THE IMPACT OF EXOGENOUS SHOCKS ON FINANCIAL MARKETS

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Context

- Due to the COVID-19 pandemic, the Ukraine war, the energy crisis and various geopolitical tensions, the financial and economic systems face one of the biggest tests to date, forcing individuals, companies and investors alike to manage heightened risks.

- These shocks are not just another situation of a ‘natural disaster’ located and contained at the level of a single jurisdiction.

- Instead, they evolved into an unprecedented global crisis, of uncertain magnitude and duration, to the entire economic and financial systems.

Context

- Moreover, this turmoil goes beyond a simple break in the ‘business-as-usual’ mechanisms because of its economic, social and behavioural consequences.

- Thus, the analysis of these consequences cannot be simply positioned in the conventional ‘economics of natural disasters’ framework.

Research question

What type of effects can be associated with financial markets' response to shocks purely arising from their outside environment?

- The scale of the exogenous shocks' associated negative effects makes responding to such a question of paramount importance for comprehending and assessing the disruption of financial markets' normal evolution.

- Nevertheless, a significant difficulty is represented by the absence of a well-developed conceptual framework.

Literature review

The existing literature indeed provides several pieces of evidence about the two-ways linkages between individuals' reactions during economic crises and several social, cultural and psychological factors, such as:

- ✓ herding behaviour and self-organized patterns (Spelta et al.,2021; Tsuchiya, 2015; Youssef & Mokni, 2018),
- ✓ economic freedom and economic perceptions (Nikolaev & Bennett, 2016; Bjørnskov, 2016),
- ✓ human and social wellbeing and social norms (Grogan & Koka,2013; Mohseni-Cheraghlou, 2016),
- ✓ network properties of societal structures (Faggini et al., 2019),
- ✓ social capital (Wong,2013),
- ✓ bounded rational behaviours (Huck et al., 2020) or even religious culture (Blau, 2018).

Literature review

- However, this literature is usually limited, as it mainly focuses on social/ individual reactions to market-endogenous crises and pays less attention to social and behavioural responses to crises induced by entirely exogenous (with respect to financial market) socio-economic factors.

- The most important lesson to be learned from post-2020 evolutions is perhaps that markets might persistently derive from the equilibrium areas, as these are reflecting the fundamentals under the impact of a large set of persistent endogenous and exogenous factors.

Contributions

In this context, we propose here a two-fold contribution:

1. we seek to examine the possibilities provided by the frame of a *High Dimensional Latent Factor Stochastic Volatility Model* to describe financial markets' return volatilities, as this can be viewed as an expression of uncertainty surrounding trading decisions during large shock periods.

2. we apply such a model to six major international financial markets for an analysis period between 2020 and 2023. Such a period is rich in out-of-the-market induced perturbations and then is an interesting example of when large adjustments in market dynamics are not necessarily caused by internal factors.

Methodology

High Dimensional Latent Factor Stochastic Volatility Model

- Accounting for time-varying variance is of paramount importance in a realistic description of financial time series dynamics.
- We employ the stochastic volatility (SV) model first proposed by Taylor (1982)

$$\eta_t = x_t\beta + \exp\left(\frac{h_t}{2}\right)\varepsilon_t,$$

$$h_{t+1} = \mu + \varphi(h_t - \mu) + \sigma\iota_t, \qquad (1)$$

$$\varepsilon_t \sim \mathcal{N}(0,1),$$

$$\iota_t \sim \mathcal{N}(0,1)$$

Here $\mathcal{N}(b,B)$ denotes the normal distribution with mean $b \in \mathbb{R}$ and variance $B \in \mathbb{R}^+$. Meanwhile, ε_t, ι_t are independent. The log-variance process $h = (h_1,\ldots,h_n)^T$ is initialized by $h_0 \sim \mathcal{N}\left(\mu, \frac{\sigma^2}{(1-\varphi^2)}\right)$. x is an $n \times K$ matrix containing in its t^{th} row the vector of K regressors at time t. μ is the level, φ is the persistence, and σ is the standard deviation of the log-variance.

Methodology

- In the case of the multivariate SV models, a significant difficulty may occur for the dynamic covariance estimation when there are a high number of unknowns compared to the number of observations.
- A solution to such difficulties might consist in considering an approach based on "latent factors" that allows a parsimonious representation of multivariate stochastic volatility.
- As Hosszejni & and Kastner (2021, p.6) argue: "Latent factor models embody the idea that even high dimensional systems are driven by only a few sources of randomness. These few sources of randomness control a few factors, which in turn account for the interactions between the observations. Moreover, latent factor models provide an efficient tool for dynamic covariance matrix estimation. They allow for a reduction in the number of unknowns".

Methodology

A standard latent factor model with r factors implies the following decomposition:

$$\Sigma_t = \overset{\vee}{\Sigma}_t + \bar{\Sigma}_t \qquad (2)$$

Here, $\text{rank}\left(\overset{\vee}{\Sigma}_t\right) = r < m$, and $\bar{\Sigma}_t$ is the diagonal matrix containing the variances of the idiosyncratic errors.

