally, there exists strong stability in the results for the National Accounts (GDP, investment and trade balance) and labor market variables (with the exception of nominal wages and unemployment rate). All of them have been I(1) for each sub-sample with the recursive as well as with the rolling estimation methodology.

2.5 Variance ratio test (VR)

While the ADF is a parametric measure of the persistence of the shocks in a series, the one presented by Cochrane (1988) is a non-parametric measure in as much as it does not depend on the selection of the model. In this sense it is a complementary measure to the conventional Unit Root tests.

In Table 7 we present the Variance Ratio Test (VR) for each series in the period 1980-98 following the methodology describe in section 1.

If we take as a reference the VR value after 20 quarters we are able to classify the series in four groups.

---

[8] Nevertheless, for M1, real exchange rate and nominal wages this period is extremely short (3, 5 and 5 quarters, respectively), Thus, we can conclude the for these series the order of integration is 1.

The first one includes those variables which grow explosively and have values that tend to 4. Here we find the nominal wages, the CPI and M1. Not only do they show a big number but they also show a growing trend. This seems to indicate that the series could be I(2) as it was the case for these variables in the previous section (the ADF showed that, at 1% significance, the nominal wages were I(2) too).

Amongst the variables that after 20 quarters still have a persistence of close to 1 find the GDP (1.0), the real exchange rate (0.87), the trade balance (1.06) and investment (1.19). These series are those best associated with the idea of I(1) series.

The nominal interest rate, growth in M1 and inflation show values of VR$\rightarrow$0 when k$\rightarrow\infty$. This is a strong indication of a stationary series.

The variables of the labor market (with the exception of the nominal wages) conform an independent group with intermediate persistence between 0.25 and 0.64. This could be an indication of the existence of fractional integration (Sowel, 1990) or a structural break.

2.6 Unit root tests under structural break

The possibility that a structural break is the cause why many series that are trend stationary (TSP) appear to be I(1) has been the greatest challenge put forward by Perron to the results accumulated since Nelson and Plosser's original paper in 1981.

In a great number of papers from this author, his methodology has been consolidating in response to the much of the initial criticism.

Perron's first test is a conditional test where the date of the structural break is established exogenously by the analyst. One of the most important criticisms resulted from the fact that this produced a pre-testing bias in favor of the non-rejection of the null hypothesis of structural break. The condition of independence in the distribution with respect to the data was not satisfied. For that reason, Perron (1994) and Volgelsang and Perron (1994) developed a testing methodology that allowed for the endogenous detection of the break date. With respect to the use of a priori information, Maddala and Kim (1998) state that this criticisms is partially unjustified since it would not make sense to look for a structural break in the whole sample when we know that there is a significant event. According to the authors, the search should be performed around this event. In this paper, we do exactly that with the change of government in 1989:II and the convertibility in 1991:I.

Following the steps in our methodology from section 1, we'll analyze the minimum t statistic for ρ=1 in order to detect the structural break in the endogenous alternative, selecting it *a priori* in the exogenous one.

2.6.1 Perron unit root test with exogenous structural break

In Table 8 we present the results for Perron's Unit Root test with exogenous structural break for every variable analyzed in this paper. In each one we tested the three alternative models presented in section 1: A)Crash model, that allows for a change in the constant, B)Changing Growth model, that allows for a change in the rate of grow or slope, and model C) that allows for a simultaneous change in both constant and slope.

The critical values for the tests can be found in Perron (1989). As regards the dates of the breaks, after a qualitative analysis of the series we decided to use as break date for the GDP and the other real variables the third quarter of 1989 (89:III) since it coincides with the lowest point for most of them and with the coming to power of a new government that implemented a strong set of policies of structural changes to gain credibility.

For the nominal variables, on the other hand, the most relevant structural change seems to have been dated in the second quarter of 1991 (91:II), with the beginning of the Convertibility Plan (currency board) that, as we've already seen, dramatically reduced to international standards the rates of change and the volatility of these variables.

With respect to the real wages we chose as a structural break the third quarter of 1984 (the last "keynesian" attempt to increase real wages) since from that date on the variable changed its growing trend and begun to fall.

In general terms, the test changed only partially the results of the conventional tests of Unit Root (ADF and PP) or those of the persistence measures (VR).

The GDP, the nominal wages, the trade balance, investment, unemployment and employment are I(1) series even though we allow for the exogenously set structural change.

In the case of the nominal interest rate, in any of the specifications (A, B or C) it appears to be I(0), in contrast with the results for the ADF test and confirming the result of the PP test and the VR which showed a value of 0.09.

In the case of M1, the series appears to be I(1) for every model, contradicting the ADF and PP tests, as well as the VR which showed a value of 3.69. Consistently, dM1 is I(0), confirming the results of the three conventional tests.

In the case of the CPI, the variable is I(1) for every model and this contradicts the ADF and VR results but confirms the PP test.

In the case of the real wages and the real exchange rate if we allow for a break in the slope and in the constant respectively, both show the series to be I(0) at 5%, contradicting the previous results from the ADF and PP tests. However, anticipating this result the VR showed an intermediate value for both series (0.64 and 0.87).

Lastly, the rate of participation turns I(0) when we allow for a change in the slope or in the slope and the constant simultaneously.

2.6.2 Perron unit root test with endogenous structural break

Of the five possible models, as we've seen in section 1, in Table 9 we present the three most relevant, that cover the widest number of results.

The model IO1 allows for a gradual change in the intercept only, the model IO2 allows for the gradual change in the intercept and the slope together and the AO2 allows for a change in the slope.

With respect to an important byproduct such as the date of the structural break, endogenously selected by each model, we observe great dispersion. Model IO2 is the one that most concentrates the breaks around 1988-1989. On the contrary, model IO1 presents the most dispersions in the break dates.

The real wages and the participation rate present the oldest structural breaks, at the beginning of the eighties (approximately 20 quarters before any other variable).

Comparing between models, IO1 model presents 4 variables which are I(0) at 5%, the IO2 model 8 variable I(0) while in the AO2 model only 2 variables appear to be I(0). Only dM1 is considered stationary by all three models. Meanwhile, the nominal interest rate, inflation, unemployment and participation rate are found stationary by at least two models. Undoubtedly, there exists a direct relationship between the number of series that change to being stationary and the flexibility to admit structural changes since IO2 is the model that admits the most shifting coefficients.

As a first result, we highlight the confirmation of the existence of a Unit Root even under the hypothesis of an endogenous structural break (in any of its alternatives) in 5 of the 14 series: the GDP, the real wages, the trade balance, investment and employment.

Amongst the particular cases, nominal wages, M1 and CPI appear to be stationary according to model IO2. This contradicts every other test we've performed for the complete sample (ADF, PP and VR) but it is consistent with the results of the Rolling ADF for the ending period of the sample, that is, when the data from the convertibility period enters with its full weight. In this variables there is a strong discrepancy between tests about the date of the structural break. IO tests indicate it inside the period 87-89 while the AO test puts it between the years 92-93.

With respect to the nominal interest rate, in both IO1 and IO2 models it appears to be a stationary series, coherently with the PP test and VR but in contradiction with the ADF for the complete sample. However, this result is consistent with the rolling ADF that showed stationarity of nominal interest rates in the last period of the sample (the convertibility).

In the labor market, the participation rate is stationary under two alternatives, the same happening with the unemployment rate. This contradicts the ADF and PP results. With respect to the measure of persistence, we observe that both series had intermediate values, especially the participation rate (0.64). This results also contradict those coming from the Rolling ADF where only the unemployment appears stationary during a brief period of time. All other labor market variable are I(1).

3 A COMPARATIVE ANALISYS

In Table 10 we present a comparative analysis for each variable using every test (eleven) proposed in the methodology.

To build a unique indicator of integration, we took the order of integration suggested by each test for each variable and calculated the average order of integration for every series.

Number 0.5 indicates that the series is I(0) at 5% but I(1) at 1%, a value of 1 states the series is I(1) under both critical values, 1.5 means the series is I(2) at 1% but I(1) at 5%, while a value of 2 indicates the value is I(2) at both 5% and 1%.

In the case of the rolling or recursive ADF tests, a 0.5 value indicates that in an important part of the sample the test shows a change from I(1) for the ADF to I(0) for the complete sample.

