Academic Finance for the Practical Investor

Sparsh Sah

2020 Fall

BACKGROUND

Although the word "quant" today conjures up images of lightning-fast computers and huge datasets with server racks pressed up as close to the wall as possible so that electrical signals don't have to travel a single millimeter farther along the Ethernet cable than necessary, those things are much more useful in high-frequency proprietary trading than medium-term systematic investing.

On the other hand, people tend to associate academic finance with stodgy research into banking systems and curmudgeonly debates over fiscal policy. But the literature is rich with applications of optimization and statistics that actually matter to a practitioner. This is my attempt at a survey of some outstanding examples of papers that are, from the perspective of a liquid-alts manager who entered the industry with zero finance background:

- Rigorous.
- Easy (or at least, reasonable) to digest.
- Interesting.
- Useful.

I roughly group the papers into six categories:

1. **Micro- and Macro-economics**
2. **Asset prices as stochastic processes**
3. **Portfolio-construction basics**
4. **Factor investing**
5. **Global macro**
6. **Risk management and trading implementation**

As an aside, these three papers are, in my opinion, the standard "seminal" papers in academic finance:

1. Markowitz 1952, "Portfolio Selection": The mean-variance optimization paper.
2. Black-Scholes 1973, "The Pricing of Options and Corporate Liabilities": The Black-Scholes option-pricing paper.
3. Fama-French 1992, "The Cross-Section of Expected Stock Returns": The 5-factor model paper. (Builds heavily on previous papers on the Capital-Asset Pricing Model and Arbitrage-Pricing Theory.)

MICRO- AND MACRO-ECONOMICS

- Bauman, Yoram. 2007. U of Washington. "N Gregory Mankiw's 10 principles of economics, translated for the uninitiated" . American Association for the Advancement of Science.

- Blyth, Stephen. 2013. Harvard Management Company, Harvard Dept of Statistics. "An Introduction to Quantitative Finance" . Oxford Press.
  - Key takeaway: The Fundamental Theorem of Asset Pricing.
  - Topics: Arbitrage, Equivalent martingale measures.
  - What this will help teach you: Understand and price derivatives like forwards, futures, swaps, and options.
  - Investment strategies that apply this: Futures-curve arbitrage, Options arbitrage.
  - Questions you should be able to answer after reading this:
    * When Bloomberg runs the headline "September 2021 S&P 500 futures point higher", why does that have nothing to do with where people expect stocks are going to be next year, and everything to do with where they expect stocks to be 45 minutes from now at 930am when the market opens? (A: Spot-futures no-arb relationship.)
    * Why do we tend to see a "smirk" in the option-premium-implied volatility surface? (A: Black-Scholes does not have parameters for skew or kurtosis, nor does it have a parameter for put premia being bid up by risk-averse investors looking to insure their large stock portfolios. This doesn't mean that investors pay more for deep-out-of-the-money puts than at-the-money puts, it just means that they *don't pay as much less* as Black-Scholes would predict.)
    * Why, in light of the above two questions, can I not effectively go long the VIX by going long VIX futures, waiting for a blowup, and then retiring with my profits? After all, the VIX has never dropped to zero, but it often doubles within weeks. (A: There is no tradable spot VIX security, so there is no way to construct the replicating portfolio that would usually enforce the spot-futures no-arb relationship. Therefore, there is immense upward pressure on prices for long-dated contracts (which will be active for a long time), which tends to relax as maturity approaches and no immediate danger seems imminent. (For a similar reason, the option-premium-implied volatility surface slopes upward as the underlying option becomes longer-dated. That is, you'd expect investors to pay more for longer-dated options than for shorter-dated options—since cumulative volatility increases with duration even if instantaneous volatility stays constant—but in reality we observe them paying *even more* than Black-Scholes would predict.) The futures-spot carry is hence bleedingly negative on average – For illustration, just look at the long-term track record of any the large long-VIX ETFs, which just package up long-futures positions. Unfortunately, the XIV meltdown shows that the opposite approach—opening a passive short position and rolling every quarter—isn't a sure bet either.)
  - Followup questions:
    * Arbitraging a security requires it to be very liquid, as you've got to be able to buy it at the low venue and sell it at the high venue very quickly, else you run the risk that prices will move against you, closing or even inverting the gap. But liquid securities are exactly the ones least likely to see mispricings, since there are so many people paying attention to them. How often do arbitrage opportunities arise in the real world, and what are the limits of arbitrage that can keep them open?

