Trends, structural breaks and economic growth regimes in the states of Mexico, 1940-2006

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"Stories happen to those who are able to tell them".
Paul Auster**

Abstract

This paper analyses the long run dynamics of the GDP of Mexico and its 32 states over the period 1940-2006 in order to determine whether such series are stationary once one and two structural breaks are allowed. Structural breaks are interpreted as large, infrequent shocks switching the economy from one regime to another. Our main findings are: 1) output is stationary around a deterministic segmented trend in fourteen out of thirty three cases; 2) estimated structural breaks can be associated to different economic growth strategies (regimes) that Mexico has followed in the past decades, and 3) there has been a generalised long run decline in the average growth rates of the output of all states. One implication of our results is that economic policies aiming to promote economic growth can have permanent effects and, therefore, drive output to higher growth rate regimes.

Key words: Trends, unit roots, structural change, growth regimes, state production, México.
JEL: O47, R11, C22.

Resumen

Tendencias, quiebres estructurales y regímenes de crecimiento en los estados de México, 1940-2006

Este documento analiza la dinámica de largo plazo del PIB de México y de sus 32 estados para el periodo 1940-2006, con el fin de determinar si tales

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** Citado en Canova, F. (1998). "Detrending and business cycle facts: A user's guide", *Journal of Monetary Economics*, Vol. 41, pp 533-540

RECEPCIÓN: 12/05/2011 ACEPTACIÓN: 22/07/2011

series son estacionarias una vez que uno y dos quiebres estructurales son incorporados. Nuestros principales resultados son: 1) la producción es estacionaria en torno a una tendencia determinista segmentada en catorce de treinta y tres casos analizados; 2) los quiebres estimados pueden asociarse a las distintas estrategias (regímenes) de crecimiento implementados en México en las décadas pasadas; y 3) ha habido una reducción generalizada de largo plazo en las tasas de crecimiento de la producción de los diferentes estados. Una implicación de nuestros resultados es que las políticas que busquen promover el crecimiento pueden tener efectos permanentes y, por lo tanto, impulsar la producción hacia regímenes de crecimiento mayor.
Palabras clave: tendencias, raíces unitarias, quiebres estructurales, regímenes de crecimiento económico, producción estatal, México.
Clasificación JEL: O47, R11, C22.

Introduction

The Mexican economy has experienced deep transformations over the past seven decades that have generated differences in the long run performance of output. A first major change occurred from the late forties to the earlier fifties, when the government promoted an industrialisation process based on the substitution of imports by domestically produced goods. Internal production, mainly manufactures, was fomented by the creation and enlargement of a captive domestic market and the provision of basic infrastructure financed by increasing government expenditure. Consequently, investors were willing to produce a wide variety of goods and services, which allowed the economy to grow at an average annual rate above 6% until the early eighties. However, economic growth could only keep its pace during the late sixties and the seventies due to a growing public expenditure financed with external debt and oil revenues.[1] Although this growth strategy generated some distortions, there is some agreement about the importance of capital accumulation as a central source of growth over those four decades (see Elías, 1992, and Santaella, 1998).

1. Cárdenas (1996) and Villarreal (2000), among others, provide deep analysis of the strategies followed during this period of time as well as the results in terms of the performance of the economy.

Nevertheless, the limitations of this growth strategy became evident by the early eighties, when the economy was largely indebted and highly dependent on oil revenues, in an international context characterised by increasing interest rates and decreasing oil prices. Expansionary fiscal and monetary policies and overvaluation of the real exchange rate caused highly unsustainable trade and current account deficit as well as increasing inflation rates. These phenomena triggered an economic crisis that suddenly showed up the disequilibria caused by protectionist policies that provoked distortions of prices, misallocation of resources, deep anti-export biases of the productive sector and, overall, a lack of competitiveness of the economy as a whole (see Ros, 1987; Cárdenas, 1996).

Short-run stabilisation policies, implemented to overcome the economic crisis, were supplemented with structural reforms aiming to deeply modify the structure and working of the economy. These reforms constitute the second major transformation experienced by the Mexican economy that could have meant a structural change.

Thus, during the following decade, trade was liberalised both unilaterally and through the signature of trade agreements (notably the North American Free Trade Agreement), which caused an exponential growth of the external trade, especially of manufactures. On the other hand, voluntary private capitals returned after the renegotiation of the external debt, whilst foreign direct investment expanded before the expectation of the integration of Mexico to the largest market of the world (NAFTA) and the raising of restrictions to invest in specific sectors. At the same time, markets were deregulated and public enterprises were privatised (see Cárdenas, 1994). Consequently, the Mexican economy transited from a closed, government-led economy to an open, market-oriented economy, highly integrated to the global economy, mainly to the US market.

So far, however, these reforms have not yield the expected results in terms of economic growth. Thus, although exports and foreign direct investment have grown at very high rates over the last twenty five years, output has shown a moderate average annual growth rate of 2.2% between 1982 and 2006, which is

rather far from the rates of the period 1940-1981 and is clearly insufficient to meet the needs of an increasing population.

Furthermore, these growth strategies have had different manifestations at regional and state levels. For example, economic growth of Jalisco, Nuevo León, Distrito Federal and the State of Mexico can be explained by the import-substitution industrialisation, whilst Baja California, Sonora, Chihuahua and Tamaulipas grew faster on the basis of the 'maquila' production in the context of an open economy.[2] In general, the resulting heterogeneous performance of output led first to convergence in state output until the mid eighties; afterwards Mexican states have gone through a divergence process.[3] Therefore, it can be claimed that national economic policies have had different effects depending on the specific structural characteristics and policies of the state economies.

In summary, during the last seven decades the Mexican economy has gone throughout different economic growth regimes resulting from specific economic policies. From a historical perspective, two major transformations can be identified. The first one may be related to the import-substitution industrialisation process of the forties and fifties and the second one to the opening and liberalisation process of the economy started in the early eighties. These growth strategies seem to have generated different growth rates of output, not only over time but also across states, whose performance have been analysed in several studies, such as those cited above. However, only a few papers have carried out econometric analyses to model the dynamics of output growth and, specifically, the structural changes that could have experienced.

In this paper we contribute to the analysis of the long-run dynamics of the Mexican output by testing the GDP of the Mexican states for the existence of unit roots over the period 1940-2006. Given the evidence reported so far, there seems to be two major transformations in the long run performance of the Mexican

2. Section 3.1 gives more detailed information about the growth rates of the Mexican states.

3. See Esquivel (1999), Aroca, *et al*. (2005) and Chiquiar (2005), as well as references there in, for analyses of this subject.

economy that could have implied structural changes in the dynamics of output. In these circumstances we look for unit roots in output series by allowing for one and two structural breaks occurring at an unknown date by applying the tests of Zivot and Andrews (1992) and Lumsdaine and Papell (1997); hereafter referred as ZA and LP tests, respectively. We relate the breaks to changes in the economic growth strategy and we interpret them as shifts from one regime to another. Our results support this view in several cases. Moreover, this paper shows that national growth strategies have had different effects on state output performance and sets the base for future research investigating their specific causes, a largely ignored area in the literature.