The analysis of these values should be performed together with the analysis of the dispersion of the results amongst the tests (measured by the variation coefficient) to check for the robustness of the conclusions.

A series with coefficients equal to 1 and small percentage of dispersion in the results can be considered robustly as I(1).

As the coefficients get closer to zero, there is greater possibility that the tests considered the series as I(0).

With values between 0 and 1 we require a detailed analysis of the structure of the results of the different tests. If the rolling ADF and one or several UR tests under the structural break hypothesis signal an I(0) series, then we are in the presence of a variable where the non-stationarity given by the tests for the complete sample (ADF, PP, VR) is an error induced by an extraordinary event. For that reason, the series should be considered stationary. Another possibility is that the series presents fractional integration.

Values higher than 1 are an indication of I(2) series, although we must be cautious with regards to the robustness of this result, since we could find too much dispersion when working with sub-samples due to the possibility of structural breaks.

From the result we can see that the GDP, investment and the trade balance are the only three series that pass all the tests, so we can consider them as robustly I(1). The assumption of a stochastic trend when proceeding to extract the cycle seems to be the best strategy to accurately model the series. In the case of GDP, our results are similar to those of Sosa-Escudero (1997) for the period 1970-92.

The real exchange rate is a non-stationary variable in the sample as a whole. Only for models AO1 and IO2 the variable is considered stationary at 5%. However, with respect to the date of the structural break the majority of the tests indicate that it occurred in the third quarter of 1989 (89:III).

The nominal interest rate, dM1 and inflation are clearly stationary variables. They present a structural break in 1989 according to the majority of the structural break tests. This indicates that the convertibility is not the key date for this series as we had assumed for the case of exogenous breaks.

M1 (in levels), the CPI and nominal wages show a strongly non-stationary behavior. For some of the tests in a sub-sample these series appeared as I(2). Only the IO2 test, which is the most flexible in allowing for changes, indicated that the three series were I(0) even at 1% with a break date around 88:IV and 89:1 where the intercept and the slope changed for the nominal variables in levels.

The series of the labor market have a behavior that tends to be non-stationary.

The value for employment and real wages is very close to 1. Employment is always I(1) except for the VR measure where it has a very low persistence, 0.26. The AO2 test, that allows the analyst to select the break date, suggests that real wages are I(0) but only at 5%. It is interesting to notice that none of the tests that allow for the endogenous selection of the break date find an I(0) result for these variables.

The participation rate and the unemployment rate have intermediate-high values which indicate the presence of a structural break or of fractional integration. While the conventional DF type tests say the series are I(1), the VR measure of persistence is very low. The break tests indicate that unemployment has a structural break even though they differ strongly as regards the date of the break (94:1 for the IO1 and 89:II for the AO). For the participation rate, the most tests of structural break point to a break that occurred in the second quarter of 1982 (82:II). The break seems to have been a sudden change in the slope.

4 Conclusions

The objective of this paper is to provide with a robust methodology for the analysis of persistence of shocks affecting macroeconomic series and its consequences on the modeling of the cyclical and permanent components.

Our strategy is to test the stationarity of the series by using a sequence of indicators in such a way that we can analyze the problem from 3 converging points of view: Persistence of the series, Unit Root (UR) and UR with a structural break.

We apply this methodology to the main macroeconomic series for Argentina, with the following results:

Depending on the procedure (stochastic or deterministic trend) used to extract the cycle of the series, remarkable differences will appear as regards their persistence.

From our methodology, we can group the series according to its order of integration into four groups:

1) The nominal interest rate, M1 growth and inflation are the series that appear to be stationary.
2) The unemployment and participation rates appear, with a greater degree of persistence in shocks, which indicates the possibility of fractional integration.
3) The GDP, real wages, real exchange rate, trade balance, investment and the employment rate is the group of series that for most tests appear to be I(1), a confirmation of the Unit Root hypothesis.
4) Finally, the nominal wages, M1 and the CPI, which seem to have more than one Unit Root.

For these last variables, in group 4, the results show notorious differences between the complete sample conventional tests and those that allow for structural change. These variables seem to have changed form I(2) to I(1) in the nineties.

In the case of the most flexible Unit Root test with a structural change, IO2, 8 out of the 14 variables result I(0) in comparison with the 4 out of 14 for the ADF case (at 10% significance).

Based on the results for the series in group 3, the best structure for modeling their cycle seems to come from assuming a stochastic trend in the series. The underlying macroeconomic intuition is the idea that shocks affecting these variables have permanent effects. Given the fact the GDP is amongst these, the cycle that it is most useful for the analysis of the current state Argentina's economy is closer to Cycle 1 in Figure 1b, smaller and less variable than the one most often used (Cycle 2 in Figure 1b).

On the contrary, for series in groups 1 and 2 a deterministic trend (with or without a structural break depending on the case) seems to be the most appropriate strategy for calculating the cycle. The kind of shocks affecting these series are mainly transitory. This implies one of two things: either the economy has forces that automatically regulate it, reverting the deviations of the series from its trend, or the policy actions taken to avoid the persistence of the deviations have been effective.

With respect to variables in group 4, we recommend a thorough analysis, looking for the possibility of multiple structural breaks and/or the correct specification of the time polynomial included in the deterministic component of the tests.

Finally, with respect to the date of the structural break relevant for the Argentinean economy, the years 1988-89 concentrate the greatest number of breaks detected endogenously for the series of these work. Thus, we can conclude that the convertibility does not appear to be a point of structural change in the data generating process of the main macroeconomic series of Argentina.

5 References

Ahumada, H., *Propiedades temporales y relaciones de cointegración de variables nominales en Argentina*, Banco Central de la República Argentina, mimeo, 1992.

Banerjee, A., Lumsdaine, R.L. and Stock, J.H., *Recursive and sequential tests of the Unit Root and Trend Break hypothesis: theory and international evidence*, Journal of Business and Economic Statistics, 10, 271-287, 1992.

Beveridge, S. and Nelson, C.R., *A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the 'Business Cycle'*, Journal of Monetary Economics, 7, 151-174, 1981.

Blanchard, O.J. and Quah, D., *The dynamic effects of aggregate demand and supply disturbances*, American Economic Review, 79, 655-673, 1989.

Brown, R.L., Durbin, J. and Evans, J.M., *Techniques for testing the constancy of regression relationships over time*, Journal of the Royal Statistical Society, Series B 37, 149-163, 1975.

Carrera J.E., Féliz, M. and Panigo, D.T., *Shocks identification in Argentina and Brasil. A Vector Error Correction Model*, XVI Meeting of the Latin American Econometric Society, Universidad Católica del Perú, Lima, Perú, 1998a.

Carrera J.E., Féliz, M. and Panigo, D.T., *The meassurement of the equilibrium real exchange rate. A new econometric approximation*, Anales, XXXIII Reunión Anual de la Asociación Argentina de la Economía Política (AAEP), 1998b.

Cati, R.C., *Stochastic and segmented trends in Brazilian GDP from 1900 to 1993*, Anales, Sociedad Brasileña de Econometría, 1998.

Cochrane, J.H., *How big is the random walk in GNP?*, Journal of Political Economy, 96, 893-920, 1988.

Cochrane, J.H., *A critique of the application of Unit Root tests*, Journal of Economic Dynamics and Control, 15, 275-284, 1991.

Cribari Neto, F., *The cyclical component in Brazilian GDP*, Revista de Econometría, 1, 1-22, 1993.

Charenza, W:W. and Deadman, D.F., *New directions in econometric practice*, Edward Elgar Publishing, 1997.

Cheung, Y. and Lai, K., *Lag order and critical values of the Augmented Dickey-Fuller test*, Journal of Business and Economic Statistics, 13, 277-280, 1995.

Dickey, D.A. and Fuller, W.A., *Likelihood ratio statistics for autoregressive time series with a Unit Root*, Econometrica, 49, 1057-1072, 1981.

Fuller, W.A., *Introduction to Statistical Time Series*, John Wiley, New York, 1976.

Lo, A.W. and MacKinlay, A.C., *Stock market prices do not follow random walks: evidence from simple specification tests*, Review of Financial Studies, 1, 41-66, 1988.

