Polish Economic Institute

Green inflation and great volatility – challanges to green transition

November 28th, 2022 – AIECE meeting, Brussels

Summary:

- Part I: Carbon pricing – calculate impact of EUA on HICP
  - Positive impact on Energy prices, non-significant on core inflation
  - Methods:
    - Calculating Effective costs of Energy per MWh
    - VAR models – impulse response functions.

- Part II: Risk management – Energy portfolio:
  - Unstable relations between ETS and major commodities:
    - DCC GARCH modelling – Conditional correlations
  - Increase in Value at Risks

Part I

Carbon pricing

Literature review

- Moessner (2022) - *Effects of Carbon Pricing on Inflation, CESIfo*
  - ETS price up by 10 EUR = higher energy inflation by 0,8pp.
  - No statistically significant effect on food prices and core inflation

- Santabárbara & Suárez-Varela (2022), Carbon Pricing and Inflation Volatility, Bank of Spain:
  - ETS system increases energy inflation volatility by 0.6pp.
  - Changes in core inflation and food prices neglible.

- Känzig, D.R. (2021), *The Unequal Economic Consequences of Carbon Pricing*:
  - Costs of carbon pricing mainly visible for the low-earning households.

Effective energy costs

Effective commodity cost (ECC) per MWh:

- CP - Commodity Price – World Benchmark
- CU – Commodity usage – Effective Commodity consumption used in during production of MWh – EIA Data
- CES – Commodity Electricity Share: proportion of commodity used in the energy mix

$$ECC = CP * CU * CES$$

Effective ETS Cost ($EUETSC$) per MWh:

- EUETSP - EU ETS Price – EU Benchmark
- CO2eEI - CO2eq emission Intensity

$$EUETSC = EUETSP * CO2eEI$$

Model specification

- VAR system – panel data.
  - Inflation from 2015 to 2022 - monthly
  - EU 27 countries excluding Baltics, Luxemburg, Malta and Cyprus.

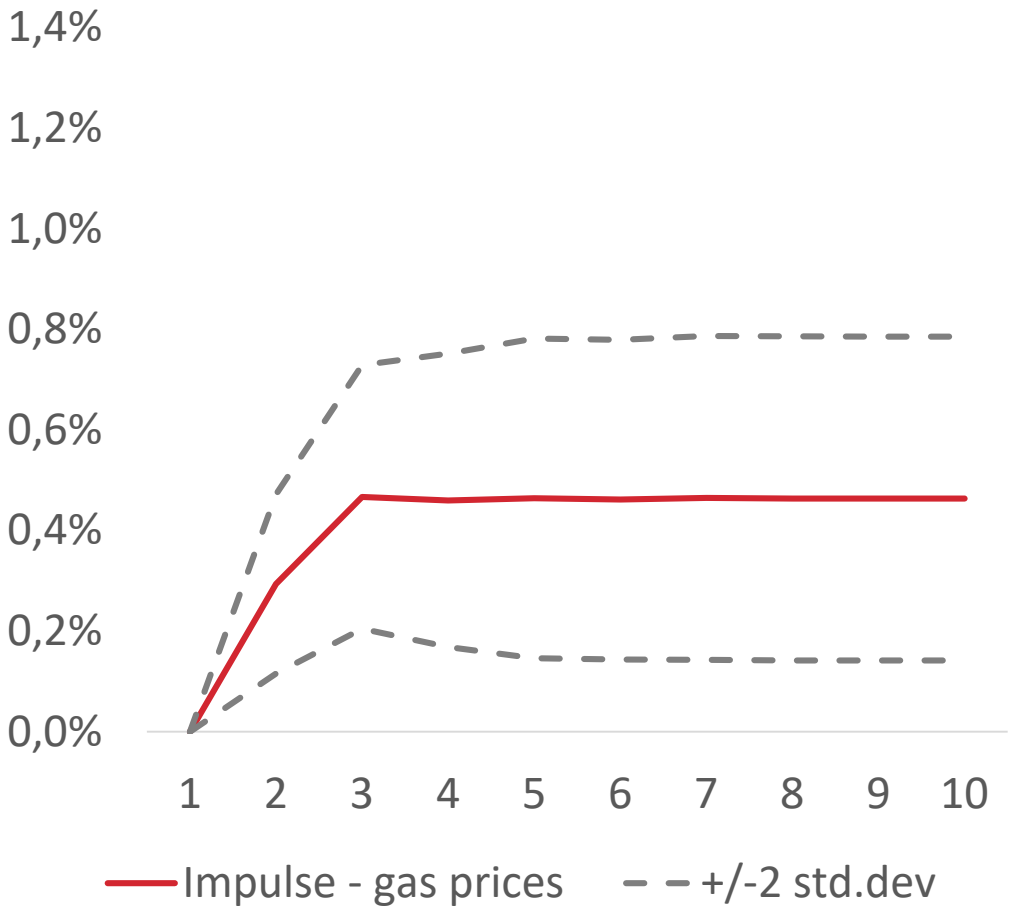
- Example equation:

$$\begin{cases} \Delta \log(HICP_t) = A_1 * \Delta \log(HICP_{t-1}) + B_1 * \Delta \log(energy_{t-1}) + C_1 * \Delta \log(X_{t-1}) \\ \Delta \log(energy_t) = A_2 * \Delta \log(HICP_{t-1}) + B_2 * \Delta \log(energy_{t-1}) + C_2 * \Delta \log(X_{t-1}) \\ \Delta \log(X_t) = A_3 * \Delta \log(HICP_{t-1}) + B_2 * \Delta \log(energy_{t-1}) + C_2 * \Delta \log(X_{t-1}) \end{cases}$$