The rest of this paper contains three additional sections. Unit roots tests with structural breaks are presented in section 1, where methodological issues are emphasised. The data base and their basic statistical properties are presented in section 2; also, the results of the stationarity analysis are reported and discussed in that section. Finally, some conclusions are stated.

1. A BRIEF LITERATURE REVIEW

Since the publication of the seminal paper of Nelson and Plosser (1982), a branch of the literature has emphasised the need of modelling the nature of underlying trends of macroeconomic time series. Statistical implications on the long run behaviour of a series having a deterministic underlying trend as well policy recommendations are very different compared with those from a series with an underlying stochastic trend. Essentially, shocks hitting a series with a deterministic underlying trend would have transitory effects and the series would exhibit the trend-reversion property. On the contrary, the existence of a stochastic trend would cause shocks having permanent effects with no tendency of the series to revert to the trend. On the other hand, Perron (1989) has argued that ignoring structural breaks in the long run trend when testing for the nature of the underlying trend can generate misleading guidelines in terms of both statistical inference and

policy strategies. In particular, he claimed that structural breaks can be interpreted as large, infrequent shocks (both exogenous or policy-induced) affecting the level or the growth rate of the series, generating switches from one regime to another (see also Startz, 1998). This viewpoint has gained many adepts and several researchers have analysed the long run properties of output series of a number of countries.[4]

In the case of Mexico, it is interesting to observe that there are only a few studies analysing these topics, despite this country has experienced deep economic transformations. The first paper we are aware of is that of Ruprah (1991), who concluded, by using the augmented Dickey-Fuller (ADF) tests, that the GDP per capita is non-stationary over the period 1921-1987. However, by simple visual inspection of the evolution of the series we can detect the presence of two structural breaks associated to the Great Depression and the debt crisis of the early eighties that may bias these results. Mejía and Hernández (1998), in turn, made a first attempt to address the effects of these changes on the stationarity of the same series by dividing the period 1921-1995 into two sub-samples. By applying the ADF and the Phillips-Perron unit root tests as well as the variance ratio proposed by Cochrane (1988), they find that this series is stationary only for the 1932-1981 sub-sample, when the large mentioned shocks are excluded. On the other hand, Mejía and Ramírez (2005) evaluate whether the GDP per capita and the components of the aggregate demand and supply exhibit a trend break in the early eighties as the total GDP does, according to other papers (mentioned below). By applying the Perron's (1989) test, they find that only the GDP per capita, the total GDP and investment are stationary over the period 1931-2001 with a break in 1982.

Although these papers have tried to incorporate the effects of structural breaks on the stationarity analysis of several Mexican macro-aggregates, they are subject to criticism due to the assumption of an exogenous break date. To overcome these methodolo-

4. See, for example, Ben-David and Papell (1995, 1998), Ben-David, *et al*. (2003) for analyses of the developed countries and Smyth and Inder (2004) for the case of the Chinese provinces.

gical flaws, a couple of papers have used techniques that define the break dates endogenously. First, Noriega and Ramírez (1999) use re-sampling methods to date the breaks; they claim that the Mexican GDP is stationary around a segmented, deterministic trend with statistically significant breaks in 1931, 1950 and 1980. In turn, Castillo and Díaz (2002) apply the tests introduced by Perron (1989) and Zivot and Andrews (1992) and report non-stationarity of GDP and trend breaks in 1907, 1932, 1983 and 1995.[5]

Finally, two papers analyse the long run dynamics of the state output in Mexico. In the first one, Carrion and German (2007) study the degree of convergence among the state GDP per capita in presence of structural breaks. They analyse the stationarity of the ratio of the state to the national GDP per capita, as well as the cointegration between the levels of these two variables. They find evidence of up to two breaks and conclude that convergence exists in most cases. They further extend their analysis by using a panel data framework where they reinforce their conclusions but report more breaks for most states (Carrion and German, 2009). Our paper differs from these two papers at least in two important aspects. First, we are interested in characterising economic growth regimes and determining the time of the shift from one to another by taking the GDP series individually according to the lines of Ben-David and Papell (1995, 1998), Ben-David, *et al*. (2003) and Smyth and Inder (2004). Second, since there have been two major economic growth strategies in Mexico over the last seven decades, we consider up to two structural breaks in the stationarity tests.

2. Stationarity, trends and structural break tests

In this section, we first briefly expose a selective portion of the literature related to the evaluation of stationarity of macroeconomic series in presence of structural breaks; special emphasis is devoted to the economic interpretation of breaks. Next, we explain

5. Notice, however, that break dates are only relevant when the series is stationary.

the statistical methods to be used in this study in order to determine whether or not a series is stationary around a broken trend.

2.1. Stationarity and structural breaks

After the publication of the influential paper of Nelson and Plosser (1982), one branch of the econometrics literature has emphasised the importance of defining the nature of underlying trends of macroeconomic variables, which depends upon the existence of unit roots. In general, when the autoregressive representation of a series has no unit roots, the series can be seen as stationary, exhibiting mean-reversion, since shocks affecting it only generate stationary fluctuations around a constant mean. On the contrary, when the autoregressive representation has a unit root the series becomes nonstationary, wandering permanently, since shocks hitting it have permanent effects on its long-run dynamics; it is said that such a series follows a random walk.[6] In the case of trended-series, deviations from a deterministic trend are analysed for stationarity: if such deviations are stationary, the series shows trend-reversion and the underlying trend is deterministic. In the opposite case, there is no trend-reversion and the underlying trend becomes stochastic.

Nelson and Plosser (1982) applied the techniques developed by Dickey and Fuller (1979, 1981) to a set of macroeconomic variables of the United States (US) and concluded that most of them had a unit root, implying that their underlying trends were stochastic. Their results had important theoretical and economic implications and opened a big debate. In the first place, this evidence seemed to support the view that economic fluctuations were originated on the supply-side, by real factors such as technological change, capital accumulation and population growth, rather than by demand-side factors. In that sense, there seemed to be support to the real business

6. In other words, it is said that there are no unit roots when the roots of the corresponding lag polynomial lie outside the unit circle; in the opposite case, the roots lie on the unit circle. In addition, when there are no unit roots, the autocovariance does not depend on time, and vice versa. See Enders (2003) for a good exposition of this issue and the statistical implications of non-stationarity.

cycle theories (Nelson and Plosser, 1982). However, more recently some new Keynesian economists have developed models with price and wage rigidities where demand shock effects on output eventually vanish, but can be highly persistent, generating a stationary series with a near-unit root.[7] Therefore, empirical evidence on non-stationarity in output series should be taken with caution (see Mankiw, 1985, for example).