Lo, A.W. and MacKinlay, A.C., *The size and power of the Variance Ratio test in finite samples: a Monte Carlo investigation*, Journal of Econometrics, 40, 203-238, 1989.

Maddala, G.S. and Kim, I., *Unit Roots, cointegration and structural change*, Cambridge University Press, 1998.

MacKinnon, J.G., *Critical values for cointegration tests*, in R.F. Engle and C.W.J. Granger (eds), Long-run Economic Relationships, Oxford University Press, Oxford, 1991.

Nelson, C.R. and Kang, H., *Spurious periodicity in inappropriately detrended time series*, Journal of Monetary Economics, 10, 139-162, 1981.

Newey, W.K. and West, K.D., *Automatic lags selection in covariance-matrix estimation*, Review of Economics Studies, 61, 1994.

Perron, P. and Ng, S., *Useful modifications to some Unit Root tests and dependent errors and their local asymptotic properties*, Review of Economic Studies, 63, 435-465, 1996.

Perron, P., *The Great Crash, the Oil Price Shock, and the Unit Root hypothesis*, Econometrica, 57, 1361-1401, 1989.

Perron, P., *The Hump-shaped behavior of macroeconomic fluctuations*, Empirical Economics, 18, 707-727, 1993.

Perron, P., *Trend, Unit Root and structural change in macroeconomic time series*, in Cointegration for the Applied Economist, B.B.Rao (ed), Basingstoke, Macmillan Press, 1994a.

Perron, P., *Further evidence on Breaking Trend Functions in macroeconomic variables*, Journal of Econometrics, 1994b.

Phillips, P.C.B. and Perron, P., *Testing for a Unit Root in time series regression*, Biometrika, 75, 335-346, 1988.

Plosser, C.I. and Schwert, W.G., *Money, income and sunspots: measuring economic relationships and the effects of differencing*, Journal of Monetary Economics, 4, 637-660, 1978.

Nelson, C.R. and Plosser, C.I., *Trends and random walks in macroeconomic time series*, Journal of Monetary Economics, 10, 139-162, 1982.

Sargan, J.D. and Bhargava, A., *Testing residuals from Least Squares regression for being generated by the Gaussian random walk*, Econometrica, 51, 153-174, 1983.

Sosa-Escudero, W., *Testing for Unit Root and Trend Breaks in Argentine real GDP*, Económica, XLIII, 1-2, La Plata, 1997.

Sowel, Fallaw, *The fractional Unit Root distribution*, Econometrica, 58, 495-505, 1990.

Sturzenegger, F., *Explicando las fluctuaciones del producto en la Argentina*, Económica, XXXV, 1-2, La Plata, 1989.

Cribari Neto, F., *On time series econometrics*, The Quarterly Review of Economics and Finance, 36, Special Issue, 37-60, 1996.

Volgelsang, T.J. and Perron, P., *Additional tests for a Unit Root allowing for a break in the trend function at an unknown time*, CRDE, Université de Montréal, Cahier de Recherche, No 2694, 1994.

6 APPENDIX

6.1 Tables

Table 2. Relative Persistence Measure

Code	Variable	Log./Rates	Cycle 1	Cycle 2
A1	GDP	0.91	0.02	0.73
A2	Wages	1.01	0.50	0.89
A3	Real Wages	0.87	-0.04	0.54
A4	Nominal Interest Rate	0.33	-0.09	0.26
A5	M1	1.01	0.58	0.89
A6	M1 growth	0.37	-0.08	0.34
A7	CPI	1.01	0.51	0.90
A8	Inflation	0.28	-0.09	0.25
A9	RER	0.84	0.02	0.67
A10	Trade Balance	0.82	0.10	0.73
A11	Investment	0.82	0.08	0.75
B1	Participation Rate	0.84	-0.03	0.65
B2	Unemployment Rate	0.85	-0.02	0.44
B3	Employment Rate	0.42	-0.07	0.17

Table 3. Augmented Dickey – Fuller Test for Unit Root

			MacKinnon Critical Values			Test Structure	
Variable	Test in:	ADF Statistic	1%	5%	10%	Deterministic Regresors	Lags
GDP	Log.	-1.90	-4.09	-3.47	-3.16	C, T	5
	First Difference	-4.08	-2.60	-1.95	-1.62	(NDR)	4
Nominal wages	Log.	-1.59	-3.52	-2.90	-2.59	C	2
	First Difference	-2.07	-2.59	-1.94	-1.62	(NDR)	1
Real Wages	Log.	-2.24	-4.09	-3.47	-3.16	C,T	6
	First Difference	-6.03	-2.60	-1.94	-1.62	(NDR)	2
Nominal Interest	Rate	-2.38	-3.52	-2.90	-2.59	C	2
	First Difference	-10.99	-2.59	-1.94	-1.62	(NDR)	1
M1	Log.	-1.97	-3.52	-2.90	-2.59	C	4
	First Difference	-2.43	-3.52	-2.90	-2.59	C	3
M1 Growth	Rate	-3.22	-3.52	-2.90	-2.59	C	1
	First Difference	-8.88	-2.59	-1.94	-1.62	(NDR)	1
CPI	Log.	-1.83	-2.59	-1.94	-1.62	(NDR)	2
	First Difference	-1.53	-2.60	-1.94	-1.62	(NDR)	2
Inflation	Rate	-3.17	-3.52	-2.90	-2.59	C	1
	First Difference	-8.97	-2.59	-1.94	-1.62	(NDR)	1
Real Echange Rate	Log.	-2.39	-4.08	-3.47	-3.16	C,T	0
	First Difference	-8.53	-2.59	-1.94	-1.62	(NDR)	0
Trade Balance	GDP Percent.	-2.80	-4.09	-3.47	-3.16	C,T	3
	First Difference	-6.55	-2.59	-1.94	-1.62	(NDR)	0
Investment	Log.	-2.56	-4.09	-3.47	-3.16	C,T	3
	First Difference	-3.29	-2.60	-1.94	-1.62	(NDR)	2
Participation	Rate	-2.29	-4.17	-3.51	-3.18	C,T	3
	First Difference	-2.93	-2.61	-1.95	-1.62	(NDR)	3
Unemployment	Rate	-2.62	-4.16	-3.51	-3.18	C,T	2
	First Difference	-3.74	-2.61	-1.95	-1.62	(NDR)	1
Employment	Rate	-2.802	-3.58	-2.93	-2.60	C	3
	First Difference	-6.86	-2.61	-1.95	-1.62	(NDR)	0

Table 4. Modified Phillip - Perron Test for Unit Root

Variable	Test in:	P-P Statistic	MacKinnon Critical Values 1%	5%	10%	Test Structure: Deterministic Regresors	Trucation Lags
GDP	Log.	-1.99	-4.08	-3.47	-3.16	C,T	3
	First Difference	-7.19	-2.59	-1.94	-1.62	(NDR)	3
Nominal wages	Log.	0.12	-4.08	-3.47	-3.16	C,T	3
	First Difference	-4.59	-4.09	-3.47	-3.16	C,T	3
Real Wages	Log.	-3.33	-4.08	-3.47	-3.16	C,T	3
	First Difference	-7.37	-2.59	-1.94	-1.62	C,T	3
Nominal Interest	Rate	-5.98	-3.52	-2.90	-2.59	C	3
	First Difference	-18.25	-2.59	-1.94	-1.62	(NDR)	3
M1	Log.	0.11	-4.08	-3.47	-3.16	C,T	3
	First Difference	-1.94	-2.59	-1.94	-1.62	(NDR)	3
M1 Growth	Rate	-4.16	-3.52	-2.90	-2.59	C	3
	First Difference	-12.38	-2.59	-1.94	-1.62	(NDR)	3
CPI	Log.	0.12	-4.08	-3.47	-3.16	C,T	3
	First Difference	-3.83	-3.52	-2.90	-2.59	C	3
Inflation	Rate	-5.77	-3.52	-2.90	-2.59	C	3
	First Difference	-17.01	-2.59	-1.94	-1.62	(NDR)	3
Real Echange Rate	Log.	-2.41	-4.08	-3.47	-3.16	C,T	3
	First Difference	-8.54	-2.59	-1.94	-1.62	(NDR)	3
Trade Balance	GDP Percent.	-2.01	-4.08	-3.47	-3.16	C,T	3
	First Difference	-6.57	-2.59	-1.94	-1.62	(NDR)	3
Investment	Log.	-1.86	-4.08	-3.47	-3.16	C,T	3
	First Difference	-9.18	-4.09	-3.47	-3.16	C,T	3
Participation Rate	Rate	-2.59	-4.15	-3.50	-3.18	C,T	3
	First Difference	-9.32	-2.61	-1.95	-1.62	(NDR)	3
Unemployment	Rate	-2.64	-4.15	-3.50	-3.18	C,T	3
	First Difference	-8.20	-2.61	-1.95	-1.62	(NDR)	3
Employment	Rate	-2.56	-3.57	-2.92	-2.60	C	3
	First Difference	-6.87	-2.61	-1.95	-1.62	(NDR)	3

Table 5. Recursive ADF Test For Unit Root.

