Wharton
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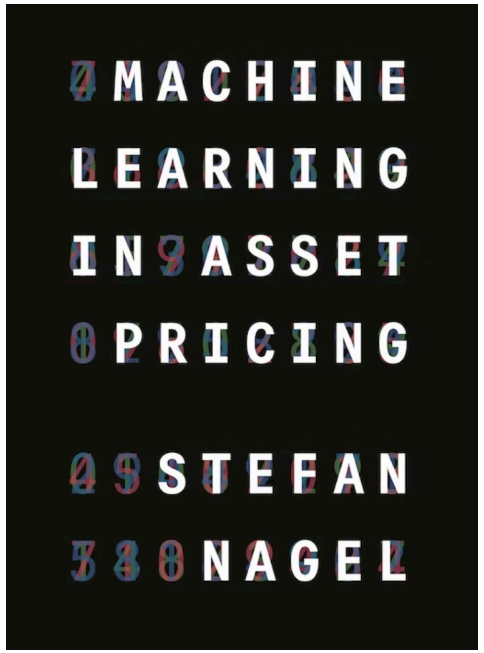
JACOBS LEVY EQUITY
MANAGEMENT CENTER
for Quantitative Financial Research

Discussion on "The Statistical Limits to Arbitrage" by Da, Nagel and Xiu

Yao Zeng, Wharton School, University of Pennsylvania

A little more color on background

I'm reluctant to give this team advice on financial econometrics or machine learning



Financial Machine Learning

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My "Xiu-number" is 2: Jianqing Fan as a shared co-author

A little more color on background

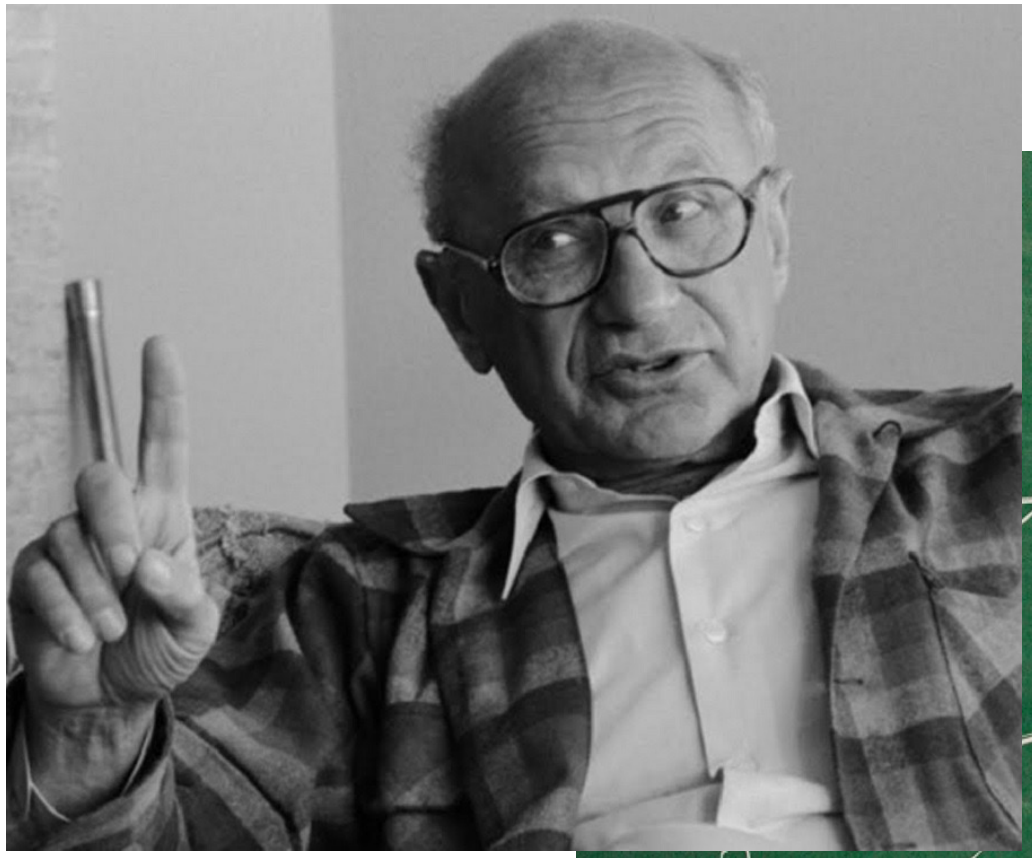
But, I immediately say yes when asked as a discussant; a fascinating read and a polished paper

