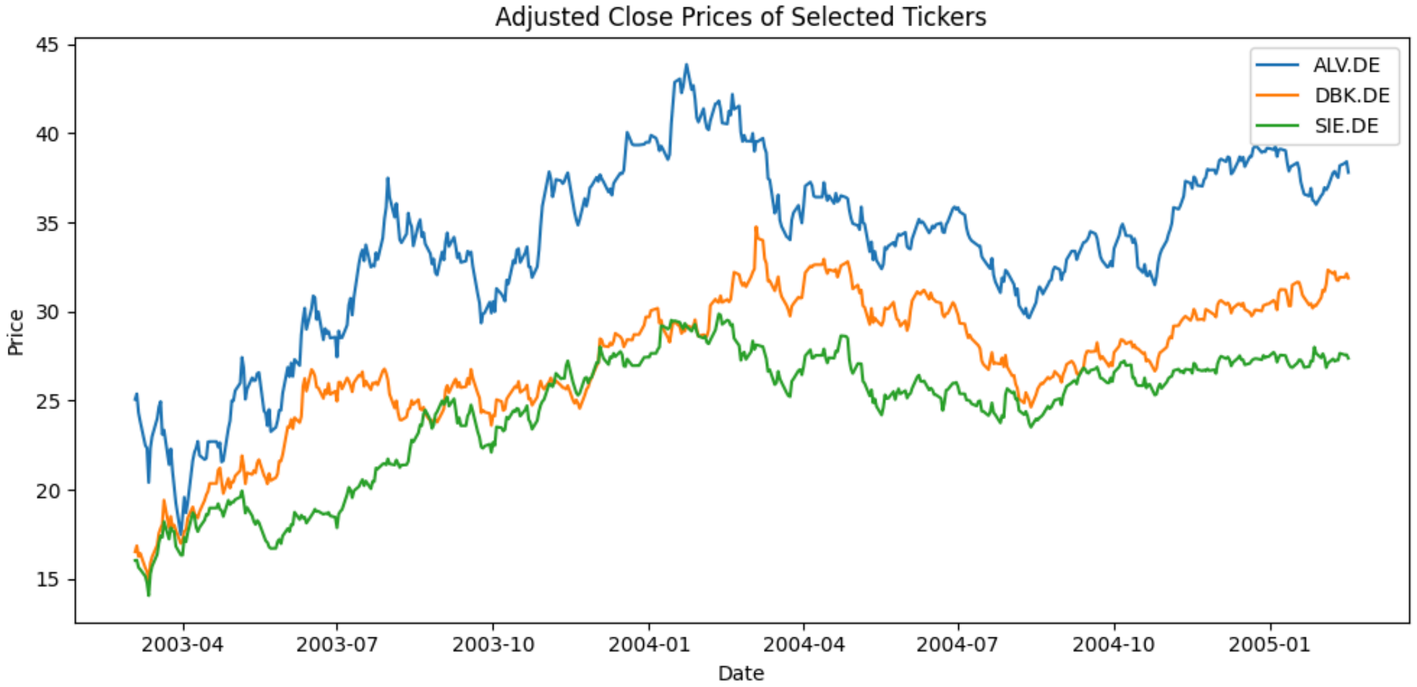
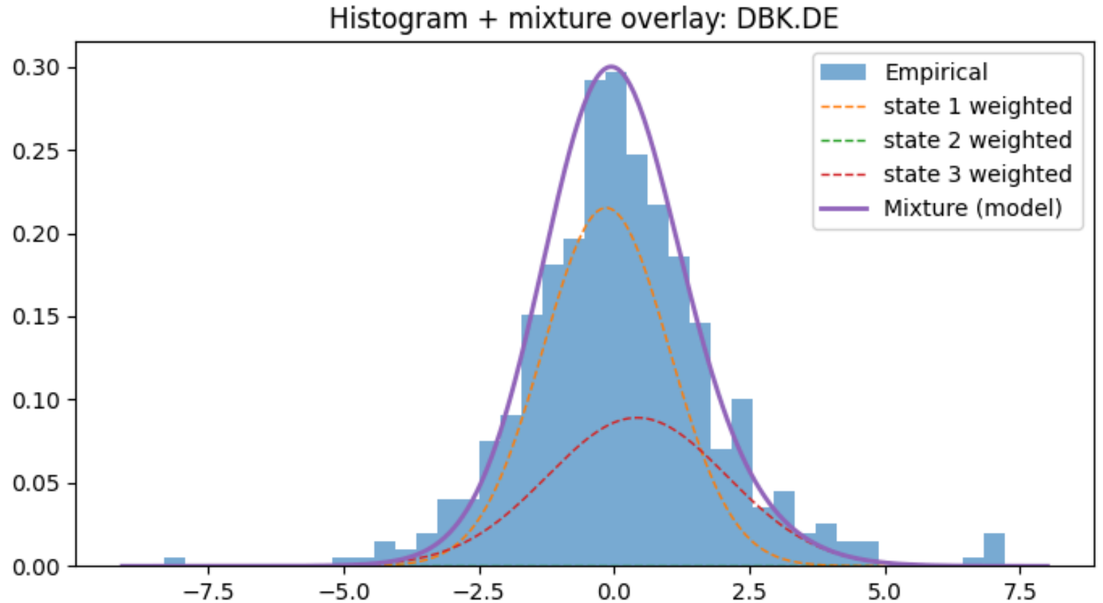
HIDDEN MARKOV MODELS FOR FINANCIAL TIME SERIES

