Three states of the French Business Cycle

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Motivation

It is important to **nowcast** the current state of the economy since:

- the final macro statistics on the current point are published with a lag of several weeks
- it is the key input into state-dependent models for monetary policy

It is also important to determine rapidly how deep a crisis is, notably after:

- the Global Financial Crisis
- the Covid crisis

Framework and purpose

- Markov-Switching Dynamic Factor Models (MS-DFM):
  - DFM: one or several factors summarize aggregate economic conditions
  - this(these) factor(s) is(are) modelled as Markov-Switching AR processes
- Using a one-factor MS-DFM, we aim to find the most accurate specification of the French business cycle:
  - 2 or 3 underlying states?
  - order of AR?
  - switch in trend?
- Based on this model, we aim to classify, nowcast and predict the states of the French business cycle.

Literature

Initial MS-DFM framework:

- Seminal papers for MS-DFMs: Diebold and Rudebusch (1996), Kim and Yoo (1995)
- Subsequent papers: Chauvet (1998), Kim and Nelson (1998), Chauvet and Piger (2008), Hamilton (2011), Chauvet and Potter (2013), Camacho, Perez-Quiros and Poncela (2014, 2018)

All these papers consider small or very small datasets and MS process with 2 states (recession/expansion)

Literature 2/2

Some recent papers have addressed the issue of crises heterogeneity (after 2008) e.g.:

- Eo and Kim (2016): univariate MS model of the US business cycle, with 2 states and time varying parameters
- Doz, Ferrara and Pionnier (2020): MS specification in mean and variance, associated to different types of recession or expansion phases (US data)
- Carstensen, Reif and Wolters (2020): three-states business cycle, with ordinary and severe recessions (German data)
- Leiva-Leon, Perez-Quiros and Rots (2021): 2 states, with time varying parameters (several countries or zones).

The Markov-Switching Dynamic Factor model

- **Dynamic Factor Models** (DFM): the comovements of N series are driven by a small number of unobservable factors :

  $$x_t = \Lambda f_t + e_t$$

  f_t is a vector of size $r, r \ll N$, e_t is a vector idiosyncratic components and is uncorrelated with the factors.

- If a one factor model is considered $(r = 1)$: the factor can be seen as a coincident index, summarizing aggregate economic conditions.

- **MS-DFMs** : the parameters describing the dynamics of the factor(s) vary across periods and are linked to a state variable S_t, which is a Markovian process (of order 1).

Model specifications

- Baseline model (frequently used in the empirical literature):
  $f_t = \mu_{S_t} + \varphi f_{t-1} + \sigma_{S_t} \varepsilon_t$ with ε_t i.i.d. $\mathcal{N}(0,1)$

- We analyse the following extensions of the baseline model:

  $$f_t = \mu_{S_t} + \varphi_{S_t} f_{t-1} + \sigma_{S_t} \varepsilon_t$$
  $$f_t = \mu_{S_t} + \varphi_1 f_{t-1} + \varphi_2 f_{t-2} + \sigma_{S_t} \varepsilon_t$$
  $$f_t = \mu_{S_t} + \varphi_{1 S_t} f_{t-1} + \varphi_{2 S_t} f_{t-2} + \sigma_{S_t} \varepsilon_t$$

  for the Markov chain S_t taking 2 or 3 states.

2-step estimation procedure

- 1st step:
  We estimate a one-factor DFM:

  $$x_t = \lambda f_t + e_t$$

  by PCA, without taking the dynamics of f_t into account. Under standard assumptions, PCA provides a consistent estimate $\hat{f}_t$ of f_t, for any t.

- 2nd step:
  We estimate the MS model with $\hat{f}_t$ playing the role of f_t.

Final output

If $\hat{\theta}$ denotes the parameters estimates vector, the Kalman filter and the Kalman smoother also allow to compute filtered and smoothed probabilities for the state variable:

$$P(S_t = j | I_t, \hat{\theta}) \text{ and } P(S_t = j | I_T, \hat{\theta})$$

where $I_t = \{x_1, \ldots, x_t\}$ and $I_T = \{x_1, \ldots, x_T\}$.

