Neural networks and econometric models in forecasting stock returns

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Agenda

1. Introduction
   - Motivation (what for?)
   - Targets (what do we want?)
   - Tasks (how to achieve it?)
2. Pre-experiment
   - Hypothesis (what is assumed?)
   - Data analysis (what/where/insights)
   - Method (how it was proved?)
3. Post-experiment
   - Tables of comparison (experiment results)
   - Discussion (new insights)
4. References
5. Conclusion

Reason

- Money around us
- Profit and utility maximization
- New methods are needed
- How to find the best model in case of different markets?

Consequence

- Data $\Rightarrow$ Big Data
- Statistics $\Rightarrow$ AI & Econometrics
- Machine Learning vs Econometrics
- Deep Learning vs Econometrics

Motivation

- **Theoretical**: Further rapid development of forecasting models.
- **Practical**: Much easier $\Rightarrow$ much quicker — "Buy, hold or sell"?
  As a result — much reliable decisions $\Rightarrow$ investors are happy.

Targets

- Help traders to make accurate decisions on "Buy, hold or sell"?
- Make stock deals more "secure" (low risk) and profitable.
- Make people stop being scared of stock market.

Tasks

- Provide the sequential models' comparison based on empirical data.
- Find the "best" model, according to the topology function.
- **Data**: 15 American and Chinese companies.

  Markets: Developed (US) and developing (China).

  NB! Various industries (for overall result).

Hypothesis

Essential:

- Market Efficiency [Fama, 1970] - impossible to predict anything.

In contrast:

- Market Fractality [Mandelbrot, 2006] - markets have long memory.
- Market "inefficiency" [Sewell, 2011] - Market Efficiency is not true (but best for today).

Trial:

- Neural Network approach is the best for developed and developing markets.

Data analysis

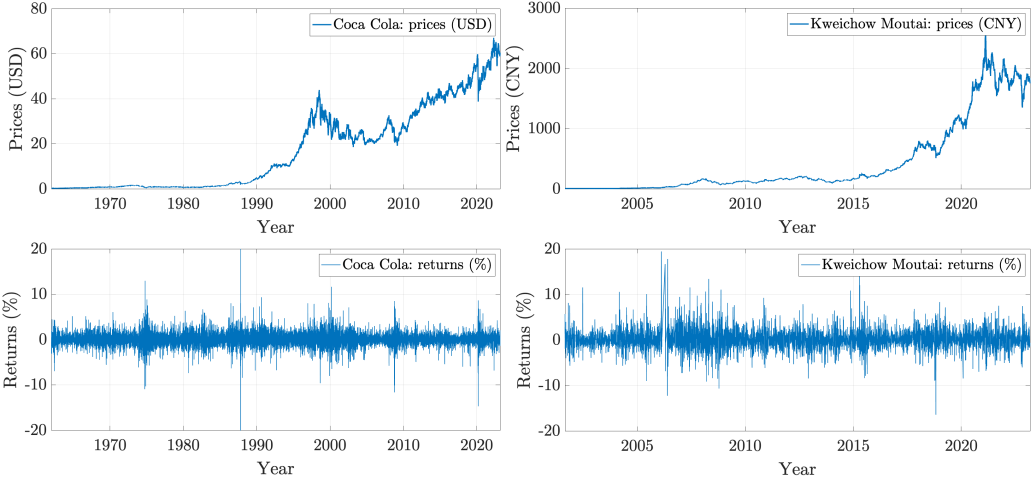
What: Stock prices of 15 US and China companies.

From: New York and Shanghai (not Hong-kong) stocks.

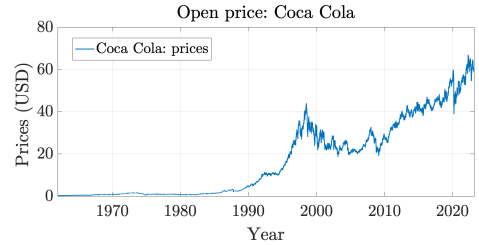
Period: IPO (different for each company) – 13/12/2022.

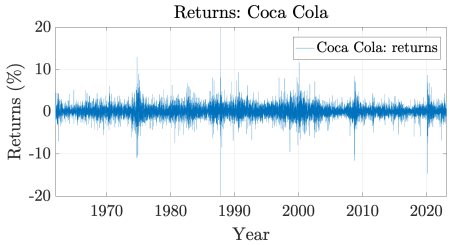
Industries: IT (AMD), media (Netflix), sales (Ebay), taxi (Uber), auto (Ford), sport (Nike), energy (General Electric) and so on.

