Paper discussion
High-Frequency Expectations from Asset Prices:
A Machine Learning Approach

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Summary of Contributions

- "The first serious application of reinforcement learning in asset pricing." (p.5)
- Promising empirical results from the learning approach.
  - Standard treatment on big data issue: basic economic models + LASSO / boosting for selection
  - Modern scientific method for training the learning models (Appendices B, D, and F)
  - Promising outcome when comparing to MIDAS and Kalman Filter.
- Interpretable method & applicable to policy / information studies.

Reinforcement Learning (RL) Method — summary from the paper

What is RL?

> 3.   An advertisement company wants to increase the number of clicks in the ads displayed to visitors of a website. To do that, a **reinforcement learning** model is used to generate an eye-catching advertisement, featuring the image of the product and a generated slogan. The model can adapt the way the elements are arranged, as well as the text, and the format. The system gets a reward every time a visitor clicks on the ad.

Figure: European Commission (2020), *Robustness and Explainability of Artificial Intelligence*, EU JRC Tech Report, p.11

Formal set-up (pp.12-3)

- State s_t, state feature $\phi(s_t)$, expected growth $a_t = \hat{\mu}_{t+1|t}$ and parameter λ
- Try learning the optimal policy $a_t = g_\lambda(s_t) = \langle \phi(s_t), \lambda \rangle$
- Minimise by approximation distance($g_\lambda^{T-1}(s_1), \mu_T$) for every announcement day T, happening once per quarter.

Potential Extension

Collaboration with time series literature?

- Learning with time series concept:[1]
  - Dynamic feature selection
  - Time series windows & order determination

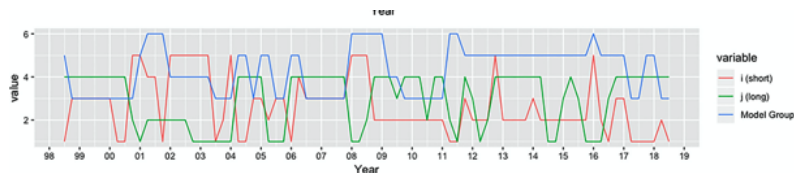- Time series treatment catered for economic context

Figure: Yang (2020)

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[1]Yang, Parley Ruogu (2020), *Using the yield curve to forecast economic growth,* Journal of Forecasting, 2020; 39: 1057– 1080. DOI: 10.1002/for.2676

Adversarial attacks / model stability? [2] ['Robustness' of AI]

- Background from learning literature: well-trained and "interpretable" Neural Networks may still identify a blurry cat as a fire lorry. This is bad and damages explainability.

Figure: The left (cat) is from CMS, Cambridge, and the right (fire lorry) is from Wikipedia

[2]Vegard Antun, Francesco Renna, Clarice Poon, Ben Adcock, Anders C. Hansen (2020), *On instabilities of deep learning in image reconstruction and the potential costs of AI* ,Proceedings of the National Academy of Sciences 2020, 201907377; DOI: 10.1073/pnas.1907377117

	Mean	Event
2011-08-08	-0.65	U.S. credit rating downgrade
2011-08-09	0.51	Fed promises to keep interest rates near zero for two years
2008-10-15	-0.51	Weak Fed economic forecasts, Bernanke comments
2008-10-28	0.50	Unclear
2011-08-04	-0.45	Weak jobs data, Japan weakens Yen, ECB re-enters bond market
2008-10-09	-0.44	Unclear
2009-03-23	0.44	Treasury announces TARP
2008-09-29	-0.43	House rejects bank bailout plan
2011-08-11	0.40	Jobless claims fall, strong earnings
2009-03-10	0.38	Citi earnings positive (were expected to be negative)

Figure: Table 7 from the paper

- In this paper: tail-side events may contribute to mis-pricing and short-term volatility. Some effort (p.17 and Table 7) has been put to identify and interpret the outcome, but more technical work could be done (or could it?)

- Interpretability issue: current work is via an ex-post rationalisation, but some may fail (labelled as "Unclear" in the table).

- Though, the interpretability and stability issues come in hand-in-hand.

Conclusion

1. Promising empirical results with innovative method that integrates statistical learning methods and engages with economic debates

2. Methodology:
   - Innovative and can be extended for future engagement with both the scientific and social science communities

3. Future:
   - Method: General models with asymptotic analysis or simulations. Stable learning algorithm desired.
   - Empirical: application to Micro-Macro / Finance-Finance panel or synthetic time series in a data-rich environment. E.g. analysis of the effect of negative interest rate policy.