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PROFESSOR: What I want to do today is to continue where we left off last time in talking about the empirical properties of stocks and bonds. I want you to develop an intuition for how to think about markets. We've already done that over the course of the last few lectures by looking at market prices and understanding how to price them, but I'd like you to get some kind of a historical perspective now on specific asset classes. Because we're going to be relying on market prices to make inferences about other kinds of securities and other decisions you're going to make.

As I told you at the very beginning of the course, we're going to rely on markets for information, because it's the wisdom of crowds that really gets us the information we need in order to make good financial decisions. So I want to begin that process of now giving you the intuition about the wisdom of crowds by looking at the historical performance of stocks and bonds. And then we're going to talk about how to quantify risk more analytically and put it all together in the very basics of modern portfolio theory.

So I want to start by asking the question, first of all, what characterizes US equity returns? How do we get our arms around the behavior of that asset class? And the way I'm going to do that is to give you some performance statistics about the volatility, about the average return, about how predictable they are, and also patterns of returns across different kinds of stocks. So we're going to look at some empirical anomalies before actually turning to the analytical work of trying to figure out how to make sense of this from a more formal mathematical framework.

Before I do that, let me ask you to think about the following question, which is, if you are designing a market for stocks, what properties would you want that market to have? And I'm going to argue that there are a few properties that all of us, I think, can recognize as being good properties for stock prices. So the first is that stock market prices are random and unpredictable.

Now, that might seem a little counterintuitive, and certainly I think you would acknowledge that over the last several weeks markets have been supremely unpredictable. And that doesn't feel so good. It doesn't seem like that's a good thing. But in a minute, I'm going to try to make that a little bit more clear by looking at the alternative of predictable-- or unpredictable, which is predictable. So let me come back to that point.

The second property that I think you'll agree is a reasonable one for us to expect is that prices should react quickly to new information. It should adjust to new information really without any kind of delay. And finally, we'd like to see that investors shouldn't be able to earn abnormal returns after you adjust for risk. So in other words, once risk adjustment is taken into account, there shouldn't be any additional return left over. That's what we think of as a well-functioning market.

Another way of putting it is that a market is highly competitive. It's hard to make money in those markets. Now, they may not be markets that you would enjoy trading in, but that's not the question. The question is, what would be a good market, an efficient market?

So let me talk about predictability for a minute, because I said that it seems a little counterintuitive that a good market is one that's not predictable. So let's pretend that this is the stock market. This is the S&P 500. That looks nice-- a nice, regular curve.

Anybody come up with a prediction for this? How would you go about predicting the behavior of this kind of a stock market? What's that?

STUDENT: Cyclical.

PROFESSOR: Cyclical. What kind of curve would you fit to this?

STUDENT: Sine wave.

PROFESSOR: Yeah, sine wave. In fact, that's how I generated this. I used a sine wave, and then I add a little noise. Now, why might this not be a good model for a market? If this were the stock market, what would you do? Yeah?

STUDENT: Everybody would buy on the low and sell them high [INAUDIBLE] the other end.

PROFESSOR: Exactly. After a few of these cycles, you sort of get the idea. And if you're down here, you're going to think, well, gee, I think it's likely to go back up so I'm going to buy a ton over here.

And when you get right up there, you'll say, gee, you know, I think it's time for me to sell a ton. And you don't have to go through too many of these before you get richer than your wildest dreams. Yeah?

STUDENT: I would think that [INAUDIBLE] regular market like that is not true, because as soon as you

want it to raise, it's going to collapse at 50, 10 points below.

PROFESSOR: That's exactly right. So as soon as you start doing this, as soon as you try to do this, what happens to the pattern? The pattern disappears-- exactly. You see, this is one of the reasons why finance is a lot more challenging than physics.

In physics, if you try to drop a ball in a gravitational field, it won't change its mind and say gee, now I'm going to change the gravitational constant on you just because you're testing me. But in financial markets, the moment you try to take advantage of this pattern, the pattern changes. In fact, the more you try to take advantage of it, the more quickly the pattern changes. In fact, if you do this a lot-- if there are a lot of people trying to predict patterns-- then you know what you get?

You get no pattern. You get randomness. That's the idea behind an efficient market being random. If it were not random, then that means that there aren't enough people who are bothering to try to forecast the price and incorporate information into the price.

Now, I said two things that at first seemed different, but in fact they're opposite sides of the same coin. When you are forecasting market prices, you know what you're doing? You're actually helping markets become more efficient by incorporating information into that price. How do you do that?

Well, if, for example, you think that having a presidential election will cause volatility to decline, then if you know that there's a presidential election coming up, you will start trading in a way that will ultimately be betting on volatility declining. As you start that trading, you force that volatility index to go down. So the fact that you've got information and you think you can forecast prices, when you use the information, what does it mean to use the information when you buy or sell securities on the basis of that information? Then the price of the security ultimately reflects the information, right?

So an efficient market is one where you don't have this. You don't have a very strong predictability. If it is strongly predictable, then most likely either the market is rigged, or there aren't enough people that are trading in order to make prices fully reflective of all available information.

Now, this is the way markets really look. These are random walks with drift, drift meaning there's a positive trend or, in some cases, a negative trend. But otherwise, it's random around

that trend.

So you can't really easily forecast it. And you can see that prices go up, they go down. There are long periods where they go up, but there are also, for other stocks, long periods where they go down. And you don't know what's going to happen next.

This is a sign of a very efficient market. A while ago, there was an academic study that was done to try to test for efficiency, and one of the tests was that if the underlying price series was not very volatile, that was considered an efficient market. But it turned out that was roundly criticized because of the point that just because a market is not volatile, it doesn't mean that it's working well.

And an example was, at the time-- this was, like, 20 or 30 years ago-- the Chinese stock market, the Shanghai Stock Exchange. It was a relatively young market, and at that time, there were only two stocks that traded on it. It was the National Railroad Company and the Bank of China. And at that time, which is, again, about 15 or 20 years ago, it was considered unpatriotic to sell the security if you had bought it.

So you could buy it, but you weren't allowed to sell it. And so the price went way up and up and up, and that's not an example of an efficient market. It was not at all volatile. But as a result, there was no real information reflected in that price. Yeah?

STUDENT: India is talking about getting out. It looks like somebody's doing one of those roller coaster rides that goes up and down and up and down. So is volatility a sign of [? inefficient ?] [INAUDIBLE]?