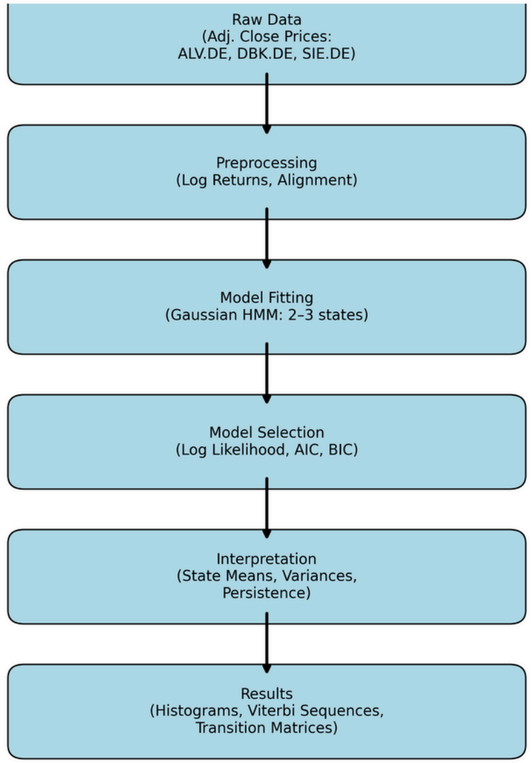
- Financial returns often show volatility clustering and hidden regimes.
- Simple Gaussian models cannot capture such patterns.
- Hidden Markov Models (HMMs) allow us to model unobserved states like low and high volatility regimes.
- Objective: Fit HMMs on stock returns to detect and interpret market regimes.

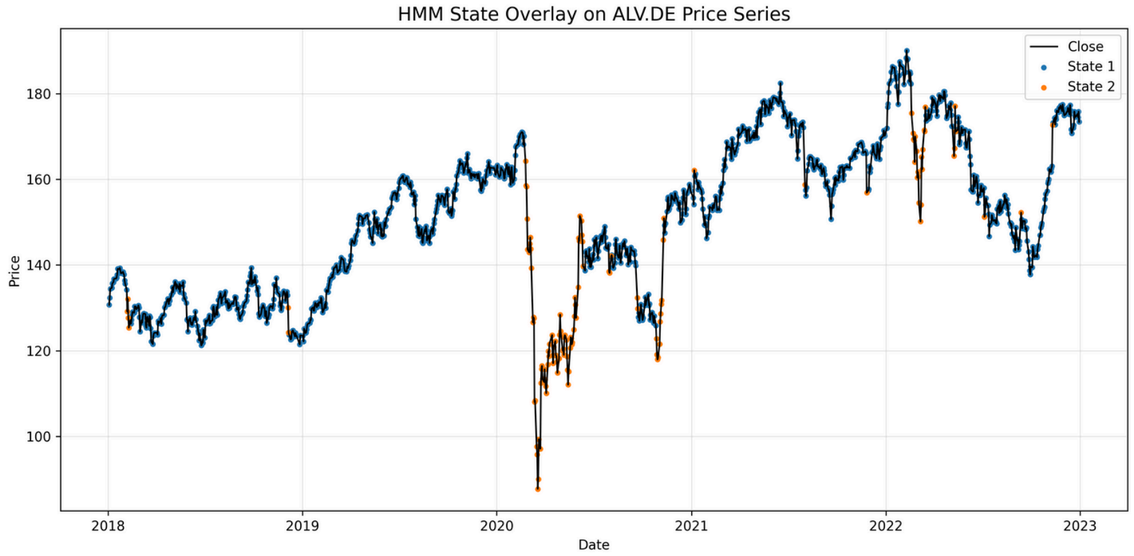




APPROACH

- Collected daily adjusted close data (2003–2005) for 3 German stocks.
- Computed log returns and aligned time series.
- Fitted Gaussian HMMs with 2 and 3 states.
- Used log-likelihood, AIC, BIC for model selection.
- Extracted transition probabilities, stationary distribution, state means & variances.

