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Class 8: Equity in the Time Series, Part 1

Predicting the Market

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For some, predicting the market is a safe conversation piece, just like talking about the weather. I became a Finance professor in July 2000. The day before, I was a PhD student. The day after, I became a professor. Nothing really changed. But because of the new label, suddenly people were seeking for my opinion on financial matters. By far, the question I got the most was can I teach them how to predict the market. Wanting to know something about the future is hard wired in most of us. On Wall Street, the appetite for predicting stock prices is as old as the existence of the markets. In this class, let's take a look at the empirical evidences on stock return predictability.

We will start with the efficient market hypothesis, using it as a framework to help us understand what it means to be able to predict the market. People often believe that market efficiency means that returns are unpredictable. This is not true. In an economy with time-varying business condition or time-varying risk appetite, the expected returns are time-varying and, most likely, persistent. As a result, you will see return predictability. The more relevant question is: How strong is the predictability? We will look at some of the empirical evidences.

1 Predictability and Market Efficiency

- **Follow the information:** The financial markets are an information central, where people bring their information to trade. If it is a correct and useful piece of information, which has not yet been incorporated into the price, then there is room for profit. But as soon as the market price adjusts to the news, the information loses its usefulness and there is no longer any profit to be made with this piece of information.

  So when it comes to predicting the market, one should follow the flow of information. A trader who wants to make a profit from predicting the market should always ask himself: Am I good at collecting information? If so, then I have all the incentive to do

so because I will be rewarded for bringing this information to the financial markets. The next question is: What kind of information am I good at collecting, macro-level for the entire economy, or micro-level for individual stocks? Depending on your talent, the nature of your trading strategy will be very different. Global macro funds place directional bets on the overall market: interest rate, foreign exchange, and maybe the stock market. Long/short equity funds or fixed-income arbitrage funds avoid taking any directional bet. Instead, they focus on the relative mis-pricing between groups of stocks or bonds. At the super high-frequency domain, where the life span of information is on the order of milliseconds, market making funds and statistical arbitrage funds populate this space to facilitate trades and provide liquidity.

All of these market players are motivated by a common goal: making a profit. And they are able to do so by bringing information to the markets. As a result of these efforts, new and relevant information gets incorporated into the prices. And the markets become more efficient.

- **The efficient market hypothesis:** It's impossible to talk about market predictability without bringing up the efficient market hypothesis, or the question about market efficiency. So let me spend some time clarifying some of the confusions.

First of all, in my personal opinion, the efficient market hypothesis is simply a statement that defines what it means to have an efficient market: when market prices incorporate information. It is like saying, being happy means to have peace of mind.

Second, without a proper asset pricing model, there is no way to test the efficient market hypothesis. With a proper model, then we are simply testing the model (e.g., the CAPM) which usually assumes market efficiency. So there is really no point in sweating over it. To be more specific, the efficient market hypothesis is not a stand alone test on market efficiency. It is always a joint test. Market efficiency can only be tested in the context of an asset pricing model that specifies equilibrium expected returns. For example, market efficiency implies zero predictability only if the expected returns that investors require to hold stocks are constant through time (or at least serially uncorrelated). Otherwise, if expected stock returns are time-varying and persistent, then there will be predictability in stock returns and it does not imply at all market inefficiency.

Third, Finance in general and efficient market hypothesis in particular is really not a system of beliefs. What we can offer in Finance are tools. Tools for clear thinking. Don't believe, don't don't believe. Use the tools, apply them to the data and to your

own experiences, make an honest and sincere effort to figure things out for yourself.

- **Orange juice:** Since we are on the topic of market efficiency, let me tell one story that impressed me the most over the years. It is about orange juice, written in a 1984 paper by Prof. Roll from UCLA. It is the kind of paper I've always wanted to write: simplicity at its best; maximum power with minimum fluff.

