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Structural Change, Macroeconomic Crises and the Long Run Economic Performance of Output and Growth in the Us and Mexico

Alejandro Rodriguez-Arana
Department of Economics
Universidad Iberoamericana
México

Abstract

We estimate two recursive equations of growth for the US and México of the kind of those initially proposed by Dickey and Fuller (1979). Using the Bai-Perron's (1998) method of endogenous structural breaks, we find that the debt crisis of the eighties in México was followed by a poor performance of output and growth in this country. Instead, we did not find evidence to support that other crises, like the one in 1995, changed the long run performance of output in México. Another finding is that the 2008 crisis in the developed world did not change the long growth of the US significantly, but it worsened the long run performance of the level of output. Given the strong relation that México has with the US, output in México also suffered a permanent loss.

JEL: C22, O33, O40, O47

Introduction

Though growth and the business cycle are perhaps the main topics of macroeconomics, in many cases they have been studied in a separated way. The very popular IS-LM model, proposed by Hicks (1937), is a framework dedicated exclusively to the analysis of business cycles, while the Solow model (Solow (1956) (1957)) focus only on growth. The real business cycle theory (Kydland and Prescott (1982)) analyses both problems together, but in many cases the effect of cycles only affect the short run performance of GDP and not the long run trajectory.

In real life growth and the business cycles happen at the same time. Investment is highly procyclical, so in recessions it falls more than GDP and in booms it rises higher than output. These observations suggest that in the years that follow a recession perhaps growth recedes, since previous investment was low. Instead, after booms growth could be higher because previous investment was high. Less clear is whether some booms might produce a permanent positive effect on output and/or recessions could generate a negative permanent effect on the same variable.

There is some economic literature on the effects of recessions over the subsequent trajectory of output. Schumpeter (1934) proposed the hypothesis of creative destructions. According to this premise, when there is a recession, the less productive firms leave the market, which improves the global productivity of the economy and future growth increases.

Beginning in the last decade of the XX century, the Schumpeterian hypothesis, known as the cleansing effect of recessions, has been defended by different economists like Caballero and Hammour (1994) (1996), Mortensen and Pissarides (1994), Hall (2000) and in more recent times Osotimehin and Pappada (2017). Other analysts like Barlevy (2002) (2003), Musso and Schiavo (2007), Ouyang (2009) and Santoro and Gaffeo (2016) assert that recessions worsen the future trajectory of output, especially when they are accompanied by problems in credit markets, which generate misallocation of resources.

The anti-Schumpeterian hypothesis has been based in different empirical observations. The works by Jovanovic (1982), Baden-Fuller (1989) and Davis and Haltinwanger (1992) found that in different recessions productive firms left the market before than less productive ones. Something similar happened with productive workers. In a very recent paper, Furceri et al (2021) have analyzed different industries in developed countries. Their main finding is that total factor productivity is affected negatively and in a permanent way by recessions.

This paper performs an empirical investigation for the US and México of structural changes affecting the performance of GDP and growth. To do that we propose growth equations similar to those set first by Dickey and Fuller (1979) and then by Nelson and Plosser (1982) and other authors, like Perron (1989), Bai and Perron (1998), Zivot and Andrews (1992) and Lee and Strazicich (2003). The proposed equation for the US is an augmented Dickey-Fuller equation (ADF). The equation for México is also defined as an ADF equation, but one of its arguments is the log of the US GDP, since there is a strong economic relation between the two countries, but the GDP of México is about 5% of the GDP of the US.

We first run the ADF regressions and then look for endogenous structural changes using the multiple breakpoint test proposed by Bai and Perron (1998). For the US there are two breakpoints, one that starts in 1962 and other in 2008. For México there is one structural break starting in 1983. Two of these three structural breaks (1983 and 2008) correspond to macroeconomic crises that caused recessions, the one at the beginning of the eighties in México and the other one in 2008 in both countries.