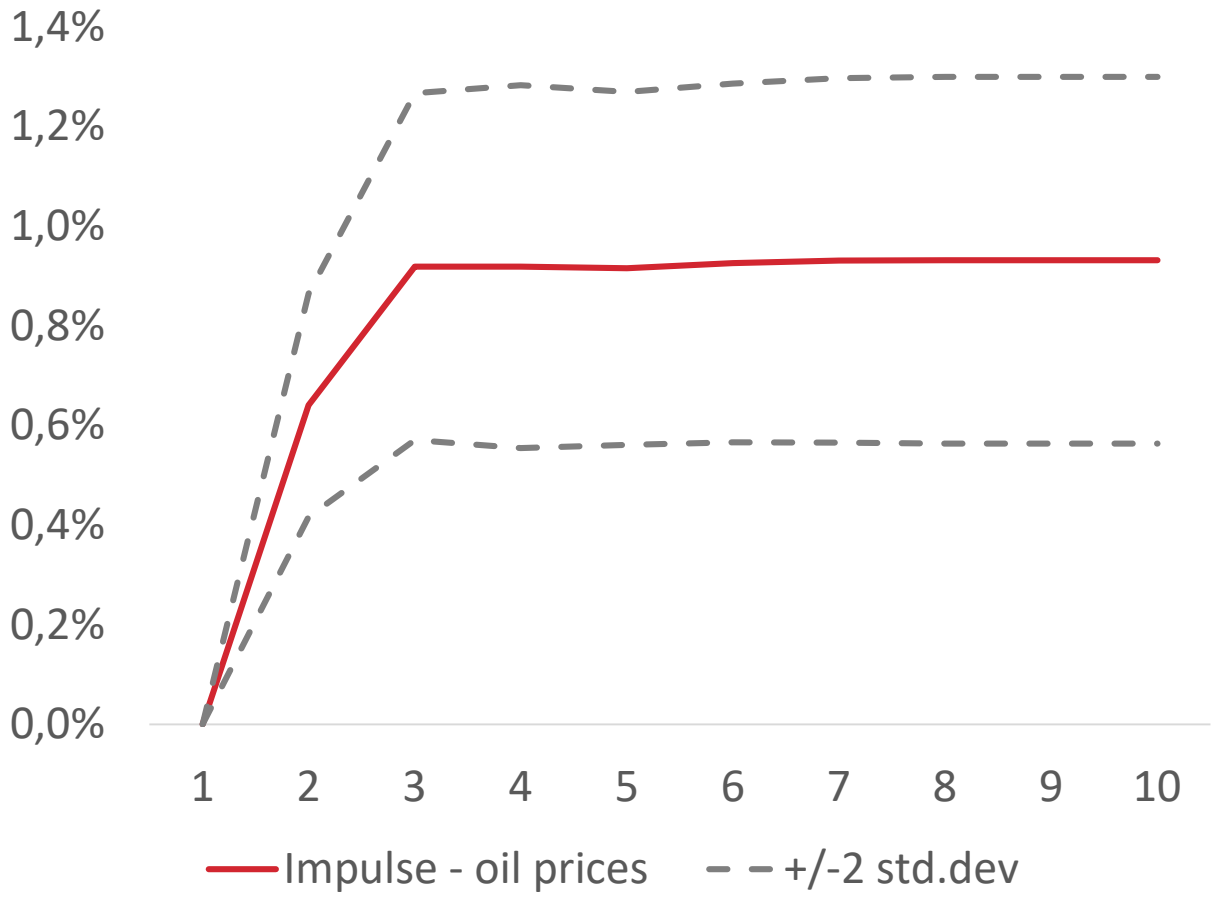
- Where X_t :
  - $wages$
  - $M3$

Impulse responses

Core inflation reaction to gas prices increase



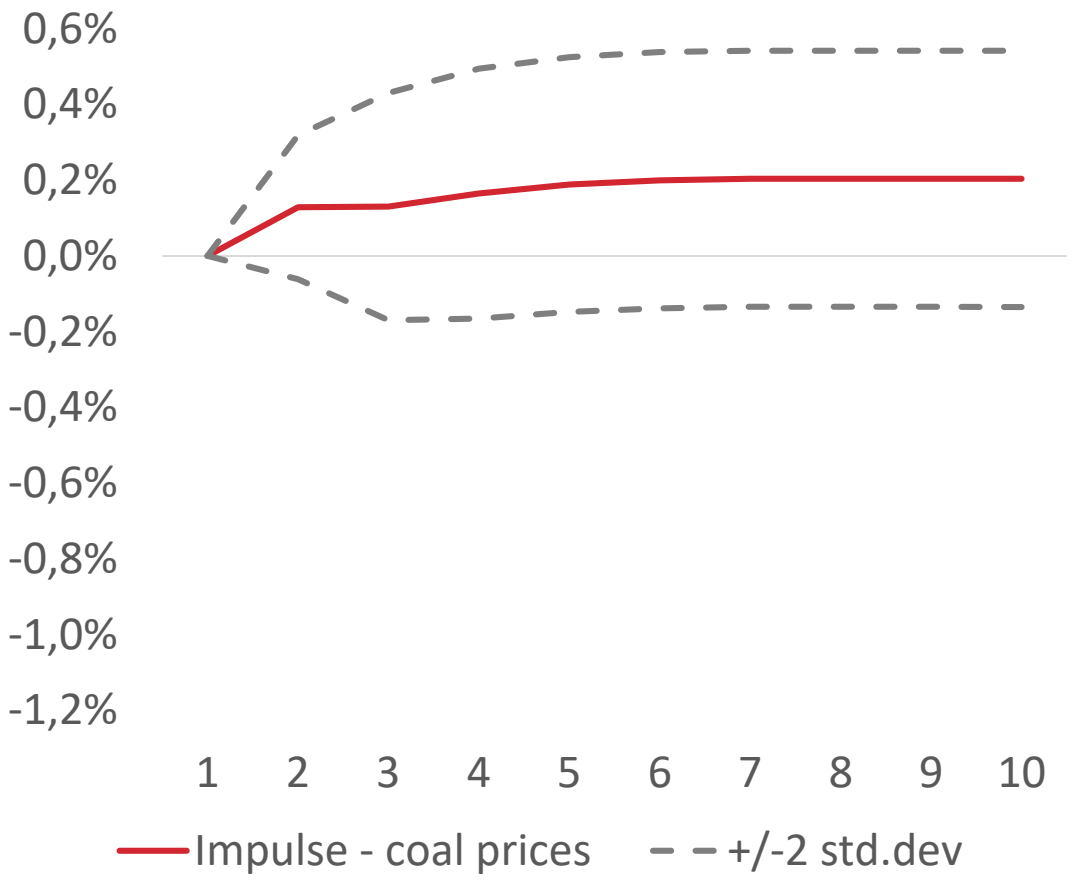
Core inflation reaction to oil prices increase