	$t_{ADF}^{Máx}$	t_{ADF}^{Min}	t_{ADF}^{Diff}	5% C.V. $t_{ADF}^{Máx}$	5% C.V. t_{ADF}^{Min}	5% C.V. t_{ADF}^{Diff}	Date for $t_{ADF}^{Máx}$	Date for t_{ADF}^{Min}
GDP	-0.76	-2.75	2.00	-1.99	-4.33	3.65	I/94	IV/87
Nominal Wages	1.73	-1.59	3.31	-1.99	-4.33	3.65	III/89	IV/98
Real Wages	-0.86	-2.29	1.43	-1.99	-4.33	3.65	II/87	IV/96
Nom. Interest Rate	-0.03	-2.53	2.50	-1.99	-4.33	3.65	II/89	III/88
M1	1.18	-1.97	3.15	-1.99	-4.33	3.65	III/89	IV/98
M1 Growth	3.79	-4.17	7.96	-1.99	-4.33	3.65	III/89	IV/98
Consumer Price Index	1.48	-1.79	3.27	-1.99	-4.33	3.65	III/89	IV/98
Inflation	0.47	-4.07	4.54	-1.99	-4.33	3.65	III/89	IV/89
Real Exchange Rate	-0.95	-2.39	1.44	-1.99	-4.33	3.65	IV/86	IV/98
Trade Balance	-1.14	-2.80	1.65	-1.99	-4.33	3.65	III/87	IV/98
Investment	-0.80	-2.27	1.47	-1.99	-4.33	3.65	II/87	II/89
Participation Rate	0.11	-2.29	2.40	-1.99	-4.33	3.65	I/87	II/98
Unemployment rate	0.27	-3.23	3.49	-1.99	-4.33	3.65	I/95	II/93
Employment Rate	-0.41	-2.80	2.39	-1.99	-4.33	3.65	II/83	I/98

Table 6. Rolling ADF Test For Unit Root.

	$t_{ADF}^{Máx}$	$t_{ADF}^{Mín}$	t_{ADF}^{Diff}	5% C.V. $t_{ADF}^{Máx}$	5% C.V. $t_{ADF}^{Mín}$	5% C.V. t_{ADF}^{Diff}	Date for $t_{ADF}^{Máx}$	Date for $t_{ADF}^{Mín}$
GDP	-0.47	-3.59	3.13	-1.49	-5.01	4.76	I/90	I/96
Nominal Wages	1.53	-18.89	20.42	-1.49	-5.01	4.76	III/89	IV/96
Real Wages	-0.64	-4.27	3.63	-1.49	-5.01	4.76	III/95	IV/97
Nom. Interest Rate	-0.18	-15.89	15.71	-1.49	-5.01	4.76	II/89	I/98
M1	1.25	-18.19	19.43	-1.49	-5.01	4.76	III/89	II/96
M1 Growth	3.42	-10.14	13.56	-1.49	-5.01	4.76	III/89	III/96
Consumer Price Index	1.48	-24.39	25.87	-1.49	-5.01	4.76	III/89	IV/96
Inflation	0.26	-24.70	24.97	-1.49	-5.01	4.76	III/89	I/97
Real Exchange Rate	-0.38	-8.28	7.90	-1.49	-5.01	4.76	II/89	IV/96
Trade Balance	-1.13	-3.42	2.29	-1.49	-5.01	4.76	III/90	IV/88
Investment	-0.48	-3.13	2.65	-1.49	-5.01	4.76	II/90	I/98
Participation Rate	0.31	-3.34	3.64	-1.49	-5.01	4.76	I/87	II/92
Unemployment rate	0.75	-6.02	6.77	-1.49	-5.01	4.76	I/95	II/90
Employment Rate	-0.41	-2.33	1.92	-1.49	-5.01	4.76	II/83	II/90

Table 7. Variance Ratio. Cochrane's measure of persistence

	Lags						
Variable	2	3	4	5	10	15	20
GDP	1.08	1.09	1.22	1.30	1.15	0.96	1.00
Nominal Wages	1.04	1.44	1.82	2.16	3.31	3.72	3.77
Real Wages	1.15	1.08	0.97	0.88	0.74	0.63	0.61
Nominal Interest Rate	0.49	0.31	0.31	0.27	0.17	0.13	0.09
M1	0.98	1.38	1.75	2.08	3.19	3.59	3.69
M1 Growth	0.71	0.51	0.51	0.46	0.30	0.22	0.16
Consumer Price Index	1.06	1.47	1.86	2.21	3.39	3.87	3.98
Inflation	0.46	0.39	0.36	0.32	0.20	0.15	0.10
Real Exchange Rate	1.02	1.08	1.13	1.17	1.19	0.96	0.87
Trade Balance	1.27	1.39	1.55	1.63	1.72	1.36	1.06
Investment	0.99	1.18	1.36	1.52	1.58	1.30	1.19
Participation Rate	0.75	0.59	0.51	0.59	0.60	0.64	0.64
Unemployment Rate	0.79	0.95	0.86	0.94	0.57	0.40	0.37
Employment Rate	1.00	1.10	1.04	1.00	0.36	0.38	0.25

Table 8. Perron Unit Root Test with exogenous selection of TB

	Model	Lags	Break date	$t_{\rho=1}$	CV 5%	Integration order at 5%
GDP	AO1	4	III/89	-2.07	-3.76	I(1)
	AO2	4	III/89	-3.61	-3.96	I(1)
	AO3	4	III/89	-3.68	-4.24	I(1)
Nominal Wages	AO1	1	II/91	-0.02	-3.76	I(1)
	AO2	1	II/91	-2.04	-3.95	I(1)
	AO3	1	II/91	-2.03	-4.24	I(1)
Real Wages	AO1	0	III/84	-2.41	-3.77	I(1)
	AO2	0	III/84	-3.99	-3.80	I(0)
	AO3	0	III/84	-3.66	-3.99	I(1)
Nom. Interest Rate	AO1	0	II/91	-7.39	-3.76	I(0)
	AO2	0	II/91	-7.53	-3.95	I(0)
	AO3	0	II/91	-7.48	-4.24	I(0)
M1	AO1	1	II/91	-0.36	-3.76	I(1)
	AO2	3	II/91	-3.92	-3.95	I(1)
	AO3	2	II/91	-3.11	-4.24	I(1)
M1 Growth	AO1	0	II/91	-4.99	-3.76	I(0)
	AO2	0	II/91	-5.17	-3.95	I(0)
	AO3	0	II/91	-5.12	-4.24	I(0)
Cons. Price Index	AO1	1	II/91	0.08	-3.76	I(1)
	AO2	1	II/91	-2.17	-3.95	I(1)
	AO3	1	II/91	-2.17	-4.24	I(1)
Inflation	AO1	0	II/91	-6.57	-3.76	I(0)
	AO2	0	II/91	-6.73	-3.95	I(0)
	AO3	0	II/91	-6.68	-4.24	I(0)
Real Exchange Rate	AO1	0	III/89	-4.06	-3.76	I(0)
	AO2	0	III/89	-2.91	-3.96	I(1)
	AO3	0	III/89	-3.48	-4.24	I(1)
Trade Balance	AO1	0	III/89	-1.77	-3.76	I(1)
	AO2	0	III/89	-2.12	-3.96	I(1)
	AO3	1	III/89	-2.65	-4.24	I(1)
Investment	AO1	0	III/89	-1.11	-3.76	I(1)
	AO2	0	III/89	-2.38	-3.96	I(1)
	AO3	2	III/89	-3.24	-4.24	I(1)
Participation Rate	AO1	0	I/84	-2.57	-3.72	I(1)
	AO2	0	I/84	-5.49	-3.94	I(0)
	AO3	0	I/84	-5.43	-4.22	I(0)
Unemployment rate	AO1	2	II/91	-3.61	-3.80	I(1)
	AO2	2	II/91	-2.53	-3.85	I(1)
	AO3	2	II/91	-2.38	-4.18	I(1)
Employment Rate	AO1	0	I/84	-2.35	-3.72	I(1)
	AO2	2	I/84	-3.48	-3.94	I(1)
	AO3	2	I/84	-2.64	-4.22	I(1)