Methodology

Hosszejni & and Kastner (2021) consider the following description the factor SV model:

$$\eta_t \mid \beta, \Lambda, f_t, \bar{\Sigma}_t \sim \mathcal{N}_m\left(\beta + \Lambda f_t, \bar{\Sigma}_t\right),$$

$$f_t \mid \tilde{\Sigma}_t \sim \mathcal{N}_r\left(0_t, \tilde{\Sigma}_t\right) \qquad (3)$$

f_t is the vector of factors, β is an observation-specific mean, and $\Lambda \in \mathbb{R}^{mxr}$ is a tall matrix holding the factor loadings. The covariance matrices $\bar{\Sigma}_t, \tilde{\Sigma}_t$ are both diagonal representing independent vanilla SV processes.

Methodology

Based on equation (3), equation (2) can be re-written as:

$$\Sigma_t = \Lambda \tilde{\Sigma}_t \Lambda^T + \bar{\Sigma}_t \qquad (4)$$

- In this specification, several identification issues should be solved related to the order, the sign, and the scale of the factors.
- Hosszejni & and Kastner (2021) resolve the ambiguity in the scale of the factors by fixing the level of their log-variance to zero, while sign and order identification can be enforced through restrictions on the factor loadings matrix.

Methodology

- Theoretical details about the treatment of factor SV from a Bayesian point of view are provided, for instance, by Pitt & Shephard (1999), Chib et al. (2006), Han (2006), Kleppe et al. (2022), and Gunawan et al. (2021).

- Here, we follow the implementation of this latent factor model from the R package 'factorstochvol' as described by Hosszejni & Kastner (2019, 2021, and 2023), Kastner (2019), Kastner & Frühwirth-Schnatter (2014), Kastner et al. (2017), and Kastner et al. (2022).

International data

1. **DAX PERFORMANCE-INDEX (DAX)** (a stock market index consisting of the 40 major German blue chip companies trading on the Frankfurt Stock Exchange),
2. **Financial Times Stock Exchange 100 Index (FTSE 100)** (a share index of the 100 companies listed on the London Stock Exchange with the highest market capitalisation),
3. **CAC 40 index (CAC 40)** (a benchmark French stock market index that represents a capitalization-weighted measure of the 40 most significant stocks among the 100 largest market caps on the Euronext Paris)
4. **FTSE MIB Index (FTSE MIB)** consists of the 40 most liquid and capitalized stocks listed on the Borsa Italiana.

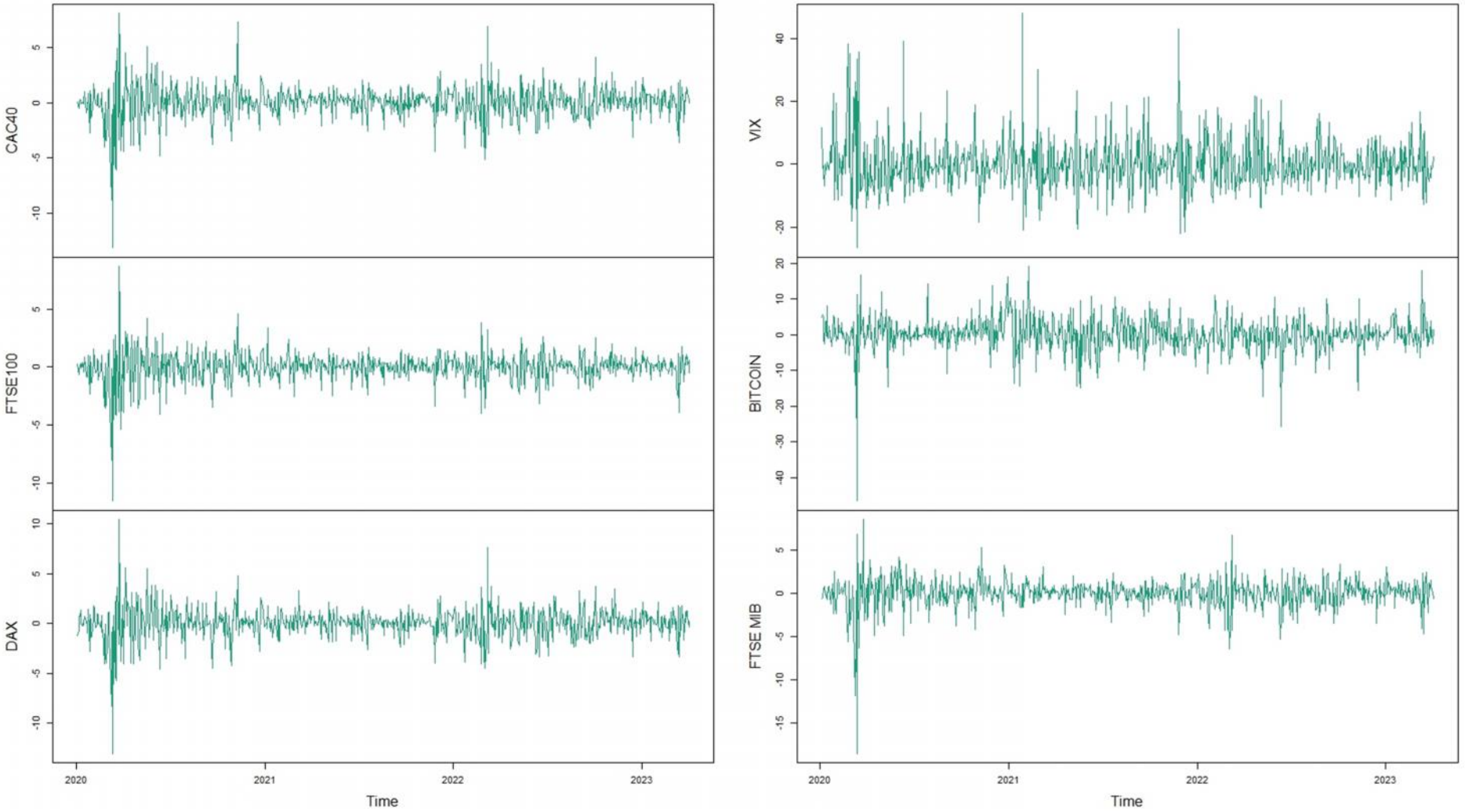
International data

- For comparison purposes, we also include the **Cboe Volatility Index** (VIX Index), a financial benchmark designed to estimate the expected volatility of the S&P 500 Index as well as the BITCOIN/ USD (BITCOIN) exchange rate.

