Hi, everyone, last time, we saw how to measure risk and

return, and we talked about simple versus compound returns.

And also, we talked about various measures of risk,

including standard deviation and beta.

What we wanna do in this week's lesson is develop some additional ways to measure

risk adjusted performance.

Essentially, what we're looking for is a way to keep score,

a way to identify both very good performance and also poor performance.

And so at the end of this lesson, you should be able to calculate various

measures of risk adjusted performance including, comparison to a benchmark,

a Sharpe ratio, a Treynor ratio, and also a Jensen's alpha.

And these measures will allow us to evaluate investment performance.

So what we are looking for in this lesson is essentially a way to keep score.

We are looking for

a way to gauge whether our investments are out-performing expectations.

And finance has developed a number of ways to compare actual performance to

expected performance.

And what we're really looking for here is a measure of our abnormal return.

And with an abnormal return, what we do is we compare the actual return of

our investment to the return that we expected.

And the difference will give us a measure of how our investment has performed.

A positive abnormal return is good, we've outperformed a benchmark.

A negative abnormal return isn't good,

it means we've underperformed what was expected.

Perhaps the easiest way to measure abnormal performance is just

compare our fund to a benchmark.

And that's what I've done on this slide,

we can do this very easily in R, we can use the return cumulative function.

And we can also plot this using the chart.CumReturns function.

And so what I do with these functions is I just feed in the fund data and

the benchmark data.

The benchmark here is just an aggregate stock market index,

think like the S&P 500 or a Total Stock market index.

And you can see the output of these functions on the the screen.

If you look at the chart, the black line represents our funds return,

the red line represents the benchmark return.

And here you can see over the period from 1980 to 2018,

our fund has significantly outperformed the benchmark.

And if you look at the data supporting this chart, the cumulative return for

our fund is 141.57, the benchmark return is only 69.29.

And by way of comparison, the risk free rate or

the rate of return on a treasury bond is only 4.07.

So our fund has significantly, significantly outperformed this benchmark.

And this gives us one initial way to identify our performance.

An alternative way to measure abnormal performance,

is to look at the Sharpe ratio.

And the Sharpe ratio is just a measure of reward versus risk of an investment.

So if you look at the formula for a Sharpe ratio in the numerator,

it's just the return on our fund minus the risks free rate.

The risk free rate here is typically the return to a treasury bond.

Which we generally take to be risk free, and

that's the reward part of the equation.

If you look at the denominator, the denominator is the standard

deviation of our return minus the risk-free rate.

And so what we have with the Sharpe ratio is a reward-to-risk ratio.

And a higher Sharpe ratio indicates higher reward per unit risk.

So higher Sharpe ratios indicate better performance.

Now the funds returned an excess of the risk-free rate,

sometimes we call that an excess return.

And we can calculate this very easily in R, and

so there's a function called SharpeRatio.

And if you look at how this function operates,

we specify our fund's return, that's the All.dat$ContraRet.

We specify the risk free return, and we get the output.

Now there are different ways to calculate the Sharpe ratio.

I'm going to focus in on the first line,

that's the traditional way to calculate the Sharpe ratio.

That's where the denominator is, the standard deviation.

And you can see here that this Sharpe ratio for our fund is about 0.19,

now you always need something to compare it to.

So I also calculated a Sharpe ratio for the overall market index

that we used as a benchmark previously, and that was 0.153.

So here's yet another way to show that our fund has had superior performances.

It has had really good performance, its Sharpe ratio of 0.19 is much

higher than the Sharpe ratio of the benchmark index.

A closely related ratio to the Sharpe ratio is the Treynor ratio.

Here the numerator stays the same, except the denominator is now beta.

So the Treynor ratio is also a reward to risk ratio,

while here the risk is measured relative to beta.

And so the interpretation is very similar here as well,

a higher Treynor ratio indicates higher reward per unit risk.

And so we can do this and calculate this as well as in R, and handily enough,

there's a function called TreynorRatio.

Format is very similar to what we saw for the Sharpe ratio.

And for our particular fund, the Treynor ratio is 0.1.

And again is a benchmark the Treynor ratio for

the overall market index is about 0.07.

And so our fund has enjoyed very strong performance by this measure as well.

Now the final measure that we can look at to measure

abnormal performance is what's called Jensen's alpha.

And so Jensen's alpha measures the abnormal return that the portfolio earns

after adjusting for beta.

And to estimate a Jensen's alpha, we need to be able to run a regression.

Add with R regression the dependent variable is

going to be R funds return in excess of the risk free rate.

And the independent variable is going to be

the market return in excess of the risk free rate.