  Cold weather is bad for orange production. Orange trees cannot withstand freezing temperatures that last for more than a few hours. The central Florida region around Orlando, which accounts for more than 98 percent of U.S. production of frozen concentrated orange juice, occasionally has freezing weather. During the 6 and 1/4 year period studied by Prof. Roll, there were four periods when the temperatures were below $30°F$, each accompanied by significant price increase in orange juice futures prices.

  Overall, the most important determinant in the pricing of orange juice futures is weather in central Florida. Quoting Prof. Roll, "So if the OJ futures market is an efficient information processor, it should incorporate all publicly available long-term and short-term weather forecasts. Any private forecasts should be incorporated to the extent that traders who are aware of those forecasts are also in command of significant resources. The futures price should, therefore, incorporate the predictable part of weather in advance."

  With this idea in mind, Prof. Roll uses the OJ futures prices to predict the weather. Not surprisingly, you will find a relationship between the two. The ingenious design of Prof. Roll's regression is to find out if the OJ futures prices can predict weather more accurately than the National Weather Service. On the left hand side of his regression is the temperature forecast error, which the percentage difference between the actual temperature and the forecast temperature provided by the National Weather Service. On the right hand side of his regression is the returns on orange juice futures.

  What did he find? Orange juice futures prices are better at predicting the weather than the National Weather Service. This predictability is especially strong for the P.M. tempature forecast because of the sensitivity of orange trees to freezing temperatures.

- **The value of millisecond:** Let me tell you another story that fascinated me. It borderlines on craziness, but is a good story. This the first paragraph of *Flash Boys*, a recent book by Michael Lewis.

  "By the summer of 2009 the line had a life of its own, and two thousand men were

digging and boring the strange home it needed to survive. Two hundred and five crews of eight men each, plus assorted advisors and inspectors, were now rising early to figure out how to blast a hole through some innocent mountain, or tunnel under some riverbed, or dig a trench beside a country road that lacked a roadside – all without ever answering the obvious question: *Why?* The line was just a one-and-a-half-inch-wide hard black plastic tube designed to shelter four hundred hair-thin strands of glass, but it already had the feeling of a living creature, a subterranean reptile, with its peculiar needs and wants. It needed its burrow to be straight, maybe the most insistently straight path ever dug into the earth. It needed to connect a data center on the South Side of Chicago to a stock exchange in northern New Jersey. Above all, apparently, it needed to be a secret."

All of these effort just so the speed of information transmission can be improved in the order of ... millisecond. Let me quote Lewis again, since he is a much better writer.

"One way to price access to the line, Tabb thought, was to figure out how much money might be made from it, from the so-called spread trade between New York and Chicago – the simple arbitrage between cash and futures. Tabb estimated that if a single Wall Street bank were to exploit the countless minuscule discrepancies in price between Thing A in Chicago and Thing A in New York, they'd make profits of $20 billion a year. He further estimated that there were as many as four hundred firms then vying to capture the $20 billion."

- **Market efficiency is not a marble statue:** In telling the previous two stories, I would like to impress upon you the process through which markets become efficient. Market efficiency is not really a doctrine for you to believe or disbelieve. It is a process, a process of arbitrageurs participating in the markets with the objective of making a profit. Sometimes, this process works; sometimes it fails. It is an organic process, not a marble statue.

  After the 2008 financial crisis, many people were hard on the efficiency market hypothesis. Some people believed that the financial crisis was the result of a misguided faith in market efficiency that encouraged market participants to accept security prices as the best estimate of value rather than conduct their own investigation. Some wrote that among the causes of the recent financial crisis was an unjustified faith in rational expectations, market efficiencies, and the techniques of modern finance.

  Seriously, I really don't know how these people got their ideas. Rational expectation builds on the understanding that all players in the market are motivated to optimize

their risk and return tradeoff; market efficiency does not happen in the vacuum; it happens only when investors bring their information to the market with the objective of making a profit; and techniques of modern finance do help reduce trading cost and improve risk sharing in the society.