PROFESSOR: Well, it's not volatility, per se, but rather the combination of the predictability per unit volatility. That's really what you want to focus on. We're going to come back to that when we talk about portfolio theory and look at this trade-off between risk and expected return.

But no, I wouldn't say that the Indian market is inefficient. It's undergoing some pretty significant changes, as is the US and as is the world. But that's because the global economy is contracting as we know it because of this financial crisis. So I wouldn't characterize it as inefficient at this point, but that remains to be seen. Yeah?

STUDENT: [INAUDIBLE] down the road [INAUDIBLE] market [INAUDIBLE]?

PROFESSOR: There isn't any hard and fast rule, no. But if you take a look at the trade-off of risk to reward, in

other words that ratio of expected return to volatility, you can come up with rules of thumb that will give you a sense of whether or not a market is efficient or inefficient. So we're going to come back to that. In fact, we'll look at that in just a minute.

Let me turn to some data now, and then we can see exactly what those trade-offs look like. Now, what's going to be interesting about this part of the talk is that when I tell you about these numbers, these numbers are based upon data from I think it was 1946 to 2001. In fact, a lot of the data that has been collected over the last year is very, very different from this, so it will be interesting to sort of compare the two.

So there are four empirical facts that I want you to take with you about the US stock market. The first is that interest rates, in general, have been slightly positive on average, but not by much. In other words, the real interest rate, the nominal interest rate minus inflation rate, has been pretty low over the course of history. So the first fact is that real rates have been slightly positive.

So you can see, for example, the average rate of return for the one-year T-bill is about 38 basis points on a monthly basis. This is monthly. I haven't annualized it. But inflation over that same period is about 32 basis points. So when you subtract the two, you're going to get six basis points on a monthly basis as the real rate of interest.

On the other hand, if you take a look at the stock market, which is represented by VW stock index-- VW doesn't mean Volkswagen. VW stands for the value weighted index. It's an index of all the stocks on the NYSE, Amex, and NASDAQ weighted according to their outstanding market capitalization. And you can see that the valuated stock market over this period is about 1% per month.

The equal weighted stock market, EW, is a little bit higher, 1.18. And Motorola over this period had an expected rate of return of about 1.66% per month. So the return has been higher for these indexes. And if you want to get a sense of why that might be, take a look at the next column, which is the standard deviation.

This, remember, is a measure of the riskiness of the security. It's a measure of the fluctuations. And if you take a look at the equal weighted and the valuated, the volatility is-- they're both a lot higher than for T-bills. So this is one of the reasons we got the idea in finance that there's a risk-reward trade-off. The more risky, the higher the expected rate of return.

And if you look at Motorola, the riskiness of Motorola is much larger than that of any of the stock indexes. Instead of a 5% monthly standard deviation, you're looking at double, or 10%, the monthly standard deviation. But look at the rate of return. The rate of return is commensurately higher. Yeah, Remi?

STUDENT: Professor, why [INAUDIBLE] standard deviation greater than zero? Isn't that [INAUDIBLE]?

PROFESSOR: Oh, because it fluctuates from month to month. So the idea is if you're buying a T-bill and you're holding it, it still has price fluctuation. The other thing that I want you to see is something along the lines of the minimum and the maximum. This is another way of representing the riskiness of the security.

So T-bills are bounded between 0.03 and 1.34 in terms of their return-- very narrow band. Treasury notes, which are 10-year instruments, obviously are going to be swinging around much more, more than a one year T-bill. So the longer the maturity, the longer the duration, the riskier is the instrument. But if you take a look at the valuated return and the equal weighted return and then Motorola, you can see progressively more and more risk involved in these kinds of securities.

Now, if you look at their compound growth rates, you get what you pay for, in the sense that you're looking at T-bills down here. So $1 invested in one of these guys will give you maybe $10 at the end of 2001, but you're looking at a much, much larger return for either the valuated or equal weighted indexes. More risk, more expected return-- that's the message that you get from looking at the basic data here.

Now, that's just to give you a sense of where interest rates have been. I think we discussed this when we did fixed income. Interest rates have really been all over the map. There was a point in our history, not that long ago, where the short-term interest rate, the one year T-bill, was something like 16% to 17% per year. That's the one-year T-bill. It's astonishing.

But that was a period where there was a large amount of inflation in the United States. On the other hand, if you take a look at the more recent period, interest rates have been extremely low, and that's part of the reason we're in a credit crisis, is because credit is very cheap. So you can get yourself into a lot of trouble when it's relatively easy for you to borrow, and it doesn't cost you that much in terms of the payments.

Now, let me show you what the total returns look like for these different asset classes. By total returns, I mean if you bought one of these instruments and you held it a month at a time and you computed the return for holding that instrument. So for a bond, it includes whatever coupons get paid, plus the price fluctuations. It's the total return.

For stocks, it'll include the dividends that got paid as well as the price fluctuations. And I'm going to do this on the exact same scale, from minus 25% to 25%. So these are monthly returns now that I'm plotting from 1946 to 2001.

And so you can see that the total return for the US 10-year bond actually has different periods where, in some cases, it's not very risky but in other cases it bounces around a great deal. When there's a fair amount of interest rate uncertainty, you get a lot of volatility, but when markets are not moving around that much on the interest rate side, you get periods that are relatively calm. Yes?

STUDENT: In the previous slide, that interest rate are the yield to maturities, right?

PROFESSOR: Yeah, that's right. That's right. Correct. These are yields to maturity. These are total returns, though. These are what you get as an investor.

This is what you get if you hold a particular security to maturity. Basically, on a given day, you will get these spot rates. You have a question?

STUDENT: [INAUDIBLE] 10 year. So in '81 and '82, you could buy any bond from the year '86 [INAUDIBLE].

PROFESSOR: Yeah.

STUDENT: So [INAUDIBLE] that incorporates future [INAUDIBLE] interest rates, right?

PROFESSOR: Well, and also inflation.

STUDENT: And that inflation-- was it people thinking that inflation was going to be [INAUDIBLE] 10% of the year, the 10 years out?

PROFESSOR: Either that, or they felt that that, plus whatever interest rate expectations, was going to be what you're going to get over a 10-year period. Yep. That's right.

STUDENT: And mentally, people think that stock [INAUDIBLE] [? upon ?] [? death. ?] [INAUDIBLE].

