

# **Business Cycle Measurement and Dating**

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## Business Cycles - Emerging Markets

- There is an increasingly vast interest on characterizing and predicting business cycles in many countries, particularly emerging market economies (EM).
- Most emerging market economies experience episodes of fast pace growth as well as abrupt declines in economic activity.
  - E.g: the 2018 financial crisis in the U.S. spread globally, but with different intensity across countries. Most emerging economies had a sharp but very short recession limited to only some sectors of the economy, while the U.S. and Euro Area had a widespread and long recession.
- Fluctuations in emerging market economic activity display peculiar dynamics – oscillations can be more intense.

# Motivation

- Models and methods that produce forecasts of long run trends or short run cycles in financial and economic series very valuable, especially before, during, and right after financial crises and recessions.

## Challenges

- Real time representation and prediction of economic and financial variables are difficult to attain:
  - Nonlinearities
  - Evidence of structural breaks
  - Parameter instability
  - Data revision

# Overview – Nonlinearities and Nonstationarities

## Nonlinearities

- Potential asymmetries underlying economic and financial series across different stages of the business cycle or financial markets.
- Variety of questions and puzzles can be understood as a result of asymmetric responses by economic agents, according to their perception of the state of business and financial conditions.
  - E.g.: changes in interest rates, exchange rates, oil prices, taxes, etc. may have stronger or weaker impact on investors' and consumers' decisions depending on whether the economy is close to the beginning or end of a recession

## Nonlinearities (cont.)

- Dividing cycles into stages provides additional insight into how the economy evolves over time than can be obtained by looking only at series over calendar periods.
- Similarly, this analysis may reveal additional information and improve forecasting compared to frameworks that take into account only the *average linear effect* of one series on another:
  - Many studies have shown that the largest errors in characterizing and predicting some series occur around turning points (i.e., the beginning or end of a cycle).

# Nonstationarities

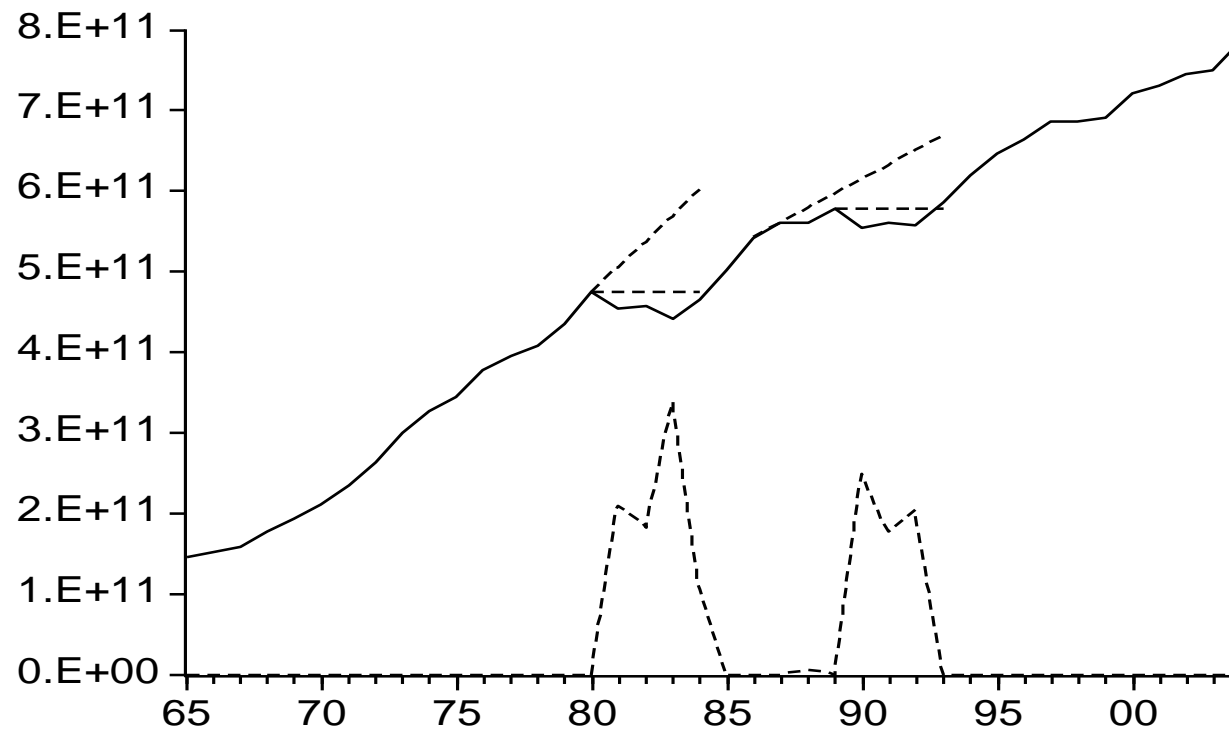
- Structural breaks (pulse or level) or time-varying parameters
  - Evidence suggests that the long-run trend of many aggregate macroeconomic and financial variables exhibits several structural breaks.
  - Interrelations between trends and cyclical fluctuations such as whether business cycles are influenced by major secular changes and/or if the long-run trend of the economy is affected by the short-term business cycle.

# Emerging Market Economies

- Chauvet (2011) model long run economic trends and business cycles of some emerging market economies:
- Emerging Markets have quite different dynamics compared to the U.S. or European countries.
- We find evidence of several structural breaks in their mean growth rate and volatility, which are closely related to financial, banking or currency crises.
- There have also been gradual shifts, which are related to long run changes in the growth and stability of EM.