As to 2008? The flow of information broke down at some point. Large banks were sitting on supposedly super safe tranches of CDO and CDO2 without realizing or the willingness to realize the real risk. The rest of the market had a very limited access to this kind of balance-sheet (or off balance-sheet) level information and the market prices failed to incorporate this information. But did the banks take these positions out of their belief of market efficiency? I really doubt it.

- **Market inefficiency and limits to arbitrage:** Since we touched upon the topic of market efficiency, I think it would be fair to mention the Behavior Finance literature on market inefficiency. It was an area of Finance that grew in popularity after the tech boom of 1990s. If you are interested in this topic, you can start with Prof. Shleifer's book, "Inefficient Markets: An Introduction to Behavioral Finance."

The efficient market hypothesis assumes that the market incorporates the new information right away. In practice, however, there is uncertainty surrounding the information and the process of price discovery itself involves uncertainty. In certain situations, a correct piece of information might not get incorporated into the price right away. If the price moves temporarily in the opposite direction of his information, the arbitrageur might in fact lose money trading this information. This argument, proposed by Shleifer and Vishny (1997) and often referred to as "limits to arbitrage" can help explain why bubble can keep building up even when many people are calling it a bubble.

When Alan Greenspan, the then chairman of the Fed, gave the famous "irrational exuberance" speech in December 1996, the Nasdaq was around 1,300. Initially, the stock markets around the world dropped precipitously in reaction to the speech. But the markets soon shrugged off the warning and started the most spectacular upward trajectory in the history of Nasdaq. A little over three years after the speech, on March 10, 2000, the Nasdaq peaked at 5,048.62. Then it went down as fast as it came up, and bottomed near 1,140 two and half years later on October 4, 2002.

One person who shared the same view with chairman Greenspan was Prof Shiller, who later wrote a book titled "irrational exuberance." Prof Shiller also shared the 2013 Nobel Prize with Prof Fama and Hansen. It was said that Prof Shiller, following his own prediction about the internet bubble, actually shorted the Nasdaq in the late

1990s, only to lose money because the market kept its upward trajectory for too long and crashed much too late.

2 Predicting the Market

- **What we've learned so far?** Talking about market efficiency and market predictability at a hypothetical level is just not that interesting. Now that we are seven classes into the semester, maybe we can start from what we've learned so far.

  By learning about the various quant strategies, we do recognize that the alpha generated by a quant strategy does come from a certain ability to predict the future. People might vary in their opinion on whether the alpha comes from market inefficiency (under/over-reactions) or systematic risk exposure. One observation I am sure that you've made is that quant investors do not take a stand on the market risk. If possible, they choose to avoid the market risk by taking long/short positions of two portfolios with similar beta exposures.

  And yet, the market risk remains the most important and pervasive. You've probably noticed in our Assignment 1 that market-neutral hedge funds are not really market neutral. For example, the hedge fund index in long/short equity has a beta around 0.40. Even for market-neutral hedge funds, the beta exposure is non-zero: around 0.20. Overall, the market risk is an important risk and let's try to understand it more.

  In this class, we will focus on the "first moment" of the aggregate stock market and move on to the "second moment" in the next class.

- **How good are investors at predicting the market?** You must have heard this famous story about Rockefeller and his shoe shine boy. After receiving unsolicited stock tips from his shoe shine boy in 1928, Rockefeller decided to get out of the stock market. His rational: when a shoe shine boy started to give stock tips, the market probably was reaching its peak.

  I don't know if the story actually happened to Rockefeller, but the gist of the story got repeated again and again in the history of financial markets. Last year, from July 2014 to July 2015, I was on sabbatical and spent most of my time in Shanghai with my parents. I was living a very simple life, far away from the financial establishments in Shanghai. Yet one can hardly avoid the hype and then the disappointment of the stock market. I had to tell my 80-year old father repeatedly that his optimal allocation

to the stock market is zero, regardless of how much money other people were making out of the market.

The empirical evidence paints a similar story: investors have no ability to predict the future. In fact, their prediction is a response to the stock market. When the markets are doing well, their prediction is optimistic; when the markets are doing poorly, they become pessimistic. Moreover, their prediction affects their behavior. The flow to equity mutual fund is driven heavily by the recent stock market performance. The same pattern of flow chasing performance can also be found in bond mutual funds.