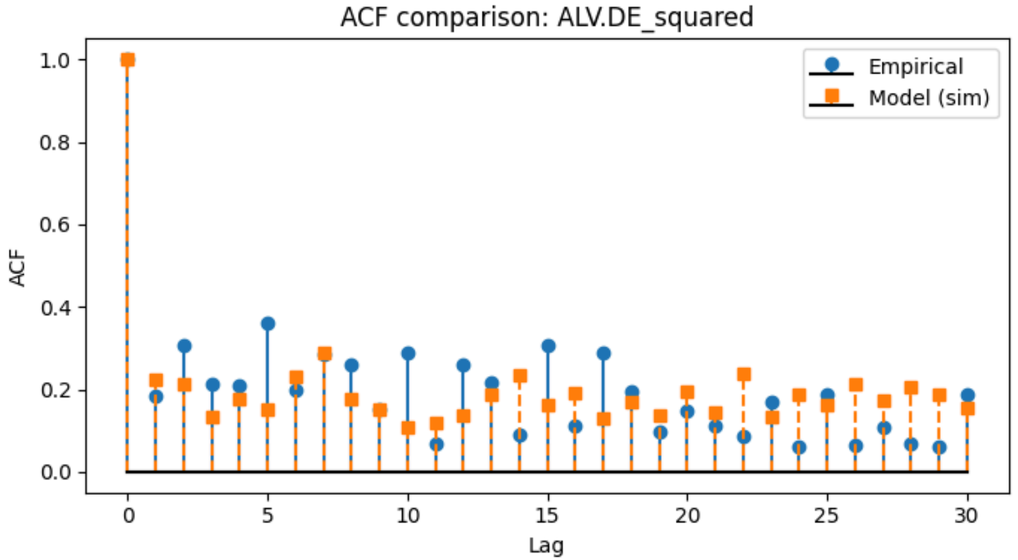


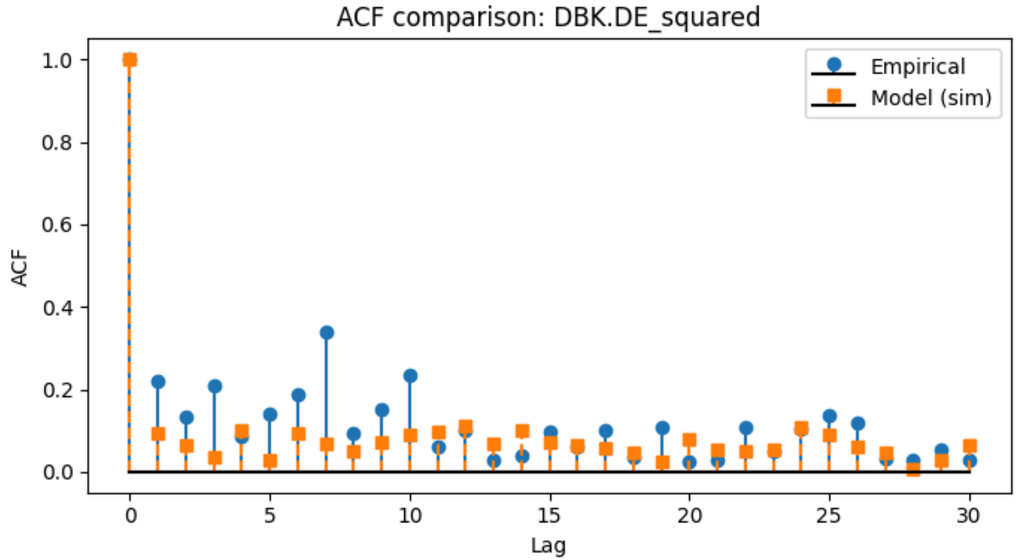


- The time series line represents the stock's actual closing prices over time.
- The colored background or line segments correspond to the hidden states identified by the HMM (e.g., "bullish," "bearish," or "sideways" regimes).
- Each state is inferred by the HMM based on statistical patterns in the returns/volatility, not directly visible in the raw price.

RESULTS

- Best model selected by BIC → typically 2 states.
- State 1: Low volatility, small return variance.
- State 2: High volatility, large return variance.
- Transition matrix shows persistence within states (markets tend to “stay” in regimes).
- HMM successfully captures hidden regimes and matches empirical volatility clustering.





- ALV.DE: Model captures overall decay but underestimates mid-lag correlations.
- DBK.DE: Model fits better, closely matching short-lag autocorrelations.