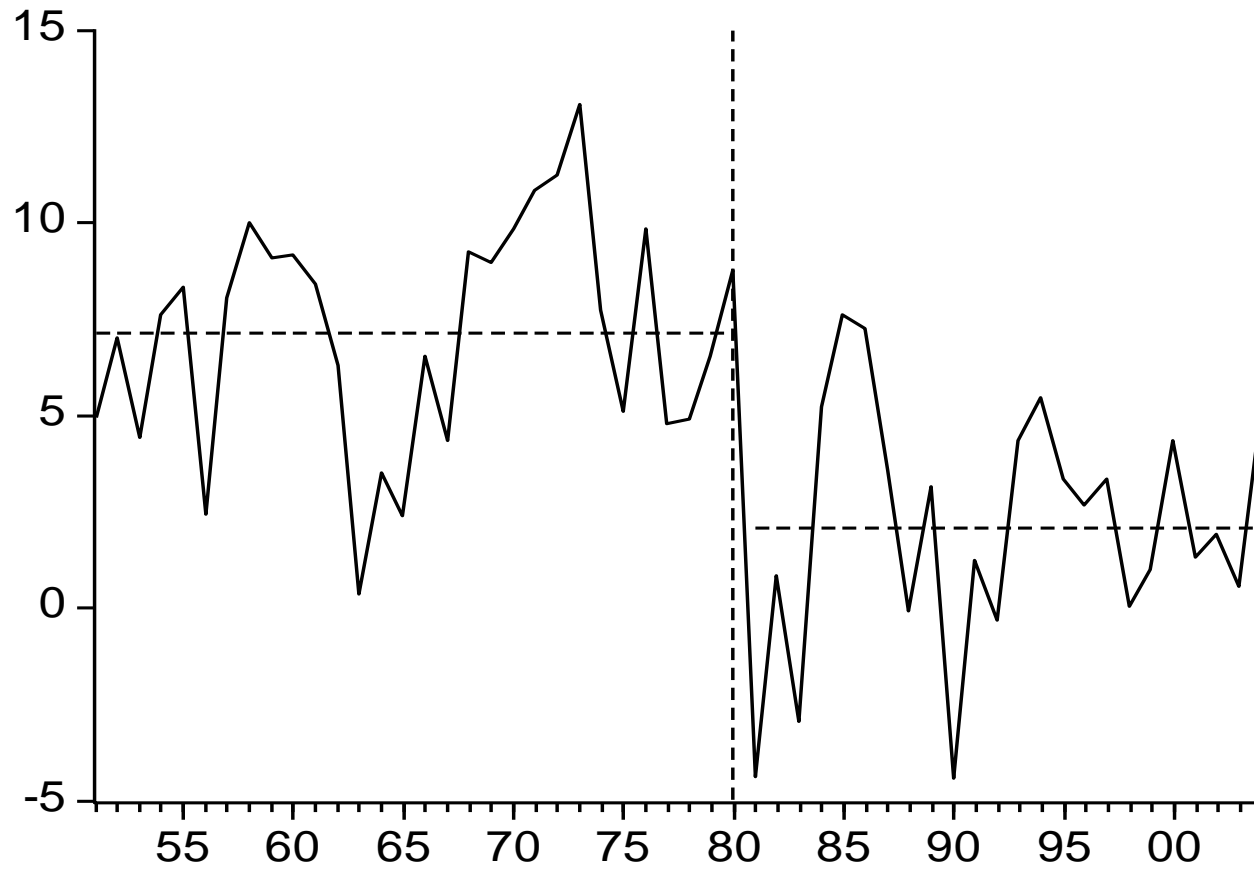
# Brazil - Trend and Cycles

## Brazil - Breaks in GDP Trend

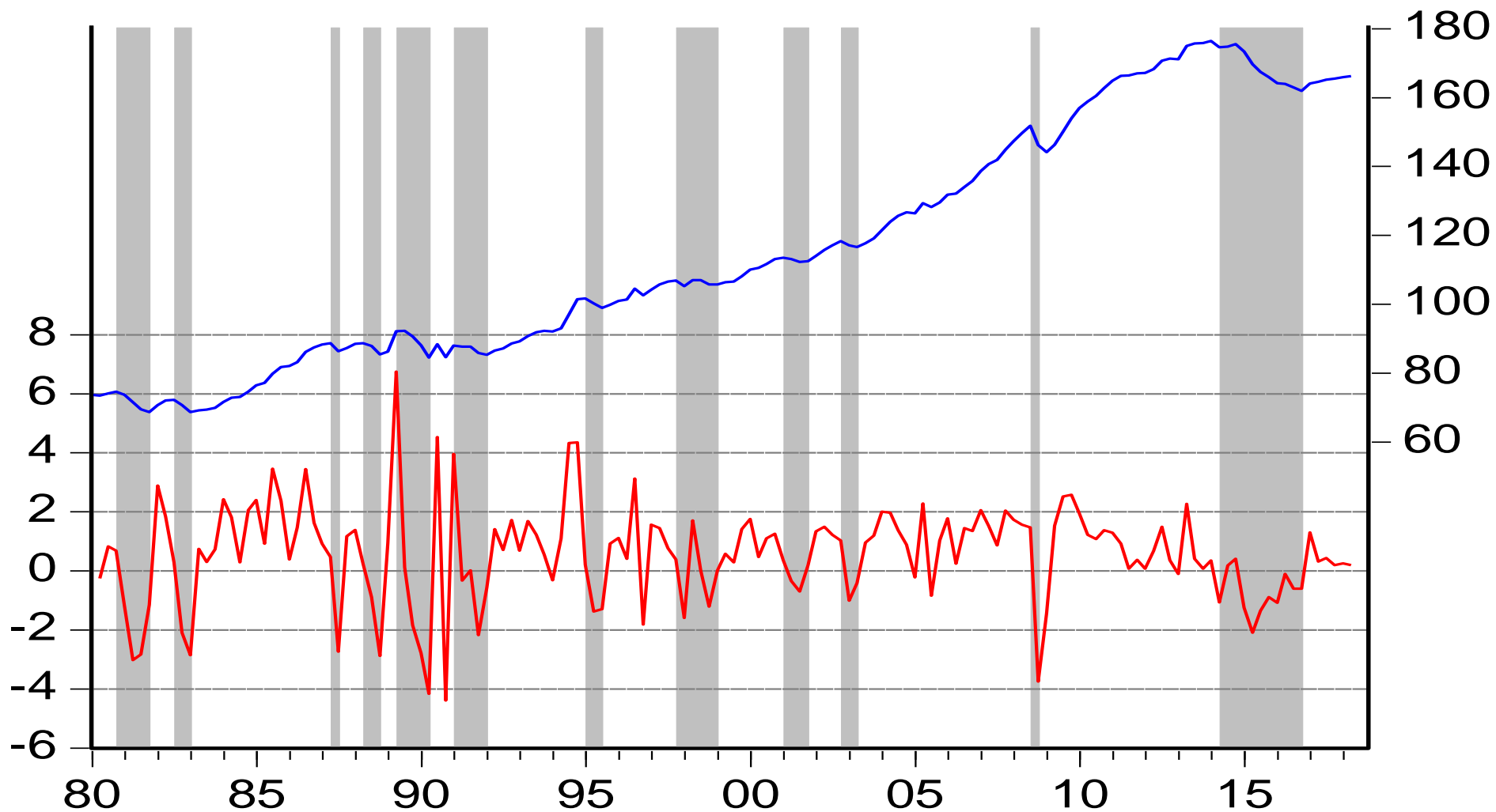




### Brazil – Cycles (GDP growth)

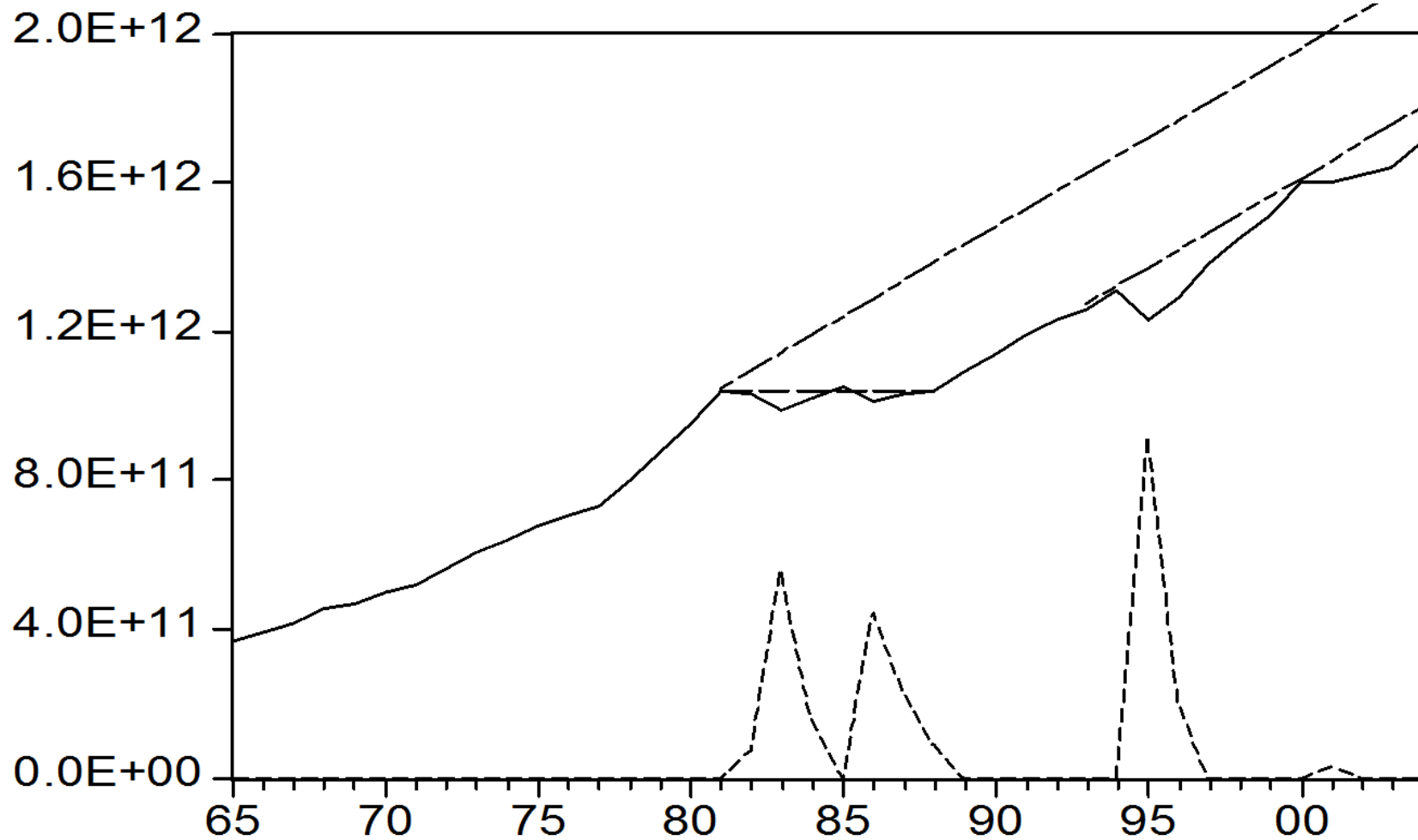


# Brazil - GDP Trend and Cycles

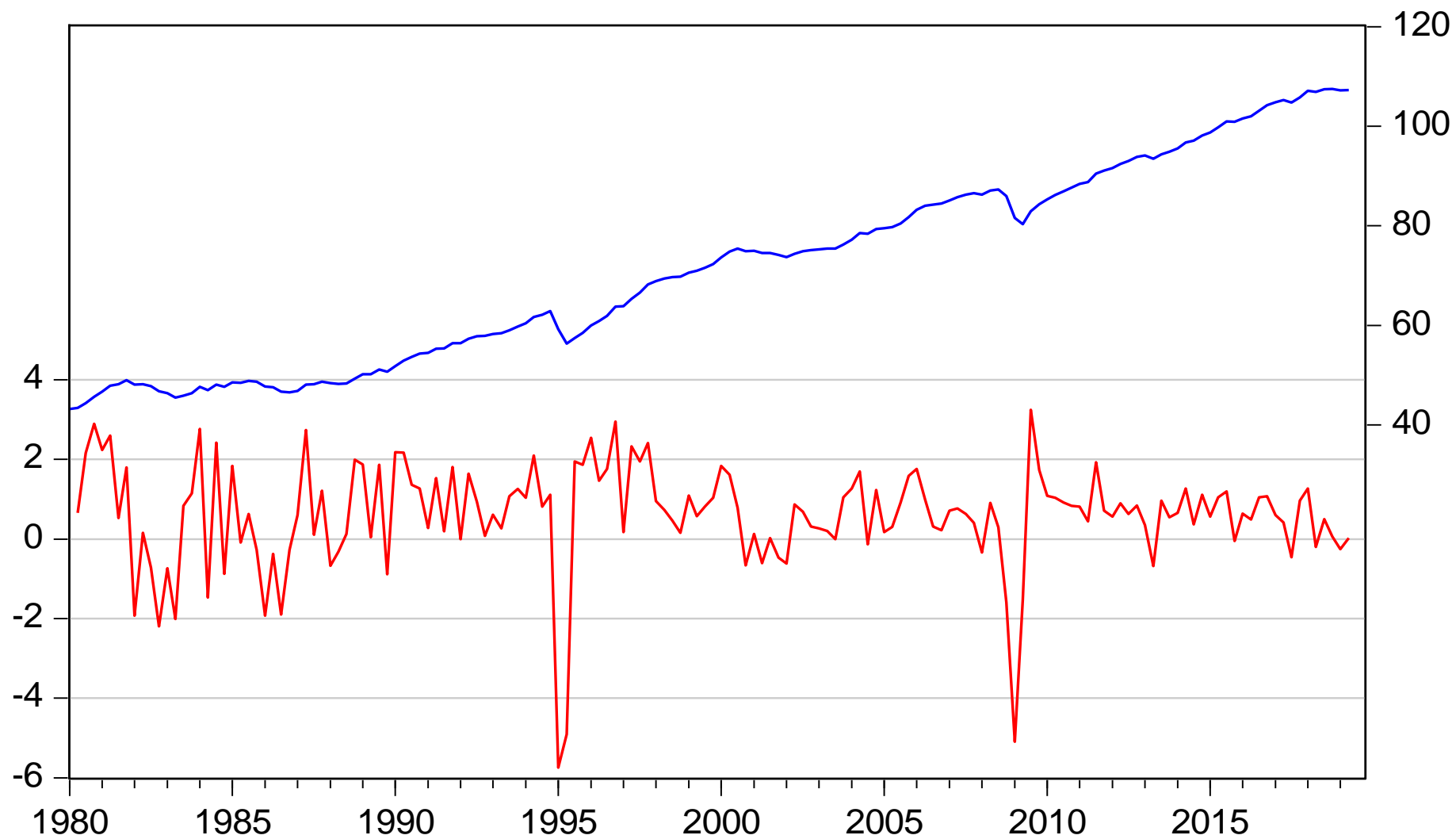


— Brazilian GDP  
— Brazilian GDP in Growth Rates

# Mexico - Trend and Cycles



# Mexico - GDP Trend and Cycles



— Mexico GDP  
— Mexico GDP in Growth Rates

# Dating Business Cycles

## Goal

- Identification of turning points – beginning and end of recessions. To