- **Use past returns to predict the future:** For anyone wanting to predict the stock market, probably the very first regression would be:

$$R_{t+1} = a + \rho R_t + \epsilon_{t+1}.$$

Given the time-series data, this is the easiest regression to run. The results are mixed, depending on the horizon over which this regression is run. At the monthly horizon, the autocorrelation ρ is generally positive and statistically significant. The magnitude is small for the value-weighted portfolio and becomes larger for the equal weighted portfolio. But this result is not very stable and could flip sign or become insignificant during sub-sample analyses. Overall, the R-squared of this predictive regression is very small, indicating that much of the future returns remains unpredictable.

In academic, there is a pretty large literature on this topic. If you are interested, you can read "Permanent and Temporary Components of Stock Prices" by Fama and French (1988), who ran this regression over a horizon of 3-5 years and found large negative autocorrelations. In "Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test," Lo and MacKinlay (1988) propose the innovative variance ratio test as an alternative to the regression analysis. In "When are Contrarian Profits due to Stock Market Overreaction?" Lo and MacKinlay (1990) explain that despite negative autocorrelation in individual stock returns, weekly portfolio returns are positively autocorrelated and are the result of important cross-autocorrelations.

- **Stock returns and business cycle:** In any Finance model, one main driver for stock returns should be the underlying economic condition. Nevertheless, the link between the two is not that strong in the data. For example, Prof. Shiller wrote a paper in 1984 entitled, "Do Stock Prices Move Too Much to be Justified by Subsequent Change in Dividend?" In this paper, he made the observation that the stock market is too

volatility (e.g., 20% per year) compared to the volatility in the fundamental: dividends or earnings.

If you plot the time-series of realized stock returns against the business cycle, you do find a link between the two. In particular, depressed expected business conditions are associated with high expected excess returns. This observation gives rise to predictive regressions using a set of variables that are related to business conditions, including default spreads, term premiums, and dividend-price ratio. By far, the best predictor for stock market returns is the dividend-price ratio. We will re-visit the default spread and term premium as we cover the fixed-income market.

- **Dividend-price ratio as a stock market predictor:** Let's run this regression at the annual frequency:
$$R_{t+1} = a + b \left(\frac{D}{P} \right)_t + \epsilon_{t+1} \, ,$$

where D/P is the dividend-price ratio (aggregate dividend divided by the value-weighted CRSP index). The general finding that is the coefficient b of this predictive regression is positive and statistically significant.

The key to this regression is 1/P. The aggregate price level is usually depressed during poor business condition (e.g. recessions). Going forward, the stock return is expected to be high. Hence the positive regression coefficient. Using D/P is just a way to scale the overall time trend of stock price increase. Using aggregate earnings, one can use replace D/P by E/P, although the earnings number is more noisy and biases the regression coefficient downward.

One important observation of this predictive regression is that the power of predictability is very weak even for the best predictor. At an annual frequency, the R-squared of this predictive regression is around 5%, indicating that 95% of the future variance remains unpredictable.

- **Market timing as a trading strategy:** This kind of result explains why market timing is not a very popular trading strategy among market participants. Of course, there is nothing wrong with taking a long position on the market if your objective is to be compensated from such a risk exposure. But if you are in and out of the market with the belief that you can predict the market, then you should be very careful. The empirical evidence tells you that you are going to be exposed to quite a bit of uncertainty. Moreover, this is a very special kind of uncertainty — the market risk, the most dangerous kind.

This is why David Swensen wrote in his book, "Market timing, according to Charles Ellis, represents a losing strategy: There is no evidence of any large institutions having anything like consistent ability to get in when the market is low and get out when the market is high. Attempts to switch between stocks and bonds, or between stocks and cash, in anticipation of market moves have been unsuccessful much more often than they have been successful. Serious investors avoid timing markets."