Table 9. Perron Unit Root Test with endogenous selection of TB

	Model	Lags	Break date	$t_{\rho=1}$	CV 5%	Integration order at 5%
GDP	IO1	6	IV/92	-3.33	-5.09	I(1)
	IO2	6	IV/88	-4.94	-5.59	I(1)
	AO2	6	I/89	-3.49	-4.83	I(1)
Nominal Wages	IO1	3	II/87	-2.61	-5.09	I(1)
	IO2	3	I/89	-7.87	-5.59	I(0)
	AO2	3	IV/92	-4.55	-4.83	I(1)
Real Wages	IO1	5	I/82	-4.82	-5.09	I(1)
	IO2	5	I/82	-4.65	-5.59	I(1)
	AO2	5	III/81	-3.48	-4.83	I(1)
Nom. Interest Rate	IO1	2	I/89	-8.13	-5.09	I(0)
	IO2	0	IV/89	-8.21	-5.59	I(0)
	AO2	2	III/88	-3.18	-4.83	I(1)
M1	IO1	3	I/88	-2.81	-5.09	I(1)
	IO2	3	IV/88	-8.07	-5.59	I(0)
	AO2	3	III/93	-4.46	-4.83	I(1)
M1 Growth	IO1	2	II/89	-6.38	-5.09	I(0)
	IO2	2	II/89	-5.86	-5.59	I(0)
	AO2	0	IV/89	-5.06	-4.83	I(0)
Cons. Price Index	IO1	3	II/87	-2.72	-5.09	I(1)
	IO2	3	IV/88	-8.93	-5.59	I(0)
	AO2	3	I/93	-4.34	-4.83	I(1)
Inflation	IO1	4	IV/89	-5.15	-5.09	I(0)
	IO2	4	II/89	-7.22	-5.59	I(0)
	AO2	1	I/89	-3.78	-4.83	I(1)
Real Exchange Rate	IO1	0	I/89	-4.94	-5.09	I(1)
	IO2	5	III/89	-6.05	-5.59	I(0)
	AO2	0	I/83	-3.19	-4.67	I(1)
Trade Balance	IO1	6	II/90	-4.35	-5.09	I(1)
	IO2	6	II/90	-5.19	-5.59	I(1)
	AO2	6	III/87	-4.25	-4.83	I(1)
Investment	IO1	3	I/93	-3.45	-5.09	I(1)
	IO2	4	IV/88	-5.2	-5.59	I(1)
	AO2	4	IV/88	-4.41	-4.83	I(1)
Participation Rate	IO1	0	I/78	-3.43	-5.23	I(1)
	IO2	0	I/82	-5.92	-5.59	I(0)
	AO2	0	II/82	-5.29	-4.83	I(0)
Unemployment rate	IO1	4	I/94	-7.47	-5.23	I(0)
	IO2	4	II/89	-5.57	-5.59	I(1)
	AO2	4	II/89	-5.63	-4.83	I(0)
Employment Rate	IO1	4	II/87	-4.79	-5.23	I(1)
	IO2	4	II/87	-4.88	-5.59	I(1)
	AO2	4	II/80	-4.29	-4.83	I(1)

Table 10. Comparative results of the different test for the Unit Root Hypothesis

Variables	Order of Integration												
	Augmented Dickey – Fuller $t_{\rho=1}$ statistic	Philllip – Perron Z_t statistic	Recursive t_{ADF}^{Min}	Rolling t_{ADF}^{Min}	Variance Ratio	Perron Test for U. Root with Structural Change. Exogenous selection of TB			Perron Test for U. Root with Structural Change. Endogenous selection of TB			Non weighted average	Coefficient of Variation
						AO1	AO2	AO3	IO1	IO2	AO2		
GDP	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0%
Nominal wages	1.5	1	1	1	2	1	1	1	1	0	1	1.0	45.1%
Real Wages	1	1	1	1	0.5	1	0	1	1	1	1	0.9	37.4%
Nominal Interest Rate	1	0	1	0.5	0	0	0	0	0	0	1	0.3	145.3%
M1	2	1.5	1	1	2	1	1	1	1	0	1	1.1	48.6%
M1 Growth	0.5	0	0.5	0.5	0	0	0	0	0	0.5	0.5	0.2	114.9%
CPI	2	1	1	0.5	2	1	1	1	1	0	1	1.0	54.3%
Inflation	0.5	0	0.5	0.5	0	0	0	0	0.5	0	1	0.3	126.1%
Real Echange Rate	1	1	1	1	1	0	1	1	1	0.5	1	0.9	37.4%
Trade Balance	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0%
Investment	1	1	1	1	1	1	1	1	1	1	1	1.0	0.0%
Participation Rate	1	1	1	1	0.5	1	0	0	1	0.5	0.5	0.7	59.3%
Unemployment Rate	1	1	1	1	0	1	1	1	0	1	0	0.7	64.2%
Employment Rate	1	1	1	1	0	1	1	1	1	1	1	0.9	33.2%

Note: The order of integration derived from each test (for each variable) has been selected comparing the observed statistics with the 1% and 5% respective critical values. A non integer order of integration implies a discrepancy between the results achieved with these critical values. For the nominal wages case in the conventional ADF test the result of 1,5 indicates that this series is I(1) al 5% and I(2) at 1%. In the same test the 0,5 value for the order of integration of inflation indicates that this variable is I(0) at 5% but I(1) at 1%.

The last column (Coefficient of Variation) has been computed as the ratio between the non weighted average of the order of integration derived from the different test and its standard deviation amongst test.

6.2 Figures

Figure 2. Recursive and Rolling estimation of FOAC for logs, Cycle 1 and Cycle 2 of each series