obtain a chronology of business cycle that can be used as a reference point for economic analysis and policy.

## Motivation – Why is it important?

- Timely identification of economic contraction and its severity allows policy intervention that may reduce its amplitude and duration.
- In addition, firms can re-evaluate projections of sales and profits, and consumers their purchasing and investment plans based on information on transitions to new business cycle phases.

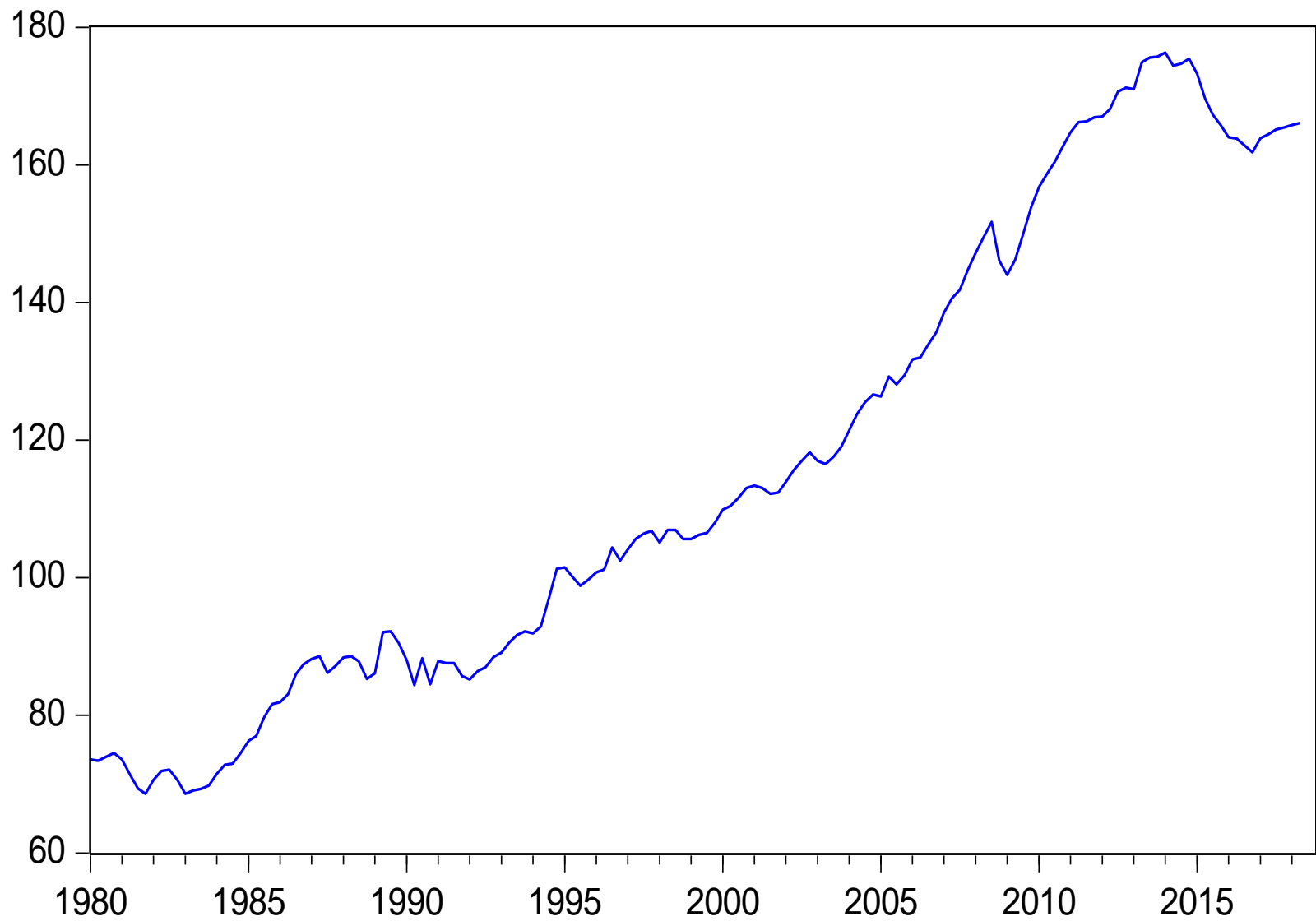
## Dating Business Cycles – Motivation (cont.)

