

# Uncertainty Through the Lenses of a Mixed-Frequency Bayesian Panel Markov-Switching Model

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## Motivation

- ▶ The **role of uncertainty** as a driver of macroeconomic fluctuations has been at the center of attention especially since the beginning of the Great Recession.
- ▶ Most of the literature so far has focused on measuring uncertainty and its effects in the U.S. economy.
- ▶ There is a clear need to study whether the results for the U.S. also hold for other countries, which differ for the structure of their goods, labour and financial markets, degree of openness, conduct of fiscal and monetary policy, and other institutional characteristics.

## Contributions

- ▶ **Economic contribution.** We take a multi-country perspective and assess the effects of financial and macroeconomic uncertainty on different macroeconomic variables in various countries.
- ▶ **Methodological contribution.** To properly address this question, we take a panel approach, as an unrestricted model for many variables and countries would be too large. We also want to allow for different effects of uncertainty over time, in particular in expansions and recessions. Finally, we want to exploit the presence of mixed frequency data to improve estimation efficiency and reduce identification problems. We develop a multi-country panel Markov-Switching unrestricted mixed-data sampling regression (panel MS-UMIDAS).

## A panel Markov-switching UMIDAS model

### Notation:

- ▶  $i = 1, \dots, n_g$ : variables.
- ▶  $g = 1, \dots, G$ : countries.
- ▶  $y_{igt}$ : quarterly (low-frequency) variable  $i$  for country  $g$ , observable only for  $t = m, 2m, 3m, \dots, mT_q$ .
- ▶  $x_{ijgt}$ : monthly (high-frequency) variables with  $j = 1, \dots, N$ , always observable (for  $t = 1, 2, 3, \dots, mT_q$ ).
- ▶ The model is evaluated at  $t = m, 2m, 3m, \dots, mT_q$ .

### Panel Markov-switching UMIDAS model:

$$c_{ig}(L^m, s_{gt})y_{igt} = \mu_{ig}(s_{gt}) + \sum_{j=1}^N \delta_{igj}(L, s_{gt})x_{ijgt} + \varepsilon_{igt} \quad (1)$$

$\forall i, g$ , where  $\varepsilon_{igt} \sim \mathcal{N}(0, \sigma_{ig}^2)$  i.i.d. for all  $t$ , and

$$c_{ig}(L^m, s_{gt}) = 1 - \sum_{l=1}^c L^l c_{igl}(s_{gt}) \quad (2)$$

$$\delta_{igj}(L, s_{gt}) = \sum_{l=0}^v \delta_{igjl}(s_{gt})L^l \quad (3)$$

with  $L^m$  the lag operator defined as  $L^m y_{igt} = y_{igt-m}$ , and  $s_{gt}$ ,  $t = m, \dots, mT_q$  is a unit-specific Markov chain process with transition probability  $P(s_{gt} = k | s_{gt-m} = l) = p_{glk}$ ,  $l, k = 1, \dots, K$ .

### Hierarchical prior on switching coefficients:

$$\mu_{igk} = \mu_k + \zeta_{\mu, gk} + \eta_{\mu, igk}, \quad (4)$$

$$c_{iglk} = c_{lk} + \zeta_{c, glk} + \eta_{c, iglk}, \quad (5)$$

$$\delta_{igjlk} = \delta_{jlk} + \zeta_{\delta, gjlk} + \eta_{\delta, igjlk}. \quad (6)$$

### Remarks:

1. Under the hierarchical prior assumption, the panel model can be interpreted as a **random effects model** with unit-specific and regime-specific effects for intercept, regression coefficients, and scale parameters.
2. The model has **heteroskedastic effects with time-variation in the error variance** driven by the Markov-switching process: that is, there is no need to insert a Markov-switching mechanism in the variance once it is present in the random effect.