PROFESSOR: Apparently. And there was a time, in fact, when the stock market did yield that for quite a bit of time. Absolutely. On the other hand, let me turn it around and ask you, now that interest rates are at-- I don't know, the 10-year I think is at-- or the 30 year is at 4.17 this morning-- do you think for the next 40 years or 30 years that treasury bills are only going to return 4% a year? Is that realistic?

I mean, it's not so easy to say, is it? When you're in the midst of it, it's not so easy to say. Based upon historical evidence, it seems crazy to think that we could possibly be in such a low interest rate environment over the next 30 years, especially given that we're printing money like it's going out of style now. And we're going to be doing that over the next couple of years. We've got to, because somebody's got to pay for all of these rescue packages.

And so we basically have to engage in some kind of inflationary monetary and fiscal policy. But it's still saying 4.17 as of this morning. So the market does the best it can, given the data, but it's hard to forecast.

And we just said at the beginning of this class that it better be hard to forecast, because if it's not hard to forecast, then something's wrong. Then it means that it's not reflecting all available information. Yeah?

STUDENT: When you showed that graph in the previous slide of the stocks going way up, I'm wondering how much of that is due to the fact that this was just a really good period of the United States and if you compare to other countries at other times.

PROFESSOR: Yeah, that is definitely a factor. So I'm not trying to explain the numbers, and I'm not trying to justify them. You're absolutely right. This is a very special country in a very special time. So you can either thank your good fortune that you're here, or you can argue that, well, it's not going to persist and time to move to wherever.

But I don't know. I don't know which that is. But it is very unusual. If you look at other countries, there are other countries that are having difficulties during this time period, but there are other countries that are growing even faster. If you look at China over the last 10 years, the growth rate of the Chinese economy is double to triple what the US economy.

Now, it was a smaller economy, but still over an extended period of time it's got tremendous growth rate. So that really is the challenge, is to try to understand what's going on in the context of where we're living and how we're living. So let me go through and show you some

more numbers, and then we can talk about some of the interpretations.

So this is the total return for the US 10-year. You've get a sense of the scale-- minus 25 to 25. Now, this is the return of the US stock market during that same period using that same scale-- more risky. So you can see the difference in fluctuations.

And if this weren't exciting enough for you, this is Motorola. And there are many stocks like Motorola. So when you invest in an individual stock, you're getting not just the fluctuations of the economy, but you're getting the fluctuations that affect that specific company.

So you should expect, if you're taking on more risk, that you're going to be getting a reward for these kinds of incredible bouncing around. And in fact, you do. The average return of Motorola is quite a bit higher than that of the market.

Now let me show you a little bit about predictability. We talked about a market that's random as one that is a good or efficient market. This plots the return today versus tomorrow, or yesterday versus today if you want to think about that-- pairs of returns for the aggregate stock market. And this is done on a daily basis.

Now, if you look at it on a monthly basis for the S&P 500 from 1926 to 1997, you've got something that also looks kind of random-- so not much predictability here, not much predictability there. But suppose we were to graph the return of General Motors against the S&P 500. Well, now, all of a sudden, it looks like there's a little bit of a pattern-- not totally random. Sort of looks like there is kind of a line that goes through that scatter of points.

There is a relationship on a given day between General Motors and the broad market index. But over the course of two days or two months, there's very little predictability. Now let me talk about volatility. Your question?

STUDENT: So on the last graph, GM is included in there, right?

PROFESSOR: That's right. GM is one of the stocks in the S&P 500.

STUDENT: So would you still see that relationship if it was everything but GM in the S&P?

PROFESSOR: Oh, absolutely. In other words, it's not any one stock that gives this random scatter of points. In other words, this random scatter of points is really all 500 stocks put into a portfolio. But remember, we're asking a different question. This is a question about the relationship between

the S&P 500 last month versus this month. There's no real relationship.

This, on the other hand, is a question about the relationship between S&P this month and GM this month, the same month. Now, you're right that S&P has GM as one of the components, but it's only one of them. If it weren't in there, you would actually still see this kind of a relationship. Yeah?

STUDENT: On slide 16, you showed us the one-year and 10-year interest rate. What does it mean when the two figures cross each other?

PROFESSOR: There's no particular significance. It just means that that one-year rate happens to be identical to the 10-year rate, so people are just assuming that that rate is going to continue over a period of time. So there's no particular economic significance to when they cross.

These are all annualized, remember. So you're asking the question, over a 10-year period what is the average interest rate you're going to get paid by the US Government, versus over a one year period what is the interest rate you're going to get paid by the US Government? That's all.

Now let me talk about volatility. These are monthly estimates of US Stock Market daily volatility from 1926 to 1997. So every month I've got 20 days or 21 days. I'm going to take the daily returns and calculate the standard deviation for those daily returns, and I plot it and it looks like this.

Now, these are monthly, so if you want to annualize it you have to multiply it by the square root of 12 to get the annualized volatility. But the point of this is that there are periods of time where the market is extremely volatile, and there are periods of time where it's relatively quiet. And if I would have extended this to the most recent period, you would see that within the last several weeks we had a spike that was about as big as this spike over here.

Anybody know what this spike is? You can sort of guess. Yeah, October 1987. That was the big stock market crash that occurred during that month. Volatility shot way up during that month-- lots of risk. And right now we're in a situation where there is lots of risk as well.

Now, I'm going to just conclude my overview with a few interesting anomalies that I want to tease you with to get you to think a little bit more carefully about stock markets. What I'm going to show you are just a bunch of factoids, factoids meaning that they are empirical facts in the data. But if you change some of the assumptions or the sample that you use, these facts could

change.

So these are not universal constants that, for some theoretical reason, has to be true. This is just properties of the data. What I've done here is to take all the stocks in the NYSE, Amex, and NASDAQ from 1964 to 2004. And on a monthly basis, I'm going to rank them by market capitalization, break them up into 10 equal numbers of securities, and then average the returns in those deciles and then compute it over time and then average those decile returns.

That sounds a little complicated, but pretty straightforward. Let me tell you, for example, what this means here. This particular bin over here is the bin of all stocks that have the largest market capitalizations among all of the stocks in my sample.

I've divided them up into 10 equal groups. This is the largest 10th, and I'm going to compute the returns monthly for that bin and then average that across my entire sample. And I get an annual return of close to 10%. This is annualized now. It's not monthly-- annualized.