And when we estimate this regression,

we will get an estimate of both alpha and beta.

And those two coefficients are gonna tell us a lot

about how a fund or how an investment has performed.

And so when we estimate Jensen's alpha, the first thing we need to do is calculate

the assets return of the funds return in excess of the risk free rate.

Typically, we do this monthly but we could also do it daily or annually.

Over the corresponding period, we're also going to calculate the return on our

index, our market index and access of the risk free rate.

Then we're gonna run the regression again where the dependent variable is our

funds access return, and the independent variable is the markets access return.

And what we're really interested in for

our measure of performance is the regressions intercept.

If the intercept is positive and it's statistically significant,

the fund has outperformed.

If it's negative and significant, the fund has underperformed.

And if the intercept is insignificant, it's generally been in line,

our performance has generally been in line with expectations.

And so we can do this in R, and

here what I've done is I've created the variables that we need.

I've created two variables, a fund excess return and a market access return.

And then we can run the regression in R, right,

we just run a linear model, LM, and you can see what I've run there.

The FundExcess is the Y variable, the MktExcess is the X variable.

And then if we look at the summary output from this regression,

it's important to focus in on the intercept, and

also the coefficient on the market return.

So I've run this in a monthly level and that's important for

interpreting the intercept.

The intercept here is approximately 0.002185% per month.

And what that indicates to me is that this fund has outperformed by 0.218% per month.

That is statistically significant, so this fund has yet again,

by this measure exhibited outstanding performance.

There are a couple other things we can look at from this regression.

The coefficient on market return, that's an estimate of beta,

and the coefficient there is 0.901.

Remember, anything less than one is less riskier than average, so

this one's slightly less riskier than average.

The other thing we also take a look at is R squared or

adjusted R squared and that's 0.83.

And that tells us a pretty high fraction of this funds return can be explained by

the overall market.

So in this lesson, we saw several ways to measure risk adjusted performance,

and by any measure that we looked at.

Whether it was comparing to a benchmark, a Sharpe ratio, a Treynor ratio or

using Jensen's alpha this fund performed extremely well.

And this opens up a number of interesting questions that are worth exploring,

is it easy to outperform the stock market?

Do some people have an ability to persistently outperform the market?

If so what are their strategies, or could this outperformance just be luck?

And in future lessons, we're going to develop and

talk about a number of these issues.

[MUSIC]

When we look at investments, it's important to

understand the risk of the investment, the return of the investment and

it's also important to measure the investments abnormal return.

But when you make investments,

it's also critically important to consider the cost of investing.

Making investments typically entail fees.

Some of those fees, like commissions, are very easy to observe.

Some of those fees are a bit hidden.

But those fees have a big impact on investment performance.

So in this lesson I'd like to talk a bit about transaction costs.

At the end of this lesson,

you should be able to discuss the impact of transaction cost on returns.

And you should be able to understand the different components of transaction costs,

commission's, market impact and delay.

Let me illustrate the impact of transaction cost

with a really simple example.

So let's first consider the perfect world case where there's no transaction costs.

And let's suppose that you acquire $1,000 worth of shares and

then you realize that 10% return.

And at this point you sell your shares.

Well, if you did that you would recognize the gain of $100 or

your investment would have grown to $1100.

And in this perfect world that case, not surprisingly, your return is 10%,

but now let's consider the case where we add transaction costs.

So let's consider the case where you again acquire would like to acquire

$1,000 worth of shares, but now you pay 150 basis point cost when you buy.

A basis point is .01%, so

a 150 basis point cost means you pay a cost of about 1.5%.

So now when you go to invest, you're only able because of

this transaction cost to buy $985 in shares.

And if the shares rise 10% and

you incur this transaction cost when you go to sell

you would only put $1,067.25 in the bank.

To put this another way, now your net return isn't 10%, it's only 6.73%.

And the main point of this example is that transaction cost will

always lower your return.

And they can have a huge impact over your investing lifetime.

And so one of of my heroes in finance is John Vogel.

He was a legendary founder of Vanguard and he has this great quote where he says,

performance comes and goes, but costs roll on forever, and

I wanted to illustrate that via an example.

So let's consider a low-fee fund.

The charges of fee of 0.1%, and

let's compare that to a high fee fund that charges a fee of 1% each year.

Suppose that before transaction cause both funds earn a 10% return.

Now let's suppose you invest $100,000 in those funds.

And we'll follow that over the next 30 years.

So in the chart you can see how your money's grown in the high fee fund

versus the low fee fund over the next 30 years.

And the low fee fund, you have

a little over $1.7 million, that is really substantial.

But if you look at the high fee fund, now you only have a little over $1.3 million.

