A Estimation of Potential GDP using a PF methodology

We assume a Cobb-Douglas PF with constant returns to scale, where GDP (Y_t) is represented by a combination of factor inputs: labor (L_t), capital stock (K_t) corrected for capacity utilization (ν_t), and adjusted for TFP (A_t), according to:

$$Y_t = A_t(K_t\nu_t)^{\alpha}L_t^{1-\alpha}, \tag{A1}$$

where α represents the output elasticity of capital. According to Solow (1957), the stock of capital that we must consider in a production function should be capital in use ($K_t\nu_t$), rather than capital in place. With this correction we avoid a spurious relationship between TFP and the business cycle. Estimating potential GDP requires removing the cyclical component from TFP, capacity utilization, and labor. Note that the capital stock series does not need to be detrended, as the series itself represents its potential level.[21]

Estimation of factor inputs: Given that Mexico does not have a capital stock series in quarterly frequency, this hasto be estimated. We do so by following the perpetual-inventory method given by:

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{A2}$$

where I_t denotes gross investment and δ denotes the depreciation rate of physical capital. We resort to the *steady-state approach* to estimate initial capital stock, K_0.[22]

To estimate labor input series, we follow Neumeyer and Perri (2005) and define labor in terms of hours as:

$$L_t = (1-u_t)p_t h_t N_t, \tag{A3}$$

[21] For more details, see Giorno et al. (1995), De Masi (1997), and Havik et al. (2014).

[22] This approach employs neoclassical growth theory and assumes that output grows at the same rate as capital stock. It can be shown that equation (A2) in period t leads to

$$K_t = \frac{I_t}{g_K + \delta} = \frac{I_t}{g_{GDP} + \delta},$$

where g_K and g_{GDP} are capital growth and output growth, respectively. This relation is unproblematic if the economy is in fact in equilibrium. However, an economy is typically not in its long-term equilibrium. Therefore, it is more reasonable to assume that, most of the time, economies are on their adjustment path towards equilibrium. Throughout this adjustment process investment and capital accumulation tend to follow a systematic pattern and we can assume that $g_K \approx g_I$, where g_I is the investment growth rate (see de la Fuente and Doménech, 2006). Hence, an initial capital stock value can be taken as $K_0 = I_0/(g_I + \delta)$.

where u_t is the unemployment rate,[23] p_t the participation rate, h_t denotes average worked hours, and N_t the working-age population. We obtain the labor force trend by detrending u_t, p_t, and h_t. Lastly, the TFP series is estimated from the Solow residual as:

$$A_t = \frac{Y_t}{(K_t \nu_t)^{\alpha} L_t^{1-\alpha}}. \tag{A4}$$

We apply the SAVN filter to obtain the trends of labor force, TFP, and capacity utilization of capital. For this step, it is typical to apply the HP filter as discussed in Giorno et al. (1995) and De Masi (1997). Nonetheless, we prefer to use the SAVN filter to address the issues inherent in the HP filter.

