

Alpha Go Everywhere: Machine Learning and International Stock Returns

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Summary

- This paper applies machine learning techniques to predict international stock returns using firm characteristics.
- Focusing on two dimensions:
 - Machine learning models: linear v.s. non-linear.
 - Data sample: U.S.-only v.s. market-specific.
- Implications for international asset pricing:
 - International return-characteristics relationships.
 - Best ML model for global market.
 - Cross-market integration.

Main Findings

- The tests are performed on **32** markets and **36** firm characteristic variables.
- In terms of **machine learning models**:
 - Neural network (NN) models seem to be the best, compared to other non-linear models (regression trees) and linear models (OLS w Huber, Lasso, Ridge).
 - A modest number of stock characteristics is enough, compared to Gu, Kelly, and Xiu (2020).
- In terms of **data choice**:
 - Local market-specific models are better than U.S.-only models.
 - But the U.S. market contains information that can improve ML model performance in other non-U.S. local markets.

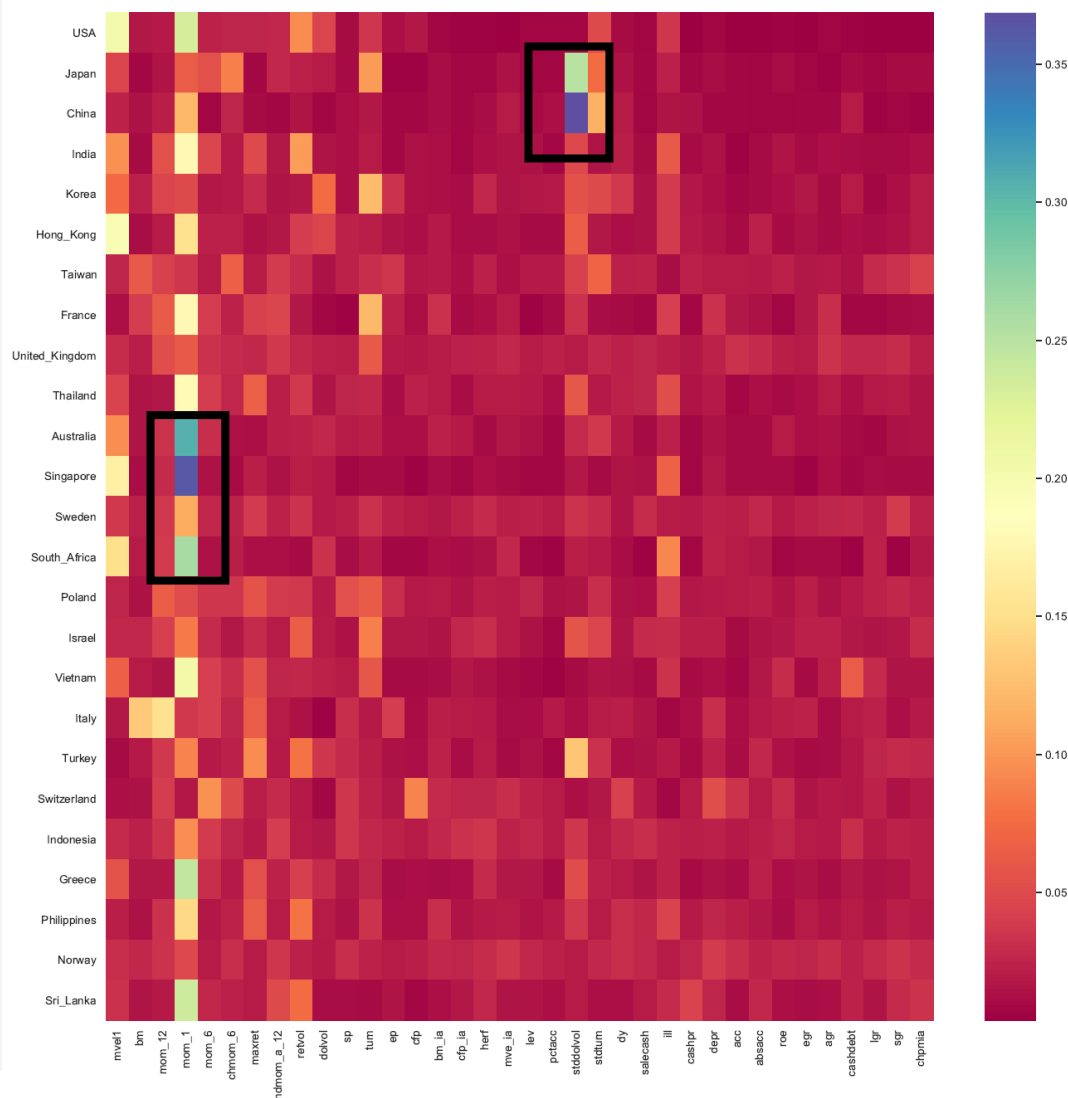
Implications for International Asset Pricing

- International return-characteristics relationship:
 - Some are common variables (market cap and 1-month reversal).
 - Others are market-specific variables (vol of trading volume and turnover for China, for example).
- NN is the best ML model for the global market.
- Cross-market Integration:
 - Augmented models with U.S. characteristics gaps and factors significantly increase the predictions of both the global and market-specific models.