- Williams, John Burr (UW Madison, Harvard). 1938. "The Theory of Investment Value" . Harvard Press.
  - Key takeaway: An asset's price should reflect its fair value, which itself can, to the first order, be modeled as the discounted value of its expected future cashflows.
  - Topics: Time value of money, Present Value, Future Value, Discounted-cashflow model.
  - What this will help teach you: Investing is not all about buying a security and holding it to maturity – If you can find a mispriced security, you can often buy it, wait for people to realize that it was mispriced, and turn around to sell it at the fair price.
  - Investment strategies that apply this: Fundamental analysis.
  - Questions you should be able to answer after reading this:
    * What is the fair price of a risk-free annuity? What about of a risk-free perpetuity?

- Followup questions:
  - How should risk aversion play into this? Isn't \$1 with certainty right now better than \$1 worth of a stock that might or might not pay out its dividend? (A: No, not at this instant in time, conditional on observing that the share is indeed trading at \$1. The whole point is that the two are, in some sense, equivalent. The dollar bill can be freely exchanged for the share, and vice versa. At equilibrium, prices should roughly "bake in" the market's view on uncertainty in future cashflows.)
  - Assuming everyone can agree on the physical probability distribution of dividends, does a DCF model identify "the" definitive fair price of an asset? (A: Absolutely not. What constitutes a fair price is not so straightforward. Williams would like to think of it as the discounted present value of expected future cashflows, but it is reasonable to think that the clearing price of a ZCB that will at year-end pay out \$1 with certainty, could be different than the clearing price of a put option that at year-end will pay out $+$\$3 with probability 0.50 and $-$\$1 otherwise (especially considering that the put is a hedge!). Microeconomists would evaluate this in terms of the "certainty equivalent" formula, wherein concave utility is the primal concept and gives rise to risk aversion. But in practice, (a) it's hard to estimate the average concavity of utility, and (b) most trading firms are so large that their utility functions can be taken as locally linear. A slightly more sophisticated approach is the "risk parity" model: The price of a share should be set so that the risk-adjusted expected return (ex-ante Sharpe ratio) is equivalent to that of every other stock. If the price is too low, people will buy it up and drive the price up. If it's too high, people will sell it off in search of greener pastures. In fact, the most widely-accepted model among quants today also takes into account correlations between assets, in a mean-variance approach. This model gives rise to the CAPM ("capital-asset-pricing model"). Under the CAPM, the aggregate amount of money invested in risky assets depends on the aggregate risk tolerance of investors (with a bit of a feedback loop from the next step). Given that aggregate amount, dollars are then allocated down to each stock in a diversified manner so that the combined Sharpe of the resulting market portfolio is maximized. Price pressures from this buying and selling will determine the final price of each stock. Those prices will in turn determine (a) the cap-weighted composition of the market portfolio, and (b) the expected return of each stock. At equilibrium, the expected return of each stock will be the product of (i) the market risk premium (determined by the aggregate risk tolerance investors) and (ii) that stock's beta (determined by the composition of the market portfolio), with no alpha above or below this.)

PORTFOLIO-CONSTRUCTION BASICS

- Markowitz, Harry (RAND Corp). 1952. "Portfolio Selection" . Journal of Finance, Vol 7, No 1.
  - Key takeaway: A mean-variance investor is a Sharpe-maximizing investor:

$$\arg\max_w \left(w'\mu - \frac{\gamma}{2} w'\Sigma w \right) = \gamma^{-1} w^* \quad \text{where} \quad w^* = \Sigma^{-1}\mu.$$