If I now compute that same rate of return for the smallest stocks, the stocks that are the smallest part of my sample-- that's down here-- I get a return of something like 15% per year. 15% versus 10%, that's a huge difference. That's like a 6 percentage point difference. No, it's more like 9% versus 15%-plus something.

Five percentage points, 500 basis points a year-- that's the gap between small stocks and large stocks. This is known as the size effect or the size premium. Small stocks seem to do better than large stocks. Now, there are lots of stories you could tell about why. I'm not going to tell those stories, but I just want you to see the data.

Now, you want to know what's weird about this? What's weird about this picture is that I'm going to change the sample ever so slightly. What I'm going to do is I'm going to compute this graph only for the month of January and then for all the other months outside of January. And I'll show you what happens.

The yellow bars-- those are the January returns, and the blue bars are all of the non-January returns. So I don't really think there's that much of a size effect once you delete the Januarys. You get a little bit of a difference between the biggest and the smallest, but the difference that we're talking about now is very small.

But look at the January effect. That's big. And it turns out that this seems to be a phenomenon

that has become a little bit less pronounced recently, but for many years it was quite strong and reliable. And people actually traded on this particular pattern, buying stocks in January, holding them in December, and holding them until January, or doing a spread where you basically tried to go long-- small stocks in December and large stocks in December and hold that spread. And then it widened.

So this is a really puzzling anomaly. Again, you can come up with explanations for this. I'm not going to tell you what they are. You can think about them and possibly even trade on them over the next month or so.

Now, the second anomaly that I want you to be aware of-- and this, depending on who you speak to, may not be considered an anomaly. For example, Warren Buffett would call this genius and fact. This is the value premium. What this suggests is that there are certain stocks that, for whatever reason, are just simply undervalued systematically-- or, alternatively, other stocks that are systematically overvalued.

The value premium is where you take the same universe of stocks that I showed you before, but instead of sorting according to market capitalization, you sort it according to another characteristic. And the characteristic is the price-equity ratio, or the reverse of that is what you usually hear about, book-to-market-- book value divided by market value. Now, you all know what that difference is by now.

Book value is the value of the company as it was initially formed and as it accrues either cash or profitability, but based upon its accounting book value. Whereas the market value is what the market thinks the company is worth. And in many cases, with technology stocks and other growth stocks, the price gets way, way ahead of the value of the company's assets. And so those are situations where you've got a very large price-to-book ratio.

If you have a very large price-to-book ratio, that means that you're going to be on the right hand of this spectrum. And that says, according to this chart, that the expected rate of return is generally pretty low. On the other hand, low book-to-market or high book-to-price-- sorry, the other way around-- high book-to-market, low price-to-book is on the left-hand side.

These are what Warren Buffett and Graham and Dodd would call "value stocks." These are stocks where you've got lots of good book value, but somehow the market doesn't really appreciate it. And so the price is low relative to the book value. In other words, the price-to-book ratio is low. And look at the returns there.

The value premium is the difference between the high price-to-book and the low price-to-book, and you're looking at a premium of about 600 to 700 basis points, on an annualized basis. That's a big difference, because in both of these bins it turns out the risks are actually roughly comparable. So it's not as if the stocks on the left are way more risky than the stocks on the right. That actually is true of the market capitalization effect.

Small stocks actually have higher volatility than large stocks. But that's not true of value and growth. So that's another puzzle, or, depending on who you talk to, this is a way to invest. Momentum-- this is something that academics discovered maybe 10 or 15 years ago, which is also really anomalous.

By momentum, we mean simply last year's return. If that's positive, does it tend to persist over the next 12 months? So the stocks with low momentum on the left-hand side seem to do worse than the stocks that have high momentum.

So the momentum effect seems to be really strong. And again, look at that difference. That difference is something on the order of a 15% spread, if not more. It's a very, very big spread. So this might lead you to try to construct a trading strategy based upon this.

And there are a bunch of other anomalies that have been reported in the academic literature. In fact, for a while, certain academic journals were accused of never meeting an anomaly that they didn't love, because they just kept publishing one after another. And in a way, you have to be a bit skeptical about this, because there are so many different ways of looking at stocks, so many characteristics. And you know that in a sample of 100 random variables, 5% of them are going to be statistically significant, even if none of them are in terms of being significantly different from zero.

So you've got to take these anomalies with a grain of salt, but what I've presented to you are the ones that seem to be the most persistent, the ones that people spin stories about, the ones that people construct mutual funds around. And so you'll have to think a little bit about whether or not you believe any of these anomalies, but I wanted to make you aware that they're there. And if you take 15433, investments, you'd actually end up spending a fair bit of time digging through each one of these to see whether or not there's something in there that you could use for investment purposes.

The last thing I want to mention with this introductory lecture is mutual funds. These anomalies

were obviously very, very exciting from the perspective of active portfolio management, because once you identify one of these anomalies you could argue, I want to take advantage of it. Of course, then the argument that was raised earlier comes into play. If you're going to take advantage of it, isn't that going to disappear?

And the answer is, in general, yes, it will, but it may take a while. And along the way, you'll do quite well. So the question was asked, well, if that's the case, if there are all these anomalies and if you can take advantage of them, well, then mutual fund managers ought to be able to outperform simple buy and hold strategies. Because they can take advantage of these anomalies.

If you do a histogram of mutual fund returns that are in excess of their risks-- so if you make some kind of a simple risk adjustment and you look at the mutual funds' additional value added above and beyond those risk adjustments-- those excess returns are given by this histogram. For data from 1972 to 1991, the histogram of excess returns has basically this kind of a distribution. You've got some positives, you've got some negatives, you've got more negatives than positives, and on average it's actually less than zero. Mutual funds net of fees are actually losing money for you on average. That was the conclusion by these academics as of a few years ago. Yeah?

STUDENT: In defense of the big ones, isn't part of the purpose to lower your risk of your portfolio to lower the volatility? For example, you might be able to get the return plus zero. But then the next year you might be able to get the return minus five. Well, I think mutual fund managers aim to get you steady terms that are [? being ?] exactly the term, plus zero.

PROFESSOR: Well, so first of all, that's not necessarily the objective of every mutual fund right there are mutual funds that are not trying to give you lower volatility, but rather they're trying to give you access to broader investment vehicles and instruments. So the original index fund that was set up by Wells Fargo in the 1970s-- the purpose was to allow an investor to get access to 100 securities without having to actually go out and buy 100 securities.