Adding structural dummy variables to the original ADF equations, we conclude that the crisis in the early eighties in México was accompanied by a dramatic reduction of growth and a very negative performance in output. On the other hand, the 2008 financial crisis of the developed world did not change the long run rate of growth of the US in a significant way, but it affected negatively the level of GDP of this country in a permanent way. Given the strong relation that México has with the US, the level of the GDP in México also suffered a permanent loss.

The paper is divided in two sections: the first one proposes and estimates the ADF equations without and with the found structural changes. This section also calculates the long run growth of these countries in the different analyzed sub periods, as well as the contribution of the US to the long run growth of México.

On the other hand, the second section performs two counterfactual exercises: the first eliminating the effect of the crisis in the early eighties in México; the second that eliminates the effect of the 2008 financial crisis in the US. In both cases we calculate the loss of output generated by these crises.

I.-An empirical growth model for México and the US. Capturing the long run growth of different subperiods when structural changes are considered.

We use annual data of the GDP for the US and México of the Penn World Table10.0 (see Feenstra et al (2015)). The model is based in Dickey-Fuller (1979) equations with a twist in the case of México. For the US, the original general augmented Dickey-Fuller (ADF) equation is set as:

$$d(\log(Y_{ust})) = a_0 + a_1 t + a_2 \log(Y_{ust-1}) + \sum_{i=1}^{n} a_{hi}\, d(\log(Y_{ust-i}) + \epsilon_t \quad (1)$$

Where Y_{us} is the GDP of the US and t is a trend.

In the case of México, there is a similar equation, but we assume a possible impact of the US´s GDP, so this equation is formulated as:

$$d(\log(Y_{mext})) = b_0 + b_1 t + b_2 \log(Y_{mext-}\ ) + b_3 \log(Y_{ust}) + \sum_{i=1}^{n} b_{hi}\, d(\log(Y_{mext-i})) + v_t \quad (2)$$

Y_{mex} is the Mexican GDP.

México and the US have strong trade relations. At the same time, the US in the main foreign investor in México. Since the US GDP is more than 20 times the size of the Mexican GDP, it is plausible to propose that the US exerts an influence in the growth process of México, but not the other way around.

The ADF test with constant and trend for these two countries proposes ADF(0) for both the US and México's growth equations.[1] We show the empirical results in equations (3) and (4):

[1] In the ADF test for México, the US GDP is not included. ADF(0) implies that there are not lags of past growth in the equations.

$d(\log(Y_{ust})) = 0.74 + 0.001t - 0.047\log(Y_{ust-1})$ (3)
(1.2) (0.9) (-1.2) R^2 :0.1 DW: 1.7 F:3.9[2]

$d(\log(Y_{mext})) = -1.9 - 0.004t + 0.18\log(Y_{ust}) - 0.07\log(Y_{mext-1})$ (4)
(-1.6) (-1.8*) (1.9*) (-2.1) R^2: 0.3 DW: 1.7 F:8.1[3]

Where t statistics are in parentheses.

It is not possible to reject unit roots in both equations, since critical values of the t statistic in absolute value of the lag of the log of the GDP of the correspondent country are much higher than the obtained values. This result is similar to that obtained by Nelson and Plosser (1982), when they studied the behavior of different time series in the US, among them the GDP per capita. At that time, they couldn´t reject the null hypothesis of unit roots in all these series.

After the work of Nelson and Plosser (1982), other papers showed that when there are structural changes there is a bias to not reject the null hypothesis of unit roots in Dickey-Fuller equations (see for example Perron (1989), Zivot and Andrews (1992), Bai and Perron (1998), Lee andStrazicich(2003)). When these structural changes are included, the rejection of unit roots becomes much more frequent.

Using the Bai-Perron (Bai and Perron (1998)) test of multiple endogenous breakpoints in equations (3) and (4), we find that there are two structural changes proposed in the US, in 1962 and in 2008. For the case of México there are one structural change in 1983.