Notwithstanding, although the existence of unit roots should not be considered as evidence supporting any of these theories, there still seems to be room for economic policy implications: fiscal and monetary policies can have permanent or highly persistent effects if the series has a unit root or a near-unit root. Moreover, it seems to be clear that well-designed demand policies can enhance the effects of exogenous positive shocks and offset those of negative shocks (see Libanio, 2005, for an overview).

These theoretical and policy implications have attracted the attention of other researchers who have further investigated the limitations of the tests applied to detect the presence of unit roots. Specifically, Perron (1989) claims that the Dickey and Fuller's unit root tests can be sensitive to the model specification used in the evaluation exercise and, thus, have low power. He shows that these tests have a bias to accept a false unit root null when the series is in fact stationary but exhibits a break resulting from an exogenous event. Indeed, once a structural break is incorporated into the Dickey and Fuller (DF) test, Perron (1989) finds that eleven out of fourteen, of the variables analysed by Nelson and Plosser are in fact stationary.

However, the approach of Perron has been subjected to a number of criticisms from a statistical point of view. Specifically, it has been criticised for taking the break point as exogenously determined and known a priori. To overcome this flaw, Zivot and Andrews (1992) and Perron (1997), among others, have advanced alternative

7. In this discussion some authors have claimed that it is really irrelevant for macroeconomic theorising whether or not unit roots are detected in output series. Furthermore, some others have argued that unit root tests cannot distinguish between a unit root and a near unit root. See Christiano and Eichenbaum (1990) and Rudebusch (1992), for example.

methodologies that endogenously date the break.[8] Furthermore, Lumsdaine and Papell (1997) extended the Zivot and Andrew's framework to allow for two breaks, both in the intercept and the trend.[9] In an analogous manner to the incorporation of one break, this framework avoids the possibility of erroneous non rejection of the unit root null when a second break is not accounted for.[10]

Despite these statistical drawbacks of Perron´s (1989) approach, one important contribution he has done is the interpretation of trend-breaks as large, infrequent shocks, having permanent effects on the long-run dynamics of the series. Regardless their causes, since trend-breaks imply changes in the trend slope they are equivalent to changes in the long run growth rates and, in that sense, they can be seen as shifts from one growth regime to another, such as Startz (1998) has suggested. In other words, large, rare stochastic or policy induced shocks can provoke changes in the economic fundamentals that can result in faster or slower long-run growth. Ben-David and Papell (1995, 1998), and Ben-David, *et al*. (2003) adopt this view to analyse the effects of structural breaks associated to the great wars and the Great Depression as well as the postwar evolution of growth in a group of developed countries. In turn, Smyth and Inder (2004) follow a similar perspective to study the dynamics of output of the Chinese regions. Our approach is close to that used in these papers.

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8. By applying their novel approach, Zivot and Andrews (1992) found that only six out of the eleven series reported by Perron (1989) as stationary, have actually this property (the null is rejected for an additional series at a significance of 10%).In turn, Perron (1997) proved the consistency of the results previously reported in his paper of 1989.

9. For comparison purposes, they also applied their test to the series used by Nelson and Plosser (1982) and concluded that the null can be rejected at a significance of 5% for seven series when two breaks are included (and for two additional ones at 10%). See also Byrne and Perman (2006) for a well-documented discussion.

10. There is some debate in the literature regarding the number of breaks to be incorporated in stationarity analyses since the inclusion of more than one break may make difficult to distinguish between a segmented-trend stationary series and a random walk process, such as Hansen (2001) and Byrne and Perman (2006) have suggested. On the other hand, however, Lumsdaine and Papell (1997) and Ben-David, *et al.* (2003) claim that considering only one break may be insufficient and may lead to a loss of information when actually there is more than one break. Most empirical studies consider up to two breaks and we follow that practice in this paper. The search for more breaks is left for future research.

2.2. Unit root tests with one and two breaks

A very active branch of the literature has criticized conventional unit root tests due to their difficulties to distinguish between processes with an authentic unit root and processes that are trend-stationary with breaks in levels. In this paper we apply the tests introduced by Zivot and Andrews (1992) and Lumsdaine and Papell (1997) to evaluate the Mexican state GDP series for the existence of unit roots in presence of one and two trend breaks, respectively. As mentioned above, both tests endogenously determine the date of the break, overcoming the statistical drawbacks of the Perron's (1989) test. The main properties of these tests are outlined next.

Both Zivot and Andrews (1992) and Lumsdaine and Papell (1997) assume under the null hypothesis that a series y_t follows a random walk with a drift,

$$y_t = \mu + y_{t-1} + e_t \tag{1}$$

Whilst, Zivot and Andrews' (1992) alternative hypothesis stipulates that y_t can be represented by a trend-stationary process with a one-time break in the trend occurring at an unknown point in time. Specifically, following Perron's (1989) ADF testing strategy, the most general regression equations used in their test is

$$y_t = \hat{\mu} + \hat{\theta} DU_t\left(\hat{\lambda}\right) + \hat{\beta} t + \hat{\gamma} DT_t\left(\hat{\lambda}\right) + \hat{\alpha} y_{t-1} + \sum_{j=1}^{k} \hat{c}_j \Delta y_{t-j} + \hat{e}_t \tag{2}$$

where $DU_t\left(\hat{\lambda}\right) = 1$ if $t > \mathrm{T}\hat{\lambda}$ and 0 otherwise; $DT_t\left(\hat{\lambda}\right) = t - T\hat{\lambda}$ if $t > T\hat{\lambda}$ and 0 otherwise. The "hats" on the λ parameter are used to emphasise that they are estimated values of the break fraction ($\lambda = T_B/T$). T_B indicates the date when the break occurs.[11]

11. The test for the change in the coefficients is constrained not to be at the ends of the sample, as there are not enough observations to identify the subsample parameters. Zivot and Andrews (1992) propose a conventional solution which consists in considering all break-dates ranging from 2/*T to* (*T*-1)/*T*.

To formally test the presence of a unit root, Zivot and Andrews considered the following t statistic for testing $\alpha=1$ in (2),

$$t_{\hat{\alpha}}(\hat{\lambda}) \tag{3}$$

Notice that this statistic depends on the location of the break fraction $\hat{\lambda}$. In this framework, the goal of Zivot and Andrews is to estimate the breakpoint that gives the heaviest weight to the trend stationary alternative, that is, the date of the break is chosen to give the least favourable result for the null hypothesis (1) using the test statistic (3). In other words, $\hat{\lambda}$ is chosen to minimise the *t* statistic for testing $\alpha=1$. Let $\hat{\lambda}_{\inf}$ denote such minimising value; then, by definition,

$$t_{\hat{\alpha}}\left[\hat{\lambda}_{\inf}\right] = \inf_{\lambda\in\Lambda} t_{\hat{\alpha}}(\lambda) \tag{4}$$

where Λ is an specified subset of (0,1).