- We collect daily data for these markets' log returns (based on closing prices) for a period between **2020-01-03 and 2023-04-04** by using the **R package "yfR** (Perlin, 2023).

- A number of **794 observations** are available after a data synchronisation is performed by removing the days with non-available information.

Fig.1. Percentage log returns of six financial markets



Main results

Fig. 2. Eigenvalues of $\Lambda^T\Lambda$ which can be used as a rough guide to selecting the number of factors

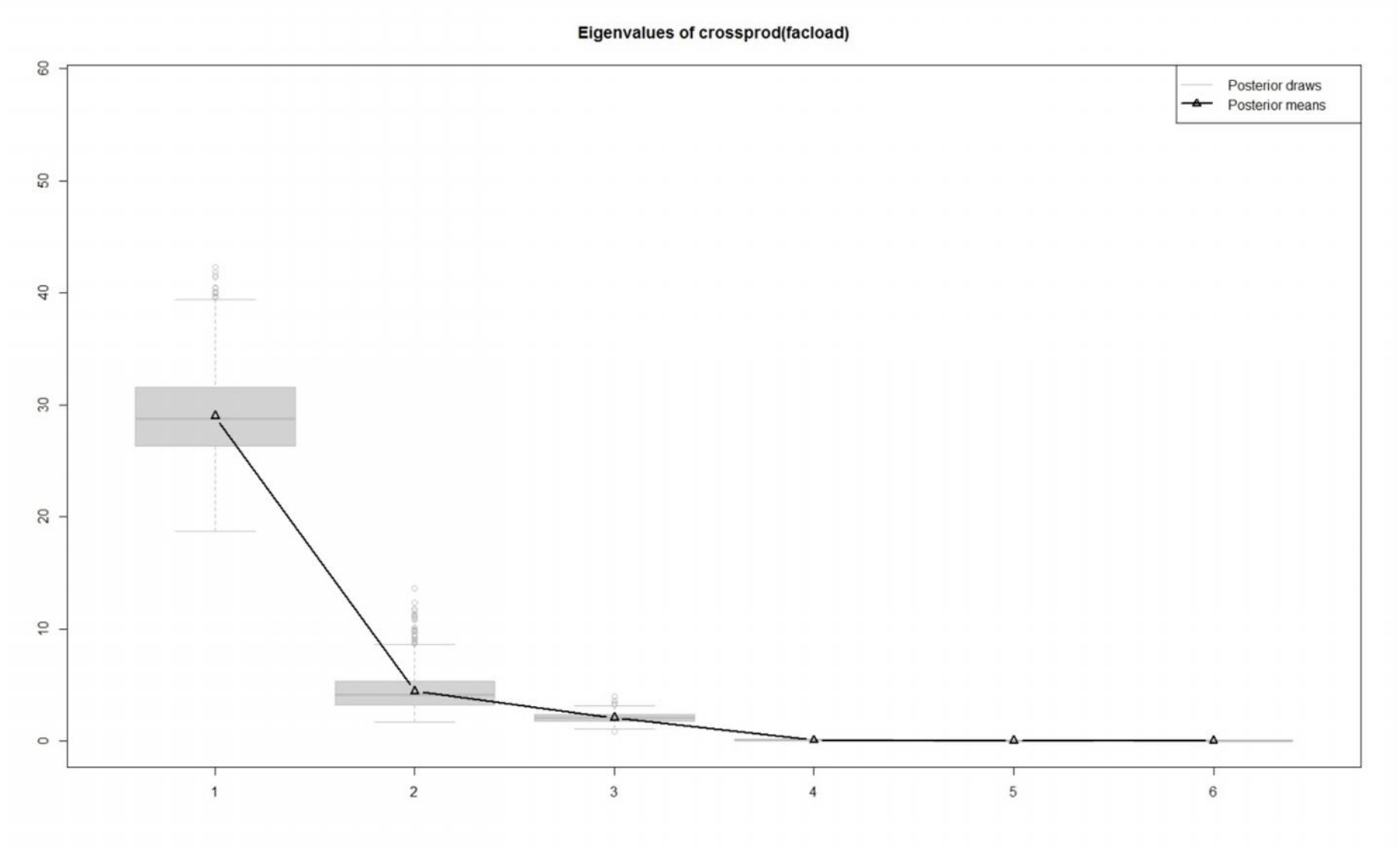


Fig.3. Three estimated correlation matrices and their posterior uncertainty depicted using circles