So that is a pretty substantial difference and that just further illustrates

how fees can add up over time and eat away at performance.

So when we look at investing, there are three big

transaction cost components that we like to think about.

The first is pretty easy to observe, it's commissions.

And that's just a fixed charge that you have to pay for executing a trade.

And so for example, I have a Charles Schwab account.

I looked up Charles Schwab, and they charge a fee of $4.95 per trade.

And that's typically known in advance and you can look up what the commission is.

The next component of these is the bid-ask spread cost,

and this is the difference between the price quoted for an immediate sale and

an immediate purchase of the stock.

And that for some investments can be substantial and

then there's the delay cost.

Sometimes we want to trade but it takes time.

It takes time for our order to execute or sometimes we're not able to trade at all.

And that's delay cost and delay costs can be substantial as well.

So I wanted to show you some examples of the bid-ask spread and

also the delay cost, so let's consider first the bid-ask spared.

And let's consider a fictitious asset management firm, AE advisers,

they wants to buy 1,000 shares of XYZ.

If you look at the chart on the screen, that's the limit order book.

And that tells you the quantities that you can buy of this stock at various prices.

And so the best offer price in this example that's the lowest

displayed price at which AE can buy shares.

And so in our example, AE can buy up to 2,000

shares and XYZ at a price of $25.42.

The best bid price is the highest displayed price at

which AE can sell shares add.

And in our example AE can sell up to 2,000 shares at a price of $25.38.

So we talked about the quoted spread when we go to trade that's

the difference between the best bid and the offer.

And in our example that difference is about 4 cents,

if we look at 4 cents divided by the average of the best bid price and

the best offer price turns out to be about 16 basis points.

And the important thing is is we incur this spread when

we have a round trip transaction,

when we go to buy some shares and then when we sell shares.

We will incur the spread.

And one other important thing to note is that the larger our order,

the more we'll pay and transaction costs, they can have a big market impact.

So here if we wanted to a buy, say 4,000 shares of XYZ,

we could buy 2,000 shares at $25.42 we could

buy another 1,500 shares at $25.43 and

we could buy the remaining shares at $25.44.

Another words, when we execute a big trade it can drive up the price or

drive down the price and that's market impact.

To illustrate the lay costs let's look at a fictitious example where fund

manager discovers an undervalued stock that she wants to buy.

That undervalued stock is currently trading at a market price of $50, and

she instructs the trader to buy $250,000 worth of this stock.

The trader looks for the most capable broker to handle the order.

However, by the time the trader chooses a broker and submits the buy order,

the price has risen to $50.25.

So this delay cost prices to move against us.

And here the delay cost is $50.25 minus the original

price of $50 which is 25 cents.

And if we express that as a percentage of the market price of

$50 the delay cost here is about 50 basis points.

So when we look at this and practice, and again,

just a reminder that 1 basis point = 0.01%.

We look at this in practice, we can get a sense of which transaction costs,

which trading costs have the biggest impact.

And commissions those fixed cost of trading are pretty small.

They amount to about five basis points those bid ask spread costs that market

impact costs those are substantially larger about ten basis points.

And then in practice these delay costs can be

really substantial about 46 basis points.

So the total transaction costs are approximately 60 basis points in this

example or about 0.60%.

And that's typically what we observe in practice.

So in summary, the important thing to take away from this lesson is that

transaction costs always work to lower your investment returns and

over time they can have a big impact.

And there are three main components to transaction costs that we look at and

practice, commissions, bid-ask spread or market impact and then delay.

All three of those are important.

Investors what we really care about is returns net of transaction costs.

We care about the returns after these transaction costs have been accounted for.

In previous lessons, we've looked at how to measure the risk and

return and performance of an investment.

And in the example that we've worked through in these lessons,

we saw that the mutual fund that we examined had superior performance.

It had high sharp ratios that outperformed its benchmark.

But how typical is that performance?

Is it easy to outperform the market?

This gets into one of the most fascinating areas of finance research,

which is market efficiency.

And so in this lesson, we're gonna talk about the evidence in support of market

efficiency and some of the evidence that I find compelling against market efficiency.

And so at the end of this lesson,

you should be able to understand the different types of market efficiency,

weak form, semi-strong form, strong-form market efficiency.

And I want you to be able to describe the evidence in support and

some of the evidence against market efficiency.

Let me start off with a thought question.

So suppose you found the following empirical pattern by

looking at stock price data.

That if a stock had gone up 2/3 of the time

over the last 20 trading days, you should buy the stock.

And if it's gone down 2/3 of the time over the last 20 trading days,

you should sell the stock.