The proposed structural change for México makes sense. In 1982 this country faced a debt crisis. The price of oil had fallen since 1981 and the international rate of interest rose. Since México was a net debtor and its main export product was oil, these facts affected México in a negative way. In 1983 there was a huge recession and the GDP fell 4.4%. After that, there has been an important reduction of average growth.

For the US, the proposed structural change in 2008 seems also reasonable, since in that year the international financial crisis started. On the other hand, the structural change in 1962 is not as clear as the others, but contrary to crises, it could indicate a good performance in the following years. The missiles crisis with Cuba and the USSR was solved by President Kennedy. Also, an ambitious spatial program was launched by that year. These facts could generate good perspectives and higher investment in the following years.

Considering the described structural changes, we propose encompassing equations for the US and México of the following way:

For the US

$$d(\log(Y_{ust})) = a_0 + a_1 t + a_2\log(Y_{ust-1}) + a_3\mathrm{d}62 + a_4 d08 + a_5 d62\log(Y_{ust-1}) + a_6 d08\log(Y_{ust-1}) + \sum_{i=1}^{3} a_{hi} d(\log(Y_{ust-1}) + \epsilon_t \quad (5)$$

For México

$$d(\log(Y_{mext})) = b_0 + b_1 t + b_2\log(Y_{mext-1}) + b_3\log(Y_{ust}) + b_4 d83 + b_5 d83\log(Y_{mext-1}) + \sum_{i=1}^{5} b_{hi}\,\mathrm{d}(\log(Y_{mext-i})) + v_t \quad (6)$$

Where dX for X=62, 83, 08 constitutes a dummy variable that has zero before the year X=62, 83, 08 and 1 in that year and the following. We include lags of the growth of GDP to correct for serial correlation that can be observed in the correlogram of the residuals. Equations (5) and (6) include the dummies alone and the dummies interacting with the lag of the log of the correspondent GDP.

Once we estimate the encompassing equations (5) and (6), we try to find more parsimonious equations. To do that, we work equation by equation, eliminating sequentially those terms who are insignificant provided the Akaike criteria is reduced. We stop the process until the Akaike criteria is minimized.[4]

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[2] t statistics in parentheses. R^2: Coefficient of determination; DW: Durbin Watson statistic F: Fischer statistic.

[3] t statistics in parentheses. R^2: Coefficient of determination; DW: Durbin Watson statistic F: Fischer statistic. * significant at 10%

[4] The Akaike (1974) criteria is one that prized the R^2 but also prizes to have the minimum possible amount of the regressors.

In the case of the US, the parsimonious equation that surges from eliminating redundant variables of (5) to minimize the Akaike criteria is:

$$d(\log(Y_{ust})) = a_0 + a_1 t + a_2 \log(Y_{ust-1}) + a_5 d62 \log(Y_{ust-1}) + a_6 d08 \log(Y_{ust-1}) + a_{h3}\, d(\log(Y_{ust-3})) + \epsilon_t \quad (7)$$

The same concept for México is:

$$d(\log(Y_{mext})) = b_0 + b_1 t + b_2 \log(Y_{mext-1}) + b_3 \log(Y_{ust}) + b_4 d83 + b_5 d83 \log(Y_{mext-1}) + b_{h5} d(\log(Y_{mext-5})) + v_t \quad (8)$$

Results for equations of the US (5) and (7) may be seen in table 1. For México, results of equations (6) and (8) are depicted in table 2.