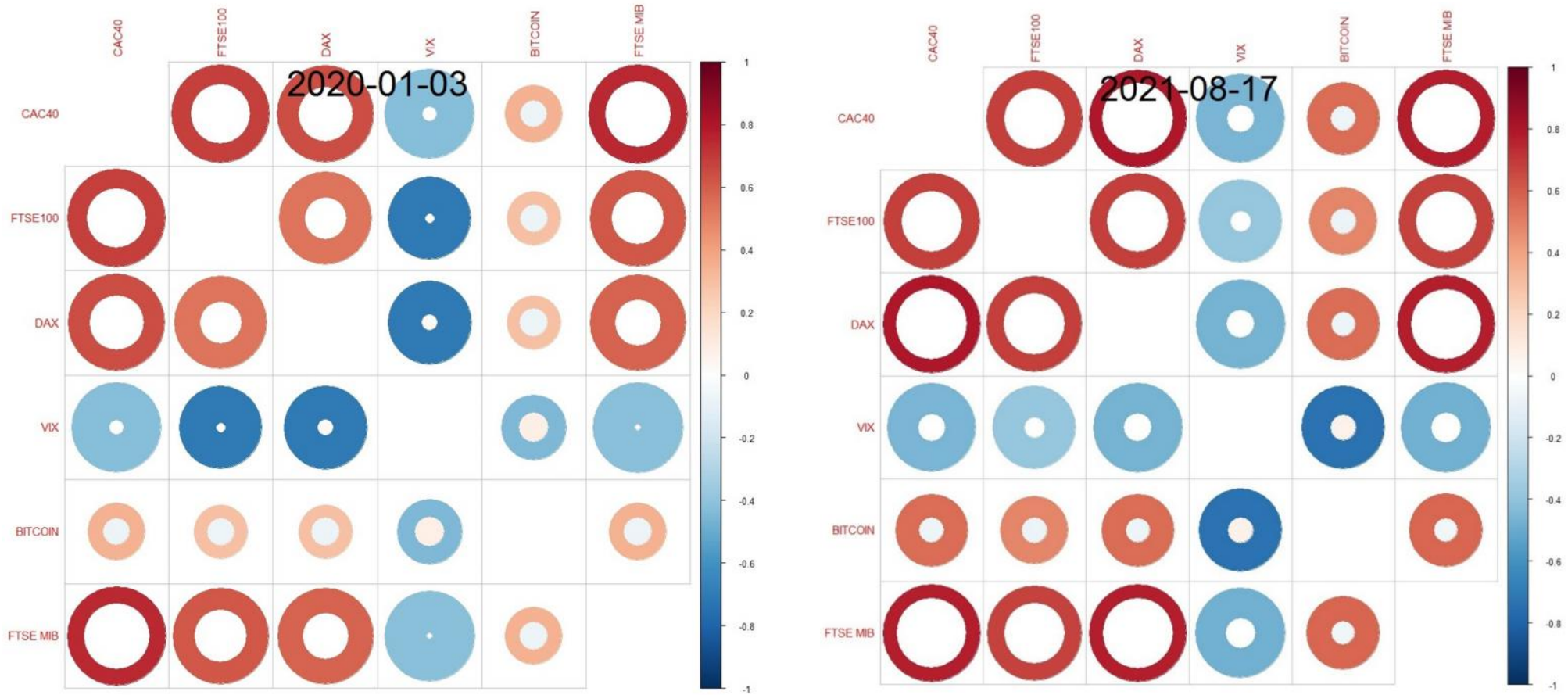


Fig.3. Three estimated correlation matrices and their posterior uncertainty depicted using circles

(CONT.)