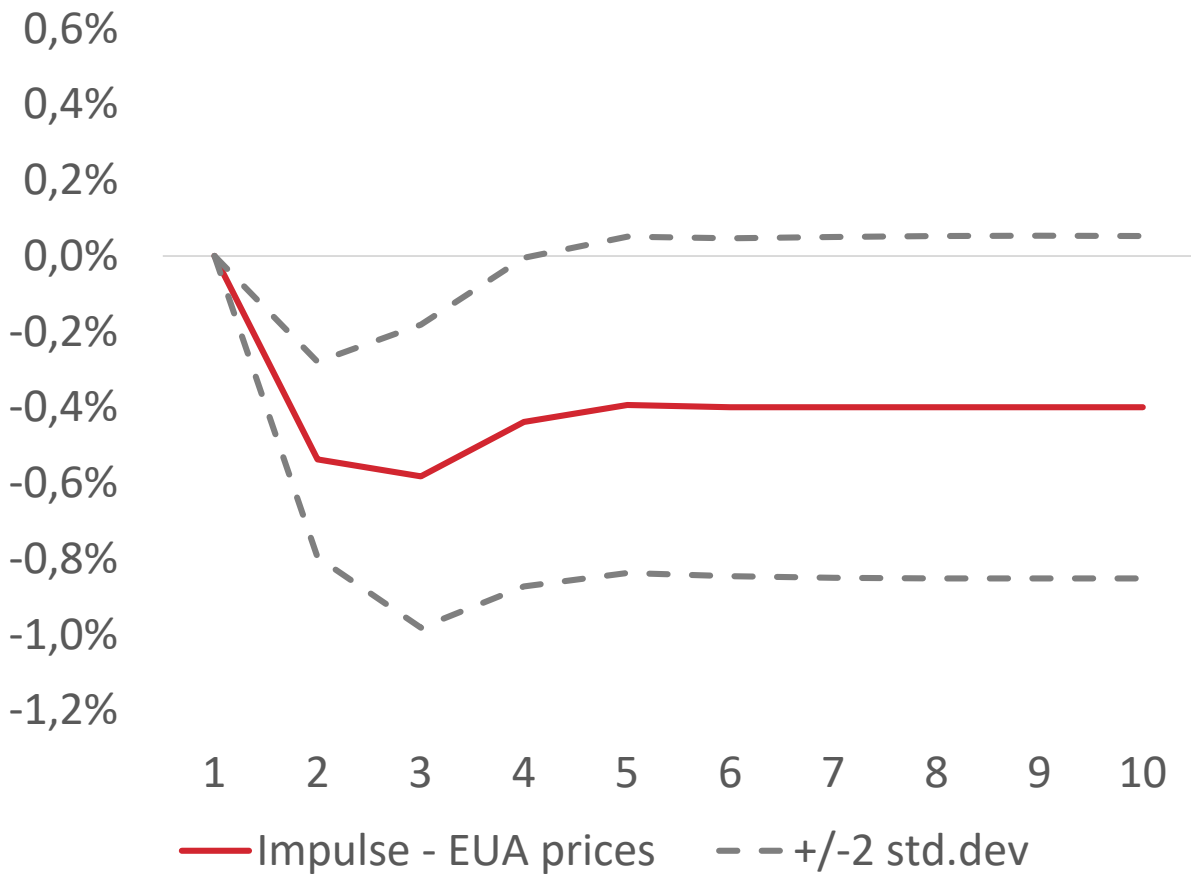
Impulse definition: One unit increase of residual.
Interpretation – percentage increase of core inflation via 1% increase in prices

Impulse responses – statistically not significant

Core inflation reaction to coal prices increase



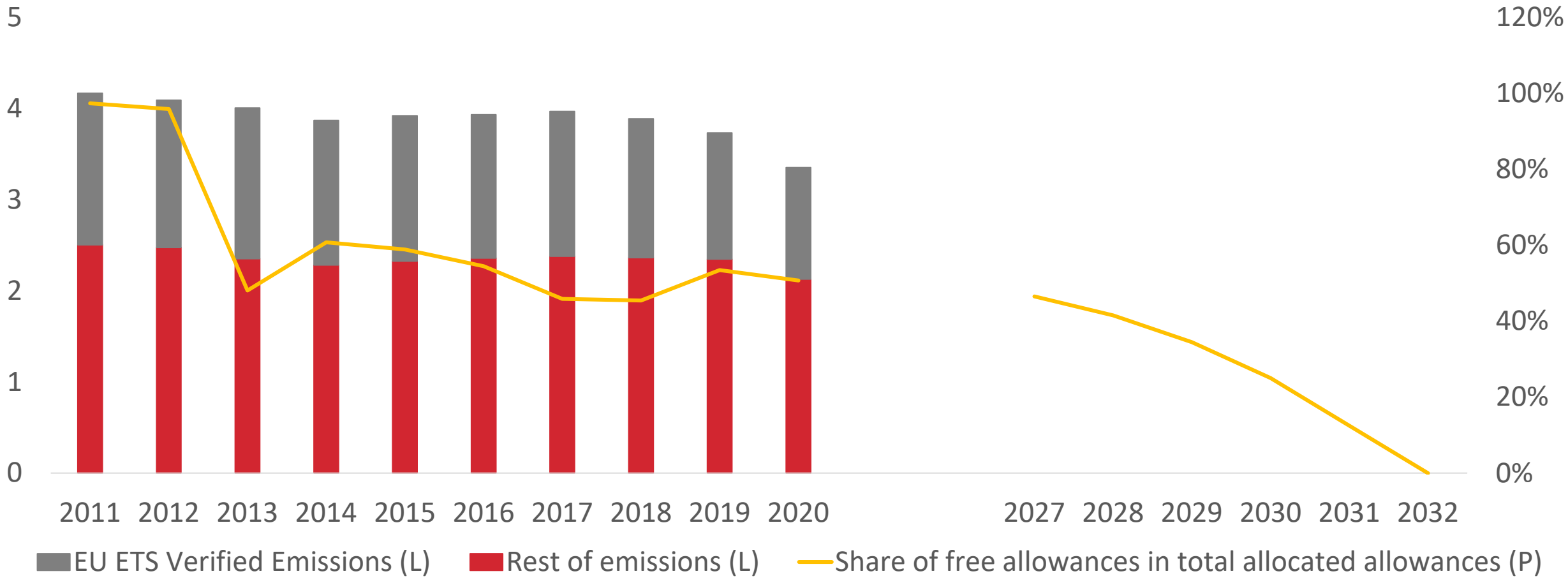
Core inflation reaction to ETS price increase



Impulse definition: One unit increase of residual.
Interpretation – percentage increase of core inflation via 1% increase in prices

Shifts in the ETS system to weight on inflation

Verified emissions (bn of CO2e tons) and percentage of free allowances.



Source: European Parliament proposal, European Energy Agency.