Table I. Results of growth regressions for the US

Dependent Variable: Annual growth of the US (logarithmic change of GDP)
Annual data 1950-2019
Method of estimation: Ordinary least squares (OLS)
t statistic in parentheses

	Equation 5	Equation 7
Constant a_0	7.2 (3.8***)	4.5 (4.9***)
Trend a_1	0.01 (4.3***)	0.009 (4.7***)
Lag of GDP a_2	-0.48 (-3.8***)	-0.31 (-4.9***)
Structural dummy starting 1962 a_3	-1.72 (-1.2)	-
Structural dummy starting 2008 a_4	2.0 (1.2)	-
Interaction d62 and lag of log of GDP a_5	0.12 (1.2)	0.003 (4.2***)
Interaction d08 and lag of log of GDP a_6	-0.12 (-1.2)	-0.003 (-4.5***)
First lag of GDP growth a_{h1}	0.12	-
Second lag of GDP growth a_{h2}	0.03 (0.3)	-
Third lag of GDP growth a_{h3}	-0.16 (-1.5)	-0.17 (-1.6)
Wald test for $a_2+a_5=0$	-0.37 (-4.5***)	-0.32 (-4.9***)
Wald test for $a_2+a_5+a_6=0$	-0.49 (-3.0***)	-0.31 (-4.9***)
R^2	0.44	0.41
DW	1.99	1.87
F	4.9	8.2
Box-Ljung statistic of the correlogram $X^2(28)$	22.4	23.4
Akaike criteria	-5.18	-5.24

***: Significant at 99% confidence
R^2: Coefficient of determination
DW: Durbin-Watson statistic
F: Fischer statistic
$X^2(28)$. Statistic X^2

Source: Elaborated by the author with data of the Penn World Table 10.0 (Feenstra et al (2015)).

Table 2. Results of growth regressions for México

Dependent Variable: Annual growth of the México (logarithmic change of GDP)
Annual data 1950-2019
Method of estimation: Ordinary least squares (OLS)
t statistic in parentheses

	Equation 6	Equation 8
Constant b_0	-1.1 (-1.0)	-1.4 (-1.4)
Trend b_1	0.008 (1.8*)	0.005 (1.8$^{*)}$
Lag of GDP b_2	-0.32 (-3.9***)	-0.27 (-5.2***)
Log of the US GDP b_3	0.33 (3.9***)	0.31 (4.1***)
Structural dummy starting 1983 b_4	4.6 (3.1***)	3.7 (4.0***)
Interaction d83 and lag of log of GDP b_5	-0.34 (-3.2***)	-0.27 (-4.0***)
First lag of GDP growth b_{h1}	0.16 (1.1)	-
Second lag of GDP growth b_{h2}	0.05 (0.33)	-
Third lag of GDP growth b_{h3}	0.03 (0.26)	-
Fourth lag of GDP growth b_{h4}	0.11 (0.99)	-
Fifth lag of GDP growth b_{h5}	-0.10 (-0.9)	-0.13 (-1.4)
Wald test for $b_2+b_5=0$	-0.66 (-3.5***)	-0.54 (-4.7***)
R^2	0.59	0.58
DW	1.9	1.7
F	7.7	13.2
Box-Ljung statistic of the correlogram $X^2(28)$	18.9	18.6
Akaike criteria	-4.41	-4.51

- Significant at 90% confidence

*** Significant al 99% confidence
R^2: Coefficient of determination
DW: Durbin-Watson statistic
F: Fischer statistic
$X^2(28)$. Statistic X^2
Source: Elaborated by the author with data of the Penn World Table 10.0 (Feenstra et al (2015)).

The parsimonious equations (7) for the US and (8) for México provide good results. The t statistics of the lag of the GDP and those of the dummy variables interacting with the same lag are large in absolute value in all cases. The value of the coefficients a_3, a_3+a_5 and $a_3+a_5+a_6$ for the US are all negative and t statistics for all of them are high in absolute value. It is then possible to reject unit roots in all the subperiods considered: 1950-1961, 1962-2007 and 2008-2019.[5]

[5] In strict terms, it is not possible to reject unit roots in equations (7) and (8) using the critical values of the ADF test. Nonetheless, since in this case the t values of the log of the lag of GDP of the correspondent country are very high in