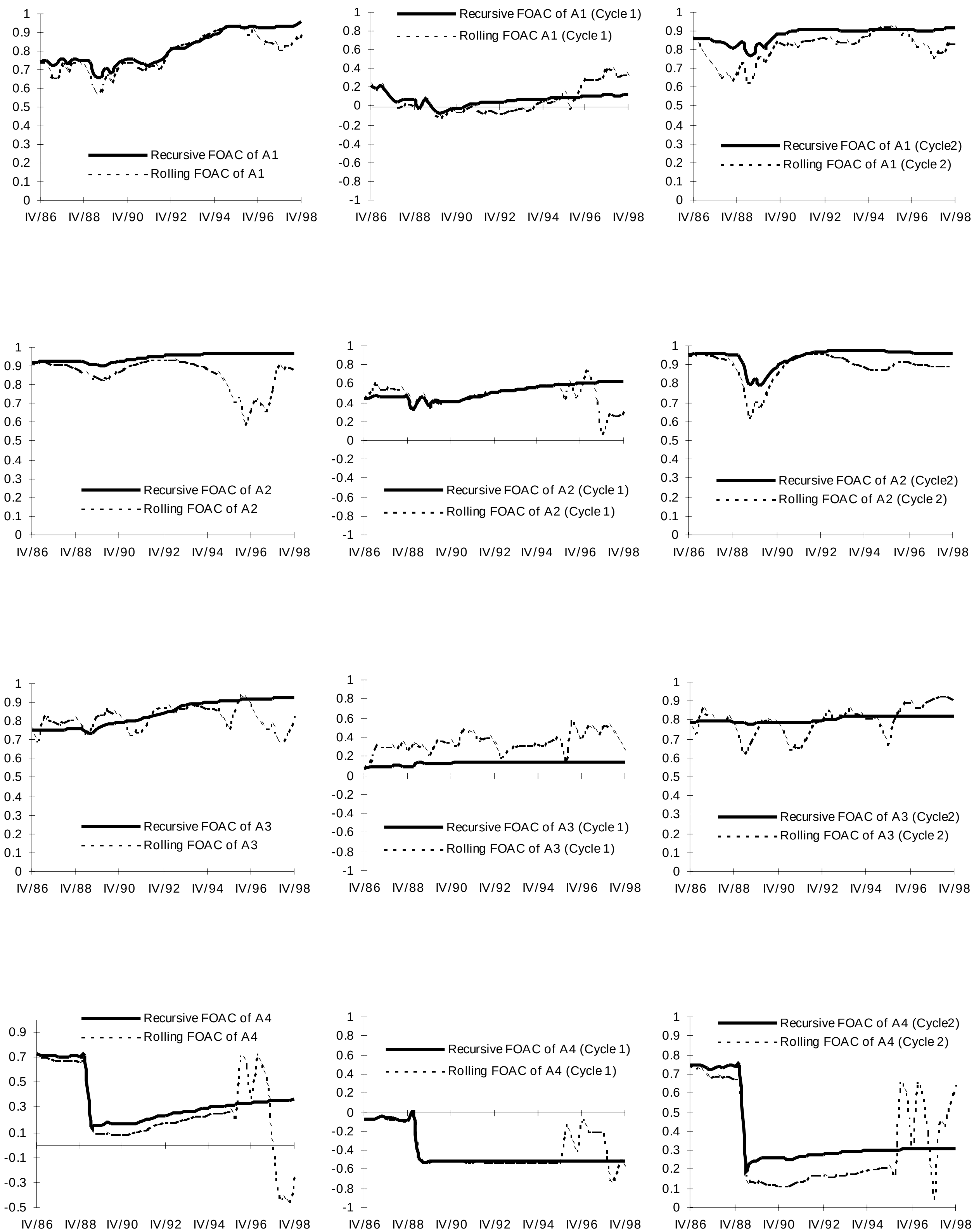


Figure 2. Recursive and Rolling estimation of FOAC for logs, Cycle 1 and Cycle 2 of each series (Continuation)

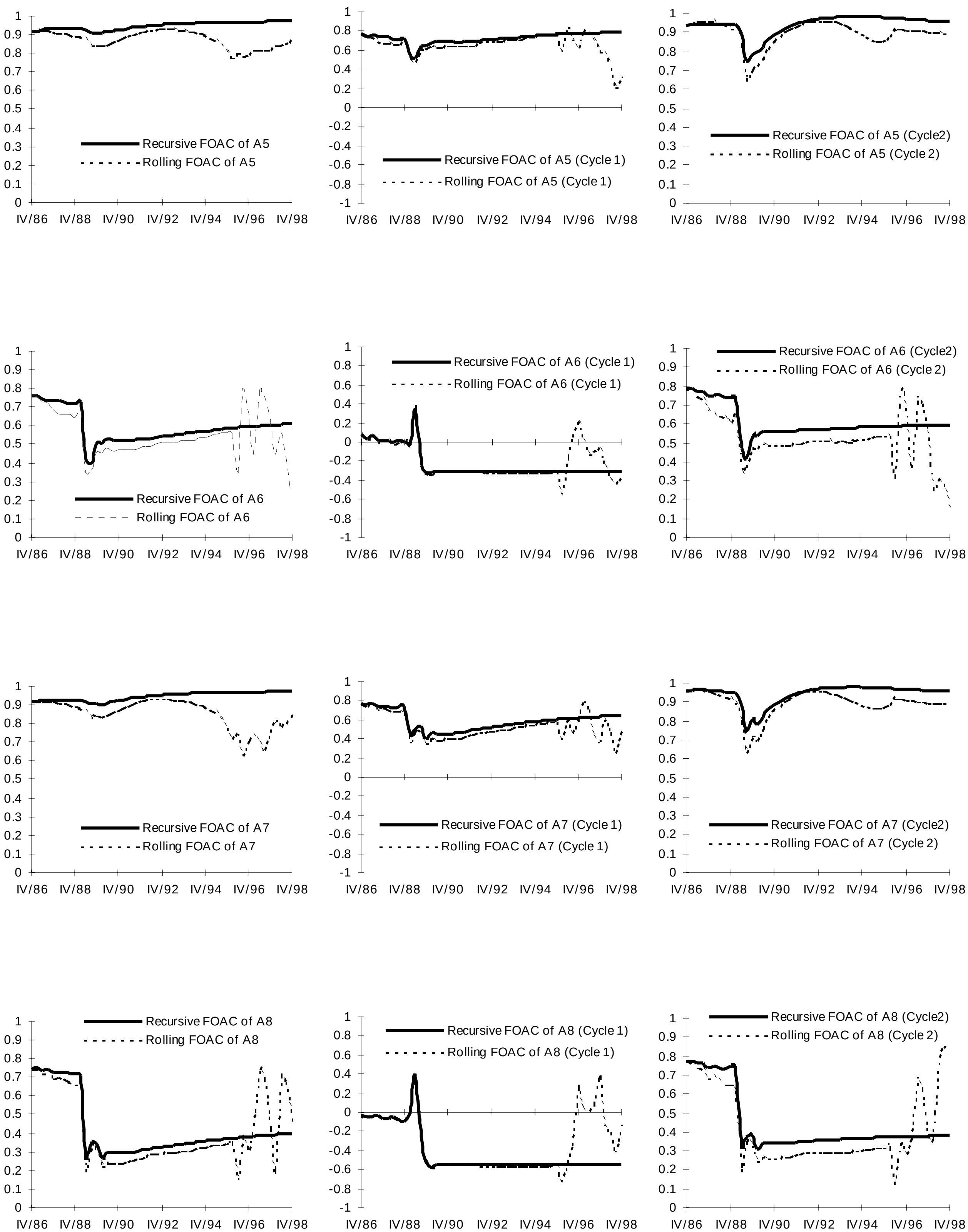


Figure 2. Recursive and Rolling estimation of FOAC for logs, Cycle 1 and Cycle 2 of each series (Continuation)