Part IIa

Risk mangaement - correlations

Basic details:

- Aim: analyse volatility and correlations between ETS and commodity prices

- Data – logarithmic returns of 4 series:
  - ETS EUA 1st position, converted to EUR
  - Brent, 1st position, converted to EUR
  - Coal – Rotterdam, 1st position, EUR
  - Henry Hub – 1 st position, converted to EUR

- Logarithmic returns are given by following formula:

$$r_t = \ln\left(\frac{K_t}{K_{t-1}}\right)$$

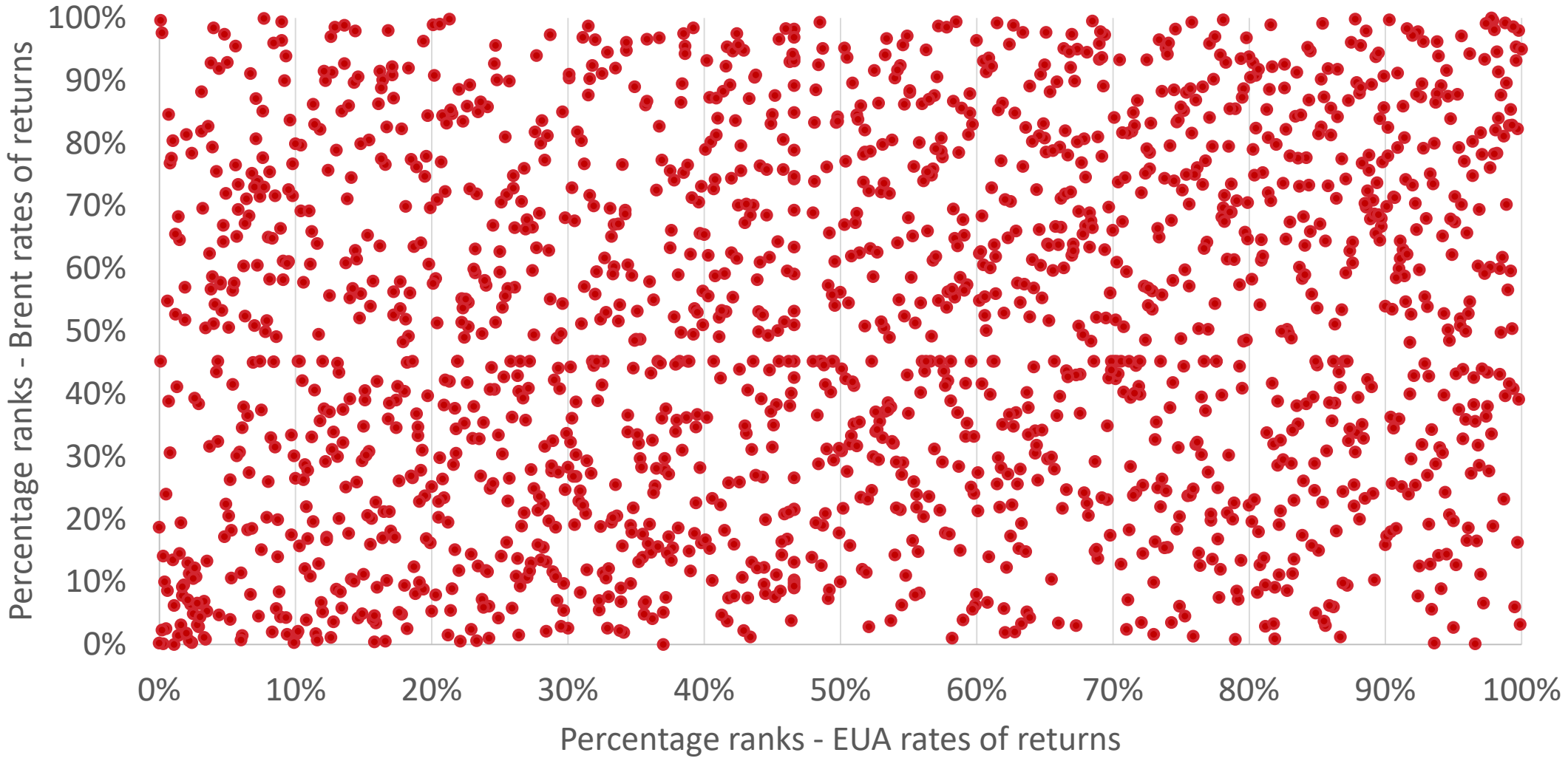
Problem: Behaviour of ETS system

- Pearson correlations are small. EUA prices does not comove with commodities in the stable time.
- Problem during the stress period. Comovement is much stronger

Correlations – returns from EUA ETS future with:

	Brent	Gas – Henry Hub	Coal - Rotterdam
To 2019	0.19	-0.01	0.17
After 2019	0.20	0.04	0.02

Common downfalls of oil and EUA prices.



Model specification

- DCC GARCH - Dynamic Conditional Correlation

- Univariate GARCH(1,1) model treats variance as an autoregressive process:

$$y_t = \mu + e_t, where\ e_t \sim N(0, \sigma_t^2)$$
$$\sigma_t^2 = \omega + \alpha_1 * \varepsilon_{t-1} + \alpha_2 * \sigma_{t-1}^2 + \varepsilon_t$$

- Model can be generalized to multivariate version with different assumption regarding variance and covariance matrix.

Model specification - correlation

- DCC GARCH variance-covariance matrix is given by following decomposition:

$$H_t = D_t * R_t * D_t$$

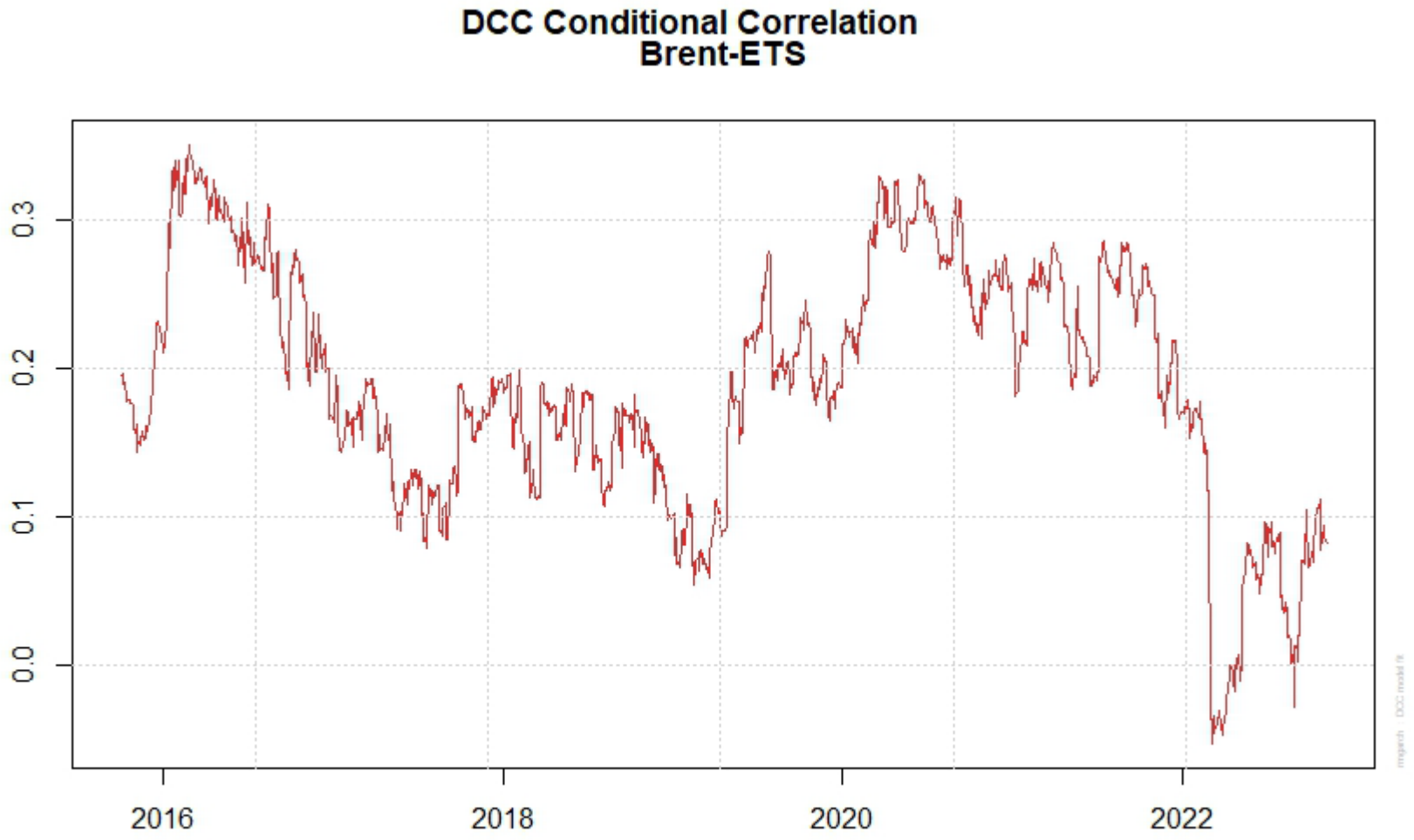
- Where D_t - matrix of GARCH standard deviations, R_t matrix of conditional correlations.
- We further decompose the latter matrix:

$$R_t = \dot{Q}^{-1}{}_t * Q_t * \dot{Q}^{-1}{}_t$$

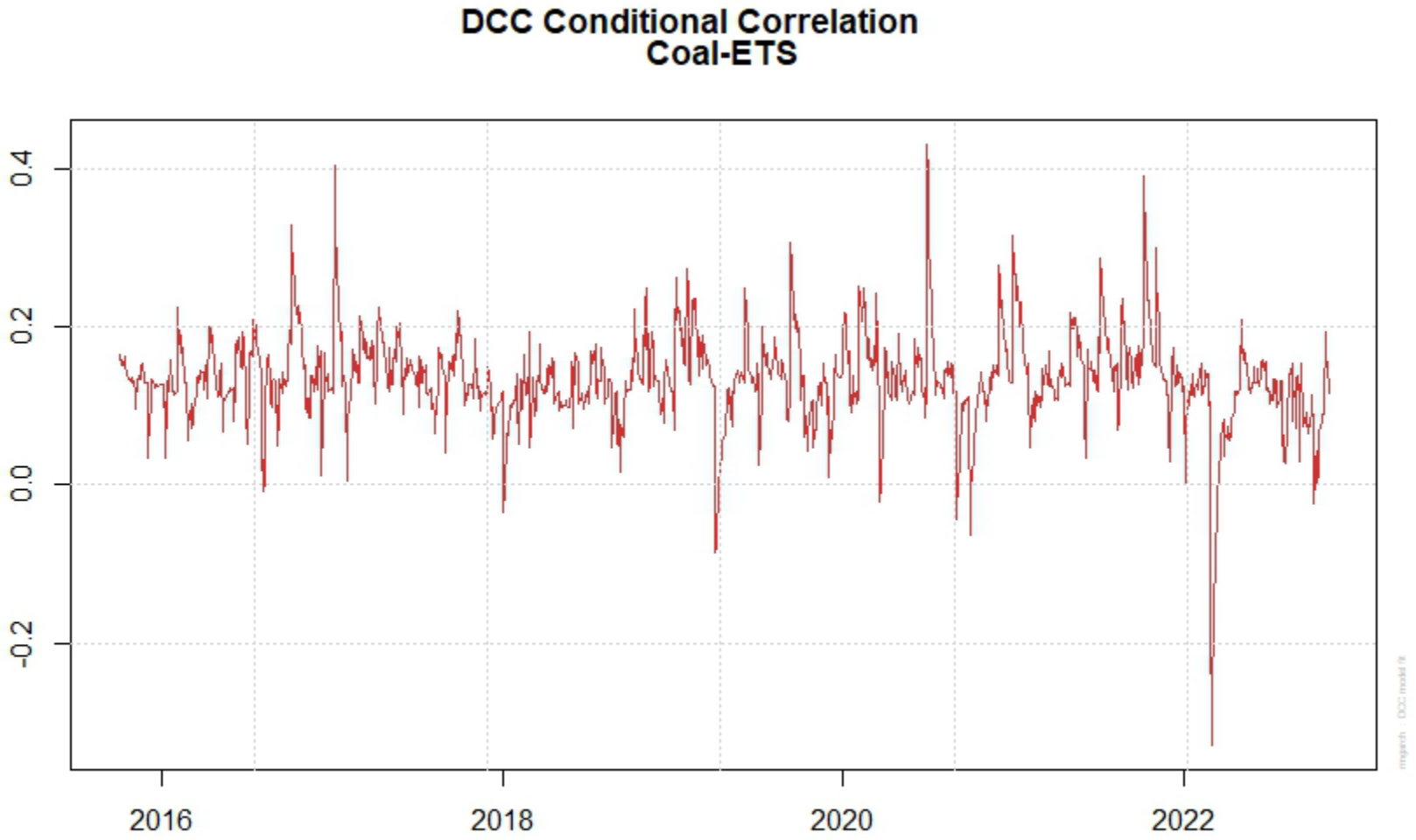
- And make assumption that Q_t is autoregressive process centered around unconditional covariance ($\overline{Q_t}$):

$$Q_t = (1 - \alpha - \beta) * \overline{Q_t} + \alpha * \varepsilon_{t-1} * \varepsilon'_{t-1} + \beta * Q_{t-1}$$