STUDENT: Thereby diversifying, right?

PROFESSOR: Right, by diversifying. But it doesn't lower the volatility, except through diversification. So you're right. Diversification will lower it, versus buying Motorola. But the question is, how does this do versus buying 100 stocks, or rather buying a mutual fund like Vanguard, the Vanguard 500 Index Trust, where you're not trying to outperform the market you're trying to match the

market?

And the argument is that the mutual funds that have been trying to beat the market, on average they don't. They don't beat the market. Some of them do; some of them don't. But as a group, they don't add any extra value. That's the argument that was made.

Now, that's not to say that there aren't good mutual funds and there aren't bad mutual funds. There may be. So somewhere in here is Peter Lynch's Magellan Fund-- terrific fund, very talented portfolio manager. But on the other hand, if you can't tell in advance who is going to be the next Peter Lynch and who's going to be the next-- I don't know who; I won't cast any aspersions. But if you can't tell in advance who's going to do bad, then you're essentially throwing a dart at this histogram.

You may be lucky and you'll get on the right side, or you may be unlucky and hit the left side. But on average, you should do better by putting your money in a passive index fund. Now, that's the argument of Vanguard and all of the passive investment vehicles. I'm not going to take a stand on that, because we're going to come back and talk a bit about that at the end of the course. And then as part of investments, you're going to re-look into that.

I just want you to get a feeling for the data that's out there. And the data that's out there says it's very hard to tell whether or not mutual funds, as an aggregate, are adding any value. By the way, you realize that there are actually more mutual funds out there than there are stocks.

You know that? Yeah, there are about 10,000 mutual funds. There are about 8,000 stocks out there, including the penny stocks and pink sheet stocks. There are probably only 4,000 or 5,000 stocks that you would actually ever invest in as a retail investor yourself. And so the number of mutual funds far exceeds the number of stocks.

The way that mutual fund managers justify that is by saying, look, there are 31 flavors of Baskin Robbins and so we want to provide investors with lots of different possibilities. Not everybody wants the S&P 500. Some people want the S&P 100. Some people want the S&P 250. Some people want the S&P 385. And so I'm going to construct a fund for every clientele that's out there.

That's a legitimate argument, as long as investors understand that when you buy into a mutual fund you're buying something that may cost you more than if you try to do this on your own. So the key points that I want you to take away is that the average return on US stocks from

1926 to 2004 was 11.2%. Now that's considered the good old days, so no more.

The average risk premium was about 8%-- again, the good old days. That's probably not going to happen for a while. Stocks are quite risky. Standard deviation of returns for the market is about 16% annually.

That isn't risky anymore. That, again, is the good old days. The market today, using the implied volatility of the VIX index, the implied volatility of S&P at the money options, was about 49%.

So the annual forward-looking S&P 500 stock market volatility right now is about 49%, which by the way is down from 80% a couple of weeks ago. So as I predicted, volatility was going to decline once the election was clear. That eliminated a piece of uncertainty, but there is still a remaining piece, which is what's going to happen to our economy. That's why the volatility is at 49% versus a historical average of 16% to 20%.

Stocks on an individual basis are clearly much more risky than as a group, so you're absolutely right, Remi, that when you put it into a portfolio you reduce the risk. And so the S&P 500 is a lot less risky than Motorola. Also, stocks tend to move together over time.

Over time, from one day to the next, there is very little relationship, but on a given day stocks tend to move together in groups, General Motors seemingly to be correlated with the S&P as well as other stocks. And obviously, market volatility changes over time, and financial ratios that can be used to create these different kinds of bins for sorting stocks and constructing these anomalies-- they actually do seem to have some kind of predictive value. Why, we don't know in many cases, but the anomalies are there. And so that's something to be aware of. Other questions?

Now that you have a feel for the data, I want to take a step back and ask the question, how do we make use of this information in a way that can help the typical investor and also help the individual trying to decide on a corporate financial decision? How do we use these kinds of empirical insights in our theory? So to do that, I'm going to turn now to lectures 13 and 14 and focus on how to measure risk and return in a more systematic way and then incorporate that into portfolios. So we're going to talk a bit about motivating the idea behind portfolio analysis and then use some of the theoretical concepts that we introduced last time, like mean, variance, and covariances and use it to piece together a good portfolio.

So the motivation for what we're trying to do now is to figure out how to combine securities into a group that will have attractive properties. If you're an investor or a corporate financial manager, this is a decision that you've got to do almost every day. For example, all of you have already made that decision today, whether you know it or not. Because if you didn't do anything between yesterday and today to rebalance your portfolio, you've made an affirmative decision to let the debt ride. Let it ride.

You're going to be taking another roll of the dice at 4:00 today, and let's hope it turns out well for you. But you've made a decision. Every day you don't do anything with your portfolio, you are making a decision. So what we want to do is to see if we can think about making that decision a little bit more systematically.

To do that, I want to define what I mean by a portfolio. So the definition, in very simple terms, is just a specific weighting or combination of securities, such that the weights add up to one. It's just a way to divide up the pie. If you've got a certain amount of wealth, you're going to allocate it among different securities into a portfolio. A portfolio is defined as a set of weights of those securities where the weights add up to one.

Now, this is sort of the framework that we use in terms of the notation. So omega, the Greek letter omega, when you write it as a vector, it denotes the set of weights for your portfolio. So if you've got n securities, then this vector omega, which is equal to omega one, comma, omega two, dot, dot, dot, omega n, that is a portfolio. And if you want to be clear about how to define it, it's simply the number of shares of security I multiplied by that price, divided by the sum of all of the values of your securities in your entire collection.

Any questions about this? Very basic stuff, but it's important to get it right upfront.

Now, by the way, the number of shares NI, I'm going to let that be a real number, meaning it could be zero, it could be five, it could be 500, it could be minus 200. Minus 200 means that you have short-sold 200 shares of that security. So these weights, they all sum to one, but they don't have to be all non-negative. Some of these weights could be zero. Some of these weights could be negative.

If some of these weights are negative, then what do you know about some of the other weights? Well, yes, they have to be positive because they have to add up to one. But tell me more about the weights.

STUDENT: Greater than one.