And if you followed this strategy, you would have normal returns.

You would earn returns that are high.

What would you do?

Well, if you spotted XYZ's stock pattern and that guaranteed you a sure profit, you

would most definitely trade on it, and you might even borrow money to trade on it.

Now, here's the interesting thing, is in the process of exploiting this anomaly,

you're gonna start to make advantage.

When you buy XYZ shares, you're gonna bid up at the XYZ stock price.

When you sell XYZ shares, you're gonna push down XYZ's stock price.

So the very fact that we figured out a pattern in stock price movements

it starts to to dissipate, it starts to go away.

And the more greedy we are, the more we trade on this strategy,

the quicker, the faster this pattern will be eliminated.

And now suppose it's not just you out there doing this.

Suppose that there is a whole army of intelligent, well-informed security

analysts, arbitragers, traders, who literally spend their lives hunting for

patterns in securities markets looking for mispriced securities.

They have high-tech computers.

They have incredible data.

They know how to analyze that data.

And these people can act and assess on information extremely quickly.

The important thing to note is that these people essentially act as the police

in the marketplace.

In their intense search for mispriced securities,

these professional investors drive up the prices that are undervalued,

they drive down the prices that are overvalued.

And in effect, they make sure that markets are efficient,

that markets reflect all available information.

And so the implications of this kind of thought process

are that the competition for finding mispriced securities is fierce.

That competition will always kill the share profit pattern,

because if there was one, people would trade on it and exploit it.

And ultimately, it would go away.

Now the first one does make a profit.

If you're the very first person to discover a trading strategy,

you will make money off of it.

But the very first person isn't likely to be me.

Maybe it'll be you, but it's difficult.

And so the implications we get from this story are that stock

prices should reflect available information, and stock returns,

the changes in stock prices, should be unpredictable.

And this is the basic idea of market efficiency.

An efficient capital market is one in which stock prices fully reflect

available information.

And in practice,

what we do is we typically distinguish between three types of market efficiency.

Weak form market efficiency says that the information that we find in past prices,

past trading volume,

that's really not going to help us predict future stock returns.

The semi-strong form of market efficiency says that all publicly available

information has already been reflected in the stock price.

And that that won't help us predict future returns.

So we shouldn't be able to make money in the stock market by reading headlines in

the Wall Street Journal, or the like, that news should already be in the stock price.

The strong form of market efficiency says as long as information's

known by at least one person, it's in the stock price.

So in this view of the world, security prices reflect all information,

both public and private.

Now we know markets aren't strong form efficient.

If you have inside information, you can make money off of it.

It's illegal and you might go to jail, but you could make money off of it.

The big debate in finance is over weak form and

semi-strong form market efficiency.

So when we think about market efficiency,

I want you to think about this as a theory of sharks.

So sometimes in the popular press, you hear of market efficiency presented as

a theory of rational man, which we sometimes call homo economy.

But it's not really that, it's a theory of this intense competition.

In liquid security markets, profit opportunities bring about a lot

of discrepancies between demand and supply.

Remember, we have these people,

these investors policing the market, well-financed, knowledgeable,

arbitragers, they spot these opportunities, they invest.

And by their actions, they close the price differentials.

Market efficiency is one of the most studied topics in all of finance.

And there's a wide body of research that looks at whether the predictions of market

efficiency actually hold.

And what I find most compelling, the test I find most compelling about market

efficiency look at whether you can use publicly available information to,

in effect, outperform the market.

So if the market is semi strong-form efficient, then no matter what publicly

available information mutual fund managers rely on to pick stocks, their average

return should be the same as those of the average investor in the market as a whole.

And so we can really test this.

We can compare the performance of professionally managed mutual funds

with the performance of a market index.

And that's what I've done here.

This shows you the percentage of actively invested US equity funds that

outperform a passive benchmark over different time horizons.

1 year, 3 year, 5 year, 10 year and 15 year.

And I've cut this by different sorts of the data.

In the first row, you have all domestic equity funds.

And then I separately look at large-cap funds, mid-cap funds,

small-cap funds, multi-cap funds, and then finally, real estate funds.

And here, you get a sense of how difficult it is to beat the market.

At the 1-year horizon, only about 42%

of all domestic equity funds are able to outperform the overall market.

When you go out to 10-year and 15-year periods, that number falls to about 16%.

And you see a similar pattern for all of the different types of fund.

At the 15-year horizon,

only 2.3% of small-cap funds are able to help perform their benchmark.

And this is actually very compelling evidence in support of semi strong-form

market efficiency.

At long time horizons, most funds fail to outperform.