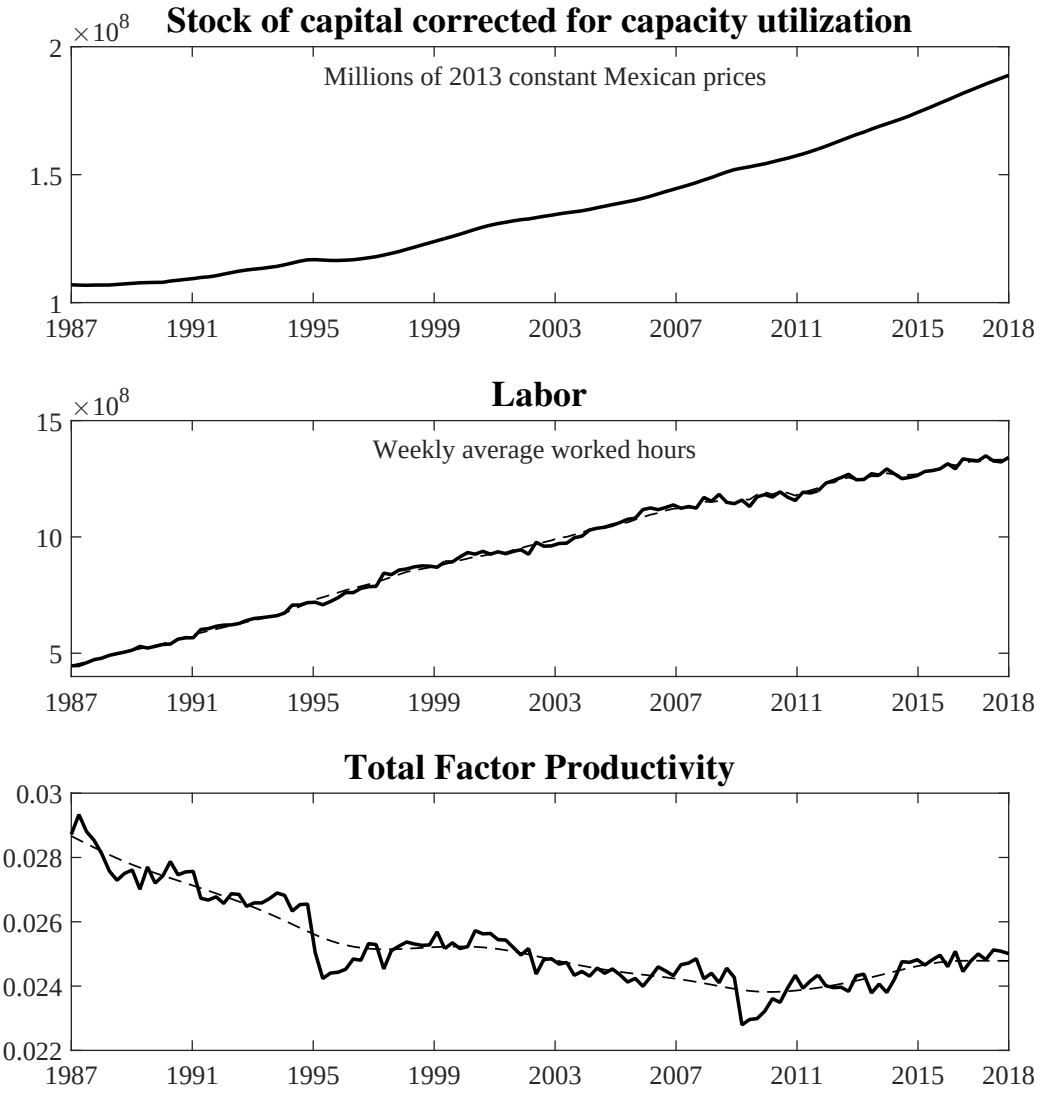
Data: We construct the potential GDP series for Mexico in quarterly frequency from 1987Q1-2017Q4. Table A1 shows the availability of each series that the PF methodology requires to estimate potential GDP. Note that the series of p_t and h_t delimit the period from 1987Q1 onwards, since these series are available from that date. Figure A1 shows the factor inputs series.

[23] We acknowledge that $(1 - u_t)$ is just an approximation. We use it because we lack a consistent series of the capacity utilization for Mexico from 1987 on. Nonetheless, as (Solow, 1957, p.314) states,"...[T]his (approximation) is undoubtedly wrong, but probably gets closer to the truth than making no correction at all."