PROFESSOR: Right. Because in order for it to add up to one, if some of these things are less than zero, then some of these other things are greater than one. What does it mean for a security to be greater than one, a weight to be greater than one? Does that make sense? What's the interpretation? Yeah, Lucas?

STUDENT: Does it mean you're leveraged?

PROFESSOR: It means that you're leveraged, that's right-- leveraged meaning that you're buying more than you have money. Where are you getting that money from? You're basically getting a loan, but who's loaning you the money? Andy?

STUDENT: Well, the stocks that you sold short gave you the extra cash that you can buy long stock.

PROFESSOR: That's right. So nobody loaned you money, but somebody loaned you something. They loaned you a stock. So this simple little framework already has given us one interesting insight, which is that when we short sell a stock and buy another one, we're actually getting a loan from somebody who's lending the stock to us that we've sold. We've taken that cash and we're putting it into another stock. So we're getting a loan of one security and turning around and using those funds to buy another security.

That's a new transaction as far as we're concerned, but it's one that's going to be very important in how we think about portfolio construction. If you didn't understand that, go back and take a look at these nodes and try to work out a numerical example for yourself. And if you still don't understand it, ask again next time or ask the TA during recitation. It is a very important point.

Now, there is a case that I'm not going to talk about in this class where the weights can actually sum to zero. I don't want to talk about that because that's a much more complex situation, where basically you have a portfolio with no money down. This is sort of like the arbitrage portfolios that I described to you in earlier settings.

We're not going to analyze that in the context of stocks, but there are a very large number of hedge fund strategies that are based upon just these portfolios. And so this will be a very important concept that you'll cover in 433, but we're not going to talk about it now. I just want to make you aware of that, that you can have the weights summing not to one but actually to zero.

Now, the assumption that I'm making implicitly is that the portfolio weights are summarizing everything there is to know about your investment. So once you know the portfolio weights and you know the stocks, then you know what your portfolio is about. So as an example, you have an investment account with $100,000, and you've got three stocks in there-- 200 shares of A, 1,000 shares of B, 700 shares of C, so that your portfolio is summarized by the weights 10%, 60%, and 30%.

So from now on, we're not going to worry about prices and shares anymore. We're going to focus just on portfolio weights and the returns of your securities multiplied by those weights. It's just simplification. Yeah, Megan?

STUDENT: I'm just wondering what you think about a 130-30 type portfolio in the context of the last slide.

PROFESSOR: Yeah, sure. So you're already asking a question that's quite a bit more advanced than what we're going to cover. What's a 130-30 portfolio? Can you explain that, or have you just heard that in the news?

STUDENT: I understand, I guess, the basic concept, which is you're 130% long and are 30% short, so you're headed back to a net exposure of zero.

PROFESSOR: Right. That's right, exactly. So let me describe a product that's out there that's been developed just over the last few years. It's called a 130-30 portfolio, and what 130-30 stands for is 130% long and 30% short.

Now, you can have a 120-20 portfolio or a 180-80 portfolio. But the idea is that you have weights that add up to 100%, but the long positions are no greater than 130%. And the short positions are no less than minus 30%.

Now, the reason that this is an interesting product is that-- I have to give you a little bit of history. This is getting a little out of our area, but I'll give you a preview of Investments 433. Typically, when institutional investors like pension funds or mutual funds, when they invest, they are not allowed to short sell.

This has nothing to do with the SEC. It has nothing to do with law. It has to do with the particular entities that are investing, because short selling was viewed way back as being a very risky endeavor because you could lose everything and more. There's unlimited amounts that you could lose because your short selling a stock can go way up and you could lose

tremendous amounts. So mutual funds were originally not allowed to short sell at all.

So for a mutual fund, the portfolio weights were restricted to be non-negative, and certain pension funds were not allowed to short sell. So if you were a pension plan or a state university and you gave your money to investment manager xyz, that investment manager would be required not to short sell for your portfolio. It was discovered over the last several years that this kind of constraint artificially dampened the return of a portfolio-- not surprisingly, because when the market goes down, if you're long-only you're going down with it.

But if you have a short position, then at least the shorts would be able to buffer some of the losses on the long side. So institutions have started getting more and more sophisticated, thanks to hedge funds pushing them into this area because, of course, hedge funds can do anything. They can short, they can long, they can go sideways, whatever. So hedge funds led the pack by saying, we're going to actually short sell some of your long-only portfolio to help you get a little bit of extra return on the downside.

And so pretty soon, institutional investors said, well, I actually like the idea of you short selling a little bit but I don't want you to do it too much. Because I don't really know what the risks are. I'm new to this. I don't want to get the risks out of control, so I'm going to limit how much you can short sell. The limit of how much you can short sell imposes a limit on how much more long you can go than 100%.

Just like we said, if something's negative, then some of the weights have got to be greater than one, or they got to add up to greater than one. So when you have that situation where you have a limit on the total negative position you can have, that limit puts a symmetric upper bound beyond the number one of what you can go long. And so for reasons that are probably a little bit too far afield to get into here, 130-30 seems to be a bit of a sweet spot for managers out there.

So they said, we will limit our short positions to no more than 30% of the capital. So you give us $100 million to manage, we will take no more than $30 million of shorts. And therefore, we will take no more than $130 million of longs. But when you add them up, you still get back to 100%.

So that's 130-30. It's very popular, and it's something that is likely to grow, particularly given this current market environment. Because 130-30 has done better than the S&P, not

surprisingly, because of that 30% short position.

So here's the example of your own portfolio and how you get those weights. That's pretty straightforward. Here's another example where you've now got some short positions here, and the short positions are not from short selling. But the short positions are in riskless bonds. In other words, now instead of shorting a stock, you're shorting a bond or selling a bond or borrowing money from a broker and getting leverage.

So this is leverage where the security that you're levering up is using bonds, and you're levering up the equity positions. So your portfolio weights look like this. Your equity positions, when you add up the equity positions, those portfolio weights, you get 200%.

But your riskless bonds, you shorted $50,000. You're borrowing $50,000 from the broker, so you've got minus 100%. When you add those two, you get back 100%, or in this case, $50,000. So you start out with $50,000 cash and then you buy $100,000 worth of stocks by borrowing an extra $50,000 from your broker. Yeah?

STUDENT: I understand the [? degree ?] of the portfolio [INAUDIBLE], but I thought, fundamentally, it's to have different risks and to manage that.

PROFESSOR: Yes.