    This is the $E = mc^2$ of quant finance.
  - Topics: MPT (modern portfolio theory), MVO (mean-variance optimization), Efficient frontier, Tangency portfolio, Capital market line.
  - What this will help teach you: Formalize the tradeoffs faced by a risk-averse investor, and construct an optimal portfolio in response.
  - Investment strategies that apply this: All of them.
  - Questions you should be able to answer after reading this:
    - How can I construct a Sharpe-maximizing portfolio?
    - How can I use hedging to turn a non-optimal portfolio into an optimal one?
    - What role does leverage play in helping me hit my ER targets (or respect my risk caps)?
  - Followup questions:
    - What are the implications for rational capital markets? (A: If all agents behave rationally under mean-variance preferences, pricing pressures will equilibrate the market until ER's are consistent with the CAPM (capital-asset pricing model). To visualize this, imagine everyone holds the market

portfolio (in one sense, this is the simplest case, as it is the only portfolio that literally everyone can hold at the same time). There is one stock in the portfolio whose additional risk premium over the market is less than its beta. This stock does not add enough ER to the portfolio to justify the risk it adds (because it has high beta, it is very correlated with the rest of the portfolio, making its marginal risk contribution correspondingly high), so people want to dump it. However, with all other buyers being equally rational, the stock must sell at a discount, forcing its ER to be high enough to justify its beta. But now that its market cap has fallen, it constitutes a much smaller fraction of the market portfolio, so that its beta—which is essentially its correlation to the market, of which it is itself a part—falls. Now its ER is actually higher than required by its beta, and people are willing to pay a premium for it. And so on and so forth until equilibrium. See also Black-Litterman.)

  - In the real world, correlation matrices are estimated. Why is shrinkage so important? (A: The same reason that collinearity blows out standard errors in an OLS regression. In that setting we call it $(X^T X)^{-1}$, here we call it $\hat{\Sigma}^{-1}$, but it's the same thing and has the same sensitivities.)
  - What if I want to define risk as something other than portfolio variance? (A: Any reasonable definition of risk should scale monotonically with position size so that e.g. zero position entails zero risk. And keep in mind that "low ER" isn't risk in this framework – you dislike money-losing positions not because they inflate the second term, but because they deflate the first term. But if you embrace this framework you will find that it is quite flexible, and amenable to adjustments to account for different definitions of risk, presence of transaction costs, and constraints.)

- Asness, Cliff (Goldman Sachs Asset Mgmt). 1996. "Why *Not* 100% Equities" . Journal of Portfolio Management, Vol 22, No 2.
  - Key takeaway: A levered safe portfolio can be a better deal than an unlevered risky one.
  - Topics: Risk-adjusted return, Diversification, Concentration, Asset allocation.
  - What this will help teach you: Leverage is not a single-edged sword.
  - Investment strategies that apply this: Risk parity.
  - Questions you should be able to answer after reading this:
    - How can I quantify the riskiness of a levered but diversified portfolio, versus an unlevered but concentrated one?
  - Followup questions:
    - Are there cases where the above analysis breaks down? (A: Yes, in high-volatility climates, geometric returns are no longer approximately-Normal. An unlevered portfolio can fall to zero, but a levered portfolio in this climate can actually go underwater. This effect will be exacerbated by the fact that you will be getting margin-called on the way down. The good news is that, in a high-volatility climate, you will not need leverage. In fact, in such a climate, a 60/40 portfolio will actually be *more* exposed to risk than a corresponding risk parity portfolio, as the risk parity portfolio will actually *delever* in response to the elevated risk.)

- Sharpe, William F (Stanford Dept of Economics). 1991. "The Arithmetic of Active Management" . Financial Analysts' Journal, Vol 47, No 1.
  - Key takeaway: It is mathematically impossible for the active-management industry as a whole to beat the market. Before costs, the average alpha will be zero, and after costs, it will be negative.
  - Topics: Alpha, Beta, Active management, Passive management, Index funds.
  - What this will help teach you: Humility.
  - Investment strategies that apply this: All of them.
  - Questions you should be able to answer after reading this:
    - Why is alpha a zero-sum game?
    - Why does a passive market-tracking fund never have to trade?
  - Followup questions:
    - What are common ways an investor can be tricked into thinking their manager has alpha, given that the average manager has none? (A: One is leverage. A manager who invests in a double-levered SPX tracker will earn about twice the excess return of an S&P 500 tracker, which is expected to be

positive over the long term. That's not alpha, that's just... more beta. This way is especially bad if the manager isn't transparent with you about the amount of risk they're taking on your behalf. Another way is "investing outside the universe". For example, some investment-grade-focused corporate bond funds will legally allow some small allocation to attractive junk bonds. They will tend to outperform the IG corporates market, since they have an allocation to higher-yielding junk that isn't included when calculating the market return. But the real question—which the manager will rarely answer—is whether their junk allocation outperformed the *junk bond* market. Otherwise, they're still not giving you alpha, they're just giving you different (and riskier) beta.)