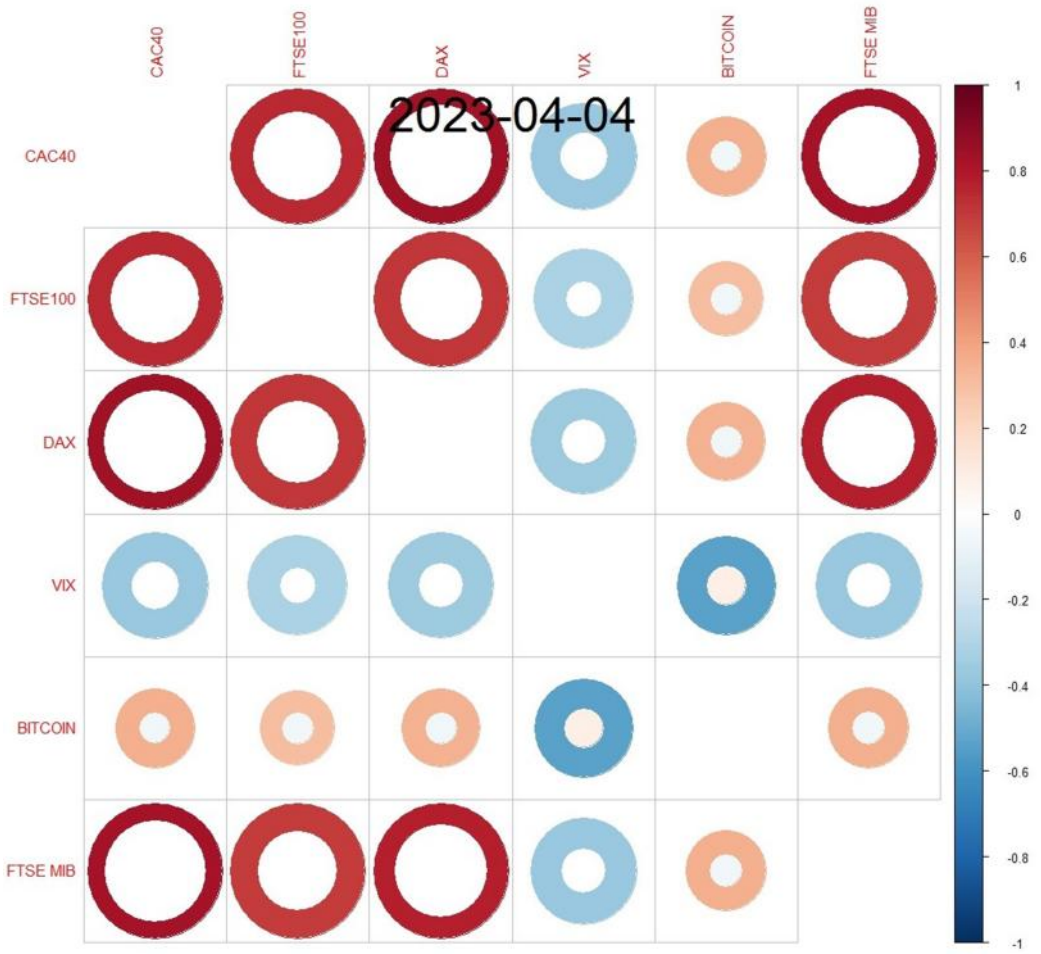


Fig.4.Posterior means of daily marginal volatilities in percent

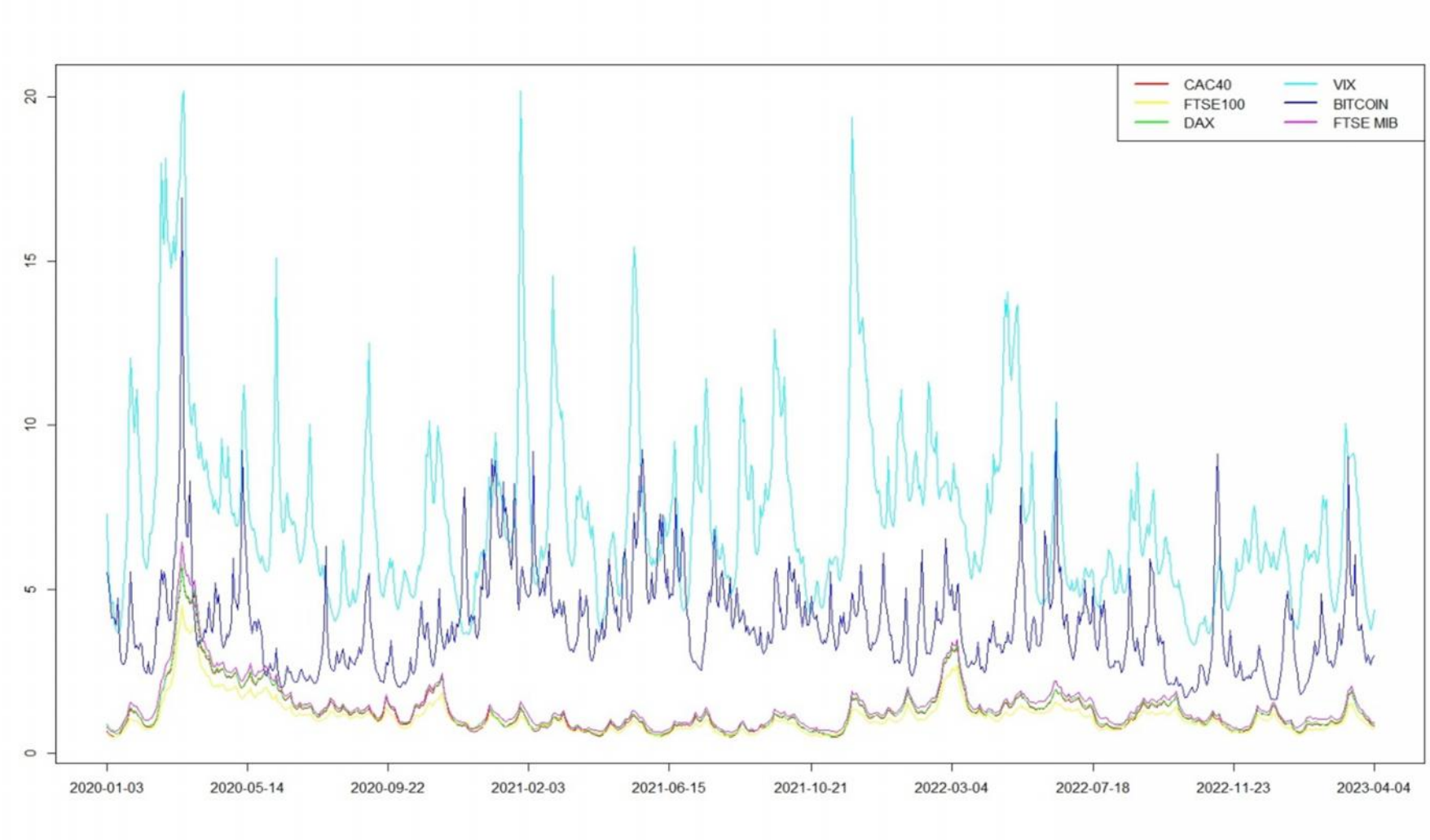


Table 1: Multiple structural changes dates- Bai and Perron's (2003) test

Market	Dates of structural changes
CAC 40	2020-06-29;
	2021-01-06;
	2021-11-23;
	2022-07-15
FTSE 100	2020-06-29;
	2021-03-09;
	2021-11-23;
	2022-07-08
DAX	2020-06-29;
	2021-01-04;
	2021-11-23;