STUDENT: So when you are actually structuring portfolios, do you have these risks [INAUDIBLE]? Because I would just be willing to do them separately. There is no reason for you to have them as [INAUDIBLE].

PROFESSOR: Well, the reason that I have them here is I want to show you exactly how you would compute the portfolio weights of your entire portfolio. So basically, what this is is your equity portfolio, but in addition, your fixed income position's added in. I mean, your whole portfolio could be anything. It could be stocks, bonds, options, currencies, real state. So I'm just including all of this in the portfolio itself.

STUDENT: So basically, it is to try to handle different risks-- I mean, different stocks or bonds or whatever they have, various risks?

PROFESSOR: Yes, absolutely, and you are doing that. Stocks A, B, and C have different risks, as does the bond. And so you're mixing and matching and putting them together into what hopefully will be an attractive portfolio.

Now, we mentioned before that when you get a mortgage, that's leverage, too. So this is an example of a situation where you buy a home for $500,000, but you only have a $100,000 payment. Your equity in the home is only $100,000. The bank has loaned you $400,000. Your leverage ratio is 5:1, so if you were to look at your portfolio weights it would be 500% house minus 400% bank or bonds or mortgage.

That's very high leverage. And in that case, when you're leveraged five to one, if the house price goes down by something like, I don't know, 2%, you've lost 10% of the value of your home-- or the value of your equity, rather. If the house price declines by 15%, that's really bad news.

So leverage is a two-edged sword. When things are working well, it gives you a boost. When things are not working well, it can hurt you on the downside as well.

Here's another example where you've got a zero net investment strategy. You can work that out for yourself. This is a little bit trickier because the portfolio weights now add up to zero.

You've got to think a little bit about what it means to have portfolio weights at all. So I'll leave that for you to look at. That's something that, as I said, we won't cover this course in great detail.

So now motivation-- what we're trying to do now that you know the basic language of portfolio weights and how to manipulate them to some degree, I want to ask the question, why bother with the portfolio? Well, we've already got a couple of comments about why you want a portfolio. You want to have stocks with different kinds of risks so you have diversification.

But there's another approach, and the other approach is championed by Warren Buffett. Warren Buffett has criticized this idea of diversification, not putting all your eggs in one basket, by saying, you should put all your eggs in one basket and then simply just watch that basket really carefully. Isn't that better?

Well, that sounds good, but what if it's the case that you don't really know how to pick the right basket? And so therefore, whatever basket you're watching may not be particularly attractive because you picked the wrong basket. So that's really the idea behind portfolio theory. It's that not all of us are Warren Buffett.

Not all of us want to become Warren Buffetts. We want to have a relatively systematic

approach to making a good investment decision. We don't want to try to beat the market. We want to figure out whether we can come up with a responsible and attractive way of investing that has some kind of economic logic to it.

So the point is that we don't know which stock is best, and so we don't want to pick just one stock like Motorola. Because there are periods where Motorola looks fantastic and periods where Motorola looks horrible. So we want to be able to pick a portfolio that's got good characteristics.

So diversification is one way to do that. It's to basically spread your risk across a number of securities, and portfolios can do that. But at the same time, they can also create focused bets. So it's not just the case that you have to buy every possible stock there is out there in order to diversify.

For example, you may have information or you may have conviction that information technology is going to do really well over the next couple of years because somebody's got to figure out how to process all of these bad loans and problem banks. And IT is going to ultimately be the solution. Well, if that's the case, you can make a bet on IT without having to make a bet on any one firm or one stock. The way you do that is to form a portfolio of stocks that are all in the IT sector. And so you get diversification, but at the same time, you're able to make a bet in an area where you think you have particular expertise.

And finally, portfolios can customize and manage your own personal risk-reward tradeoffs. So for some of you, you want a lot of risk, you want it concentrated in a small number of industries, and you want to do it with relatively small priced stocks. You can do that. Somebody else might have a very different set of preferences. Portfolios allow you to tailor the risk-reward tradeoffs to your particular preferences.

So now we have a motivation for portfolios. Then the next question is, that sounds great; now tell me, how do I construct one of these good portfolios? And in order to answer that question, I've got to tell you what "good" means, or you've got to tell me what "good" means. So typically, what we say about a good portfolio is it's a portfolio that has high mean and low risk. That's what "good" means.

There are two characteristics that we tend to focus on for purely statistical reasons. It's because those are easy to compute, and they are the first two statistics that one would look at when you're looking at an investment-- the mean and the standard deviation. So you might

think that, naturally, it would make sense to pick a portfolio that's got high mean and low standard deviation. That's an assumption.

In other words, we're assuming that we're going to measure risk by standard deviation, and we're assuming that we're measuring return by the actual expected rate of return. For certain investors, those are not appropriate. For example, there are some investors that are really keen on socially aware investing so they don't want to invest in companies that pollute the environment. They don't want to invest in companies that engage in nonunion workers, or they don't want to invest in companies that happen to be exploiting labor in unregulated markets. Those are examples of non-pecuniary characteristics that figure into this choice of stocks.

We're going to abstract from that. So for our purposes, the characteristics that we're going to look at for a good portfolio is, does it have a high return, does it have low risk? And the way we're going to measure risk is in terms of the volatility or standard deviation.

Now, here, again, there's lots of ways of measuring risk. We can measure by the upper quartile, the 5% loss or spread, but in fact, what we're going to use is this standard deviation measure. For symmetric distributions like the normal, it turns out that that's not a bad measure, but some people have argued that by looking at spread you're confusing the upside with the downside.

Nobody has any problem with upside risk or upside distribution. I haven't run across anybody that said, gee, this year I'm really making too much money and that's just not a good thing. If you meet anybody like that, introduce me. I'll help them out with their problem.

But the point is that for a symmetric distribution, it doesn't matter, and in more advanced approaches to investments people have used one-sided measures. But we're not going to do that in this course. So we're going to focus on variance or standard deviation as the measure of risk. And the assumptions that I'm going to make for the remainder of the course is that all investors like higher mean and all investors like higher variance.

Now, that's a really reasonable assumption, but you could challenge it if you wanted to argue that investors care about other things. So just be aware that I'm making an approximation, and the approximation is exactly that, that mean and variance are the only things that our prototypical investor is going to care about. So now, we actually are pretty close to being able to come up with an answer to the question, what's a good portfolio and how do we pick stocks.