Table A1: Data required for estimating potential GDP using the PF methodology

Variable	Availability	Details
I_t	1980Q1-2017Q4	This series is constructed as the sum of the Gross Fixed Capital Formation series plus the Changes in Stock series. Both available from INEGI with two base years: 1980 constant prices (1980Q1-1995Q4) and 2013 constant prices (1993Q1-2017Q4). The final series is chained to obtain a series in 2013 constant prices.*
K_t	1987Q1-2017Q4	We take the initial value as $K_0 = I_0/\delta$, where I_0 is taken as the mean of I_t from 1982Q2 to 1986Q4 (I_t remained constant on average and $g_I \approx 0$ during this period following the debt crisis in 1982).
u_t	1985Q1-2017Q4	There are three monthly series available: one from ENEU, 1985M1-2005M9 for ages 12 and over, and two from ENOE, 2000M4-2014M9 for ages 14 and over and for ages 15 and over. The final series is properly chained to construct a series for 2005M1-2017M12, working population aged 15 and over.*
p_t	1987Q1-2017Q4	There are three monthly series available: one from ENEU, 1987M1-2004M4, and two from ENOE, 2000M4-2014M9 and 2005M1-2017M12. The final series is properly chained to construct a series for working population aged 15 and over.*
h_t	1987Q1-2017Q4	INEGI reports a series for weekly average hours worked, 2005Q1-2017Q4. The final series is completed by using two monthly series from EIM** 1987M1-1995M12 and 1994M1-2008M12.
N_t	1980Q1-2017Q4	A chained series is constructed for the working population aged 15 and over, Penn World Table: 1980Q1-1989Q4, OECD: 1990Q1-2001Q1, and INEGI: 2001Q2-2017Q4.
ν_t	1987Q4-2017Q4	FRED reports a series of ν_t for Mexico as of 1998Q1. Therefore, we follow Solow (1957) and use $\nu_t \approx 1 - u_t$ as a proxy for the capacity utilization of capital.
Y_t	1980Q1-2017Q4	We chained two series from INEGI** given in 1993 constant prices, 1980Q1-2007Q4, and in 2013 constant prices, 1993Q1-2017Q4, to get a final series in 2013 constant prices.
Parameters	**Value**	**Details**
α	0.31	This is the value used for Mexico by Bergoeing et al. (2002).
δ	6% (annual)	This is the value used for Mexico by Bergoeing et al. (2002)‡.

Note: *The series was seasonally adjusted using the ARIMA-X12 method. **The series is seasonally adjusted from the original source.
INEGI: *Instituto Nacional de Estadística y Geografía* (Mexico's Office of Statistics).
ENEU: *Encuesta Nacional de Empleo Urbano* (National Survey of Urban Employment, introduced in 1987 by INEGI).
ENOE: *Encuesta Nacional de Ocupación y Empleo* (National Survey of Occupation and Employment that replaced ENEU in 2005).
EIM: Encuesta Industrial Mensual (Monthly Industrial Survey carried out by INEGI).
‡: Bergoeing et. al (2002)argue that 6% yields consistent values for the capital-output ratio of the Mexican economy and is a standard value used in both empirical and theoretical analysis in Mexico.



Dotted lines represent the trend of the series estimated via the SAVN filter. SOURCE: Authors' own estimates.

Figure A1: Factor input series.

B Structural break tests applied to the growth rate of potential GDP series (using the SAVN filter)

Kapetanios test: The auxiliary regression corresponds to the intercept model with level shifts (or DU and DT, respectively). We set the maximum number of lags according to the standard *ad hoc* rule $p_{\max} = \left[12\left(\frac{T}{100}\right)^{1/4}\right]$, where T is sample size and $[x]$ denotes the integer part of x, and then test down from the maximum lag. We set five breaks and a trimming of 0.10. The null hypothesis of unit root is rejected at the 5% level.

Table B1: Kapetanios test

Input	Results	Break dates
Bound: 23 Mmax: 5 Kmax: 1	tstat: -28.46* Des: 'Ho rejected'**	1971Q4, 1978Q4, 1985Q2, 1992Q1, 2003Q4

Note: Bound: # of observations between breaks (equivalent to a trimming of 0.10); Mmax: # of Breaks (Max. 5); Kmax: # of lags allowed (Min. 1); *Kapetanios (2005)' values. **Significant at the 5% level.

Bai-Perron testing procedure: The test is applied with a constant as a regressor. We allow for up to five breaks and set a trimming of 0.10. Serial correlation and different variances of residuals along the subsamples are allowed. The null hypothesis of parameter stability is systematically rejected for this series at the 5% level, for between 1 and 5 breaks.