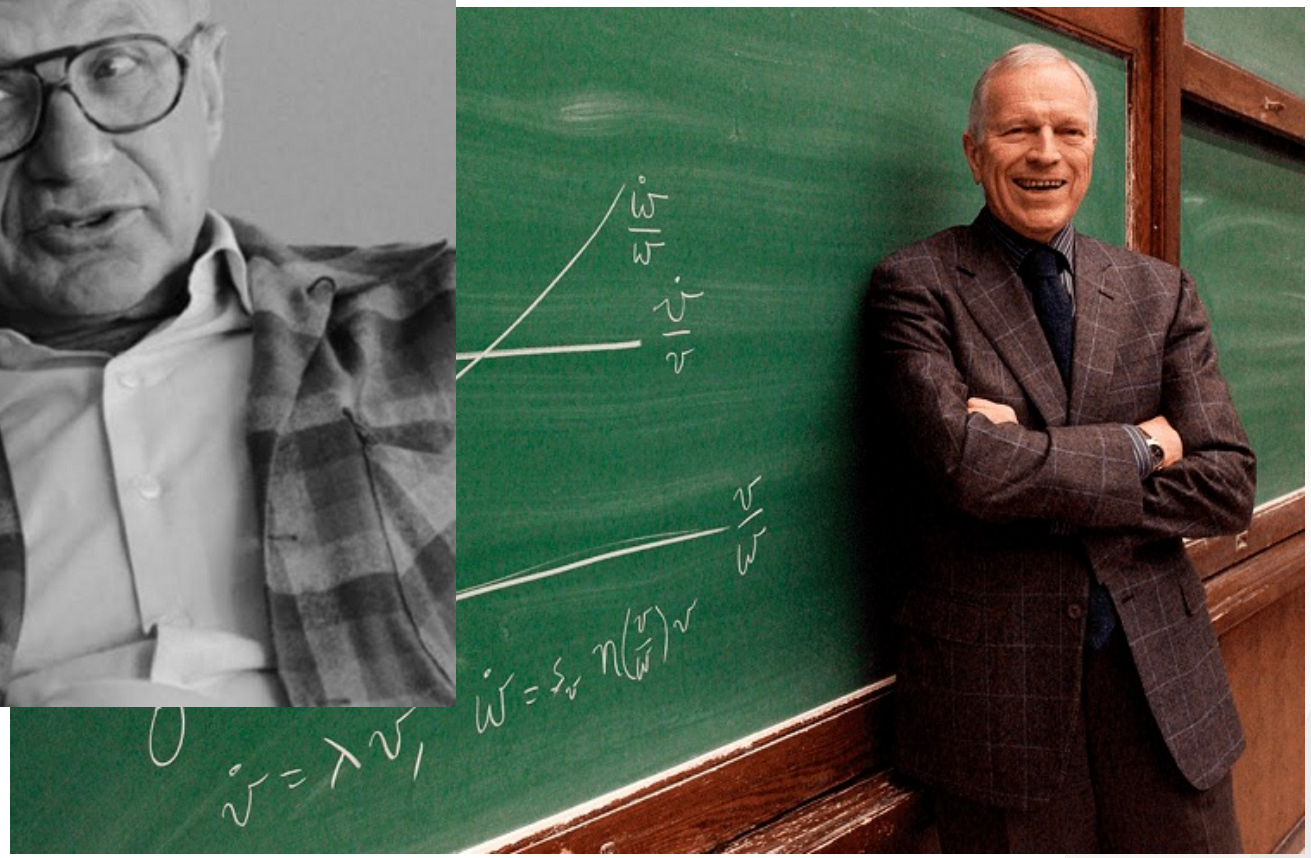
Keywords: *learning* and *arbitrage*

Discussion today focuses on putting paper into context and potential follow-up work

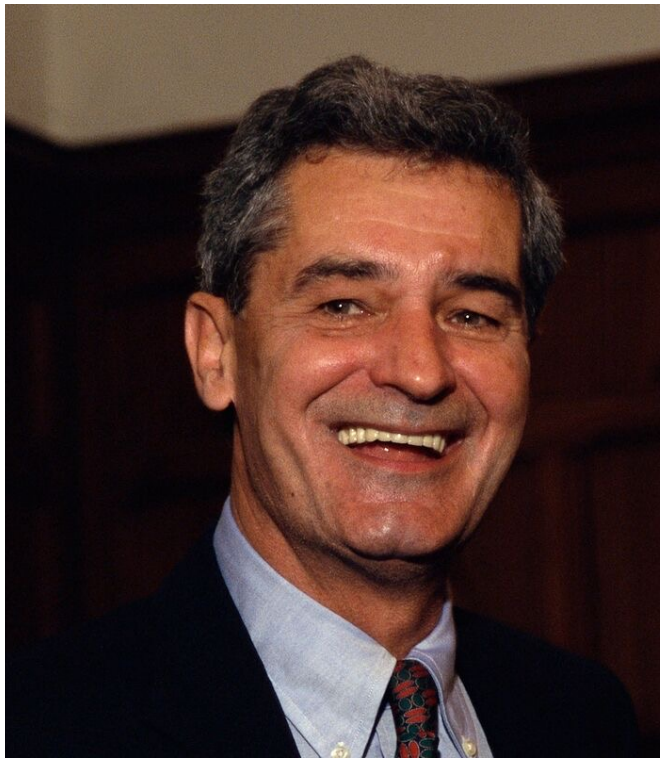
Understanding expectation formation

Adaptive expectations (pre-Lucas)