My comments:

- Overall, the paper offers a very large-scale and extensive ML exercises on the international equity market.
- The empirical tests are carefully designed and well executed.
- The contribution to the machine learning literature (with finance application) is clearly significant.
- The paper could benefit from more in-depth discussions on international asset pricing implications. In particular, **what are the insights that are not achievable using traditional linear models/approaches?**

Example 1: International return-characteristics relationship



- How are the relative importance of characteristics differ from the existing findings based on simple linear methods (characteristics-based sorted factors) for international markets?
- Debate on risk v.s. mispricing?

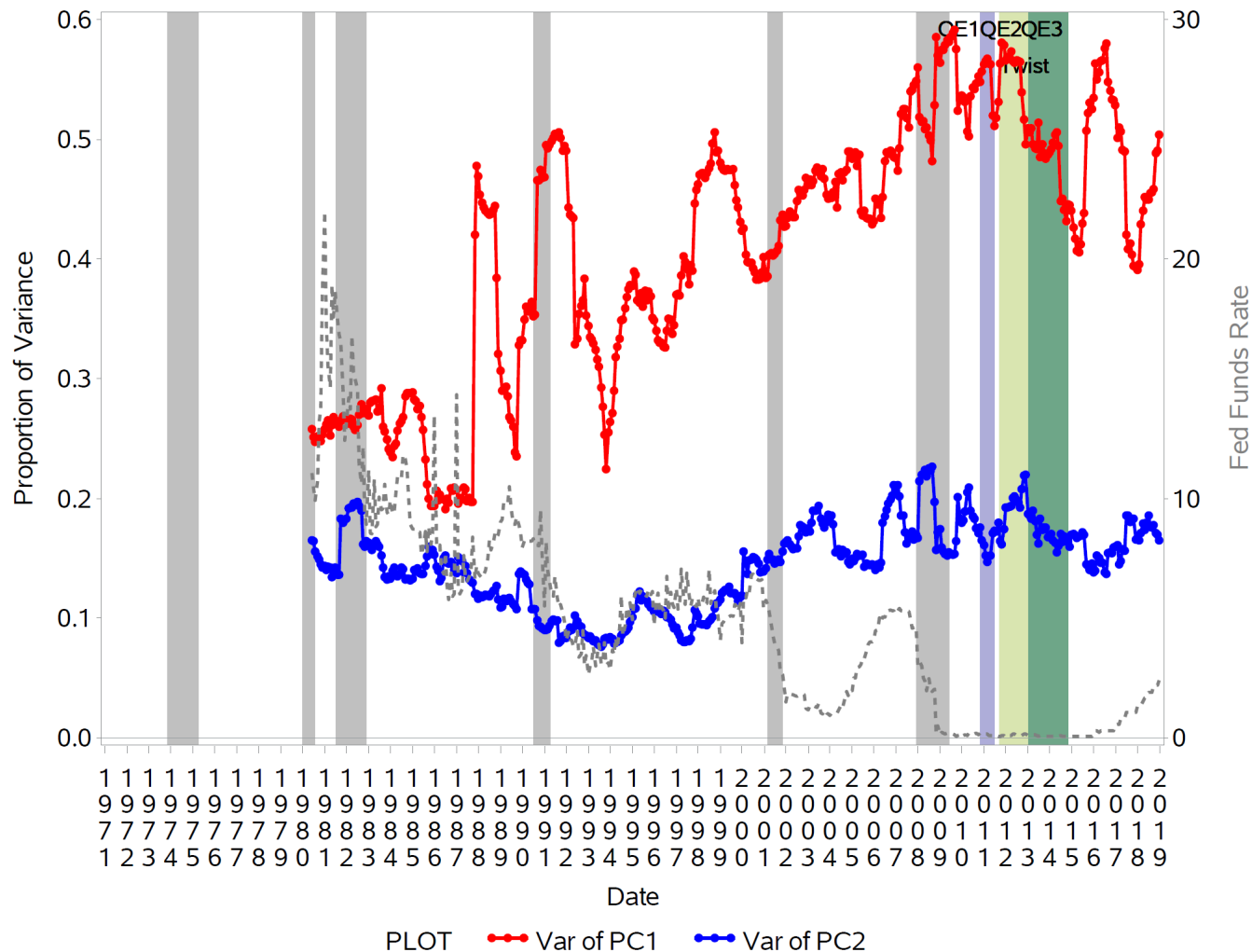
Example 2: Cross-Market Integration

Panel A: Augmented model using all stock characteristics, all US factors, all local factors, and all US characteristic gaps vs. original model