The number of extra regressors, *k*, required in the ADF regressions is allowed to vary for each tentative choice of $\hat{\lambda}$. In turn, in order to determine the truncation lag parameter, *k*, we follow the same selection procedure proposed by Perron (1989).[12] Finally, let us say that when we treat the selection of $\hat{\lambda}$ as a result of the estimation procedure we can no longer use the critical values of Perron (1989). Therefore, Zivot and Andrews (1992) derive the asymptotic distributions of the test statistic in (4) and the corresponding critical values to test the null in (1) against the alternative in (2).[13]

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12. The procedure starts with an upper bound lag, say k_{max}. If the last included lag is significant, choose $k = k_{max}$; if not, reduce *k* by 1 until the last lag becomes significant. If no lags are significant, set $k = 0$; k_{max} is set equal to 8 by Perron (1989). A 10% value of the asymptotic normal distribution, 1.60, is applied to evaluate the significance of the last lag. Moreover, Ng and Perron (1995) use a simulation approach to prove that these sequential tests are superior to the information-based methods, such as the information criteria of Akaike and Schwarz, since the former shows less size distortions without much loss of power. Zivot and Andrews (1992) and Lumsdaine and Papell (1997) used the same approach.

13. For further methodological details see Zivot and Andrews (1992). Lucatero

On the other hand, Lumsdaine and Papell (1997) extend the endogenous break methodology introduced by Zivot and Andrews (1992) to allow for a two-break alternative. The test statistic suggested by them is computed using the full sample, allowing for two shifts, both in the intercept and the deterministic trend, at distinct unknown dates. The most general model considered by Lumsdaine and Papell (their Model CC) can be expressed as

$$\Delta y_t = \hat{\mu} + \hat{\beta}t + \hat{\theta}DU1_t + \hat{\gamma}DT1_t + \hat{\varpi}DU2_t + \hat{\psi}DT2_t + \hat{\alpha}y_{t-1} + \sum_{j=1}^{k} \hat{c}_j \Delta y_{t-j} + \hat{e}_t \quad (5)$$

for $t = 1, \ldots, T$, where $DU1_t$=1 if t >$TB1$, 0 otherwise; $DU2_t$=1 if t >$TB2$, 0, otherwise; $DT1_t$= t-$TB1$ if t >$TB1$ and 0 otherwise, and $DT2_t$ = t-$TB2$ if t >$TB2$ and 0 otherwise.

Notice that unlike Zivot and Andrews, Lumsdaine and Papell (1997) consider the unit root hypothesis that α=0 and, therefore, the test statistic of interest is the t-statistic associated with this hypothesis. Alike Zivot and Andrews, Lumsdaine and Papell suggest using the minimum of the sequence of the t-statistics computed over the two-dimensional grid of possible combinations of k_1 and k_2, where $k_i = \lfloor T\delta_i \rfloor$ for i = 0, 1, 2, and δ_0 represents some startup fraction of the sample. That is, the relevant test statistic can be expressed as

$$\underset{k_0 \le k_1, k_2 \le T - k_0}{Min} \hat{t}(k_1/T, k_2/T; \delta_0) \quad (6)$$

The test rules out the possibility that the two breaks occurred on consecutive dates. 14 Regarding the maximum lag length k of the augmented Dickey-Fuller procedure, they follow a general-to-specific approach for each series, as in Perron (1989). Finally,

(2009) offers a good presentation of this methodology.

14. Following Zivot and Andrews (1992), the authors choose a "trimming" value and estimate equation (5) for values δ_1 and δ_2=$TB2$/T between 2/T and (T-1/T).

these authors also compute critical values to be compared to the test statistic in expression (6).

In the next section we test the GDP series of Mexico and its states for stationary in presence of structural changes.

3. Unit roots and structural changes in the GDP of the Mexican states

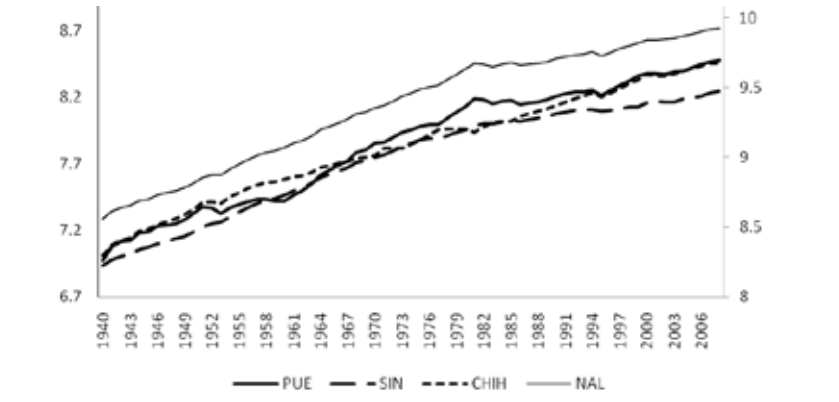
This section presents the basic statistical characteristics of the GDP of the 32 states of Mexico over the period from 1940 to 2006 to give some intuition about the relevance of analysing structural changes in this country.[15] Afterwards, the results about the existence of unit roots with and without structural changes for each case are presented. Finally, we discuss the results.

3.1. Basic statistical characteristics

The dynamics of the Mexican GDP has shown two very well differentiated growth regimes throughout the period 1940-2006. In Graph 1, it is possible to observe that national GDP presented a sustained expansion with an annual average growth rate of 6.5% from 1940 to 1981. Afterwards, from 1982 to 2006 the national output experienced short-lasting phases of expansion and contraction and lower growth: the annual average growth rate during this period equated 2.2 %. The series seems to exhibit a change in the slope around 1982, which has been associated to the debt crisis and the shift in the economic growth strategy from a closed, government-led economy to an open, market economy. Thereafter, the Mexican economy entered a period of lower growth and higher volatility (Cárdenas, 1996, and Mejía and Ramírez, 2005). This evidence reinforces the supposition about the existence of a trend break in the early eighties, such as Mejía and Hernández (1998), Noriega and Ramírez (1999) and Castillo and Díaz (2002) have suggested.

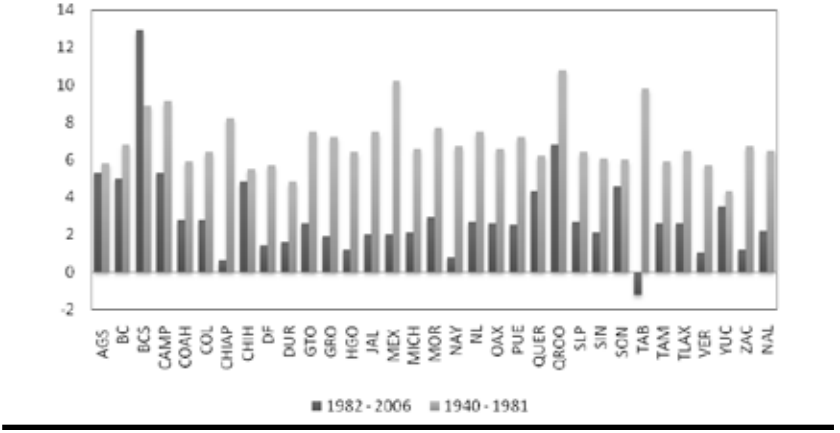
15. The sources of statistical information about the GDP of the Mexican states are German (2005) and the Instituto Nacional de Estadística y Geografía (INEGI, www.inegi.org.mx) for periods 1940-1992 and 1993-2006, respectively.