## Uncertainty in a panel of countries

### Economic question:

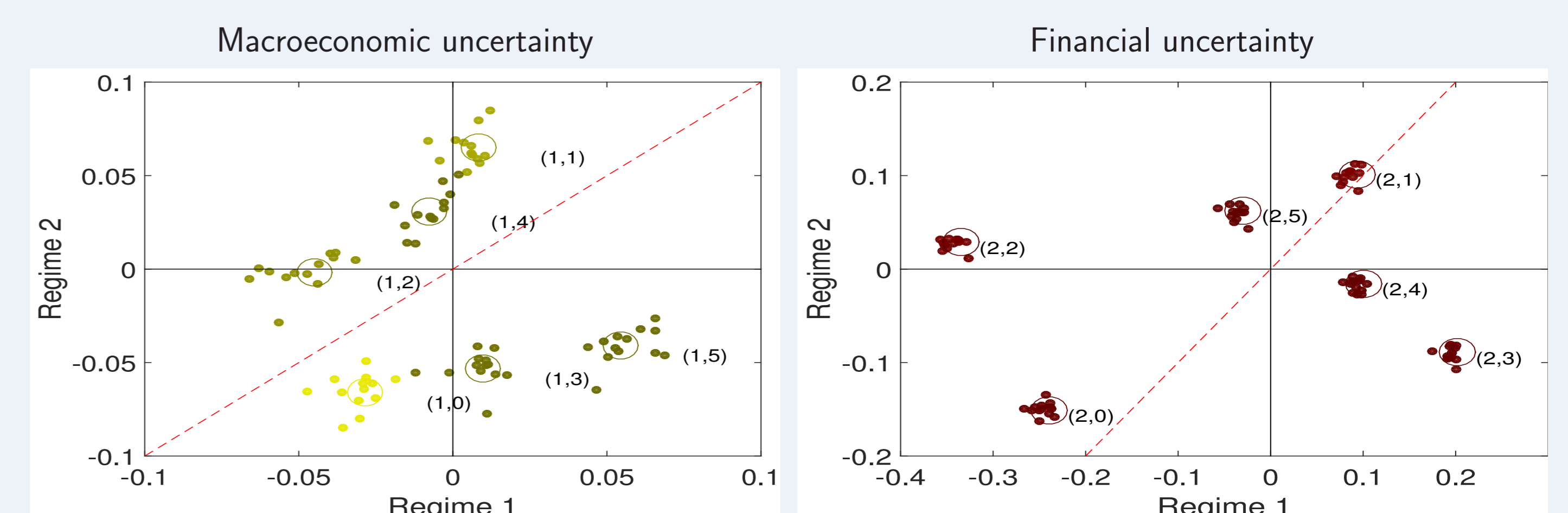
- We study the **effects of macroeconomic and financial uncertainty** on different sectors/variables across a panel of countries.
- ▶ Variables may react differently to uncertainty shocks in different phases of the business cycle.
  - ▶ Firms and sectors can take different decisions in response to uncertainty.

### Data:

- ▶ 13 developed countries.
- ▶ Various quarterly variables: GDP, industrial production, employment, consumption, inflation, nominal and real earnings, working hours, interest rates, M2.
- ▶ Monthly uncertainty measures:
  - ▷ **Macroeconomic uncertainty:** disagreement about the projections for the real GDP growth among the professional forecasters participating to the Consensus economic polls (standard deviations of one-year ahead forecasts).
  - ▷ **Financial uncertainty:** VIX.
- ▶ Sample: 1997Q1 - 2014Q4.

## Results: real GDP

Figure 1: Impact of macroeconomic and financial shocks on real GDP



Note: Regime 1 indicates a recession, Regime 2 an expansion.

## Results: summary

- ▶ There is an asymmetric effect of uncertainty shocks across regimes.
- ▶ The coefficients of financial uncertainty are larger than those of macroeconomic uncertainty almost in all cases.
- ▶ Macroeconomic uncertainty has a more temporary effect than financial uncertainty for many variables.

## Robustness

- ▶ Evidence is qualitatively similar when we remove the contemporaneous effect of uncertainty to avoid any possible endogeneity.
- ▶ When we ignore financial uncertainty, coefficients of macroeconomic uncertainty become larger, capturing parts of the effects of financial uncertainty.
- ▶ With other measures of financial uncertainty results are confirmed, if not strengthened.

## Conclusion

- ▶ We develop a panel MS-UMIDAS model. This framework allows to model a large panel of countries and several variables for each country. It allows for an endogenous time-varying transition mechanism, non-linearity in the model, and mixed frequency data.
- ▶ We use the panel MS-UMIDAS to study the effects of macroeconomic and financial uncertainty on a set of macroeconomic variables. We find that financial uncertainty dominates macroeconomic uncertainty, and that the effects of uncertainty differ between contraction and expansion regimes.