- Analysis of the economy according to the current economic stage. Transparency with respect to the information of the state and strength of the economy.
- Turning points as reference for the construction of coincident and leading indicators of the economy.
- In the U.S., the National Bureau of Economic Research (NBER) business cycle dating is regarded as authoritative by both academic researchers and the public at large. Dates as outcome of NBER's qualitative judgment about the state of the economy.
  - Policy and planning decisions by government bodies, private firms, and individual households.

# Example

## Dating Brazilian GDP

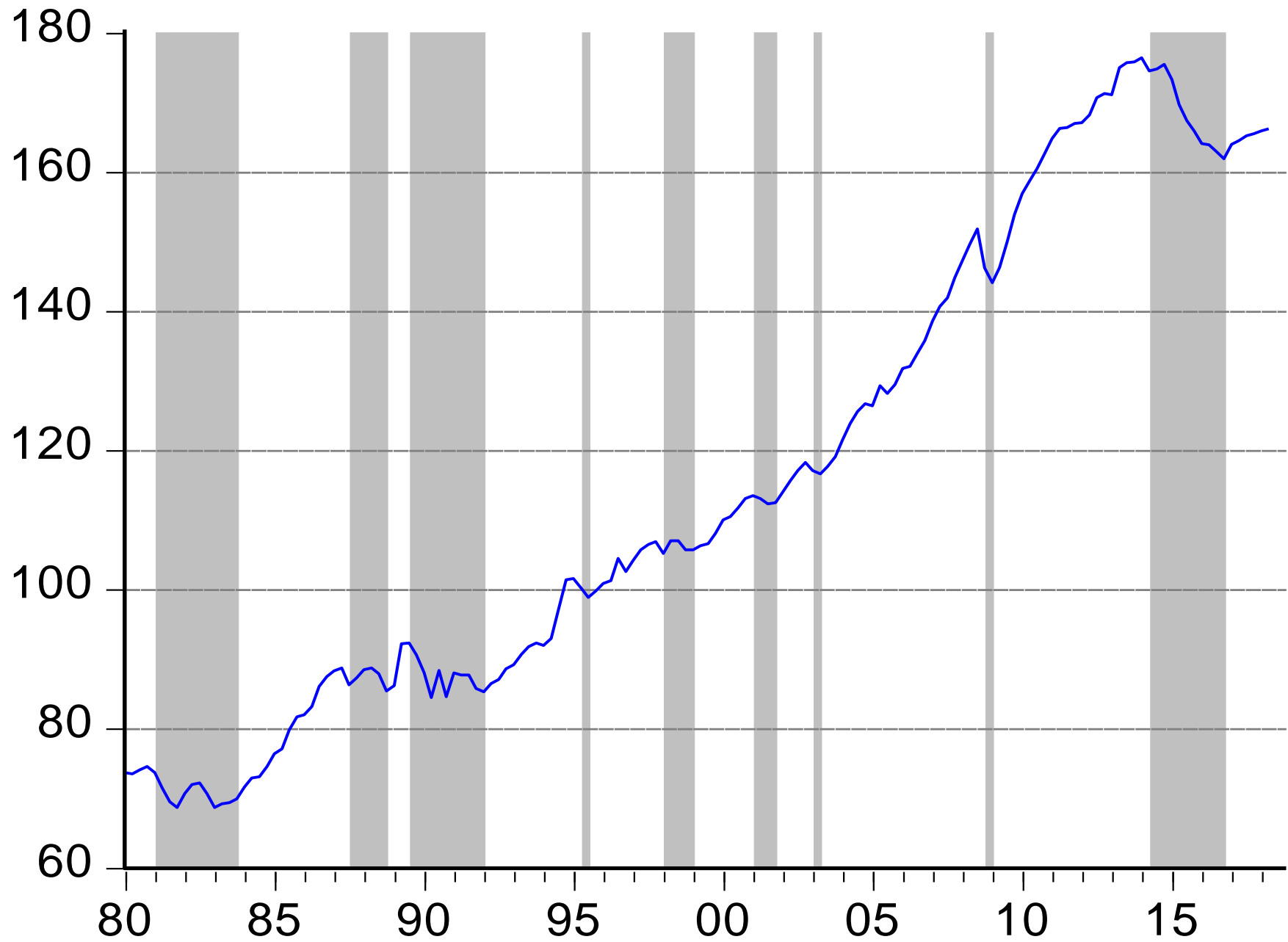
# Brazilian GDP



— Brazilian GDP



# GDP - Dating of Brazilian Business Cycles



# Business Cycle Measurement

- Definition NBER: The classical business cycle is characterized by a decrease in the level of economic activity and a subsequent recovery:

“A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle. This sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximately their own.” (Burns e Mitchell 1946)

## Business Cycle Measurement (cont.)

- Burns and Mitchell's (1946) business cycle definition is considered institutional, since it explains economic fluctuations per se, instead of developing an abstract model to explain cyclical behavior.
- The advantage of this approach is that it yields a benchmark analytic tool for business cycles that is independent on a theory or particular model.

## Business Cycle Definition - Traditional Method NBER

The description of the classical business cycle can be summarized in 4 factors:

- 1) **Amplitude** (depth and recovery): to be considered a cycle, economic activity has to present a pronounced decline followed by a recovery.
- 2) **Duration** (length): the duration of a business cycle – which includes the length of expansions and recessions – is of at least 1 year. The maximum extension observed is 12 years. This definition excludes seasonal fluctuations and fixed cycles.
- 3) **Diffusion** (impact): a business cycle has to be broad and affect several industries and economic activities simultaneously.
- 4) **Displacement** (severity): it measures the degree of economic deterioration during recessions, and the degree of utilization during expansions. The level of displacement can help in the classification of cycles by the analysis of its degree of severity. Two common measures of displacement are employment and capacity utilization.

# Business Cycle Definition - Traditional Method NBER

(cont.)

- Once the cycle features are defined, one can distinguish the phases of the cycle. Burns and Mitchell distinguish two critical points in the cycle: **peak and trough**. These reference-measures define periods of growth and deceleration in economic activity, based on two hypotheses:
  - 1) Economic cycles are continuous – an expansion is followed by a recession, which, by its turn, is followed by a contraction and a period of recovery;
  - 2) The peaks and trough measures are enough to delineate the economic turning points.

# Business Cycle Definition - Traditional Method NBER

(cont.)

- The popular terminology maintains three segments of Burns and Mitchel's proposition: recession, recovery and expansion:
  - **Recession** refers to the period from peak to trough.
  - **Recovery** refers to the period from trough to the point in which the level of economic activity returns to the previous peak.
  - **Expansion** refers to the period in which the level of economic activity grow beyond the previous peak.

# Rules of the Dating Committee

- The duration of each cycle phase should be at least 6 months and the complete cycle should be at least 15 months, measured peak to peak or trough to trough.
- Strikes and other special factors that generate outliers are generally ignored if their effects are temporary and completely reversible.