Graph 1
Real GDP of Mexico and several states (Logarithms)



Source: Own elaboration with data from German (2005) and INEGI.

Graph 2
Growth rate of real GDP of Mexico and its states, 1940-2006
(Percentages)



Source: Own elaboration with data from German (2005) and INEGI.

In turn, Graph 2 presents the state average growth rates for the two sub-periods defined on the basis of the existing literature, namely 1940-1981 and 1982-2006. During the first period the states experienced high growth rates, standing out the cases of Tabasco,

Quintana Roo and the State of Mexico, which reached average rates of approximately 10%. On the other hand, the average growth rates during the second sub-period, 1981-2006, reveal a decline in the productive activity of the states. In general, their growth rates did not exceed 3% per annum in the average.[16] These figures show the spread across states of the economic growth slowdown that Santaella (2008), Ibarra (2008) and Ros (2008) have documented for the national output over the second period.[17]

On the other hand, by visual inspection, three different trend patterns can be identified in the behaviour of the GDP of the Mexican states; some examples are presented also in Graph 1. In the first pattern, corresponding to the description presented in the above paragraphs, the state output shows a performance similar to that of the national GDP, where there seems to be a break around the early eighties; the production of Sinaloa is depicted as an example. The second pattern corresponds to the existence of two possible breaks in the dynamics of GDP occurring around 1960 and in the early eighties. As previously mentioned, these changes may be associated to the economic transformations caused by the import-substitution industrialization strategy and the liberalisation of the economy, respectively. As an example, the GDP of Puebla is depicted in Graph 1. Finally, we present the GDP of Chihuahua as a case of the third pattern: its production does not show any visible breaks and we might conclude that the series is stationary around a deterministic trend. [18]

16. It is possible to observe that among all states, Tabasco was the most affected, probably due to the decline in the prices and production of oil during this period, which caused it to have a negative annual average growth rate of 1.2 %.

17. Notwithstanding, despite the generalised slowdown of the output growth, some states have managed to expand their production. In particular, Baja California Sur reached an average annual growth rate of 13%, a figure that exceeds the 9% of the former period. In turn, Aguascalientes, Baja California, Queretaro, Quintana Roo, Sonora and Yucatan have also exhibited high growth rates, which have even doubled the national one during the last period. However, this growth rates are lower than those they experienced during the national prosperity period.

18. Chiapas, Distrito Federal, Guerrero, Guanajuato, Hidalgo, Jalisco, State of Mexico, Nayarit, Nuevo León, Sinaloa, Sonora, Tamaulipas, Veracruz, Yucatán and Zacatecas could be included in the first pattern. In turn, the states of Aguascalientes, Baja California Sur, Campeche, Colima, Durango, Michoacan, Morelos, Oaxaca, Puebla,

This simple description shows preliminary evidence of changes in the long-run trend of Mexico's GDP that may have been provoked by changes in the strategies of economic growth. In the rest of this paper, we analyse the stationarity of the GDP series of Mexico and its states by taking into account the existence of one and two trend breaks that, a priori, can be associated to the industrialisation of the fifties and the economic liberalisation of the eighties.

3.2. Unit roots and trends

In this section we present the results of the application of the tests described in Section 1.2 to evaluate the national and state output of Mexico for the existence of unit roots in presence of structural breaks.[19] Table 1 shows the minimum *t* statistic values corresponding to the Zivot and Andrews' (1992) test obtained by recursive estimation of equation (2). The logs of the series have been used in the estimation. In turn, the maximum value of *k* in (2) to capture possible autocorrelation was set equal to 8, a value conventionally used in this literature.[20]

Queretaro, Quintana Roo, San Luis Potosi, Tabasco and Tlaxcala could be included in the second pattern. Finally, states in the third pattern could be those of Baja California and Coahuila.

19. We first apply the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron tests (PP) to the natural logarithm of the series (in levels). Robustly, both tests indicate that output is trend-stationary only in the case of Chihuhua. However, as discussed above, these tests may have low power in presence of structural breaks. These results are not reported in the paper to save space, but they are available upon request.

20. The estimations were carried out in gauss 7.0 by using a code elaborated by Junsoo Lee, available at: http://www.cba.ua.edu/~jlee/gauss/.

Table 1
Zivot and Andrews test for the GDP of the States of Mexico, 1940-2006

$$y_t = \hat{\mu} + \hat{\theta}DU_t(\hat{\lambda}) + \hat{\beta}t + \hat{\gamma}DT_t^*(\hat{\lambda}) + \hat{\alpha}y_{t-1} + \sum_{j=1}^{k}\hat{c}_j\Delta y_{t-j} + \hat{e}_t$$

STATE	Minimum t statistic	Break date	k	STATE	Minimum t statistic	Break date	k
AGS	-4.3646	1971	7	NAY	-5.3392[2]	1977	7
BC	-3.4047	1979	4	NL	-3.7860	1969	3
BCS	-6.3234[1]	1974	3	OAX	-5.9553[1]	1981	7
CAMP	-8.1403[1]	1980	3	PUE	-4.0467	1962	0
CHIAP	-7.1063[1]	1975	7	QROO	-3.6928	1953	6
CHIH	-4.9611	1953	1	QUER	-4.6334	1977	6
COAH	-5.2938[2]	1977	3	SIN	-4.3800	1971	5
COL	-3.0789	1984	0	SLP	-4.5768	1977	6
DF	-3.6147	1981	1	SON	-7.2937[1]	1976	3
DUR	-4.7132	1977	6	TAB	-8.5441[1]	1975	8
GRO	-4.0404	1977	1	TAM	-4.2301	1977	6
GTO	-4.2245	1971	6	TLAX	-4.4970	1977	3
HGO	-4.5058	1977	4	VER	-4.6103	1985	0
JAL	-4.1652	1977	6	YUC	-6.2269[1]	1970	4
MEX	-4.2572	1977	6	ZAC	-4.8009	1979	6
MICH	-4.8433[3]	1977	7	NAL	-5.7102[1]	1978	6
MOR	-3.8333	1977	6				

Critical values at 1%, 5% and 10% are: -5.57, -5.08 and -4.82 respectively. [1]Significant at 1%. [2]Significant at 5%. [3]Significant at 10%.

The estimated t statistics show that most states share a trend break occurring during the second half of the seventies as the national output does. Although there are some differences, it is apparent that this is the relevant date in terms of stationarity. In fact, the unit root null can also be rejected for the GDP of the states of Baja California Sur, Campeche, Chiapas, Coahuila,

Michoacan, Nayarit, Oaxaca, Sonora, Tabasco and Yucatan. The GDP of the rest of the states appear as non-stationary even if one trend break is allowed.