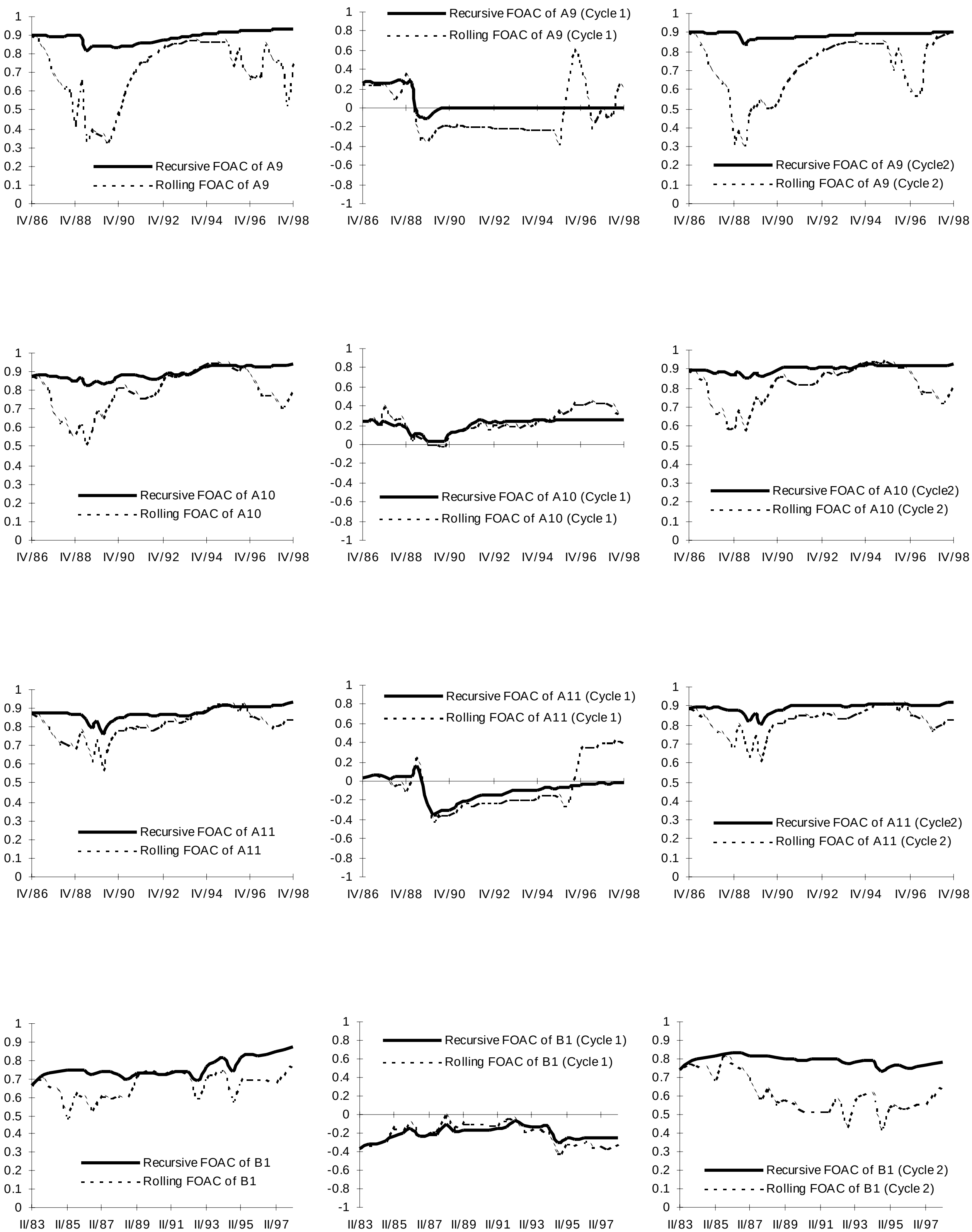


Figure 2. Recursive and Rolling estimation of FOAC for logs, Cycle 1 and Cycle 2 of each series (Continuation)

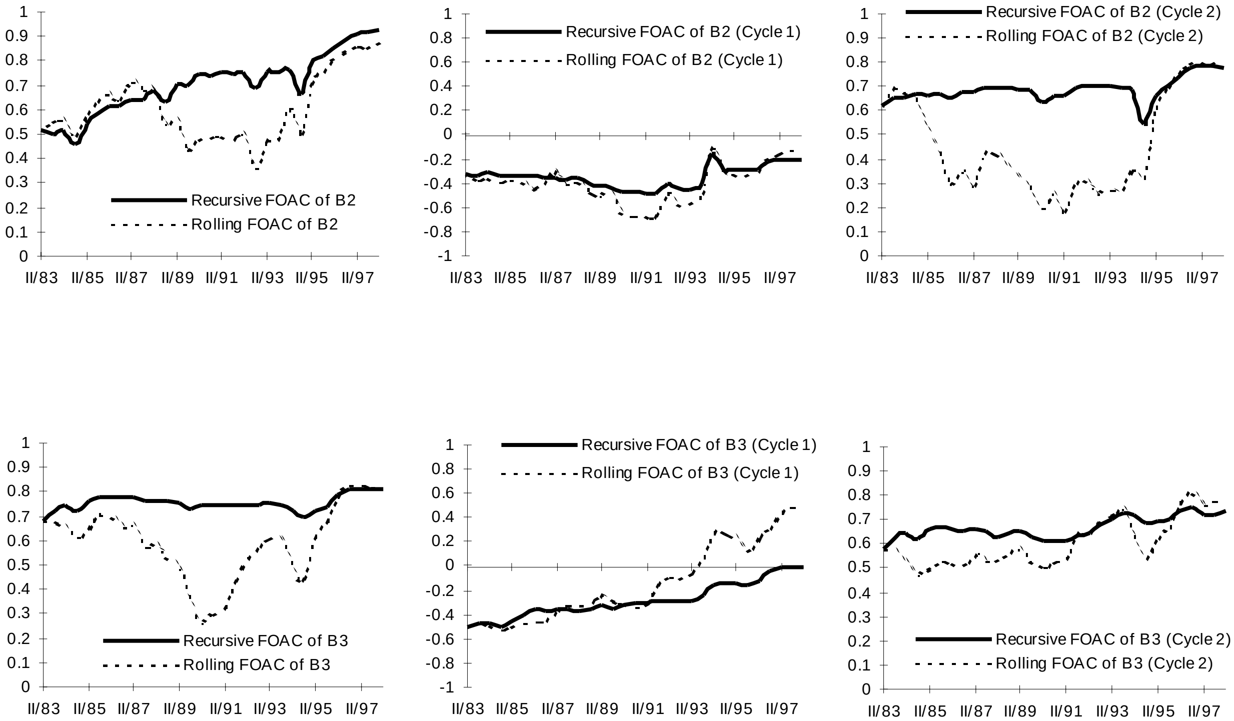


Figure 3. Recursive and Rolling estimation of ADF t statistic for ρ=1

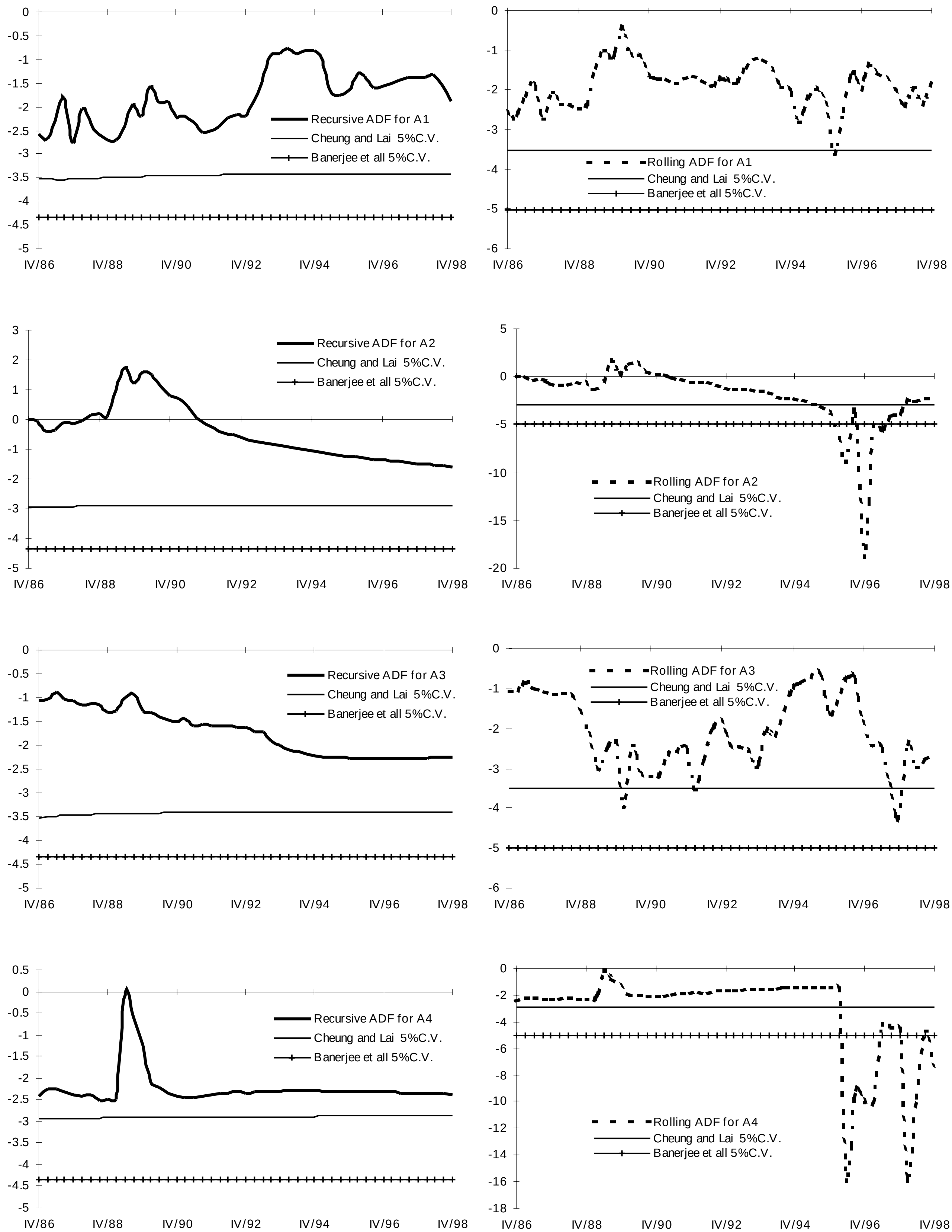


Figure 3. Recursive and Rolling estimation of ADF t statistic for ρ=1 (continuation)