In the case of México, the value of the coefficients b_2 and b_2+b_5 are also negative and t statistics are high in absolute value. Therefore, we can reject unit roots in the subperiods considered: 1950-1982 and 1983-2018.
Using the parsimonious estimation (7), equations of growth for the US in the three analyzed subperiods are the following:

1950-1961 and 2008-2019

$$d(\log(Y_{ust})) = 4.5 + 0.009t - 0.31\log(Y_{ust-1}) - 0.17d(\log(Y_{ust-3})) + \epsilon_t \quad (9)$$

1962-2007

$$d(\log(Y_{ust})) = 4.5 + 0.009t - 0.30\log(Y_{ust-1}) - 0.17d(\log(Y_{ust-3})) + \epsilon_t \quad (10)$$

For México, the parsimonious estimation (8) generates the following equations of growth:

1950-1981

$$d(\log(Y_{mext})) = -1.4 + 0.005t + 0.31\log(Y_{usat}) - 0.27\log(Y_{mext-\ }) - 0.13d(\log(Y_{mext-\ })) + v_t \quad (11)$$

1982-2019

$$d(\log(Y_{mext})) = 2.4 + 0.005t + 0.31\log(Y_{usat}) - 0.54\log(Y_{mext-1}) - 0.13d(\log(Y_{mext-5})) + v_t \quad (12)$$

Equations for the US are very similar, however though the 1962 and 2008 shocks changed the long run growth in a minimum way; they changed the level of output in a considerable amount. For instance in 2008 there is a shock of -0.003log (Y_{ust-1}), which implies a marginal reduction of growth of 5 percentage points. If long run growth remains almost the same, there is a permanent loss in the value of GDP when compared with the counterfactual case where the shock is absent.

For México, there is a huge increase in the coefficient of convergence, which passes from -0.27 to the double in negative terms (-0.54) (see equations (11) and (12)). That fact reduces the long run growth as we will see soon.
Since it is possible to reject unit roots, it is not possible to reject conditional convergence.[6] Given a linear trend, we can obtain the long run growth for these countries in the sub periods considered. Theoretically, conditional convergence implies a constant rate of growth of GDP. Consider an equation of growth of any country of the following form:

$$d(\log(Y_t)) = \gamma_0 + \gamma_1 t + \gamma_2\log(h_t) + \gamma_3\log(Y_{t-1}) + \sum_{i=0}^{n}\gamma_{hi}\mathrm{d}(\log(Y_{t-i})) \quad (13)$$

We assume that h is a variable that in the long run grows at a constant rate. For the US h=0, for México h is the US GDP.

If γ_3 is negative, there is conditional convergence. Growth will converge to a constant value, then differentiating equation (13), we get:

$$g_Y = \frac{d(\log(Y))}{dt} = -\frac{\gamma_1}{\gamma_3} - \frac{\gamma_2}{\gamma_3}\frac{d(\log(h))}{dt} == -\frac{\gamma_1}{\gamma_3} - \frac{\gamma_2}{\gamma_3}g_h \quad (14)$$

Where g_Y is the long run growth of GDP of the country and g_h is the long run growth of the parameter h. For México it would be the long run growth of the US GDP. For the US it would be zero.

Table 3 shows the long run growth values for the US and México in all subperiods. Column 2 shows the US long run growth, column 3 shows the equation of long run for México, which depends upon the long run growth of the US, and column 4 shows the punctual long run growth for México.

Table 3: Estimated long run growth of the US and México

t statistic in parentheses

Subperiods	US GDP long run growth (%)	Mexican equation of long run growth	Mexican GDP long run growth (%)
1950-1961	3.04 (43.3***)	$0.02+1.17g_{yus}$ (2.1**) (4.4***)	5.55
1962-1982	3.07	$0.02+1.17g_{yus}$	5.59

absolute value, it is plausible to reject unit roots.