Due to the fact that the trend breaks are only relevant when the series are stationary around a segmented trend, we report more specific results regarding the coefficient estimates of the ZA test specification for the series that appear as stationary in Table 2. A general characteristic we can observe is a statistically significant negative change in the trend slope of the production in all the cases ($\hat{\gamma}$), which suggests that there has been indeed a slowdown in the long run growth of these states, such as the average growth rates in Graph 1 indicate.[21] Also notice that the intercept estimates increase after the breaks, except in the case of Sonora, suggesting a higher level of GDP in the context of the oil boom that Mexico experienced at that time. In other words, it appears that the GDP of these states experienced an increase in the level, but a lower growth rate after the break.

However, although illustratively, these results may also be biased since they ignore the possibility of additional breaks. The simple graphical analysis we presented in Section 2.1 suggests that the GDP trend may have more than one break in several cases. Since ignoring this option may also bias our results (such as those obtained from conventional unit root tests), we next explore stationary by applying the LP test on the basis of expression (5). These results are presented in Table 3.

21. On the other hand, notice that for a series to be stationary the estimated autoregressive coefficient of the regression equation must be lower than one. Surprisingly, the autoregressive coefficient estimated is greater than one in case of the GDP of Sonora; however, the unit root null is rejected.

Table 2
Estimates for the states of Mexico with a stationary GDP, 1940-2006.
Zivot and Andrews test

$$y_t = \hat{\mu} + \hat{\theta}DU_t(\hat{\lambda}) + \hat{\beta}t + \hat{\gamma}DT_t^*(\hat{\lambda}) + \hat{\alpha}y_{t-1} + \sum_{j=1}^{k}\hat{c}_j\Delta y_{t-j} + \hat{e}_t$$

STATE	T_b	$\hat{\mu}$	$\hat{\theta}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\alpha}$
BCS	1974	4.7042	0.4886	0.0683	-0.0405	-0.8966
		(6.3938)	(3.6853)	(5.8994)	(-4.8265)	(-6.3234)
CAMP	1980	2.0023	0.5185	0.0215	-0.0234	-0.3369
		(8.1475)	(6.9436)	(7.4609)	(-6.4541)	(-8.1403)
CHIAP	1975	1.6410	0.1179	0.0155	-0.0120	-0.2250
		(7.2032)	(5.8774)	(7.0324)	(-7.0922)	(-7.1063)
COAH	1977	5.4131	0.0884	0.0297	-0.0070	-0.6574
		(5.3354)	(2.7804)	(5.2306)	(-3.6162)	(-5.2938)
MICH	1977	2.0059	0.0567	0.0166	-0.0098	-0.2632
		(4.8978)	(2.4498)	(4.8384)	(-4.5607)	(-4.8433)
NAY	1977	2.3363	0.0859	0.0218	-0.0176	-0.3523
		(5.4076)	(3.3762)	(5.2103)	(-5.0970)	(-5.3392)
OAX	1981	2.4431	0.0748	0.0190	-0.0124	-0.3310
		(6.0085)	(3.7592)	(5.9215)	(-5.821)	(-5.9553)
SON	1976	8.8209	-0.0079	0.0722	-0.0426	-1.1304
		(7.3557)	(-0.2654)	(7.2268)	(-6.875)	(-7.2937)
TAB	1975	3.0464	0.4328	0.0372	-0.0409	-0.4480
		(8.6010)	(6.9952)	(8.4023)	(-8.2173)	(-8.5441)
YUC	1970	2.6409	0.0983	0.0135	-0.0020	-0.3481
		(6.2703)	(5.3548)	(6.2703)	(-2.4745)	(-6.2269)
NAL	1978	8.2099	0.0678	0.0435	-0.0258	-0.7126
		(5.7509)	(3.0722)	(5.7408)	(-5.7728)	(-5.7102)

It is important to underline that the LP test rejects the unit root null (at 5% of significance at least) in most cases the ZA test does. Specifically, the national GDP as well as the GDP series of Baja Cali-

fornia Sur, Campeche, Chiapas, Coahuila, Michoacán, Oaxaca, Sonora and Tabasco remain stationary when two breaks are taken into account. Of course, some of the break dates change. Notice, however, that although in the cases of Campeche, Chiapas, Oaxaca and Tabasco, the null hypothesis is rejected, the coefficients of $DU1t$ and $DT1t$ in expression (5) are not statistically significant, which offers support in favour of the one break alternative according to the ZA test results (see Tables 3 and 4). On the other hand, the cases of Baja California and Hidalgo are very interesting, since they show the consequences of using a miss-specified model regarding the number of breaks: the ZA test cannot reject the non-stationarity null, but the LP test does at least at 5% of significance.[22]

Regarding the stationarity of the national GDP it is interesting to observe that the first break date (1979) is very close to that yielded by the ZA test (1978), which does not correspond to the dates previously reported in the literature, as discussed above. The second break date (1994) delivered by the LP test is closed to that reported by Castillo and Díaz (2002), who claim that there is a break in 1995.

22. Similarly, there is evidence of stationarity in the case of Chihuahua. However, these results should be taken with caution since the estimate of the broken-trend coefficient in the ZA test is not significant, and the LP test statistic rejects the null in favour of the alternative with two breaks at the lowest conventional significance level (10%).

Table 3
Lumsdaine-Papell test for the GDP of the states of Mexico, 1940-2006

$$y_t = \mu + \beta t + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \psi DT2_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$$

STATE	Minimum t statistic	Break dates	*k*	STATE	Minimum t statistic	Break dates	*k*
AGS	-4.7263	1953 1971	7	NAY	-5.4666	1955 1977	7
BC	-7.6637[1]	1956 1980	3	NL	-5.4124	1968 1985	6
BCS	-7.2208[2]	1976 1982	0	OAX	-6.7516[3]	1955 1981	7
CAMP	-8.3267[1]	1976 1980	3	PUE	-6.0995	1963 1982	0
CHIAP	-7.5189[1]	1960 1975	7	QROO	-5.8017	1955 1990	3
CHIH	-6.7498[3]	1955 1980	3	QUER	-5.1693	1957 1979	6
COAH	-7.7088[1]	1952 1985	3	SIN	-5.1269	1971 1980	3
COL	-5.6526	1954 1977	3	SLP	-5.6586	1957 1979	6
DF	-6.3126	1963 1977	6	SON	-8.1394[1]	1970 1974	3
DUR	-5.9534	1957 1979	6	TAB	-9.3368[1]	1970 1975	8
GRO	-5.8456	1963 1979	0	TAM	-5.0932	1955 1977	6
GTO	-5.2064	1955 1974	3	TLAX	-6.4429	1953 1977	3
HGO	-7.7984[1]	1956 1985	3	VER	-5.9587	1977 1996	0
JAL	-4.8658	1955 1977	6	YUC	-6.4162	1960 1970	4
MEX	-4.6668	1956 1977	6	ZAC	-6.1789	1973 1977	3
MICH	-7.2304[2]	1956 1978	7	NAL	-7.2320[2]	1979 1994	6
MOR	-5.9712	1963 1979	3				

Critical values at 1%, 5% and 10% are -7.34, -6.82 and -6.49 respectively. [1]1% significant. [2]5% significant, 310% significant.