Rational expectations revolution (1970-90s)



Informational/behavioral frictions (2000-10s)

STICKY INFORMATION VERSUS STICKY PRICES: A PROPOSAL TO REPLACE THE NEW KEYNESIAN PHILLIPS CURVE*

N. GREGORY MANKIW AND RICARDO REIS

This paper examines a model of dynamic price adjustment based on
assumption that information disseminates slowly throughout the popula
Compared with the commonly used sticky-price model, this sticky-informa
model displays three related prop
views about the effects of monetary
tionary (although announced disin
ones). Second, monetary policy sh
with a substantial delay. Third, t
with the level of economic activity.

Implications of rational inattention ☆

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Abstract

bservations only through a communication
be able to play a role very similar to that of a
t in standard control problems. The resulting
ional expectations theories to suggest that it
cations for policy are different enough to be

LEARNING FROM INFLATION EXPERIENCES*

ULRIKE MALMENDIER AND STEFAN NAGEL

How do individuals form expectations about future inflation? We propose that individuals overweight inflation experienced during their lifetimes. This approach modifies existing adaptive learning models to allow for age-dependent updating of expectations in response to inflation surprises. Young individuals update their expectations more strongly than older individuals since recent experiences account for a greater share of their accumulated lifetime history. We find support for these predictions using 57 years of microdata on inflation expectations from the Reuters/Michigan Survey of Consumers. Differences in experiences strongly predict differences in expectations, including the substantial disagreement between young and old individuals in periods of highly volatile inflation, such as the 1970s. It also explains household borrowing and lending behavior, including the choice of mortgages. *JEL* Codes: E03, G02, D03, E31, E37, D84, D83, D14.

A new agenda: statistical learning under big data

Martin-Nagel (2021, *JFE*)

- Investors learn about cash flows, facing a high-dimensional inference problem
- Investors never learn perfectly, leading to *in-sample* (but not OOS) predictability

Da-Nagel-Xiu (2023, this paper)

- Arbitragers learn about model parameters, facing a high-dimensional inference problem
- Arbitragers never learn perfectly, leading to an *upper bound* of feasible Sharpe ratio

Key contribution: learning *persistence* as limit to arbitrage (a lower bound won't do the job)

- Suggestion: highlight contribution and agenda more in the context of expectation formation

Econometric and statistical learning

Learning in macroeconomics and finance

Recall: learning *persistence* as limit to arbitrage

- Stems from a high-dimensional inference problem

Past macro literature has explored learning and its aggregate and policy implications

- Introduces explicit learning dynamics, or, "*econometric learning*"
- Agents' forecasts at time t derived from an econometric model, estimated using data up until t
- Typically under low-dimensional inference environment (see, e.g., Sargent)
- Focus on conditions under which convergence to REE happens, or, "*learnability*"

Constant-gain econometric learning

Evans-Honkapohja (2003, *ReStud*) formalizes "constant-gain econometric learning"

- Goal: explain existence of *persistent macroeconomic fluctuations* from the dynamics induced by *evolving estimates* of the coefficients of people's forecasting rules
- Intuition: agents believe that the coefficients of the correct forecasting model may shift over time, and consequently place more weight on the most recent observations in their estimates
- *Predicted unconditional macro moments* (analogous to Martin-Nagel's in-sample predictability)

Suggestion: highlight paper contribution against the econometric learning literature

Suggestion: follow-up macro papers on, e.g., optimal monetary policy design under big data?

- Big data (e.g., satellite, digital footprints) increasingly relevant in macroeconomic predictions

Quantifying the difficulty of learning

Using the "wedge" approach to quantify learning difficulty

Recall: *upper bound* of Sharpe ratio as main contribution to ML-based asset pricing literature

- Section 2.5 *constructs* S^{OPT}
- Section 2.6 *estimates* S^*

The difference of these two constructs an explicit "*wedge*" from data

Any economic *friction* implies a "wedge" from a frictionless complete-market economy

- See, e.g., Chari-Kehoe-McGrattan (2007, *ECMA*), Lustig-Verdelhan (2019, *AER*)
- Allows for a quantification of underlying frictions using observable data

Suggestion: formalize relationship between "wedge" and friction following the literature

Conclusion

Beautiful and important paper on the statistical limit of arbitrage

- Learning persistence in a high-dimensional world as limit of arbitrage
- An upper bound of feasible Sharpe ratio
- A new agenda in understanding the formation of expectations under big data

I made a few suggestions for follow-up work

- Econometric and statistical learning: optimal macro policy under big data?
- A formal “wedge” approach of measuring the difficulty of learning in a big-data economy?