# Analysis of Business Cycles - Steps

**Reference cycle:** fundamental cycle that characterize the general economic activity, representing aggregate income, production and employment.

## Chronology of turning points

- First Step: determination of Reference Cycle
- Find turning points in the quarterly frequency using the same traditional method by the NBER and adopted worldwide.
- Quarterly GDP: longest series available
- Small number of monthly coincident series used to support the decision



# Dating Business Cycles in Brazil

## Brazilian Business Cycle Dating Committee - CODACE

- CODACE was founded in 2005 mirroring the experience of the NBER Business Cycle Dating Committee in the US and the CEPR in Europe. The committee is composed of seven members, who are renowned economists with practical and technical knowledge of the Brazilian economy and business cycles.
- CODACE was founded by the research institution Getulio Vargas Foundation and its members are independent scholars. The decisions regarding business cycles are, therefore, not political. They are independent and essentially technical, and result from a consensus from discussions among the members about the economic situation for each one of the business cycle observed in Brazil in the last 30 years.

## Brazilian Business Cycle Dating Committee – CODACE

- Committee met for the first time in May 2009:
  - Dating of quarterly business cycle for Brazil since 1980.  
Announcement of the peak of 2008-2009 recession (July 2008).
- Committee has since met several times to date peaks and troughs of the 2008-2009 and 2014-2016 recessions

## Methods for Dating Business Cycles - CODACE

- Traditional method described above as reference
- Several empirical representations of business cycles using series measuring production, sales, employment, and income.

Coincident indicators of the economy built from several models from committee members: weighted average of monthly coincident series, principal component adjusted to 36 monthly series representing sectors that compose GDP; construction of monthly GDP series: wavelet-based indicators, etc.

I use Dynamic factor model with Markov switching applied to a small number of coincident series: probabilities of monthly recessions and business cycle turning points

Also, probabilities of quarterly recessions and reference turning points obtained from Markov switching model adjusted to GDP

## CODACE Dating

Recession			
Period	Duration (quarters)	Cumulative Variation from Peak to Trough	Quarterly Average Variation annual
1980:Q4 – 1983:Q1	9	-8.5%	-3.9%
1987:Q2 – 1988:Q4	6	-4.2%	-2.8%
1989:Q2 – 1992:Q1	11	-7.7	-2.9%
1995:Q1 – 1995:Q3	2	-2.8%	-5.6%
1997:Q4 – 1999:Q1	5	-1.5%	-1.2%
2001:Q1 – 2001:Q4	3	-0.9%	-1.2%
2002:Q4 – 2003:Q2	2	-1.6%	-3.1%
2008:Q3 – 2009:Q1	2	-5.5%	-10.8%
2014:Q2 – 2016:Q4	11	-8.6%	-3.2%

# Modeling and Forecasting Business Cycles

- Uncertainty regarding the current state of the economy.
- Is the economy weakening or strengthening?
  - Public can interpret a low growth phase as a more severe recession or continue to believe that the economy is in a recession long after a recovery is under way.
- Formal quantitative methods can produce economic assessments to the public and government in real time.
- Models not only date cycles, but also gives information on strength of the economy

## Model-Based Business Cycle Analysis

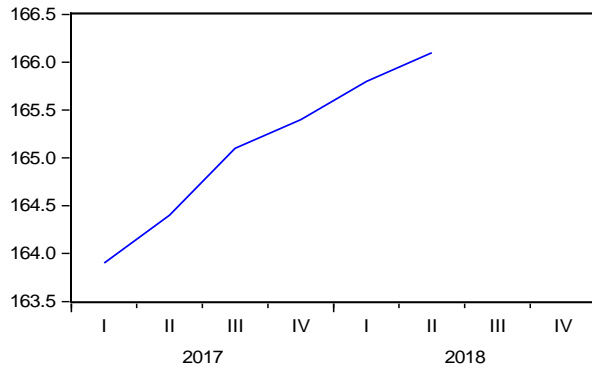
- Use a statistical model to obtain probability of recession or expansion in real time.
- Probabilities gauge the strength or weakness of the economy and the stage of the business cycle on a monthly basis.
- Dynamic Factor Model with Regime Switching DFMS Chauvet (1998) for the US
  - Extensions: Chauvet and Piger 2003, 2008, Chauvet and Hamilton 2005, Barnett, Leiva-Leon and Chauvet (2016)
- Probit Model with Recurrent Breaks and Time Varying Parameters: Chauvet and Potter (2002, 2005, 2011)
  - *These models take into account nonlinearities and nonstationarities in the dynamics of the economy*

## Data – Selection of Variables

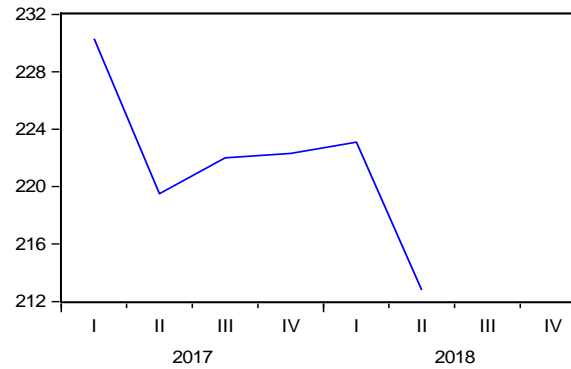
- Burns and Mitchell (1946) selected only 4 coincident series out of 500 to date business cycles
- NBER uses same 4 series in addition to GDP:
  - Industrial Production, Manufacturing and Trade Sales, Real Personal Income, Employment
- Barnett, Chauvet, Leiva-Leon (2016) show that a small number of series represent and forecast business cycles with more accuracy than large number of series:
  - Non-synchronous cycles offset each other
  - More variables reduce signal/noise identification of cycles as add more noise.