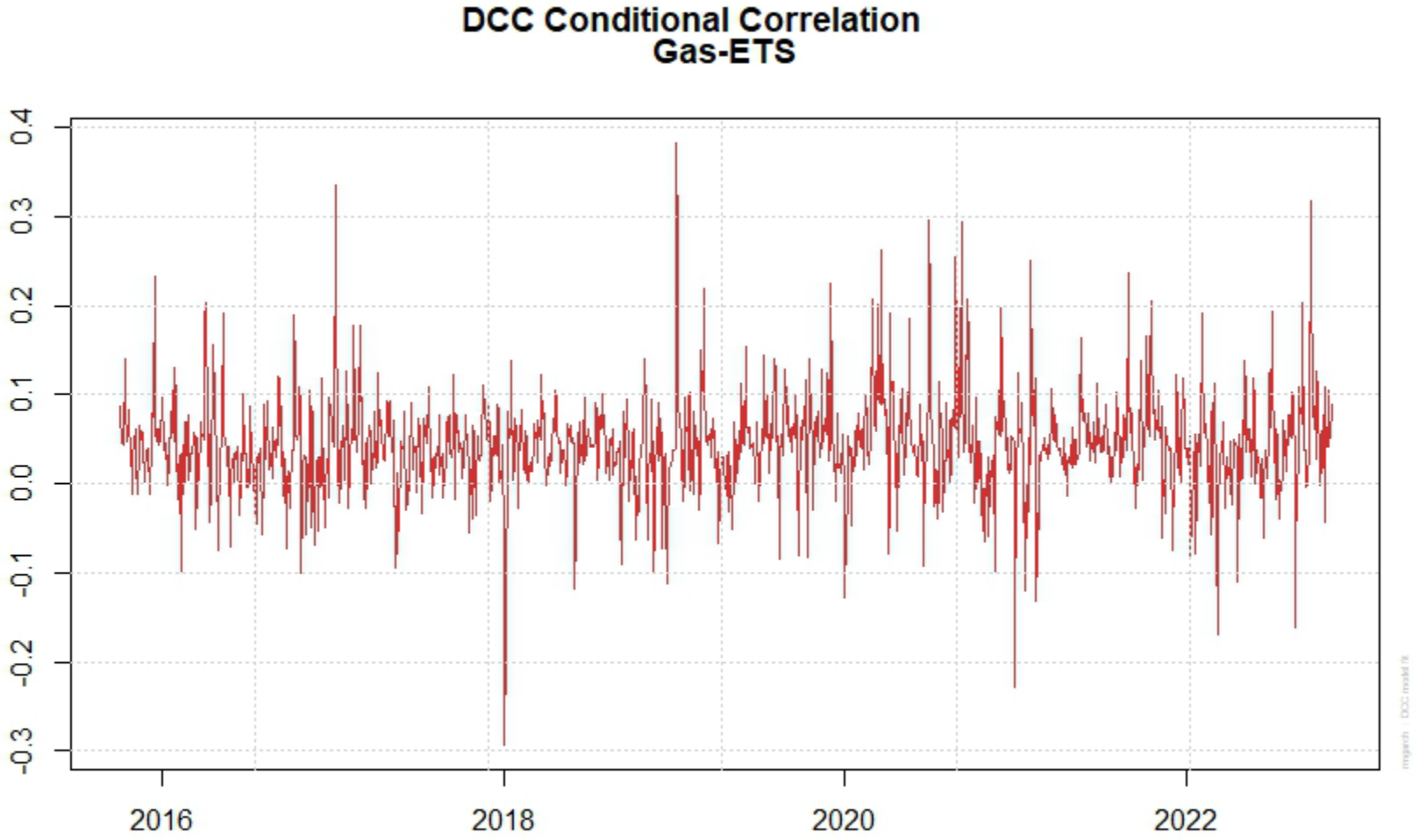
Conditional Correlations – DCC Garch (1)



Conditional Correlations – DCC Garch (2)



Conditional Correlations – DCC Garch (3)



Part IIb

Risk mangaement - VaR

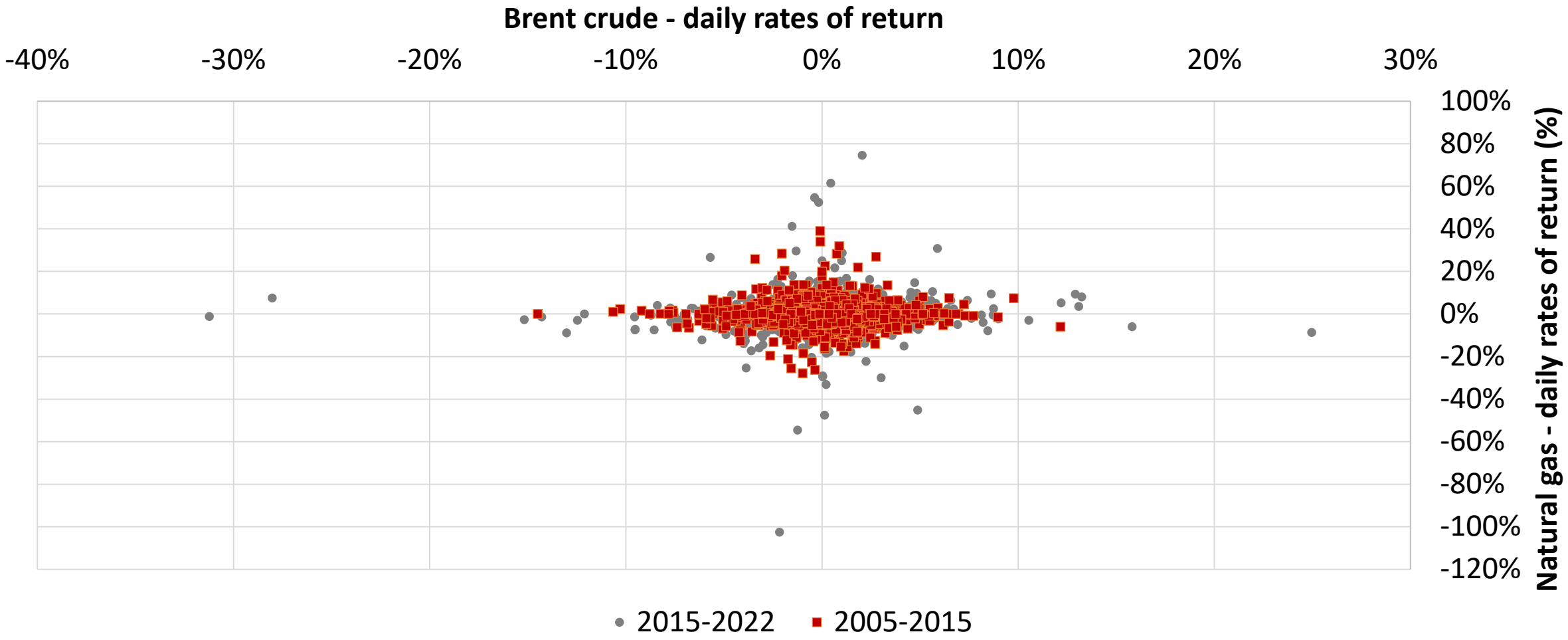
VaR – value at risk

- Definition – percentage loss, which you need to consider during the month of trading

- Derivation:
  - 5th percentile of the logarithmic returns' distribution
  - We analyzed the same series as in case of DCC-GARCH
  - Rolling 10 – years windows.