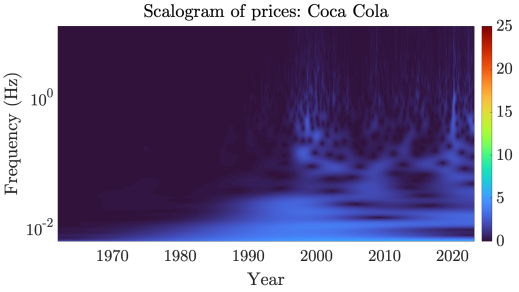
Data analysis (visual insights) — Open prices and returns: US & China

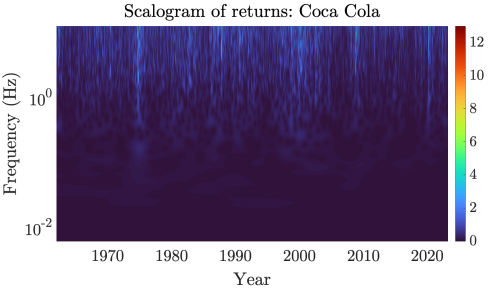


Data analysis (scalogram insights) — Coca Cola

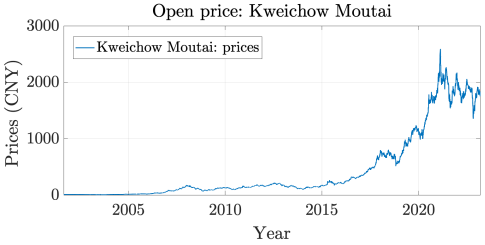


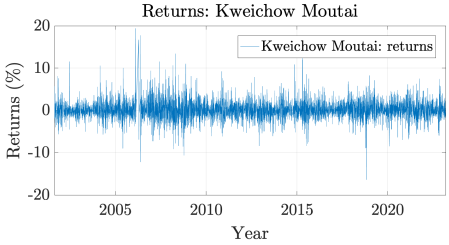


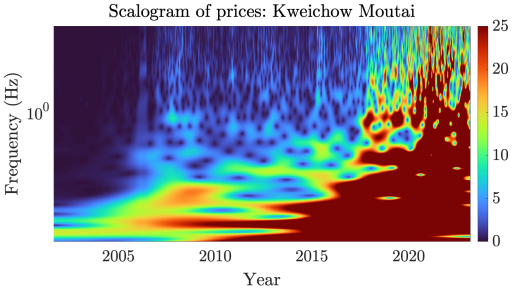


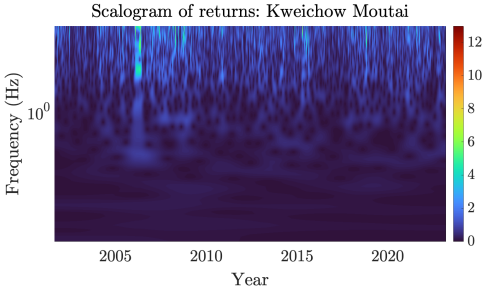


Data analysis (scalogram insights) — Kweichow Moutai









Method

Econometric approach:

1. EWMA
2. ARIMA
3. ARIMA + (FI)GARCH
4. ARFIMA
5. ARFIMA + (FI)GARCH
6. SSA (Singular Spectrum Analysis)

Network approach:

1. MLP/RNN/WN
2. MSSA/EWMA + MLP/RNN/WN
3. No "transformers" $\Leftarrow$ [Zeng et al., 2022]

Metrics Function:

$$\text{WAPE}(\hat{y}, y) = \frac{\sum_{t=1}^{n} |y_t - \hat{y}_t|}{\sum_{t=1}^{n} |y_t|} \qquad (1)$$

NB! MSSA — Multistage Singular Spectrum Analysis [Kuang et al., 2020].