According to the lines discussed in the Introduction, some interesting implications can be drawn from our results. First, the break dates can be associated to major changes in the economic growth strategies of Mexico. Particularly, the first break, dated in the fifties, can be seen as a result of the import-substitution industrialisation strategy started at that time in several states and their effects on other neighbouring states; this interpretation may be more sensible for the northern and central states. In turn, in several cases, including the national one, the second break is dated on the second half of the seventies or the first years of the eighties, which can be related to the expansionary effects of the oil boom, whilst the rest of the breaks could be seen as a result of the external debt crisis of 1982 and the structural reforms implemented afterwards. An additional break is dated in the trend of the national GDP in 1994, which may have been caused by the coming into force of the North American Free Trade Agreement and the resulting expansion of Mexican trade flows. Together, this evidence reflects differentiated effects of the national growth strategies followed over the last seven decades in Mexico.

Indeed, the estimates presented in Table 5 about the intercept and trend breaks can be related to different growth regimes according to the lines of Startz (1998) and Ben-David and Papell (1995, 1998) and Ben-David, *et al*. (2003). Specifically, on the basis of the estimates of the trend coefficients, three different groups of states can be identified. The national GDP belongs to the first group characterised by a decline in the slope of the trend after the first break (1979) and an increase following the second one (1994). As it has been well documented in the literature, during the first period the national economy experienced a high sustained growth in the context of a close economy with a significant participation of government. This process came to an end with the oil boom which apparently meant only a higher level of the GDP, as estimated by the intercept of the second period.

Table 4
Estimates for the states of Mexico with stationary GDP, 1940-2006
Lumsdaine-Papell test

$$\Delta y_t = \mu + \beta t + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \psi DT2_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$$

STATE	T_b	μ	β	θ	γ	ω	ψ	α
BC	1956	10.1355	0.1109	0.0114	-0.0301	-0.1657	-0.0257	-1.3578
	1980	(7.7566)	(7.3551)	(0.4040)	(-5.6699)	(-5.3715)	(-6.4025)	(-7.6637)
BCS	1976	3.9143	0.0630	1.2559	-0.3654	1.0439	0.3182	-0.7728
	1982	(7.2112)	(7.1076)	(4.8188)	(-5.9528)	(5.6475)	(5.432)	(-7.2208)
CAMP	1976	2.0475	0.0211	-0.1026	0.0592	0.4106	-0.0822	-0.3430
	1980	(8.3511)	(7.1283)	(-0.9269)	(1.5134)	(4.2197)	(-2.0803)	(-8.3267)
CHIAP	1960	1.7525	0.0130	0.0290	0.0031	0.1234	-0.0125	-0.2375
	1975	(7.6233)	(5.4366)	(1.7972)	(1.4691)	(6.1512)	(-5.7058)	(-7.5189)
CHIH	1955	9.3715	0.0732	0.0114	-0.0215	-0.0900	-0.0010	-1.1383
	1980	(6.8263)	(6.3595)	(0.5645)	(-4.8835)	(-4.3306)	(-0.8117)	(-6.7498)
COAH	1952	10.2317	0.0307	-0.0183	0.0317	-0.1863	-0.0123	-1.2279
	1985	(7.7198)	(4.2127)	(-0.5234)	(3.9914)	(-5.358)	(-4.5623)	(-7.7088)
HGO	1956	8.3451	0.0405	-0.1002	0.0391	-0.1691	-0.0540	-1.1450
	1985	(7.8288)	(6.3259)	(-2.6804)	(6.1012)	(-4.7716)	(-7.2415)	(-7.7984)
MICH	1956	4.5485	0.0272	-0.0783	0.0176	0.0331	-0.0303	-0.5850
	1978	(7.2642)	(5.4356)	(-3.2798)	(4.3578)	(1.8166)	(-6.8150)	(-7.2304)
OAX	1955	3.1045	0.0188	-0.0501	0.0072	0.0673	-0.0186	-0.4106
	1981	(6.8594)	(3.0850)	(-1.8606)	(1.4945)	(3.5319)	(-6.2880)	(-6.7516)
SON	1970	9.1429	0.0759	0.1547	-0.0777	0.2154	0.0326	-1.1730
	1974	(8.2086)	(8.0324)	(2.1412)	(-3.0018)	(3.9309)	(1.2742)	(-8.1394)
TAB	1970	3.1952	0.0355	0.0987	-0.0013	0.4167	-0.0379	-0.4662
	1975	(9.4340)	(8.3921)	(1.6883)	(-0.0782)	(6.1624)	(-2.2077)	(-9.3368)
NAL	1979	12.0338	0.0639	0.1009	-0.0414	-0.0365	0.0108	-1.0450
	1994	(7.2844)	(7.2846)	(4.4270)	(-7.5347)	(-1.9851)	(3.9730)	(-7.2320)

Our estimates also reflect the episode of lower growth associated to the stabilisation of the economy during most of the eighties and the recession of 1995, which seem to have caused a lower level of GDP during the third period as captured in our models by a decrease in the intercept after the second break. Also, the opening of the economy and the market-oriented reforms caused greater growth rates during the most recent period. Baja California Sur and Sonora can be found in this group.

A sustained decline in the growth rates is appreciated in a second group of state economies, although two of them, Baja California and Chihuahua, have managed to maintain their growth at relatively high rates (above an annual average of 5%). Additionally, in both states there has been an upward shift in the level of GDP during the second period corresponding to the industrialization process.[23] A different situation can be found in Tabasco and Campeche: although the estimates of the intercept coefficients suggest an increase in the level of GDP from the first to the second period, a decline in its growth rates can be observed during the latter. The greater level can be explained by the oil boom of the late seventies whilst the lower growth may have been a result of the instability of the exploitation and exportation of oil as well as the difficulties of this state to get involved in the international economy. Chiapas, Oaxaca, Nayarit and Yucatan can also be classified in this group. Finally, the GDP of the states in the third group exhibits minor changes in the intercepts, but significant increases in the growth rates from the first to the second period, which evidences the positive effects of the industrialisation based on the substitution of imports. The growth rates, however, experienced a generalised decrease during the period started around 1980. Coahuila, Hidalgo and Michoacan can be found in this group.

Thus, in general our results on structural breaks can be interpreted as infrequent shocks with permanent effects associated to the different economic growth strategies that Mexico has followed

23. Notice, however, that in the case of Chihuahua the estimates are very close to each other, which undermines the evidence on the existence of breaks, such as the ZA test implies.