	2022-07-18
VIX	2020-06-29;
	2020-12-18;
	2021-11-23;
	2022-05-19
BITCOIN	2020-06-29;
	2020-12-17;
	2021-06-29;
	2022-07-28
FTSE MIB	2020-06-29;
	2021-02-03;
	2021-11-23;
	2022-07-18

COMMENTS

Several exogenous- market -events might be linked to the occurrence of these structural changes points:

- In the **second quarter of 2020,** the global COVID-19 death toll surpasses 500,000;
- On **3 September 2020**, the Frankfurt Stock Exchange admitted in its Regulated Market the quotation of the first Bitcoin exchange-traded note (ETN), centrally cleared via Eurex Clearing;
- In **December 2020**, the Biden administration faces a challenge as Congress drops state aid to secure stimulus;
- On **January 6. 2021** there was the United States Capitol attack;

COMMENTS

- Federal elections were held in Germany on **26 September 2021** to elect the members of the 20th Bundestag. In November 2021, a coalition deal has been announced in Germany and Center-left Social Democrat Olaf Scholz has been elected by the Bundestag as the new chancellor of Germany;
- In **November 2021**, the Biden administration renominates J.H. Powell, the Federal Reserve chair, to another four-year term resisting political pressures;
- On **24 February 2022**, Russia invaded and occupied parts of Ukraine;
- The 2022 French presidential election was held on **10 and 24 April 2022**. As no candidate won a majority in the first round, a runoff was held, in which Emmanuel Macron defeated Marine Le Pen and was re-elected as President of France.

COMMENTS

- Supplies of Russian gas for Europe—critical for heating, industrial processes, and power—have been cut by more than eighty percent in 2022. The cost of liquefied natural gas (LNG) has more than doubled during this year. Meanwhile, oil prices hit their highest level since 2008;
- In **June 2022**, Spain and Portugal adopted the “Iberian exception,” capping the price of gas used for generating electricity while central heating was restricted in Italy for 2022 winter;
- In **June 2022**, the cryptocurrency hedge fund Three Arrows Capital defaulted on a Bitcoin loan and was ordered into liquidation;

COMMENTS

- In **July 2022**, in Italy, the Po River basin was facing the highest level of drought severity. Drought emergency has been declared in five Italian regions and insufficient water availability has led to multiple use restrictions across municipalities. The energy production was also affected;
- On **26 September 2022**, a series of bombings and subsequent underwater gas leaks occurred on the Nord Stream 1 and Nord Stream 2 natural gas pipelines. On 27 September 2022, European gas prices jumped twelve percent;
- The liquidation of Bahamas-based cryptocurrency exchange FTX began in **November 2022.**

Fig. 5. Communalities: Posterior means plus/minus two posterior standard deviations