Diagram of Price Errors Comparison (%)

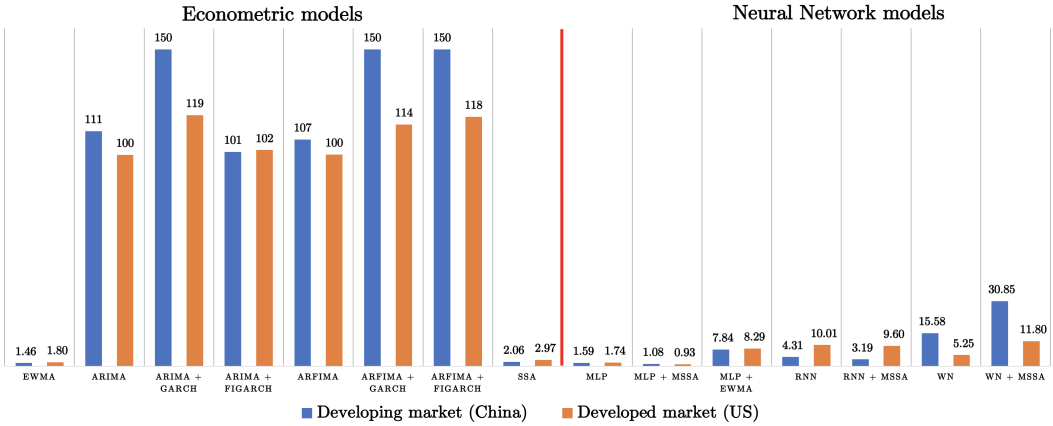
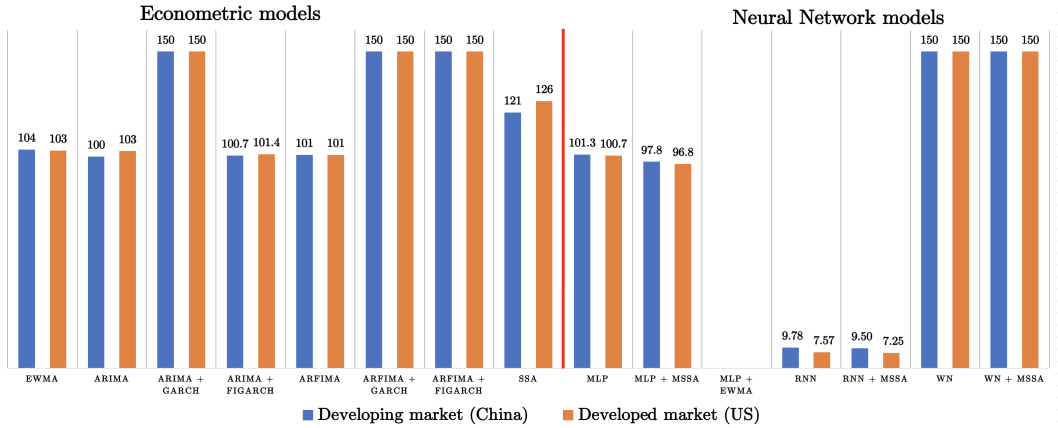


Diagram of Returns Errors Comparison (%)



Discussion (new insights)

1. (Accuracy) Prices forecast $\gg$ Returns forecast
2. MSSA + MLP $\Rightarrow$ Best for prices
3. MSSA + RNN $\Rightarrow$ Best for returns
4. Econometric models $\Rightarrow$ bad for returns forecasting
5. Econometric models $\Rightarrow$ less accurate for developing market (prices)
6. No noise $\Rightarrow$ more accurate forecast: **exception** Wavelet Networks
7. WN & MSSA + WN $\equiv$ 7 days of Network training
8. EWMA $\equiv$ the fastest and is "simple" RNN
9. Boosting $\equiv$ bad attempt (ARIMA + GARCH, ARFIMA + GARCH)
10. ARFIMA is better than ARIMA $\Rightarrow$ Market fractallity exists [Mandelbrot, 2006]

References

[Fama, 1970] Fama, E. (1970).
Efficient capital markets, a review of theory and empirical work.
The journal of Finance, 25(2):383–417.

[Kuang et al., 2020] Kuang, W., Wang, S., Lai, Y., and Ling, W.-K. (2020).
Efficient and adaptive signal denoising based on multistage singular spectrum analysis.
IEEE Transactions on Instrumentation and Measurement, 70:1–20.

[Mandelbrot, 2006] Mandelbrot, B. (2006).
The (mis)behavior of markets, a fractal view of risk, ruin and reward.
Journal of Economic Behavior and Organization, 61(3):513–515.

[Sewell, 2011] Sewell, M. (2011).
History of the efficient market hypothesis.
Rn, 11(04):04.

[Zeng et al., 2022] Zeng, A., Chen, M., Zhang, L., and Xu, Q. (2022).
Are transformers effective for time series forecasting?

Conclusion

Thank you for attention!