And in fact, the level of out performance you see is about what you would expect by

random chance.

And so what this chart tells me is it tells me that most mutual fund managers

who rely on publicly available information are not able to outperform the market

over longer time periods.

So in summary for this session, efficient markets the result of intense competition.

People are searching for mispriced securities,

when they find those mispriced securities, they trade.

And when they trade, that helps bring prices back into line.

If markets are efficient, it shouldn't be possible to consistently generate alpha,

consistently generate out-performance over a long period of time.

And the performance of mutual fund managers suggests that markets

are efficient.

[SOUND]

In the last lesson, we talked about market efficiency.

And presented the evidence of mutual fund managers who over long time horizons,

only a very small fraction of them outperform the market and

that's consistent with stock markets being efficient.

I wanted to take a look now at some reasons why markets might not be so

efficient.

And this broadly falls under the area of behavioral finance.

And so the objectives for this lesson are I want you to understand necessary

conditions for markets to deviate from efficiency and

I want you to be able to describe some of the evidence against market efficiency.

So one big thing to know is that markets cannot be perfectly efficient.

If they were, there would be no incentive to collect any information.

That information then wouldn't get impounded into the stock price.

And so we know that can't be the case.

And over the past 30 years, 40 years, there is increasingly some evidence to

suggest that behavioral biases can cause prices to be inefficient.

And so let me give you a simple example of this.

Consider that the Herzfeld Caribbean Basin Fund.

Its stock price ticker is Cuba, C-U-B-A.

69% of its holdings are U.S. stocks, with the rest mostly in Mexican stocks.

It holds no assets in Cuba whatsoever.

So on December 18, 2014,

President Obama announced he was going to lift restrictions on Cuba.

And the interesting thing is this fund, that has no relationship to Cuba,

that doesn't invest in Cuban stocks, went up over 70%.

In fact, people looked at the ticker symbol,

assumed it had something to do with Cuba and the stock price reacted,

the stock price went up over 70% when President Obama made this announcement.

With behavioral finance, we really need two key ingredients for

markets to behave inefficiently like in the previous examples.

We need investors that are not fully rational.

And their deviations from rationality need to be correlated across investors.

That is, we need a large number of investors making similar mistakes.

And so the second key ingredient is,

we also need the police of the market, those sophisticated

investors that move prices back into line, we need them to be limited.

We need arbitrage forces to be limited.

And this could be the case, capital may be limited,

it might be difficult to get money to invest in a particular strategy.

There might be investment constraints.

Sometimes we might not be able to short sell a stock, for example.

There also might be what we call noise trader risk.

These sophisticated investors typically have limited time horizons.

They have to keep their investors happy at the quarterly horizon or

the annual horizon.

And sometimes market mispricings can last for a lot longer.

If those two key ingredients hold, then what may happen is

irrational behavior may push prices away from fundamental values.

Since those arbitrage forces are limited, they can eliminate the mispricing.

And what we may end up with in practice, is that market efficiency

maybe generally holds, but it doesn't hold all the time for all securities.

And when arbitrage forces are strong, prices will be more efficient and

when they're not so strong prices, prices will be less efficient.

So when we look at those two factors, there's evidence for both.

And in particular, the very first one is, investors have lots of behavioral biases.

And they do tend to be correlated.

That is, we all tend to poses these to some effect.

And one of the big ones is over confidence.

And this is the tendency to overestimate one's ability.

And we do tend to be over confident.

Another behavioral bias that affects a big fraction of the population is

loss aversion.

A lot of times individuals will seek pride,

they'll avoid regret, they'll be slow to admit they made a mistake.

Then there's the recency effect.

When people are making decisions,

they tend to emphasize recent information and not the full body of information.

And sometimes that might cause us to extrapolate

recent performance far into the future.

And then people exhibited what I'll call anchoring.

They tend to base decisions on a single fact, or

a single figure and anchor in on that and exclude other information.

And all of these behavioral biases could lead to inefficiencies in the marketplace.

The main takeaways from this lesson are that

we as investors have behavioral biases, we tend to be overconfident.

We tend to anchor on extraneous pieces of information,

we tend to focus on recent performance, rather than the longer history of market.

And when we couple those behavioral biases with capital market frictions,

like constraints on capital, constraints on short selling,

this might push prices away from fundamental value.

This might give us a way to, in effect,

predict where market prices might be going.

So these behavioral biases,

these frictions, might allow us to outperform the market.

And in the next session, we will look at how behavioral biases may give

rise to profitable trading opportunities.

And we'll look at several trading strategies that may come out of these

behavioral biases.

We'll look at value, momentum, the low volatility effect.

[MUSIC]