One of the things that we're going to answer over the course of the next few slides is, how much does a stock contribute to the risk and the expected return of a portfolio? So if you're thinking about investing in a new stock, it's like inviting somebody into your club. You want to ask, well, what are you going to contribute to my club?

What are you going to contribute to the portfolio? What will you add to what I already have? Are you going to help me with my expected return? Are you going to help me lower my risk?

And if the answer is no to both of them, then I don't want you. You're not going to do anything for me. Why should you be in my portfolio? So that's the kind of argument we're going to make to be able to construct a good portfolio.

So let's get a little bit more specific about that. Here's a graph, and you're going to see this a lot. This graph is going to be one that we use for all of portfolio analysis. It's where we plot on two-dimensional space the average return of the stock as well as its risk, where risk is now being measured by standard deviation.

So I've got five assets plotted here. Merck is one and General Motors is another one. Motorola is a third, McDonald's a fourth, and I've got T-bills down there on the lower left. This gives you a sense of the different trade-offs there are.

Clearly General Motors is lower risk that Motorola, but it's also lower return. And McDonald's is definitely going to be higher risk than Merck, but notice that McDonald's is also lower return than Merck. So at least in this setting, nobody in their right mind-- by that I mean, no rational investor-- would ever want to hold McDonald's over Merck-- by our assumption. We're assuming that investors like expected return and they don't like risk.

Question? Yeah?

STUDENT: This [INAUDIBLE] think that McDonald's will perform better.

PROFESSOR: Exactly, that's right. So I was waiting for somebody to say that. Warren Buffett would say that's the stupidest thing I've ever heard, because all you're doing is plotting history on this chart. And this tells you nothing about what might happen over the next 12, 24 months.

It could be that health care is going to just become a real problem, pharmaceutical companies are going to get battered because of the Democratic administration. That's going to force them to reduce the prices. And so over the next six to 12 months, the only thing that people will be

able to do is to go to their neighborhood McDonald's and just enjoy a nice hamburger and complain about what's been going on with the pharmaceutical industry.

In that case, McDonald's is a great bet and Merck is a terrible investment. We abstract from all of that. We are not in the business of forecasting stock returns. Why?

Because I just showed you in the previous set of slides that it's hard to forecast. In fact, you told me that in an efficient market it's actually hard to tell what's going to happen with these stocks. And if you could tell, then people are going to start using that information, and then the information is worthless because it'll have already been taken into account.

So you see, this is a very important philosophical difference between Warren Buffett and academics. Warren Buffett believes that there are systematic mispricings out there that can be found and taken advantage of. Academic finance, as of the 1960s and 70s when this theory was developed, started from the point that you just came to very quickly, which is that there are no patterns in the data. If there were, someone would have already done it-- which, by the way, Warren Buffett would answer by saying, you know what, that sounds like a joke about the economist walking down the road, sees a $100 bill, and walks right by it. And when somebody says, why didn't you pick up the $100 bill, they said, well, if it were real, someone would have already picked it up.

I mean, that's the argument that we made together. We made that argument, that if there was a pattern somebody would take advantage of it and then the pattern can't be there. And then, again, Warren Buffet would say, that's the stupidest thing I ever heard, because in fact, I've done it, I saw the patterns, I took advantage of it, and I have a bit more money than you do, so there.

Who do you believe? Well, it's kind of hard to argue with a $40-something billionaire. I think that's his wealth, $40 billion. But that's not the perspective of this analysis. Mike?

STUDENT: Well, let's say the expected return was you had perfect information and that's what was going to be a perfect crystal ball. It would still be irrational to buy McDonald's versus Merck, so you'd short McDonald's and long Merck until the returns became equal.

PROFESSOR: Exactly. So I'm going to talk about that for a little while, but you're right. So if you could short, then what you'd want to do is exactly what you said. You want to basically long the low risk, high yield asset, short the high risk, low yield asset, make that spread, and make it as riskless

as you can buy including other securities. Yes?

STUDENT: Yeah, but eventually it would collapse, and then the relationship would--

PROFESSOR: And then it should. That's right. So the argument that economists would make is that this picture is the equilibrium of where these returns should be, given what the market determines their fair rates of return are, relative to their risks. So that's, again, a very big philosophical difference.

An economist would say, all of these securities are exactly where they should be. And they may change over time, but at any point in time they are where they should be. Supply equals demand, market's clear, everything is equilibrium, and our decision is simply to figure out what to make of the portfolio of these securities. What is the best portfolio of these securities?

So I'm just warning you, this is a philosophical departure from what you're used to thinking and reading in the newspapers. Because the newspapers would say, well, let's take a look at the earnings at McDonald's. Let's take a look at Merck. Let's talk to the macroeconomists and see what's going to happen over the next 12 months. Let's talk to the earnings analysts and see whether they forecast higher earnings, lower earnings.

The whole point of the academic infrastructure that we set up is that you can't predict these things. And if you believe that, then basically Warren Buffett is just one really lucky guy. So I'm going to have to justify this academic position to you. And I won't do that until the end of the semester, because first of all, I have a lot of material to cover.

And I want to cover all of the material in the basic form, and then in the end I'm going to give you a sense of where things really stand. It's a fiction. It's a fiction that you can't forecast stock prices, but it's a fiction that actually is pretty close to reality for 99% of the public.

Now, you guys are not 99% of the public. But for the people that will someday be your clients or your investors, it will be true, that the typical individual has no hope of being able to out-forecast Warren Buffett. And if you can't out-forecast somebody, then you may as well assume that they're random and they're perfectly priced.

And then you still have the problem, OK, if you assume that, then what do you do? That's all we're going to try to figure out. I'm going to tell you what you do with portfolio theory.

Now, since we're almost out of time, I want to just tell you where we're going. What we're

going to do is look at this graph and ask the question, what do people want?

They want higher return, they want to go north, and they want lower risk. They want to go west. So the northwest is where we're going to be heading in this graph, and the question is, how can we get there? How can we get as northwest as possible using these securities?

And the answer will shock you, I think, because you're going to see that by doing a very simple little bit of high school algebra we can actually create a portfolio that beats all of these things. That is, if you didn't know anything about portfolio theory, you would be severely worse off, because you'd be stuck having to be on one of these five points. And if you knew a little bit of high school algebra and some finance, you could actually do a lot better. So we'll see that on Monday.