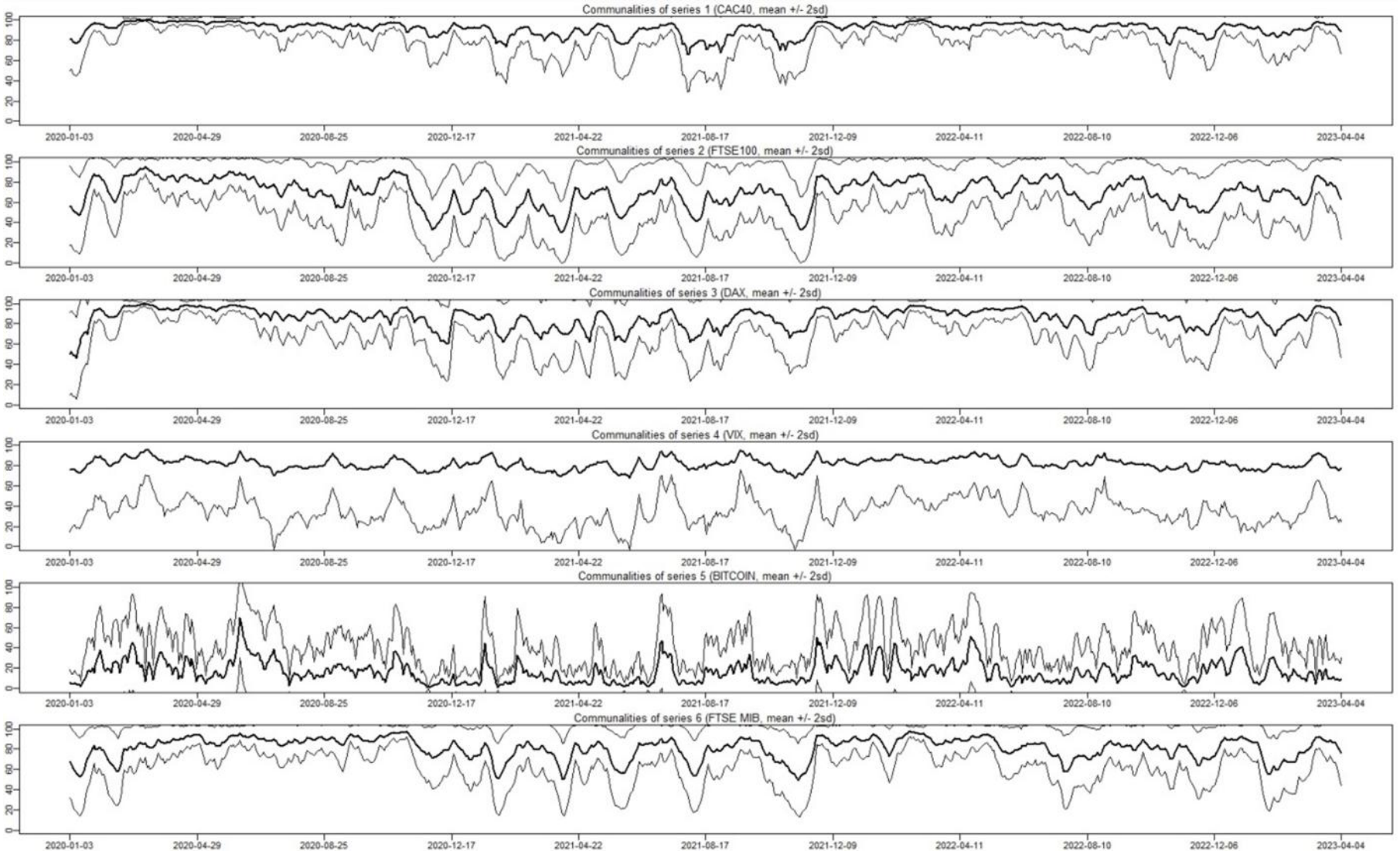


Fig.6.Idiosyncratic log variances: Posterior means plus/minus two standard deviations

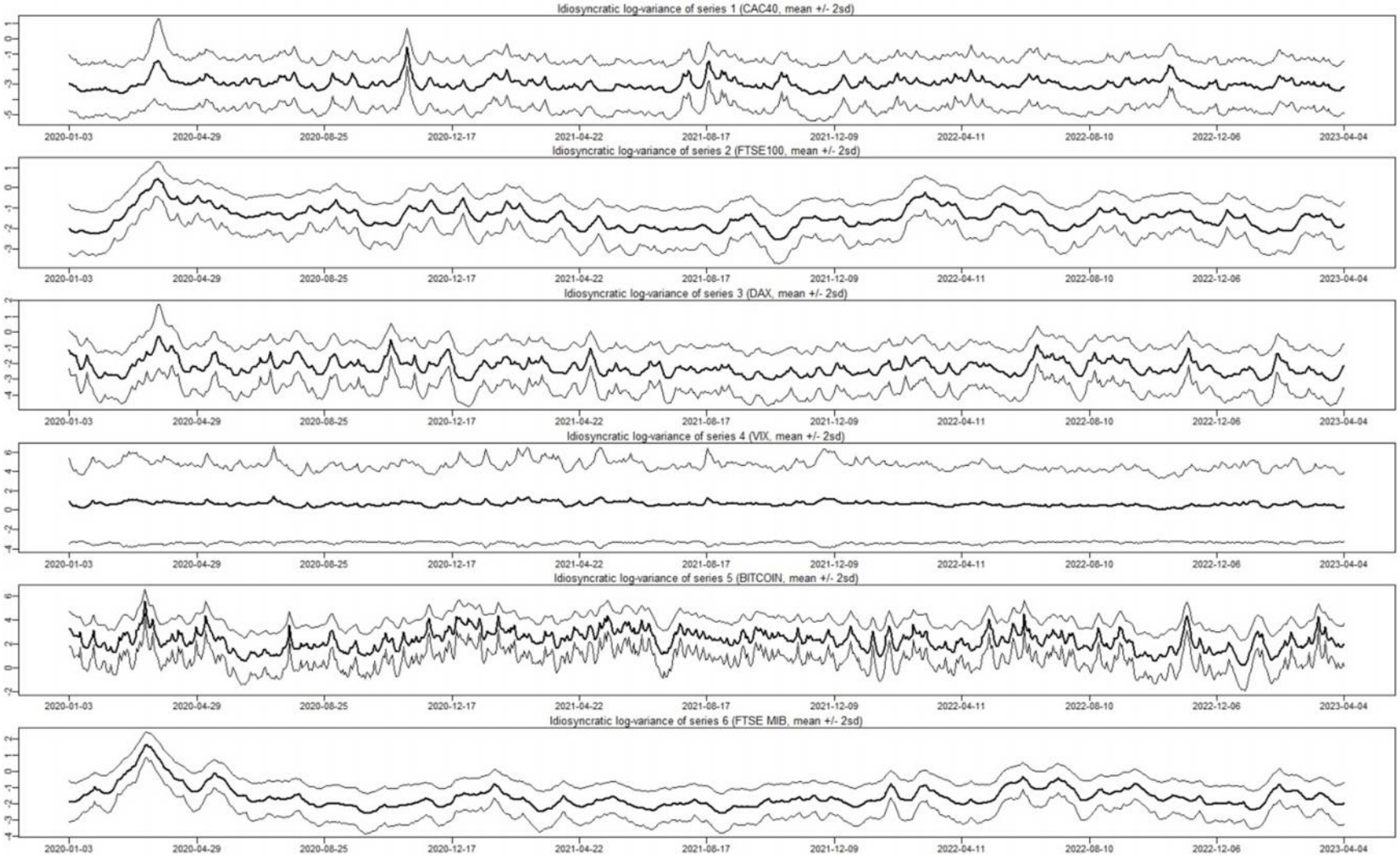
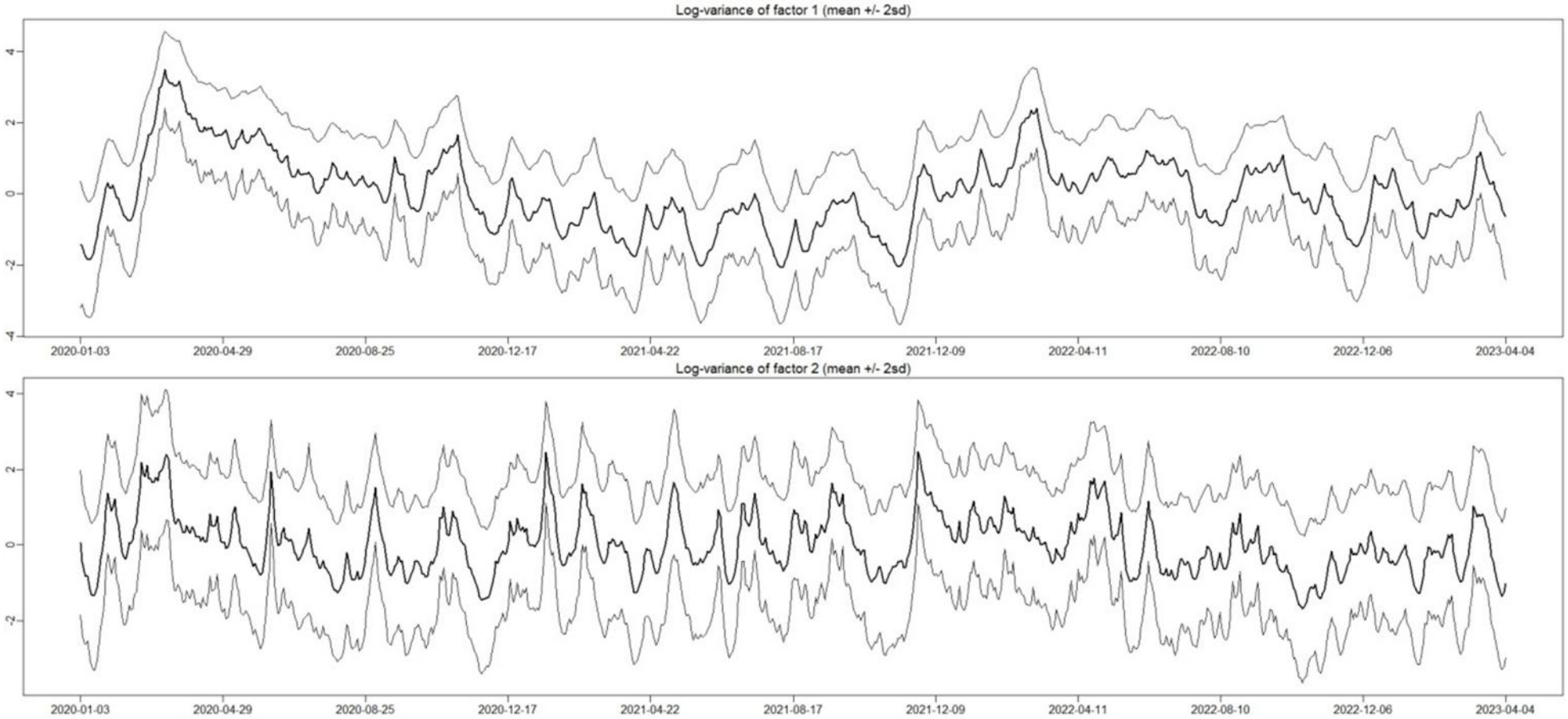