	NN1	NN2	NN3	NN4	NN5	Best NN
Sharpe Ratio (EW)	-0.31	0.15	0.72	0.36	0.83	0.57
Sharpe Ratio (VW)	0.29	0.31	0.66	0.43	0.54	0.54

- The information derived from U.S. stocks can improve the predictive power of NN models on international stock returns.
- The “U.S. information” is constructed as the U.S. characteristics gaps, factors, and their interaction terms (simple and don’t need any ML techniques).
- If we re-run the tests for simple linear models, will adding “U.S. information” also offer improvement in predictions?
 - If yes, what are the new insights on cross-market integration that we learn from complicated ML exercises?
- A minor comment: Is it really the U.S.? For example, a placebo test by replacing the U.S. with Japan.

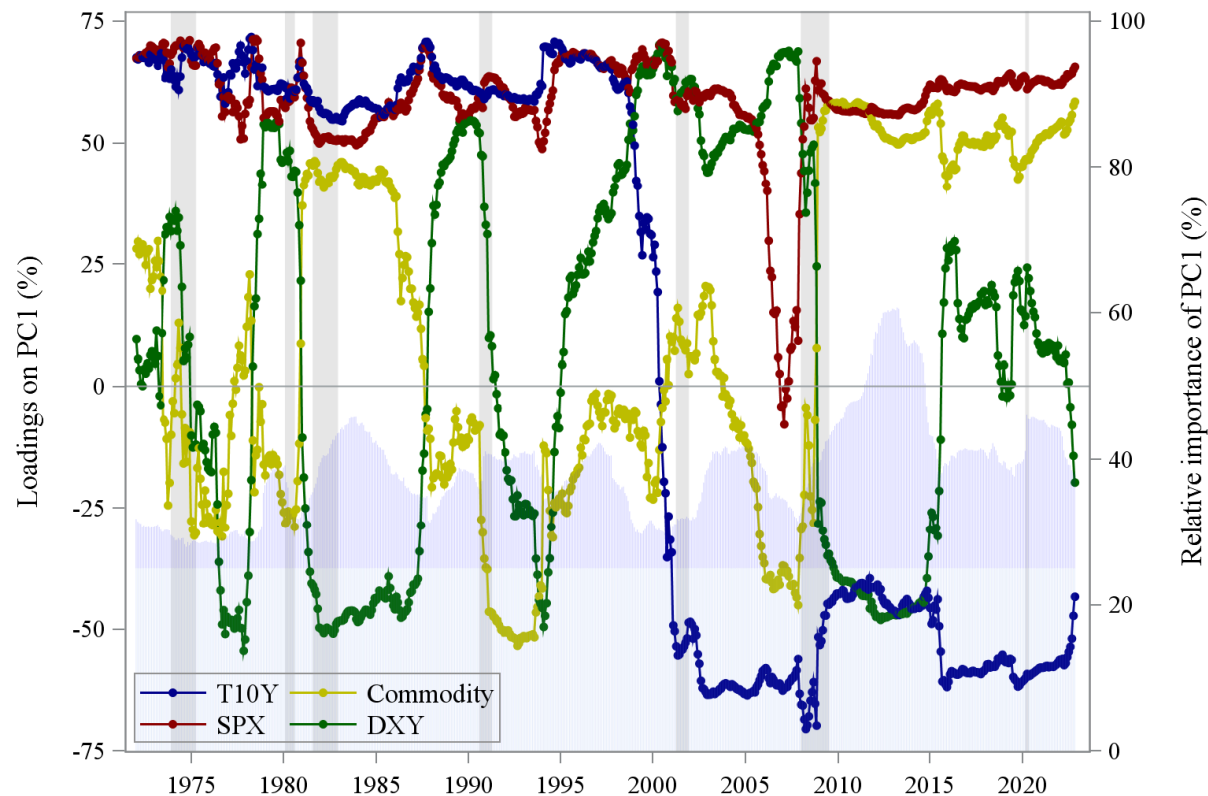
Alternative Evidences on Cross-Market Integration: A Simple PCA Analysis on International Stock Returns



Alternative Evidences on Cross-Market Integration: A Simple PCA Analysis on Global Key Assets