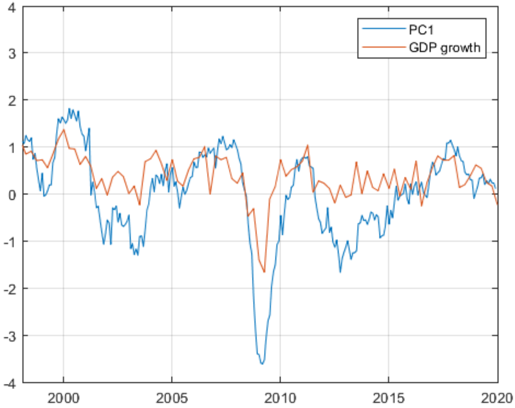
Data

We use a new large macro-financial database for France akin to the FRED-MD database for the US (127 series, starting in 1980, extracted from the database DBnomics).

1st step estimation results

- We extract the first principal component using PCA
- The dynamics of the first principal component seems to be defined by a few core macro series and does not change much with N.
- However, no reason why we should not keep N large.

To maximize N and T (given availability of series), we use a set of 100 macro and financial monthly indicators from 02/1992 to 02/2020.



2nd step estimation results for the 3-states MS-AR(1)

According to the LL, BIC and QPS, the MS-AR(1) model with 3 states and without switch in the AR term provides the best fit for the data.

Table 1: 3-state MS-AR(1) estimates

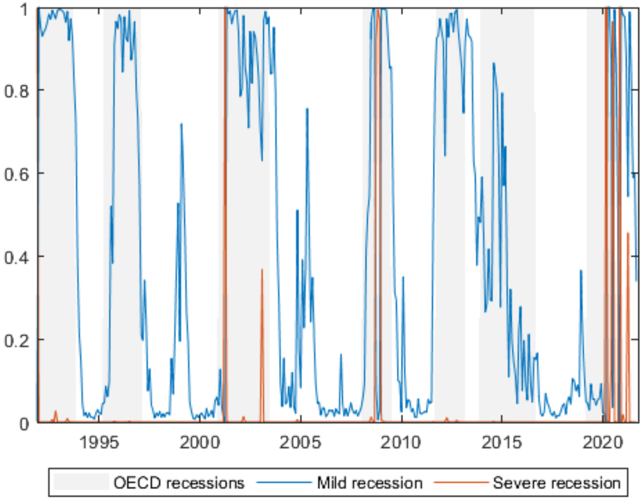
Parameter	$\hat{\mu}$	$\hat{\sigma^2_{\hat{\mu}}}$	t-stat
μ_1	0.41	0.09	4.63
μ_2	-0.60	0.19	-3.09
μ_3	-4.18	0.38	-11.10
σ_1^2	0.74	0.10	7.70
σ_2^2	1.09	0.16	6.73
σ_3^2	0.55	0.41	1.34
φ_1	0.90	0.02	47.80

Transition probabilities matrix

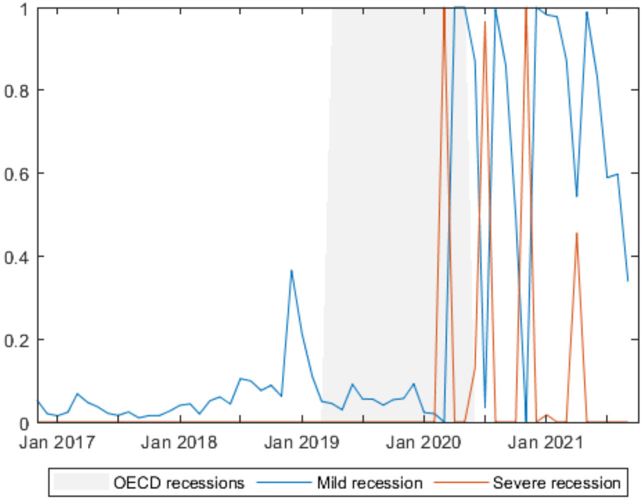
	1	2	3
1	0.97	0.03	0.00
2	0.03	0.92	0.05
3	0.00	0.52	0.48

- 3 states: expansion, mild recession and severe recession
- Severe recessions = sharp slumps in the factor level (expl: the beginning of the dot-com crisis, peak of the Great recession, Covid-19 lockdowns);
- Decreases in the factor mostly correspond to decreases in the surveys in manufacturing and services