Fig.7. Posterior means plus/minus two standard deviations of factor log variances



CONCLUSIONS

We find that a multivariate SV model with latent factors can depict the volatility of some international financial markets.

1. *these markets are playing a critical role in the context of financial globalization.*

- They account for a significant fraction of international flows of capital.
- Meanwhile, they are linked by various mechanisms related to investors' geographically portfolio diversification.
- Hence, it can be expected to see that unobserved factors are jointly driving their volatilities.

CONCLUSIONS

2. *various pure exogenous shocks are affecting the markets' evolution during the entire analysis period.*

- Therefore, it makes sense to consider that the factors themselves are displaying time-varying volatilities.

3. *the concept of a 'structural break' implies that a time series abruptly changes at a point in time.*

- Such a break could involve a change in mean, variance or in other core parameters of the process that drives the series.
- Nevertheless, different identification methodologies can lead to the identification of different break dates in volatilities series.

CONCLUSIONS

4. *the large proportion of variances that is explained through the two latent factors can be justified by the functional inter-linkages between the markets*
5. *it may be interesting to consider other cases and, especially, some of frontier and emergent markets that are less integrated in the international flows of capital and are affected by lower levels of liquidity, a less extended set of traded financial assets, lower liquidity and thin trade, more asymmetric information distribution and less sophisticated protection against risks mechanisms.*

CONCLUSIONS

6. *the bi-univocal transmission channels between 'traditional' financial markets and different segments of the crypto-currency market should be better clarified both at the conceptual and empirical levels.*

7. *more explanations should be provided to achieve a better understanding of the impact exercised by the various categories of shocks and their specific transmission channels.*

Overall, we argue that, despite their limitations, such findings can point toward the fact that exogenous shocks *matter* in explaining the dynamic patterns followed by financial markets.