# Example Slow Recovery Brazil 2017- 2018

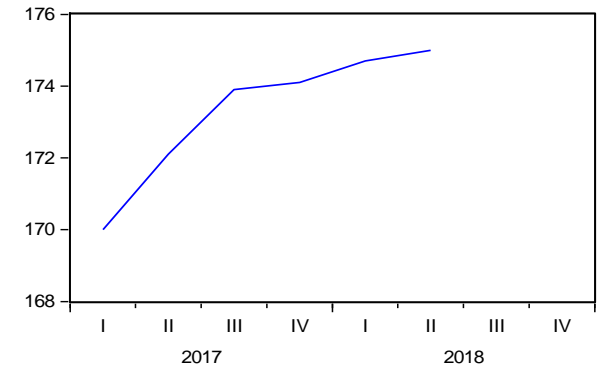
PIB2018



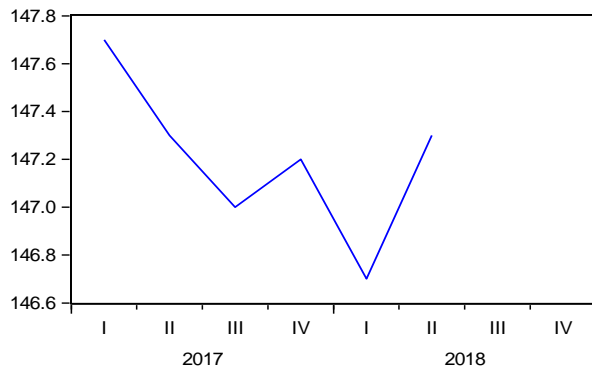
PIBAGR2018



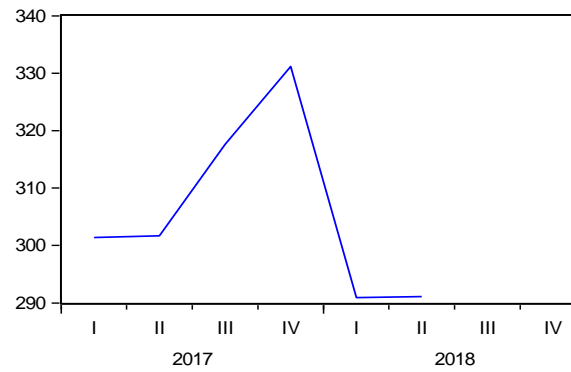
PIBCONS2018



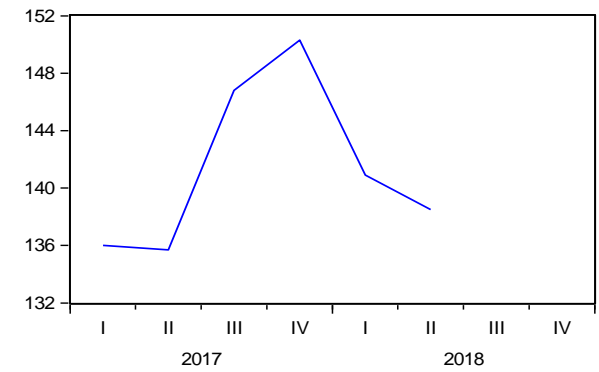
PIBCONSGOV2018



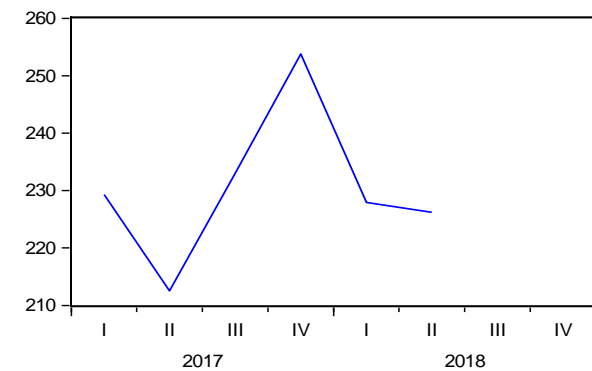
PIBEXP2018



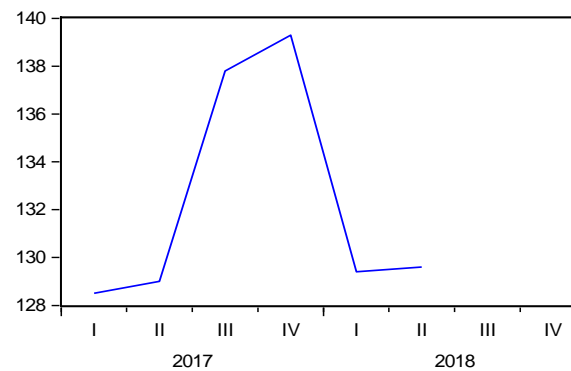
PIBFBCF2018



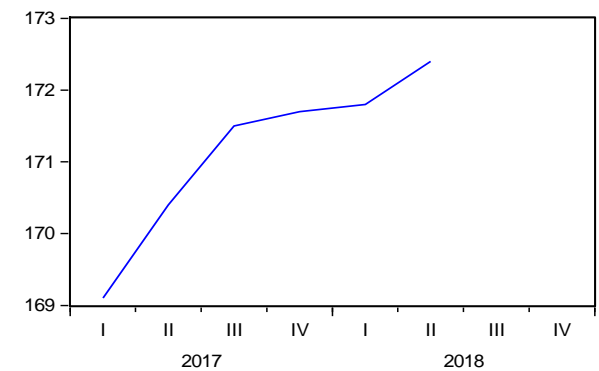
PIBIMP2018



PIBIND2018



PIBSERV2018





# Model-Based Business Cycle Analysis

## DFMS – Dynamic Factor with Markov Switching

- DFMS very successful in calling turning points in real time: probabilities have been posted monthly since October 2007 at

<http://faculty.ucr.edu/~chauvet/mc.htm>

- We also update and publish the probabilities of recession at the database Fred from the Federal Reserve Bank of Saint Louis on a monthly basis

<https://fred.stlouisfed.org/series/RECPROUSM156N>

# ☆ Smoothed U.S. Recession Probabilities (RECPROUSM156N)

DOWNLOAD 

Observation:  
Jun 2018: **0.32** (+ more)  
Updated: Sep 6, 2018

Units:  
Percent,  
Not Seasonally Adjusted

Frequency:  
Monthly

1Y | 5Y | 10Y | Max

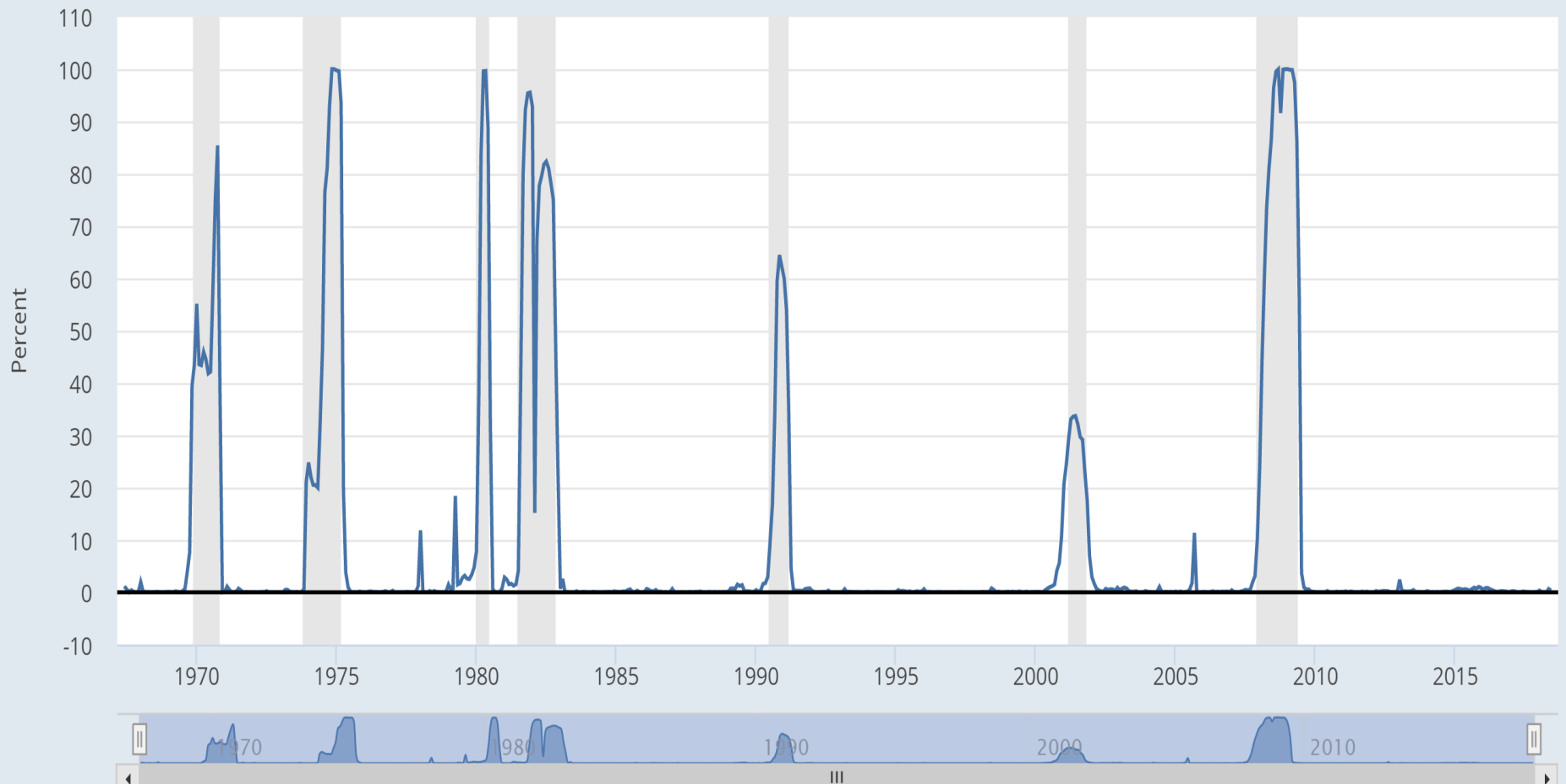
1967-06-01

to

2018-06-01

EDIT GRAPH 

## FRED — Smoothed U.S. Recession Probabilities



# DFMS – Dynamic Factor with Markov Switching

- DFMS very successful in calling turning points in real time
- Real time recursive probabilities of a recession as a tool to gauge strength or weakness of the economy on a monthly basis, the current phase of the business cycle, and the direction of the economy
- Application of the method to other countries has shown to be very successful (US, Brazil, Chile, Mexico, Spain, France, Turkey, Argentina, etc.)