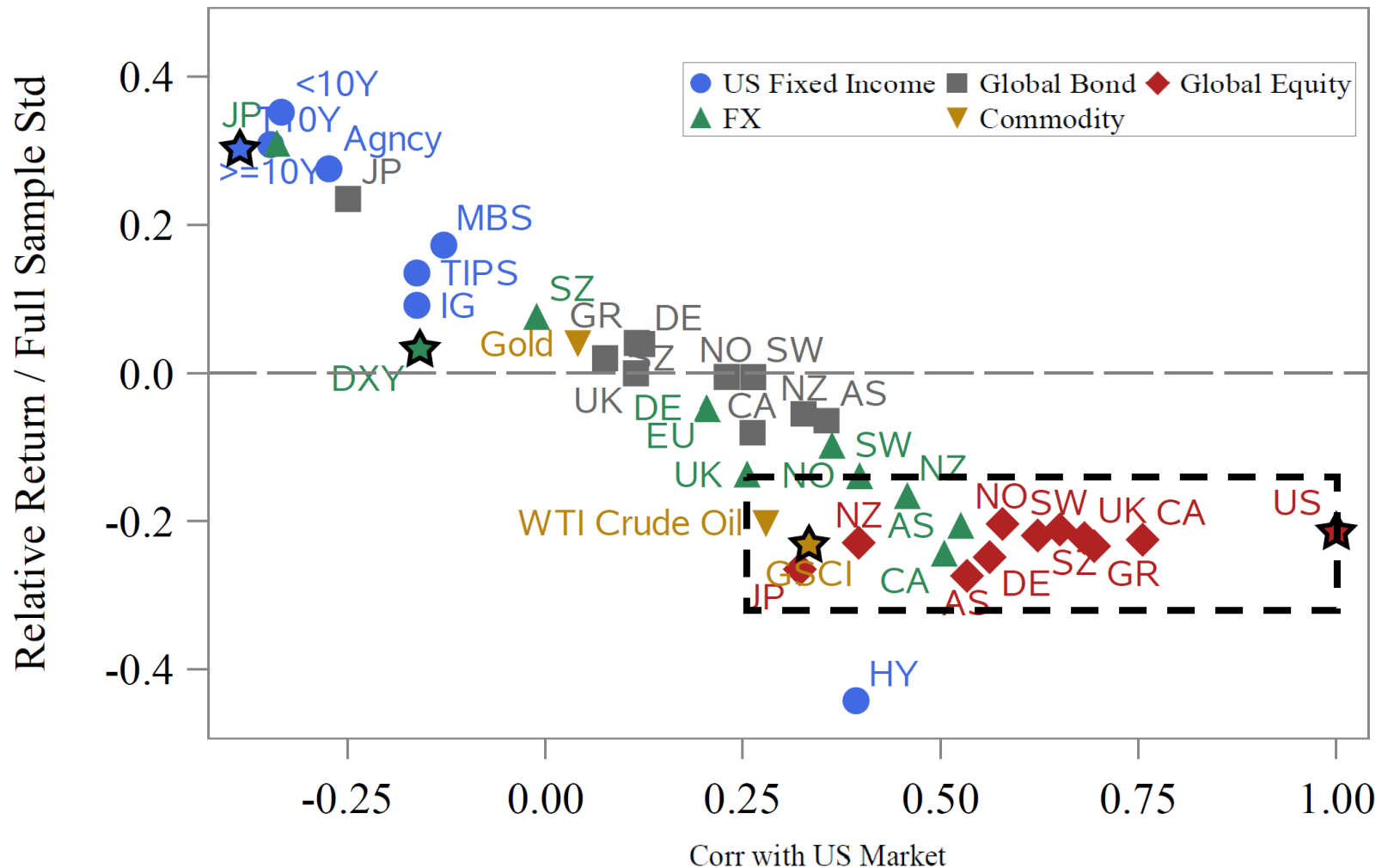
Source: Comovements in Global Markets and the Role of U.S. Treasury, Grace Xing Hu, Zhao Jin, and Jun Pan, Working Paper, 2022.

Figure 1: Principal Component Analysis on Global Key Assets



Alternative Evidences on Cross-Market Integration: Performance of Global Assets on Flight-to-Safety Days (Relative to Other Days)

Source: *Comovements in Global Markets and the Role of U.S. Treasury*, by Grace Xing Hu, Zhao Jin, and Jun Pan, Working Paper, 2022.



Conclusion

- The paper is very interesting and promising.
- The paper offers a very extensive set of machine-learning exercises on international stock returns.
- The paper could benefit from including more discussions on the unique asset-pricing implications/insights provided by the empirical results.
- Highly recommend and good luck.