- Method:
  - Presently – Empirical distributions.
  - Target: Copula

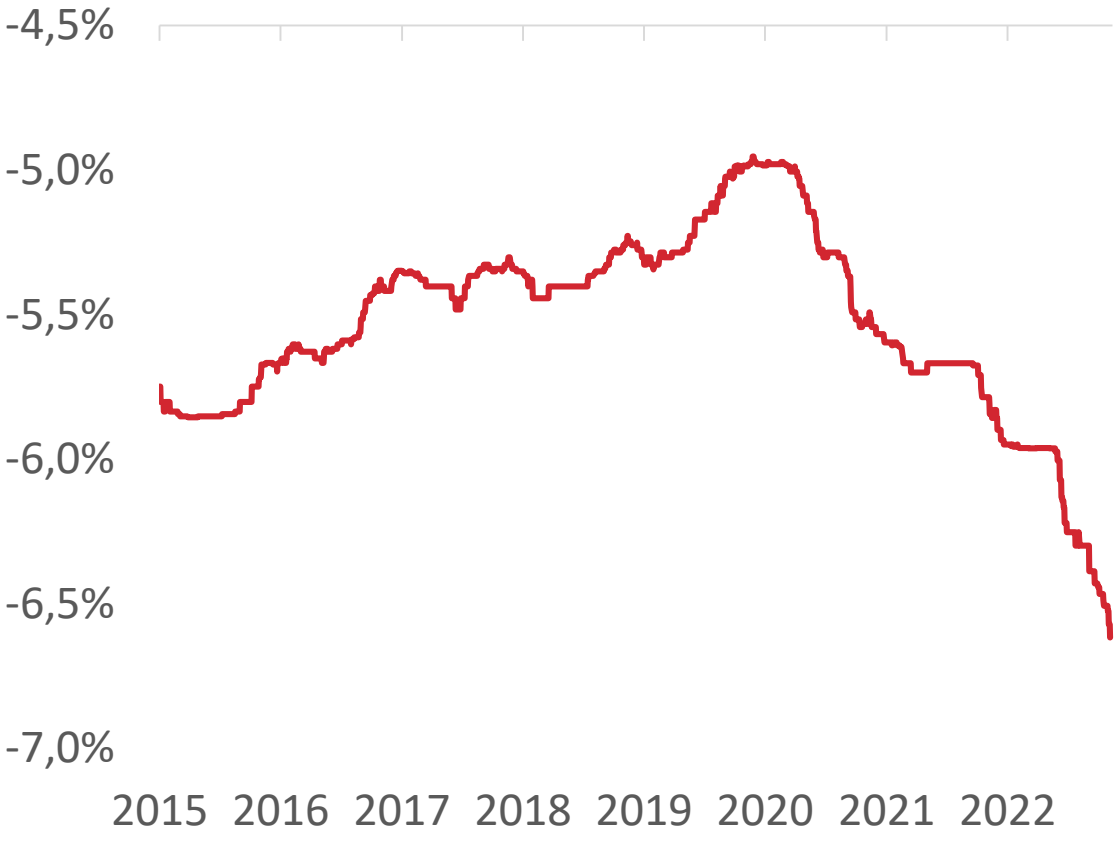
Volatility increased



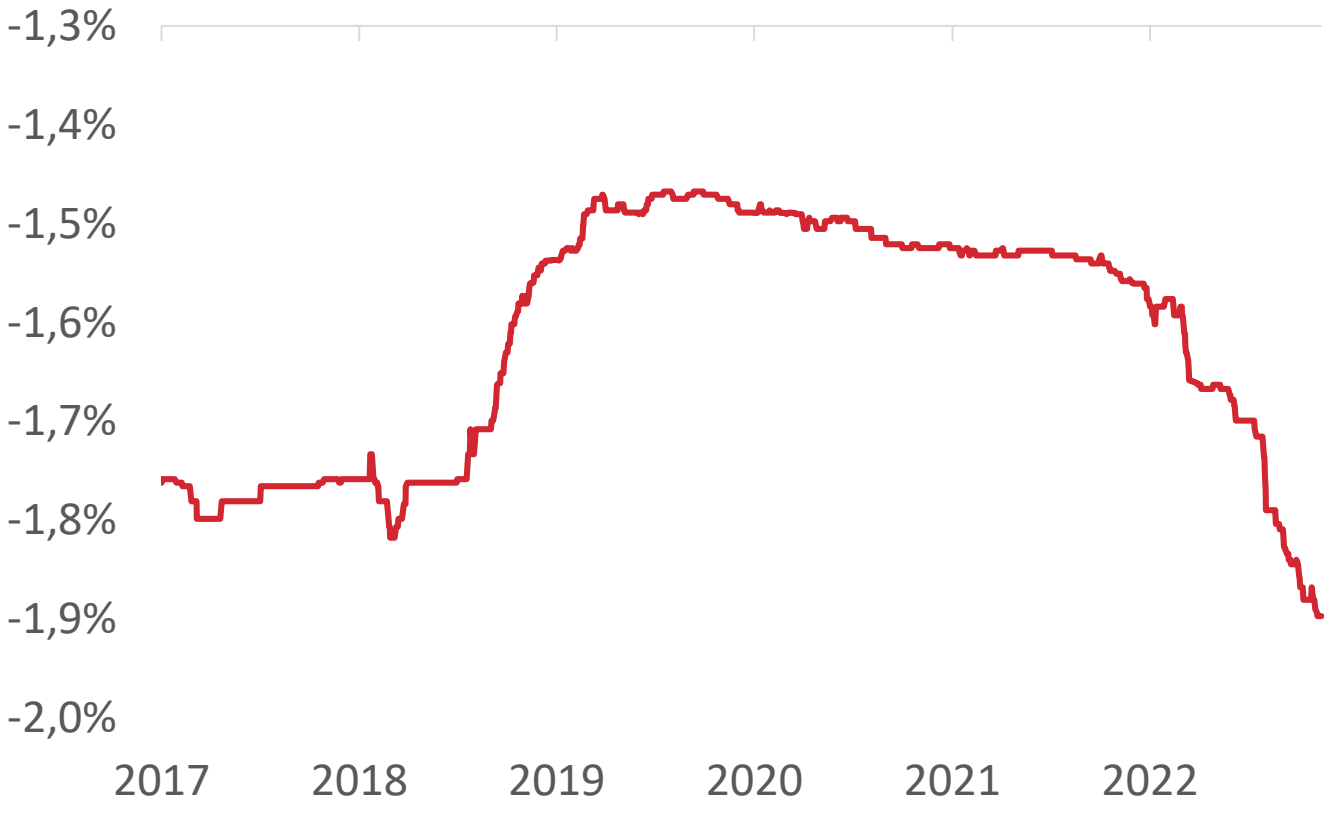
Source: Macrobond

Volatility of commodity prices increased after 2020

Value at Risk – Henry Hub natural gas futures



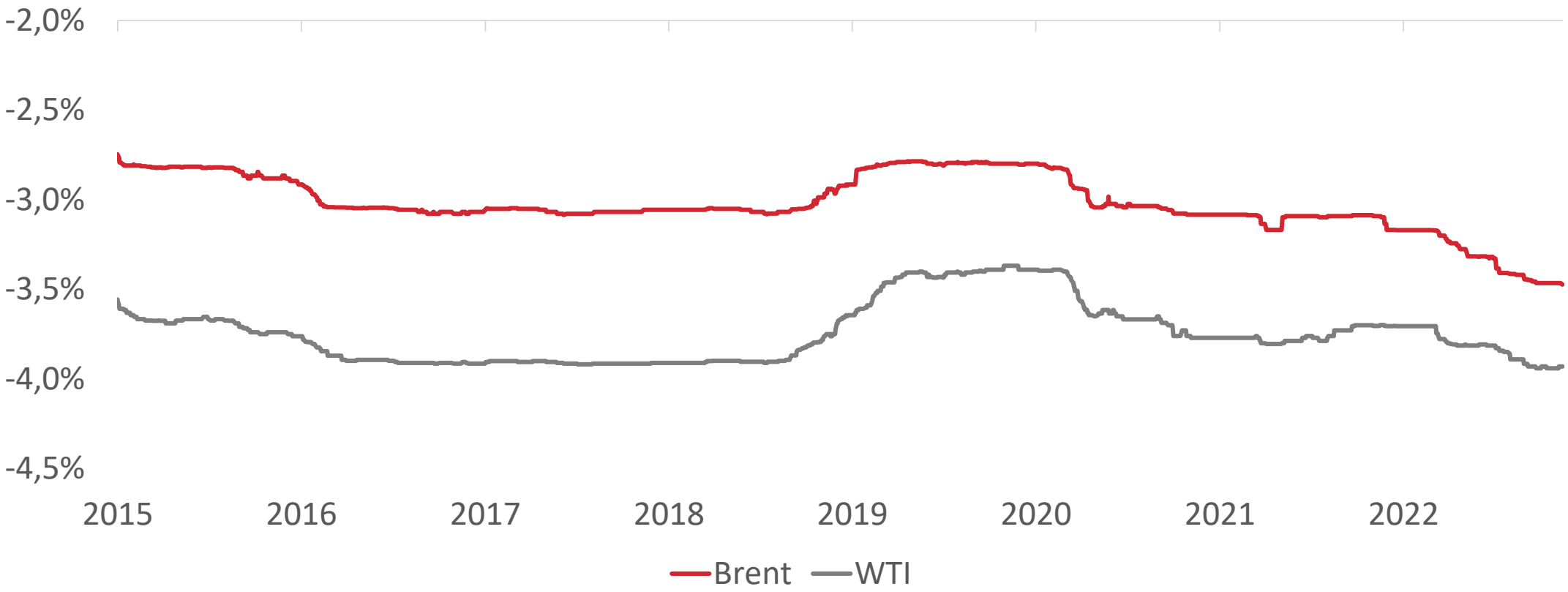
Value at Risk – Coal Rotterdam futures



Source: Macrobond., charts show 5th percentiles of logarithmic daily rates of return in the 10 year rolling window

Volatility of commodity prices increased after 2020