Table 5
Estimates of economic growth regimes for stationary state GDP in Mexico

	Break dates		Level cofficient changes		Slope Coefficient changes		Level Cofficients			Slope Coefficients		
State	TB1	TB2	TB1	TB2	TB1	TB2	1st Regime	2nd Regime	3rd Regime	1st Regime	2nd Regime	3rd Regime
NAL	1979	1994	0.101	-0.037	-0.041	0.011	12.034	12.135	12.098	0.064	0.023	0.033
BCS	1976	1982	1.256	1.044	-0.365	0.318	3.914	5.170	6.214	0.063	-0.302	0.016
SON	1970	1974	0.155	0.215	-0.078	0.033	9.143	9.298	9.513	0.076	-0.002	0.031
BC	1956	1980	0.011	-0.166	-0.030	-0.026	10.136	10.147	9.981	0.111	0.081	0.055
CAMP		1980		0.519		-0.023		2.002	2.521		0.022	-0.002
CHIAP		1975		0.118		-0.012		1.641	1.759		0.016	0.004
CHIH	1955	1980	0.011	-0.090	-0.022	-0.001	9.372	9.383	9.293	0.073	0.052	0.051
OAX		1981		0.075		-0.012		2.443	2.518		0.019	0.007
TAB		1975		0.433		-0.041		3.046	3.479		0.037	-0.004
NAY		1977		0.086		-0.018		2.336	2.422		0.022	0.004
YUC		1970		0.098		-0.002		2.641	2.739		0.014	0.012
COAH	1952	1985	-0.018	-0.186	0.032	-0.012	10.232	10.213	10.027	0.031	0.062	0.050
HGO	1956	1985	-0.100	-0.169	0.039	-0.054	8.345	8.245	8.076	0.041	0.080	0.026
MICH	1956	1978	-0.078	0.033	0.018	-0.030	4.549	4.470	4.503	0.027	0.045	0.015

Note: The estimates for the series with one break and two periods correspond to the ZA test, whilst in the cases of two breaks and three periods the estimates correspond to the LP test.

during the last seventy years. Notice that although the effects of these strategies have been heterogeneous across states, a generalised declined in their long run growth rates has been estimated, which points out the difficulties of the national economy and its states to succeed in the context of an open, market-oriented economy.

Second, our results can also be useful in terms of economic policy. Since structural breaks can be interpreted as infrequent, large shocks that have caused shifts from one growth regime to another during the last seven decades and since they can be associated to different growth strategies, it is sensible to claim that GDP can respond to economic policies aiming to promote growth. Although there is no consensus about the specific reforms that could put Mexico on a path of sustained growth, there seems to be some agreement about the need of spending on education and infrastructure, for example. Furthermore, there is a general acceptance about the importance of institutional transformation that consent the rule of the law to operate. Our results imply that any of these strategies can have positive, permanent effects either on the level or on the growth rate of GDP in the cases where segmented trend stationarity has been found.

In turn, the non rejection of the nonstationarity null implies that shocks hitting the GDP series of the Mexican states have permanent effects. However, although not statistically significant in terms of stationarity, the GDP of several of these states exhibits apparent changes in the trend slopes. This allows us to argue that the dynamics of output may be reflecting the effects of both large, infrequent shocks as well as small frequent shocks, being the latter the cause of the series to wander around the trend. Thus, we claim that successive economic policy actions can have positive and permanent effects on the growth rate of these states.

Conclusions

The economic growth experience of the Mexican economy over the last seven decades has been traditionally divided into two periods. The first one started in the decade of the forties and lasted for four decades during which the national output grew at an

annual average rate of 6.5 %. During the second period, initiated with the debt crisis of 1982, the economy grew at a lower growth rate (2.2%). In fact, the economic policy decisions adopted, at that time, derived into a change in the development strategy that has been largely studied in the literature. However, the statistical analysis of the long-run implications of these transformations has been scarcely addressed, especially at regional and state levels.

In this paper we analyse the nature of the underlying trends of the GDP of Mexico and its 32 states over the period 1940-2006. In particular, we test the GDP series for the existence of unit roots when one and two structural breaks are allowed by using the tests introduced by Zivot and Andrews (1992) and Lumsdaine and Papell (1997), respectively. Our results suggest that the Mexican GDP is stationary around a broken trend with breaks in 1979 and 1994. The backwards shift of the first break date, compared to others reported in the literature, may have been caused by the increase in the growth rate of the series at the end of the sample, an episode that has not been covered in previous studies. In turn, the second break date is consistent with the date advanced by Castillo and Diaz (2002). However, our paper seems to be the first one to endogenously date both breaks.[24]

Regarding the experience of particular states, our results indicate that the GDP of Nayarit, Yucatan, Campeche, Chiapas, Tabasco and Oaxaca appears as stationary around a one-time broken trend. On the other hand, the GDP of Baja California, Baja California Sur, Coahuila, Hidalgo, Michoacan and Sonora remains stationary when two breaks are taken into account. Finally, the GDP of Chihuahua seems to be stationary around a non-broken deterministic trend.

Hence, we can conclude that the output of thirteen states fluctuates steadily around segmented trends with one or two breaks defining two or three periods that may be related to the economic growth strategies that Mexico has followed; then the breaks can be seen as shifts from one regime to another. The first period can be associated to the pre-industrialisation phase, the second to the

24. Although they do not determine the date break endogenously, Loría *et al*. (2008) identify a structural break in 1995 by using the CUSUM residual squared test.

industrialisation process ending with the oil boom or the debt crisis, and the third to the market-oriented model. It is important to underline that the average growth rate of output has been lower during the latter.

On the other hand, our findings point out the possibility of economic policies having permanent effects on long run growth. Indeed, in the case of segmented-trend stationary GDP, deep economic reforms can be seen as infrequent, large shocks having the capacity of switching the economy from a low growth regime to a high growth regime, even if current shocks eventually vanish. In turn, when GDP is nonstationary, successive expansionary demand policies improving gradually the quality and magnitude of infrastructure, human capital or institutions, for example, can have permanent effects on the growth rate of output. At regional and state levels, economic policies can have different effects depending on the nature of underlying trends and structural local conditions.

There are a number of issues not addressed in this paper that constitute important research avenues for the future. First, the number of breaks has been set in two given that during the period of analysis the Mexican economy has gone essentially through three economic growth regimes. In fact, the aim of this paper has been to determine whether the trend breaks and the regime switches can be linked to these growth regimes. However, the particular experience of the Mexican states may imply more growth regimes and more than two breaks. The endogenous determination of the number of breaks according to the methodology advanced by Kapetanios (2005) constitutes an important analysis to be carried out. Second, a related area refers to a full explanation of the breaks and growth regimes, which is especially relevant given the critics to the incorporation of many breaks (that may make difficult to distinguish between a segmented-trend stationary series and a random walk process), such as Hansen (2001) and Byrne and Perman (2006) have suggested. Third, the analysis of the long-run and short-run interactions between the GDP of neighboring states will help to understand the regional dynamics of growth.

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