FACTOR INVESTING

- Fama, Eugene F (Univ of Chicago Graduate School of Business); French, Ken R (Univ of Chicago Graduate School of Business). 1992. "The Cross-Section of Expected Stock Returns" . Journal of Finance, Vol 47, No 2.
  - Key takeaway:
    $$R_{i,t} = \alpha_{i,t} + \beta^{\mathtt{M}}_{i,t}(R_{\mathtt{M},t} - R_{\mathtt{f},t}) + \beta^{\mathtt{SMB}}_{i,t}\mathtt{SMB}_t + \beta^{\mathtt{SMB}}_{i,t}\mathtt{HML}_t + \varepsilon_{i,t}.$$
    This was *the* seminal formalization of the idea that stocks can be exposed to common risk factors beyond just market beta.
  - Topics: Factor models, CAPM (capital-asset pricing model), APT (arbitrage pricing theory), Factor zoo, Alpha, Beta, Compensated risk factors, Uncompensated risk factors, Risk premia, Market returns, Excess returns, Pricing anomalies.
  - What this will help teach you: (1) Common risk exposures can drive covariances between security returns. (2) Compensated risk factors are worth loading up on, whereas uncompensated risk factors are pure noise and should be hedged out. (3) Model and inference-test hypothetical drivers of out- or under- performance of securities *within* a single time period.
  - Investment strategies that apply this: EMN (equity market-neutral), FIRV (fixed-income relative-value).
  - Questions you should be able to answer after reading this:
    * How can long-short portfolios help me profit off ER models without requiring a view on whether a security's price will rise or fall in absolute terms?
    * Why does the discovery of a long-short factor with significant alpha over its exposures to the named factors provide evidence that the 3-factor model is incomplete?
  - Followup questions:
    * How much of this is just p-hacking? (A: A lot. It is well-documented that ER of a factor is highest in-sample, lower out-of-sample, lower still in the period between the end of the backtest and the article's publication date.)
    * How much of this can be exploited if everyone knows about it? Won't quants "arb away" the profits i.e. buy up value stocks and sell short growth stocks until their prices become fair and there's no more anomalous profit? (A: Again, it is well-documented that ER of a factor gets discretely lower after publication of the article describing it. The consistency of this phenomenon suggests that quants do indeed read the article, implement the factor, and thereby diminish profit opportunities for second movers. Remember, by definition, a profitable factor is one whose positions can be sold at more favorable prices by first movers to second movers – and favorable to one party means unfavorable to the other!)
- Asness, Cliff (AQR Capital Mgmt); Moskowtiz, Toby (Yale SOM); Pedersen, Lasse H (Copenhagen Business School, NYU, CEPR, NBER). 2013. "Value and Momentum Everywhere" . Journal of Finance, Vol 68, No 3.
  - Key takeaway: Formulating general but self-consistent definitions of behaviorally-induced factors across sectors, geographies, asset classes, and time periods not only helps combat overfitting but also provides novel opportunities for out-of-sample significance testing.
  - Topics: Factor investing, Hypothesis testing.
  - What this will help teach you: When seeking or implementing new factors, top-down approach can be a valuable complement to a bottom-up approach.

  - Investment strategies that apply this: EMN (equity market-neutral), Relative-value macro.
  - Questions you should be able to answer after reading this:
    * Why is 5-year price reversal a good proxy for the HML factor in US single-name equities?
    * How can you form a simple market-, country-, and industry-neutral value (or momentum) portfolio using only a panel of historical stock prices?
    * How could you accomplish a similar portfolio in *any* arbitrary asset class or subclass?
  - Followup questions:
    * Can this idea be extended to other factors like carry? (A: Yes. For example, carry was traditionally considered an FX strategy. Futures-curve arbitrage—using rolldown yield as the carry signal—expanded this across macro asset classes, and dividend yield further extended this to single-name equities.)
    * What is the right balance between highly-general cross-asset-class signals, and highly-specific within-asset-class or even within-instrument-group signals? (A: One observation is that the former tends to offer more modest Sharpes but at very high capacities and liquidity, whereas the latter tends to offer much higher Sharpes but at prohibitively low capacity and liquidity. Both are valuable and complementary.)