# DFMS – Dynamic Factor with Markov Switching

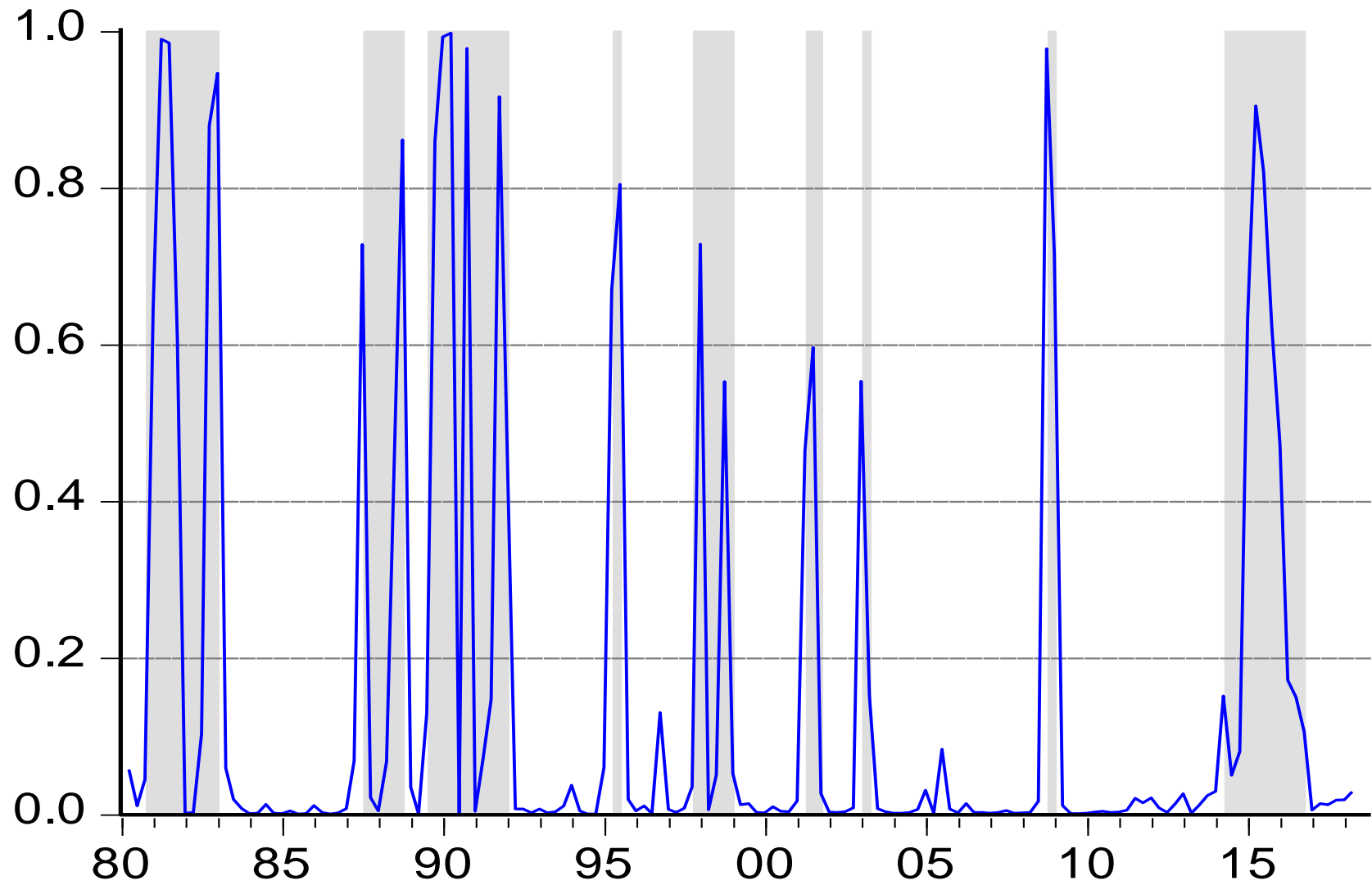
**Extension to Brazil - Chauvet (2001) Monthly Indicator of Brazilian GDP**

Combination of dynamic factor with Markov switching leads to successful representation of the sample data:

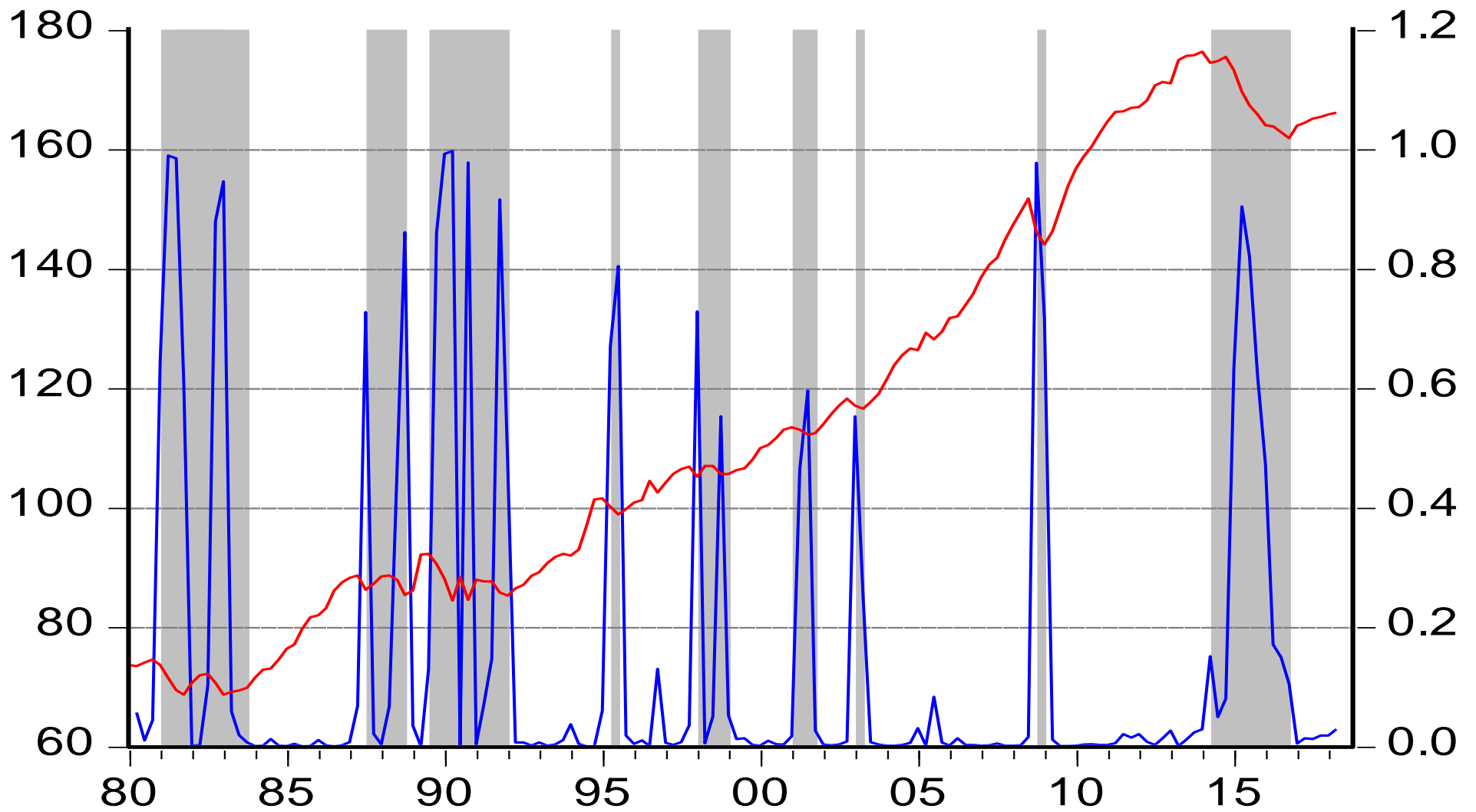
- All recessions are well characterized including the last ones
- Full sample smoothed probabilities of recessions similar to CODACE dating of business cycles.
- Real time probabilities of recession allows assessment of current conditions on a timely basis