[6] Conditional convergence refers to the fact that there is a negative relation between the rate of growth of output and the initial level of output, which in this case is the log of the lagged GDP. Rejecting unit roots for ADF growth equations imply not rejection of conditional convergence. The Solow growth model (Solow (1956) (1957)) shows conditional convergence, whereas the Romer (1986) model doesn´t (see Barro and Sala I Martin (1995) and Mankiw, Romer and Weil (1992)).

	(46.0***)	(2.1**) (4.4***)	
1983-2007	3.07 (46.0***)	$0.01+0.59g_{yus}$ (2.4**) (3.7***)	2.78
2008-2019	3.03 (47.6***)	$0.01+0.59g_{yus}$ (2.4**) (3.7***)	2.77

** Significant at 95% confidence
*** Significant at 99% confidence
Source: Elaborated by the author with data of the Penn World Table 10.0 (Feenstra et al (2015)).

Since growth in the US impacts México, when there is a change in the long run growth of the US there is also a change in the long run growth of México.

Mexican long run growth fell by the half starting in 1983. It is also true that more than the half of Mexican growth comes from its relation to the US, while growth generated domestically is very low and fell also to the half starting in 1983.

II.- Crises and their impact in the long run performance of GDP in México and the US

The model estimated in the previous section shows two crises: the first is the Mexican debt crisis of the eighties; the second is the financial crisis that started in the US and other developed countries in 2008.

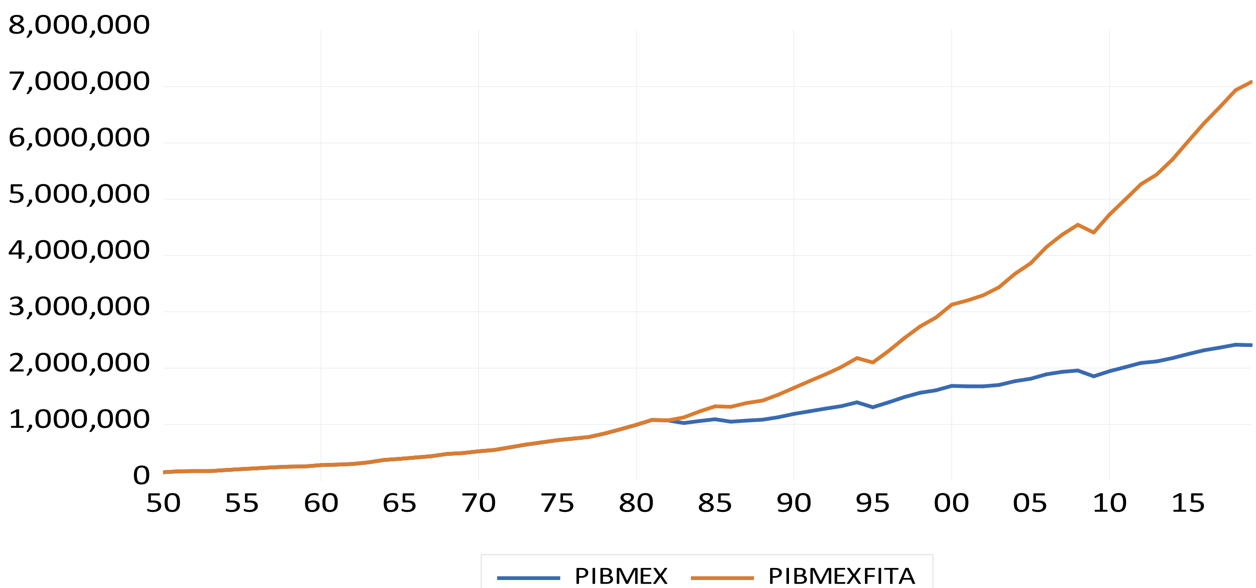
Estimated equations show an important reduction of long run growth in México since the crisis in the eighties. Instead, growth equations show a very small impact on the long run growth of the US and México because of the financial crisis starting in 2008. We will show in the next pages that this small effect on growth doesn´t mean that there was not an impact in the long run output itself.