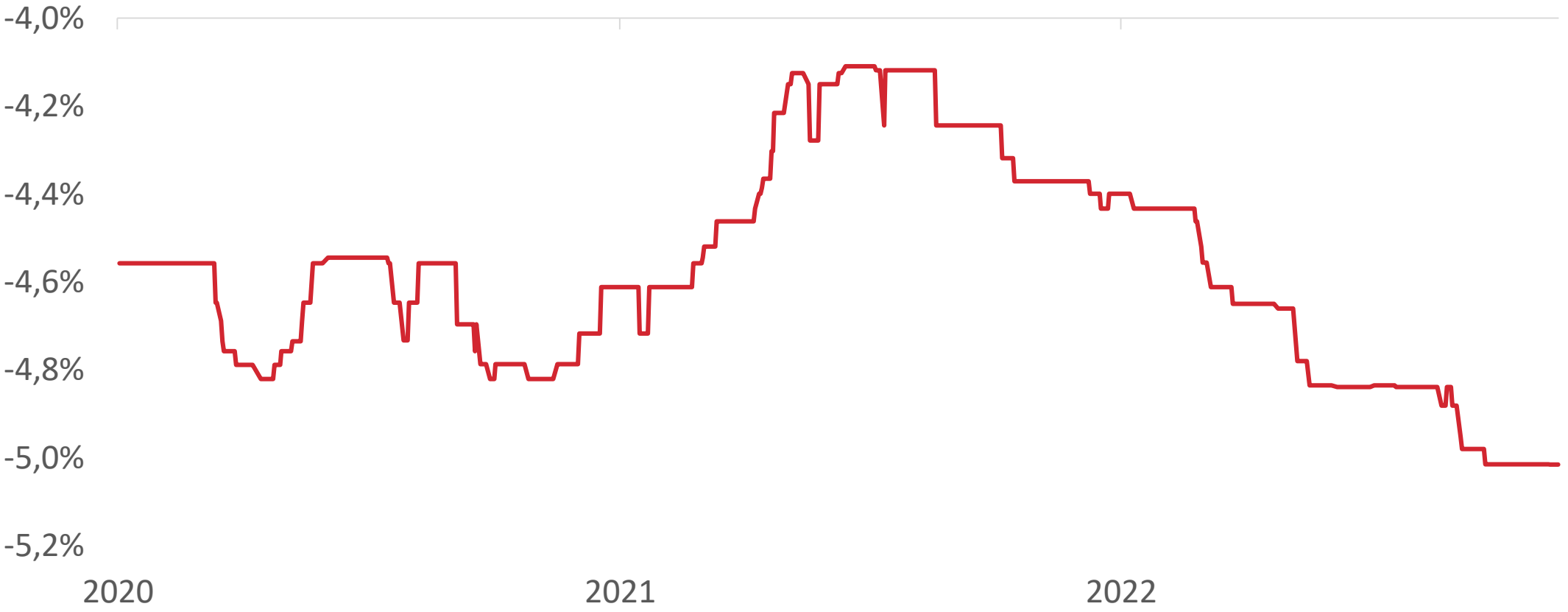
Value at Risk – WTI and Brent Oil futures



Source: Macrobond., charts show 5th percentiles of logarithmic daily rates of return in the 10 year rolling window

Simmilarly like EUA ETS prices

Value at Risk – EUA ETS futures



Source: Macrobond., charts show 5th percentiles of logarithmic daily rates of return in the 5 year rolling window

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Thank you

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