- Frazzini, Andrea (AQR Capital Mgmt); Kabiller, David (AQR Capital Mgmt); Pedersen, Lasse H (Copenhagen Business School, NYU Stern, CEPR). 2013. "Buffett's Alpha" . Financial Analysts' Journal, Vol 74, No 4.
  - Key takeaway: Much of Buffett's portfolio performance seems explained by a few liquid quant factors plus leverage.
  - Topics: Factor investing, RBSA (returns-based style analysis), Portfolio decomposition, Leverage.
  - What this will help teach you: Think about market-neutral equity strategies not as picking individual stocks, but rather as loading on or against systematically-constructed factors.
  - Investment strategies that apply this: Style premia, ARP (alternative risk premia), Smart beta.
  - Questions you should be able to answer after reading this:
    * What has the legendary Warren Buffett's realized Sharpe been? 2? 5? 10? (Spoiler alert: No. It's about 0.79. That's very good at scale!)
    * Has Buffett's public- or private-equity portfolio driven most of his outperformance?
    * How much leverage has Buffett historically applied to his holdings?
  - Followup questions:
    * What is the point of quants if they're just backfitting things that discretionary stock pickers already know about? (A: The quant edge isn't necessarily that computers can find brand-new signals – It's often simply that computers can systematize the implementation so that rather than applying the signal to 10 or 20 stocks, you can apply the signal to 1000 or 2000 stocks at once. It's also much easier to expand or port research between asset classes. Finally, it can help dampen the effects of human emotion on judgment – Computers don't get cranky when lunch is late.)
    * Okay, then what is the point of humans if computers can systematize the signals and then run them for free on a couple dollars of electricity per day? (A: Somebody has got to do the fundamental research that decides which datasets and models go into production! There's also always an epsilon between the model ER and a more precise ground-truth ER, and intense scrutiny by humans can help bridge that gap. Many deep-value strategies use computer-screened asset universes from which flagged opportunities are sent to humans to validate that they are not "value traps".)
    * So if everyone knows about these factors now, why should they persist? (A: Sometimes they don't. In fact, sometimes they're just artifacts of overfitting. But in other cases, they can persist for good reasons like risk aversion, behavioral bias, or liquidity dynamics.)

- Zuckerman, Gregory (WSJ); Ritholtz, Barry (Ritholtz Wealth Mgmt). 2007. "*Dear Investor...*: Quant Letters to Clients" . Wall Street Journal; The Big Picture.

- Key takeaway: In early August of 2007, losses of 15-30% struck quant equity portfolios across Wall Street within just a few days – then recovered almost just as quickly. The consensus by now is that some large whale was hit with a marginal call or redemption request in an unrelated illiquid strategy and had to unwind their book immediately to meet it (otherwise they themselves would not have accepted the fire-sale prices that showed up on Bloomberg screens after the fact!). Because illiquid assets are by definition hard to sell quickly, they were forced to close out their liquid quant positions—which were actually up for the year—as though taking a hammer to a piggy bank. The fact that everyone in the market-neutral quant equity game from Goldman to RenTech was following essentially the same factors meant that they all saw huge mark-to-market losses as a result, but those losses recovered as the fire sale subsided and the underlying stocks resumed logging transactions at reasonable prices. What is remarkable is that this was purely a long-short phenomenon: The longs plunged and the shorts skyrocketed, but because they balanced each other out, the S&P 500 hardly budged over this period. The crisis was harrowing as it unfolded, and investors were knocking down doors demanding to know what was going on. Every quant runs some version of a risk-targeter, and these books are run at about 10% vol ex-ante. Accounting for the 261 trading days per year and assuming daily PL is i.i.d. (a good assumption in usual times), a loss of even just 5% in one day is an 8σ event. 15% over three days is already a 14σ event. Anomalous volatility like this triggers automated selldowns to respect risk caps. Even worse, because the volatility was on the downside (losses) rather than the upside (gains), the crisis was further exacerbated by stop-loss selldowns, which are motivated less by theoretical risk-management concerns and more by the fear of liquidity squeeze and reputational damage from being margin-called on these highly-levered long-short books. This created a positive-feedback loop wherein market impact from stop-loss selling showed up as further mark-to-market losses on those positions, triggering further stop-loss selling.
- Topics: Quant crisis, Quant quake, Liquidity, Mark-to-market, Crowding.
- Followup questions:
  * As a factor gains AUM, pricing pressures will naturally "richen" it: Managers will buy up the longs, inflating their value, and sell down the shorts, deflating their value. This is good on the way up, but does it arb away the factor's short- to medium-term profits?
  * The scenario above ends up with a crowded position. That is, in an extreme case, the people who are long the factor's shorts and short its longs are a mix of individuals, institutions, and managers. But the people who are long the factor's longs and short its shorts are purely quant-equity managers. They have together cornered the market on a risky asset, but because they are not literally a single entity, they will trip over each other in case there's a run for the exit. How do you fortify your defenses against this?
  * Even worse, those longs and shorts are the only things on their books. The fact that they don't have any diversifying positions to cushion an out-of-the-blue single-factor crisis means that they are very vulnerable to such a single-factor run being triggered. How do you fortify your defenses against *this*? Magically build up a business in an unrelated asset class as a diversification tactic?