# DFMS - Dynamic Factor with Markov Switching

## Probabilities of Recession



# Probabilities of Recession



## Example: Recent Performance in Brazil

- Recovery has been very fragile
- Uncertainty in real time regarding the state of the economy, its strength and weakness, and its direction
- Models yield an objective assessment of the stage of the business cycle, which is particularly important in times of lots of uncertainty or waves of pessimism or optimism
  - Example: Brazil in April/May 2018 – Truck drivers' strike stopped the country. Waves of pessimism and expectation of new recession

## Monthly Probabilities of Recession

2018M01	0.0034
2018M02	0.0056
2018M03	0.0007
2018M04	0.0005
2018M05	0.983
2018M06	0

•  
•  
•

2019M08	0.0005
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## Quarterly Probabilities of Recession

2018Q1	0.0427
2018Q2	0.0235
2018Q3	0.0018
2018Q4	0.0007
2019Q1	0
2019Q2	0
2019Q3	0



# Conclusions: Challenges and Goals

## Economic Trends and Fluctuations in Emerging Markets

- Long-term trend exhibits multiple structural breaks and/or time-varying parameters.
- Possible interrelation between trends and cyclical fluctuations: business cycles influenced by major secular changes and/or the long-term trend of the economy influenced by the short-term business cycle.
- Presence of potential breaks could be important in the analysis of cycles in particular and in the functioning of the economy in general.

## Conclusions: Challenges and Goals

- Instability and abrupt changes of regimes that are typical of these economies can be explicitly captured with nonlinear frameworks. In particular, models that incorporate the possibility of multiple breaks are used to characterize economic activity.
- Based on these results, date business cycles and build coincident and leading indicators that take into account:
  - Impact of these breaks on duration and frequency of business cycle phases, and on recession forecasts.
  - Potential asymmetries underlying economic and financial series across different stages of the business cycle or financial markets.

## Conclusions: Challenges and Goals

### Models for Dating and Predicting Business Cycles

- Construct models of coincident and leading indicators of business cycles that are particularly fitted for emerging market economies
  - **Goal:** real-time monitoring of economic conditions - formal framework that accounts for breaks and instabilities and predict business cycles at the time the events are occurring.
- These models and methods can produce forecasts of recession probabilities are most valuable around the beginning and end of recessions, and during economic recoveries

**Thank you**

# The MS-Dynamic Factor Model

## Chauvet (1998)

$$\Delta \mathbf{Y}_t = \boldsymbol{\lambda} \mathbf{F}_t + \mathbf{v}_t$$

$\begin{matrix} nx1 & nx1 & 1x1 & nx1 \end{matrix}$

$$\Delta \mathbf{F}_t = \boldsymbol{\mu}_{S_t} + \boldsymbol{\phi}(L) \Delta \mathbf{F}_{t-1} + \boldsymbol{\eta}_{S_t}$$

$\begin{matrix} 1x1 & 1x1 & 1x1 & 1x1 & 1x1 \end{matrix}$

$$\mathbf{D}(L) \Delta \mathbf{v}_t = \boldsymbol{\varepsilon}_t$$

$\begin{matrix} nxn & nx1 & nx1 \end{matrix}$

$\mathbf{Y}_t$  - observable macroeconomic variables that move simultaneously with BC

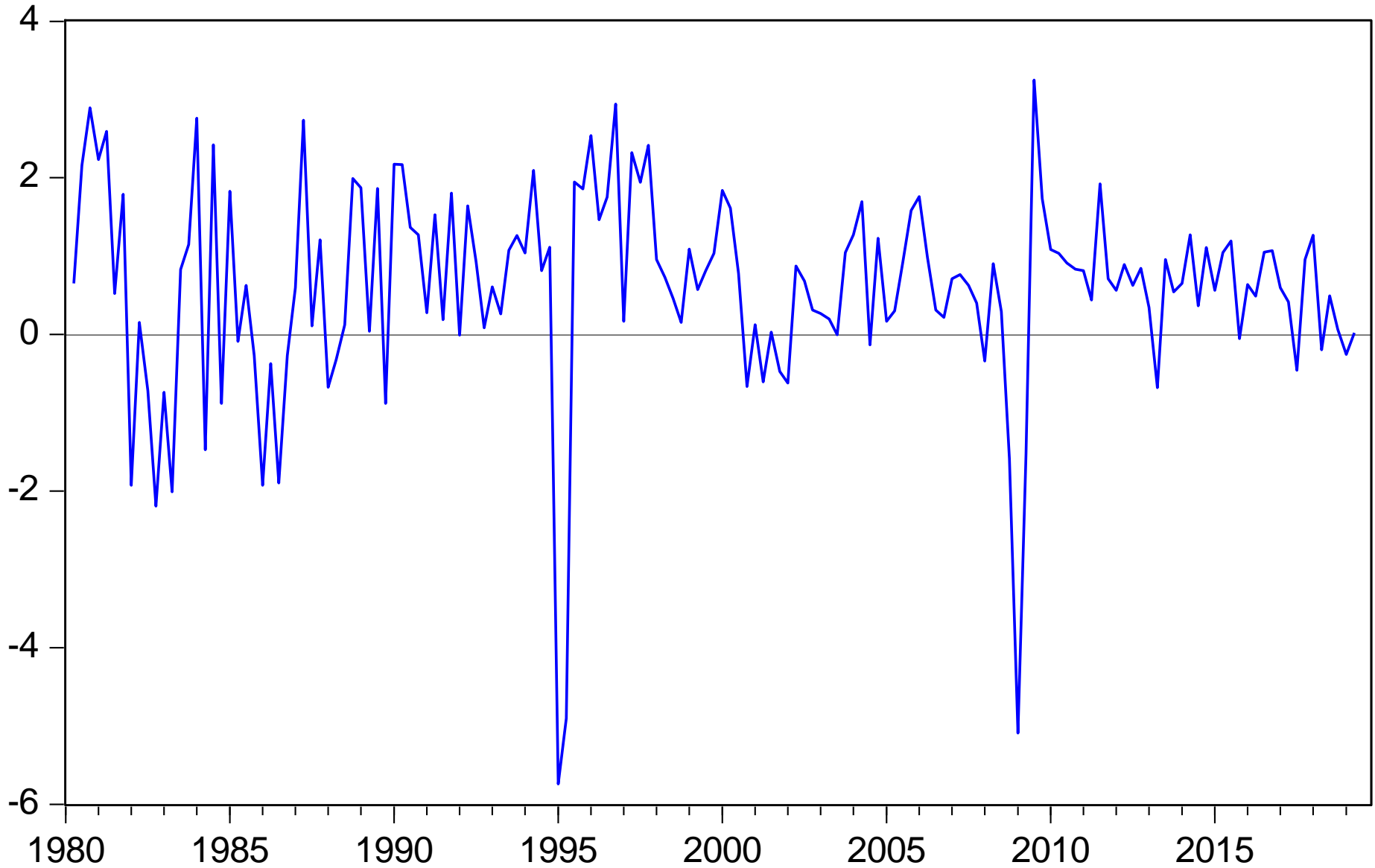
$\boldsymbol{\lambda}$  - factor loadings

$\mathbf{F}_t$  - Business Cycle Indicator

$\mathbf{v}_t$  - idiosyncratic terms

$\boldsymbol{\varepsilon}_t$  - measurement errors,  $\boldsymbol{\eta}_t$  - transitory shocks

$\boldsymbol{\mu}_{S_t} = \alpha_1 + \alpha_0 S_t$ ,  $S_t = 0, 1$   $p_{ij} = \text{Prob}[S_t=j|S_{t-1}=i]$ ,  $\sum_{j=0}^1 p_{ij} = 1$ ,  $i, j=0, 1$



— Mexico Cycles - GDP Growth