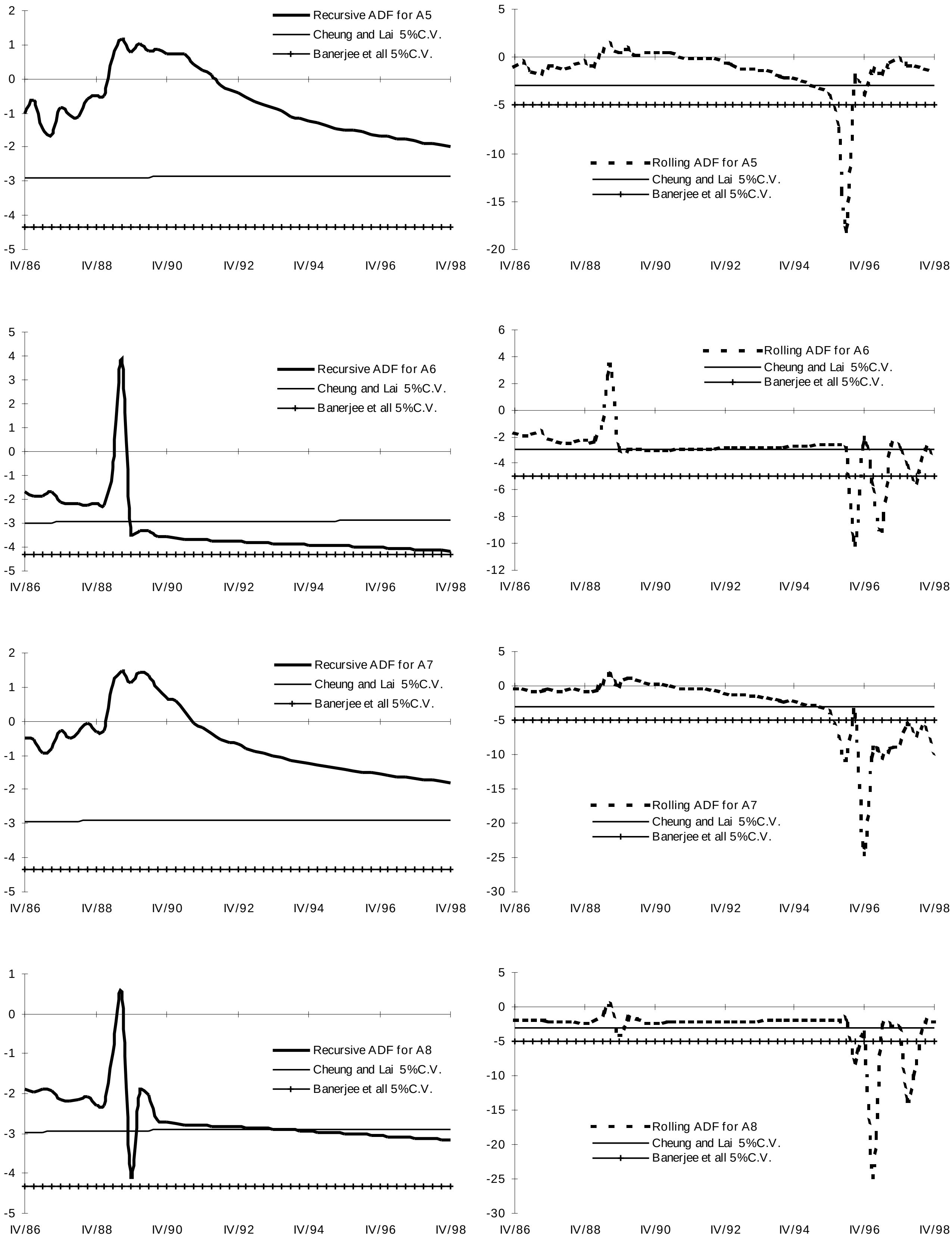


Figure 3. Recursive and Rolling estimation of ADF t statistic for ρ=1 (continuation)

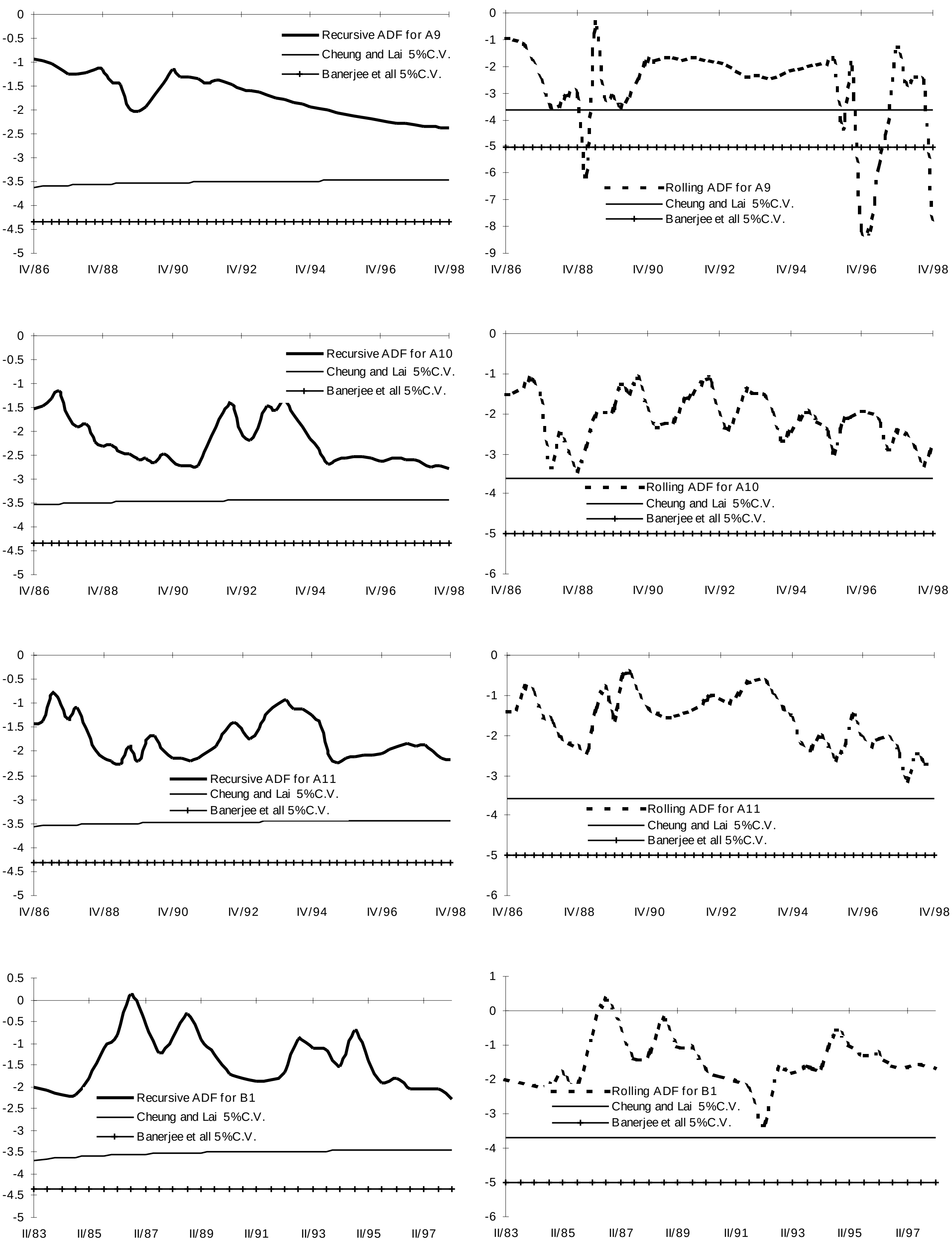


Figure 3. Recursive and Rolling estimation of ADF t statistic for ρ=1 (continuation)