Smoothed probabilities, pre-Covid-19 sample

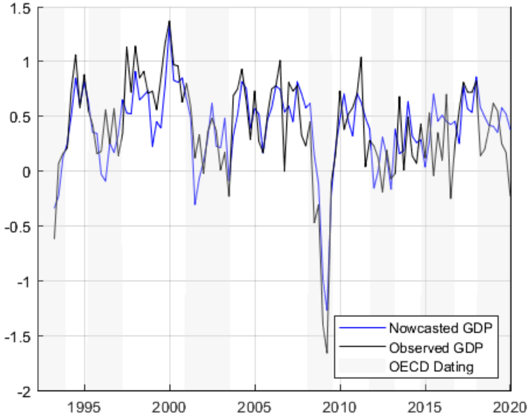


Smoothed probabilities, pre-Covid-19 sample: zoom

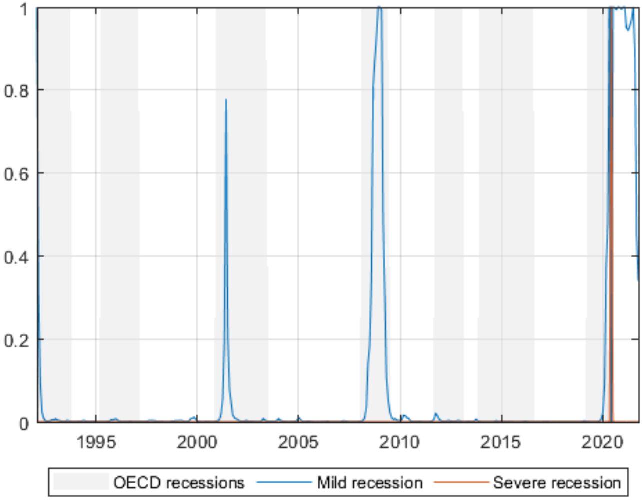


GDP nowcasting

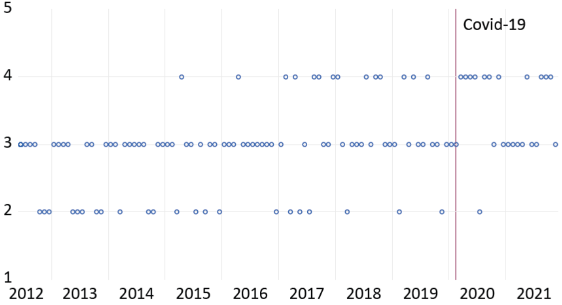
GDP growth rates nowcasted using the estimated factor and smoothed probabilities of mild and severe recessions have low RMSE=0.08 (wrt the commonly accepted one-digit after comma GDP growth estimates).



Smoothed probabilities, full sample

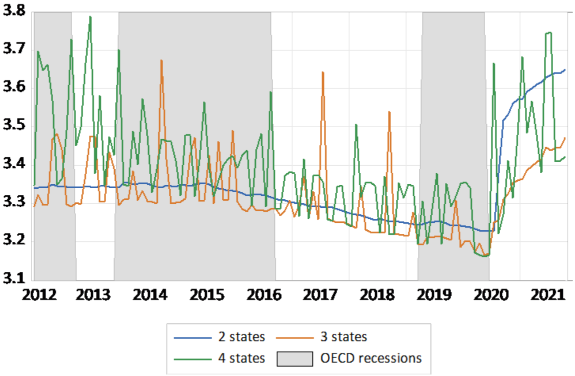


Has Covid-19 introduced a new state?



- 2 states have become less relevant after 2015 (new environment – low inflation, low amplitude of cycles, low for long interest rates – call for a third state);
- After Covid-19, 3 states are preferred to 2 states, and 4 states are becoming more and more relevant;
- Change of the pattern after the Covid-19 : the BIC rises for all models.

Has Covid-19 introduced a new state?



Conclusions 1/2

Before the Covid crisis:

- The French business cycle is better characterised as having three phases: expansion, mild recession and severe recession.
- The selected MS(3)-AR(1) model provides good nowcasts and reasonably good forecasts of the GDP growth rates, well ahead their official publication.
- The model is able to successfully capture the nuances of crises, albeit remaining very parsimonious.
- It allows early identification of the waves of the Covid-19 crisis
- The revealed distinction between mild and severe recessions allows a timely policy adjustment.

Conclusions 2/2

When the Covid crisis is included in the estimation sample:

- Many of the mild crisis are overlooked by the model
- Only the GFC and the Covid crisis are timely described.
- Nowcasting gives poor results during the Covid crisis.
- The Covid-19 crisis has likely introduced a fourth (extreme) state of the business cycle, to be confirmed as more observations are accumulated;
- The business cycle dynamics during this phase may also be completely new.

Appendix: Forecasting performance: one, two or three steps ahead

The model produces fairly accurate forecasts of the factor dynamics, but the overall quality of the GDP growth forecasts is not very high.