GLOBAL MACRO

- Brooks, Jordan (NYU Stern, AQR Capital Mgmt). 2017. "A Half Century of Macro Momentum" . Alternative Investment Analyst Review.
  - Key takeaway: There are simple, intuitive global-macro signals useful for both directional and market-neutral investment strategies (depending on how you implement a given signal).
  - Topics: Macroeconomics, Fundamental analysis, Trend, Momentum.
  - What this will help teach you: Hard-code economically-motivated signals in an appealingly lightweight and self-consistent framework. "Quant" doesn't necessarily mean "blackbox", it can also mean taking a "made-up" strategy and just distilling down the rules in Python. Then, instead of manually applying those rules across a set of 10-15 securities, you can have the computer scan a universe of hundreds in the blink of an eye, doing the same thing you'd have done but much broader and much faster. And you can use the time you save to come up with actual blackbox strategies, or just go for a walk on the beach.
  - Investment strategies that apply this: Systematic macro.

  - Questions you should be able to answer after reading this:
    * Is rising domestic inflation bullish or bearish for the home currency?

- Taylor, John B (Stanford Dept of Economics). 1993. "Discretion vs Policy Rules in Practice" . Carnegie-Rochester Conference Series on Public Policy, No 39.
  - Key takeaway: $r := p + 0.5y + 0.5(p - 2) + 2$.
  - Topics: Monetary policy, Federal Reserve, FFR (fed funds rate).
  - What this will help teach you: Reason about policy-driven changes in security prices.
  - Investment strategies that apply this: FIRC (fixed income, rates, and credit).
  - Questions you should be able to answer after reading this:
    * How aggressively should you raise the FFR if GDP growth comes in 2% too hot?
  - Followup questions:
    * Obviously, the Taylor Rule could be a self-fulfilling prophecy: Fed economists *think* it is the right response, and they decide the ultimate policy, so it becomes the actual response. But what about market participants? Suppose they expect the Fed to think the Taylor Rule is the right response. And suppose the Rule recommends raising rates. Will they rush to dump bonds, driving down prices and thereby accomplishing the rate hike with no Fed intervention at all?

- Diebold, Francis X (Univ of Penn Dept of Economics); Li, Canlin (UC Riverside Anderson). 2006. "Forecasting the Term Structure of Government Bond Yields" . Journal of Econometrics, Vol 130, No 2.
  - Key takeaway: Yield-curve forecasting can be reduced to three key parameters: level, slope, and curvature.
  - Topics: Yield-curve analysis.
  - What this will help teach you: Even the most compelling contemporaneous regression teaches you nothing about how to make money in the real world where you need to decide your position before you can trade into it.
  - Investment strategies that apply this: FIRC (fixed income, rates, and credit).
  - Questions you should be able to answer after reading this:
    * What (intuitively) is captured by the level, slope, and curvature features of the yield curve?
    * How can you construct level, slope, and curvature securities? (A: $5 \cdot 2Y + 10Y$, $10Y - 5 \cdot 2Y$, $10Y - 2 \cdot 5Y + 5 \cdot 2Y$.)
  - Followup questions:
    * Are there ways to extend this analysis to other securities whose prices are sensitive to or evolve similarly to changes in the yield curve?