We performed two counterfactual exercises. In the first we eliminate the effects of the debt crisis of the eighties in México. That only affects the performance of the GDP in México, not in the US, since the US GDP affects México but not the other way around.

Graph 1 shows the observed Mexican GDP in blue and the hypothetical GDP without the effect of the crisis of the eighties in orange.

Graph 1: Counterfactual analysis: the effect of the debt crisis of the eighties in México in the performance of the GDP of that country.

1950-2019

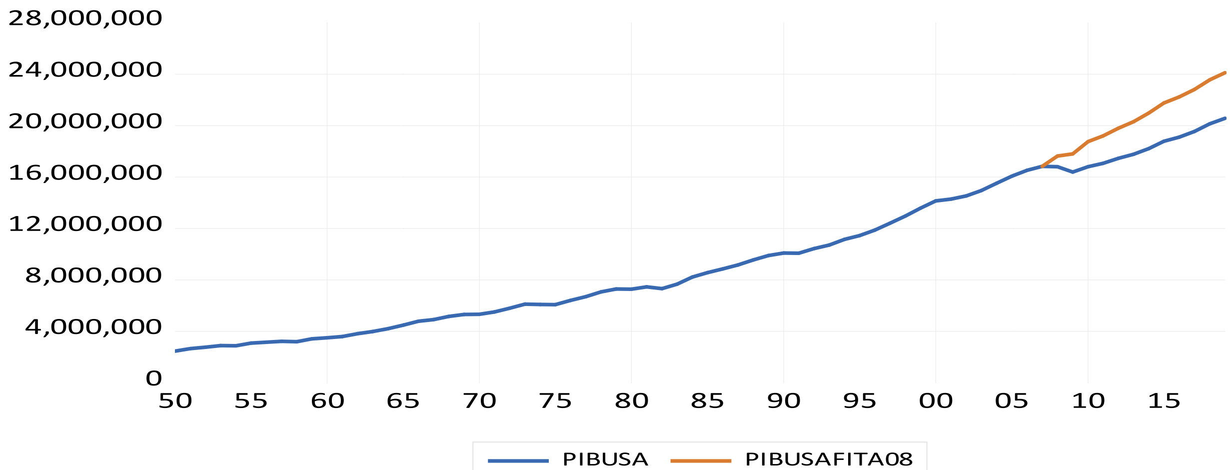


Blue: Observed GDP in México
Orange: Counterfactual exercise eliminating the effect of the crisis
Source: Elaborated by the author with data from the Penn World Table 10.0 (Feenstra et al (2015))

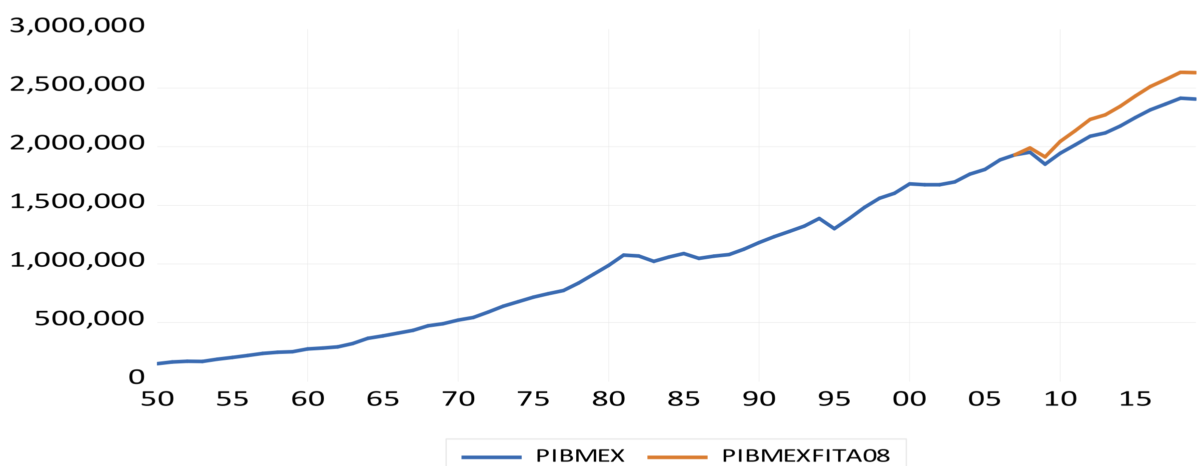
Graph 1 shows that maintaining the previous long run growth, the Mexican GDP in 2019 would have been almost three times higher (2.95 time) than what it was in that year. The 95% confidence interval implies that without the structural change beginning in 1983, the Mexican GDP in 2019 would be between 2.73 and 3.16 times higher. The debt crisis was accompanied by a poor performance of the Mexican GDP when compared with previous years.