Table B2: Bai-Perron testing procedure

Breaks	F-statistic	Scaled F-stat.	Weighted F-stat.	Critical Value
1*	13.18	13.18	13.18	9.10
2*	49.92	49.92	57.36	7.92
3*	35.54	35.54	47.28	6.84
4*	40.16	40.16	60.61	6.03
5*	53.45	**53.45**	**90.58**	5.37
UDMax statistic* 53.45			UDMax critical value** 9.52	
WDMax statistic* 90.58			WDMax critical value** 10.39	
Estimated break dates				
1	1981Q2			
2	1981Q4, 1988Q1			
3	1981Q4, 1988Q2, 2000Q2			
4	1981Q4, 1988Q2, 2000Q3, 2011Q1			
5	1974Q1, 1981Q4, 1988Q2, 2000Q3, 2011Q1			

Note: *Significant at the 5% level, Trimming 0.10. **Bai and Perron (2003)'s values.

C Structural break tests applied to the growth rate of potential GDP series (using the PF methodology)

Kapetanios test: The auxiliary regression corresponds to the intercept model with level shifts. We set two breaks and a trimming of 0.10. The null hypothesis of unit root is rejected at the 5% level.

Table C1: Kapetanios test

Input	Results	Break dates
Bound: 12 Mmax: 2 Kmax: 1	tstat: -12.69* Des: 'Ho rejected'**	1994Q1, 2010Q4

Note: Bound: # of observations between breaks (equivalent to a trimming of 0.10); Mmax: # of Breaks (Max. 5); Kmax: # of lags allowed (Min. 1); *Kapetanios (2005)' values. **Significant at the 5% level.

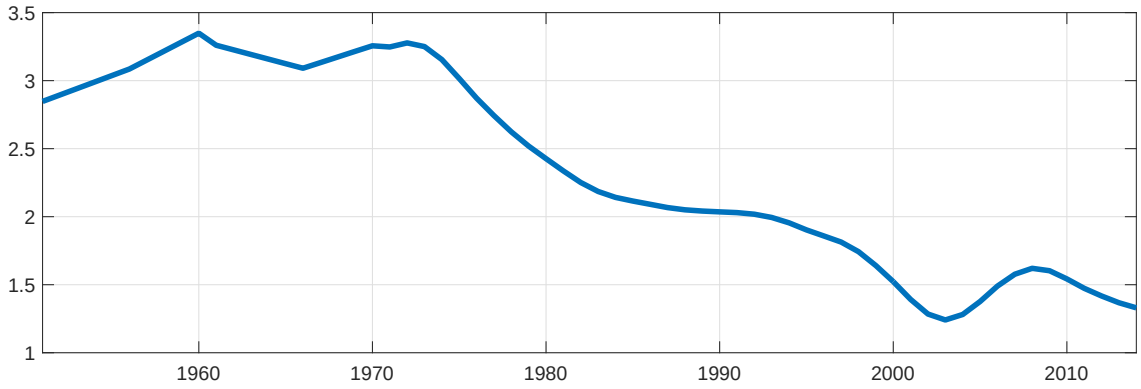
Bai-Perron testing procedure: The test is applied with a constant as a regressor. We allow for up to five breaks and set a trimming of 0.10. Serial correlation and different variances of residuals along the subsamples are allowed. The null hypothesis of parameter stability is systematically rejected for this series at the 5% level, for between 1 and 2 breaks.

Table C2: Bai-Perron testing procedure

Breaks	F-statistic	Scaled F-stat.	Weighted F-stat.	Critical Value
1*	10.95	**10.95**	**10.95**	9.10
2*	8.96	8.96	10.30	7.92
3	6.35	6.35	8.45	6.84
4	5.83	5.83	8.81	6.03
5	4.89	4.89	8.30	5.37
UDMax statistic* 10.95			UDMax critical value** 9.52	
WDMax statistic* 10.95			WDMax critical value** 10.39	
Estimated break dates				
1	2000Q3			
2	2000Q3, 2011Q1			
3	2000Q3, 2008Q1, 2011Q1			
4	2000Q3, 2008Q1, 2011Q1, 2014Q1			
5	1994Q2, 2000Q3, 2008Q1, 2011Q1, 2014Q1			

Note: *Significant at the 5% level, Trimming 0.10. **Bai and Perron (2003)'s values.

D Population growth in Mexico



SOURCE: Authors' own estimates using FRED data.

Figure D1: Mexico, population annual growth rate, 1951-2014.