- Levine, Ari (AQR Capital Mgmt); Ooi, Yao Hua (AQR Capital Mgmt); Richardson, Matthew P (NYU Stern); Sasseville, Caroline (AQR Capital Mgmt). 2016. "Commodities for the Long Run" . Financial Analysts' Journal.
  - Key takeaway: Commodity futures returns can be decomposed into excess spot returns and interest-rate-adjusted carry returns, with long-term evidence suggesting that both contribute to a combined positive return (0.25 Sharpe over the 1877-2015 period implying $p < 0.05$). *Important note: The classic "commodity carry" strategy you might have heard of does <u>not</u> take passive long positions to harvest this effect. Rather, it is a long-short strategy based on <u>relative</u> carry of different futures contracts at a given point in time.*
  - Topics: Commodities, Futures, Risk parity.
  - What this will help teach you: Understand mechanics and dynamics of commodity futures markets, which—being more liquid and not requiring physical storage warehouses—are much easier for speculators to participate in than spot markets.
  - Investment strategies that apply this: CTA (commodity-trading advisors), Managed Futures, Risk parity.
  - Questions you should be able to answer after reading this:

    - What role can passive-long commodities basket play in a traditional $60/40$ portfolio?
  - Followup questions:
    - Do you prefer the "spot + carry" decomposition or the "excess-of-cash spot + interest-rate-adjusted carry" definition?
    - A naive analysis might predict negative interest-rate-adjusted carry returns for commodity futures, since the underlying physical asset's cost of storage is quite burdensome (in other words, unlike for stocks which pay dividends, for commodities the "spot convenience yield" is negative). The paper suggests that the observed positive interest-rate-adjusted carry returns could be a liquidity-provision premium paid by commodity producers who are "natural longs" and look to hedge in futures markets. Nevertheless, do we observe lower (or even negative) adjusted carry returns for futures whose underlying commodities have more burdensome storage costs, relative to those with smaller storage costs?
    - Are there commodities for which hedging pressure from natural shorts (e.g. industries like automakers that consume commodities as raw inputs) is stronger than hedging pressure from natural longs, and therefore drives adjusted carry returns negative?

RISK MANAGEMENT AND TRADING IMPLEMENTATION

- Garleanu, Nicolae (Berkeley Haas, NBER, CEPR); Pedersen, Lasse H (Copenhagen Business School, NYU, CEPR, NBER). 2013. "Dynamic Trading with Predictable Returns and Transaction Costs" . Journal of Finance, Vol 68, No 6.
  - Key takeaway: (1) Aim in front of the target, and (2) Trade partially toward the current aim.
  - Topics: Factor investing, Portfolio optimization, Transaction costs.
  - What this will help teach you: Clients eat net ER, not gross ER.
  - Investment strategies that apply this: Liquid alternatives.
  - Questions you should be able to answer after reading this:
    - Can a multi-period t-cost opt have a lightweight closed-form solution? (A: Yes.)
    - How should factor-reversion speed influence the weight I give the factor in my portfolio?
  - Followup questions:
    - What if tcosts are not quadratic, but linear or $3/2$?
- Frazzini, Andrea (NYU Stern); Israel, Ronen (AQR Capital Mgmt); Moskowitz, Toby (Yale SOM, NBER). 2006. "Trading Costs" . AQR Capital Mgmt White Paper Series.
  - Key takeaway:

$$\frac{|MI_t|/|X_t|}{\sigma} \quad = \quad \beta\sqrt{\frac{|X_t|}{DTV_t}} \quad - \quad \sum_{i=1}^{-\infty}\left(\lambda^i \cdot \mathtt{sgn}(X_t)\mathtt{sgn}(X_{t-i}) \cdot \beta\sqrt{\frac{|X_{t-i}|}{DTV_{t-i}}}\right) \quad + \quad \varepsilon_t,$$

    where the LHS is normalized market impact (VWAP fill vs arrival) and the second term on the RHS is the cumulative reversal of temporary impact from prior trading (with λ the reversal coefficient).
  - Topics: Transaction costs, Market impact, Interday reversal, Sigma root liquidity model, TCA (t-cost analysis), BestEx (best execution).
  - What this will help teach you: Estimate a real-world t-cost model.
  - Investment strategies that apply this: Liquid alternatives.
  - Followup questions:
    - Should β and λ be the same across sectors or even asset classes, so that you can pool data across all assets? (A: It depends. For example, brokers like GS and QB put out their own materials on this for TCA and BestEx analysis, and their models do not always agree.)