On the other hand, the 2008-2009 financial crisis was accompanied also by a negative performance on the long run growth of the US. Since what happens in the US affects México, this country also suffered from that crisis. Graphs 2 and 3 shows the performance of the US and Mexican GDP and the counterfactual exercise when we eliminate the effect of the structural change in the US accompanying the crisis.

Graph 2: Counterfactual analysis: The effect of the financial 2008-2009 crisis in the performance of the US GDP



Graph 3: Counterfactual analysis: The effect of the financial 2008-2009 crisis in the performance of the Mexican GDP



Blue: Observed GDP in the US
Orange: Counterfactual exercise eliminating the effect of the crisis
Source: Elaborated by the author with data from the Penn World Table 10.0 (Feenstra et al (2015))

According to this analysis, without the effects of the financial crisis, GDP in 2019 in the US had been between 11.5% and 22.1% higher than it really was, with a mean of 17.3%. Given the effect of US in México, GDP in this country in 2019 would be between 4% and 16% higher with a mean of almost 10%. Therefore, the financial 2008-2009 in the developed world seems to have had a permanent negative effects at least in México and the US.

Conclusions

Using data from the Penn World Table 10.0 and adding dummy variables of structural change to a kind of ADF equations of growth for México and the US, we can reject the null hypothesis of unit roots, then we cannot reject conditional convergence and it is possible to find the long run growth of different sub periods.

The results show that there are two structural breakpoints for the US, one in 1962 and other in 2008, and one for México starting in 1983.Two of these breakpoints correspond to crises accompanied by recessions, the one of the early eighties in México and the financial crisis of 2008 in the US and other countries. Clearly, after the debt crisis of the eighties Mexican growth fell to the half, with a loss of output in 2019 when compared to the counterfactual exercise of no crisis of between 63% and 68%. There was not any cleansing effect of the recession in this case.

The work also shows that though the 2008 financial crisis did not change the long run growth of the US in a significant way, there is a permanent loss of output for this country in 2019, when compared with the counterfactual exercise of no crisis, of between 11% and 22%. Given that México is greatly influenced by the US GDP, the estimated loss of output there in 2019 is between 4% and 16%.

Between 1950 and 2020 there have been other recessions both in México and the US. For instance, in 1982 for the US and in 1995 in México. We did not consider them because we follow the Bai-Perron (1998) method of endogenous structural changes and these episodes do not appear in the test. Then we do not find evidence that these crises have had permanent effects on the GDP trajectories of the US and/or México.

An interesting result is the structural break found starting in 1962 for the US. According to the analysis it was a positive change for the US and indirectly also for México. It is not very clear what happened in that year, we speculate that the good management of President Kennedy in the missile crisis with Cuba and the USSR, and the launched space program, maybe generate confidence in investors at that time, but we are not so sure about that, so more research is needed in this topic.

The literature about the effects of recessions in the future performance of output and growth of nations is divided. The Schumpeterian hypothesis asserts that there should be an improvement after recessions, the anti-Schumpeterian approach says the opposite. We find some evidence in favor of the last approach.

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