

MITOCW | 10. Normative Frameworks for Business Decisions

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RICHARD Let me do a little bit of where we've been and where we're going, a little wayfinding. We did the last two-- the **SCHMALENSSEE:** last two sessions were on individuals and households. We did a rational actor model, a little drive demand, maximized preferences.

And then we talked about preferences being learned. We talked about preferences depending on others. And particularly in the last session, we talked about economic style, if you will. Maximization is only one form of cognition. That sometimes we all behave automatically rather than thoughtfully.

I have a very large book to read over spring vacation by Kahneman called *Thinking Fast and Thinking Slow* that's all about this-- good stuff. And Max Weber's distinction between rational pursuit of ends, rational pursuit of an ideal or value. It feels good or we just do it out of habit.

So we went from sort of a rational actor story about individuals and households to more complicated view of behavior. We're going to do the same thing with firms. So today is about a rational actor model about maximizing something-- we'll talk at the outset about what.

And then we'll talk about behavioral complications. Whatever it is we think firms ought to maximize as demanders-- mainly of energy, that's the focus-- before the break. They don't necessarily maximize anything.

First, they're full of people. And people don't necessarily maximize anything. And there's an additional layer of complication, which is what we'll spend most of our time on, because people in organizations are more complicated than people individually because of the structures, and incentives, and relationships, and so forth.

After vacation, we'll spend a little bit-- and these are normative prescriptive sessions-- on supply-side strategy, how might one do an energy business. So that's where we're going. It's worth spending some time, though, on-- is this reasonably clear? Are the questions? Let me-- before I pass on-- OK.

If households maximize utility, what should firms maximize? If it's your own firm-- my dad ran a garage. My dad could do whatever he wanted-- maximize utility, maximize profit-- who cares? There's nobody to tell him what to do. He aimed for profit, actually.

But for corporations, it's different because modern corporations have diffuse ownership, right? The Exxon executives maybe own a reasonable fraction of Exxon, but that reasonable fraction might be 10%. Some other companies, it's higher-- some younger companies, it's higher.

But in a lot of companies, the executives are not the owners. And the question is, what should the executives maximize-- if they should maximize anything? Milton Friedman was writing, when there were debates about imposing wage and price controls to deal with what seemed then like a lot of inflation-- we had much more later years, but it seemed like a lot of inflation in '70, '71, when, in '71, when Nixon did impose price controls-- which mostly failed.

And Milton Friedman has a distinct point of view about what corporate executives should be told to maximize. Anybody? Columbus, what do you say? What does Milton Friedman say should be the instruction?

AUDIENCE: Profits.

RICHARD Profit. OK. Why not do some social good? What's the argument against saying to Exxon, oh, come on, you're a
SCHMALENSEE: big, rich company. Do some good.

AUDIENCE: Well, there's a few different reasons why, for the stockholders, they might not want to do that for the
[INAUDIBLE] if they do that, they're not spending their own money.

RICHARD Well, that's disappointing. You gave a complete answer. Now who am I going to call on next? Does anybody want
SCHMALENSEE: to supplement that? I mean, that's the basic answer. It's taxation without representation.

If the owners want to spend money on charity, fine. But-- and if they want to tell the executive to do that, fine.
But if they don't, why should the executives of Exxon do social good? So Friedman says, nope. Their business is
to make money. The owners can contribute to charity. We'll start the debate in a minute, but let's clarify his point
of view. Did you want to add to that?

AUDIENCE: I just wanted to add that corporations can get tax deductions for donating to charities, so it's kind of a way to pay
money to get [INAUDIBLE] charitable, but really, you're just trying to-- I mean, you're just paying your taxes in a
different direction.

RICHARD So you're saying that a firm can do things that might not necessarily look to be profit maximization, like giving to
SCHMALENSEE: charity, but might be thought through correctly contribute to their long-run success. So you wouldn't necessarily
want to squeeze every nickel out. OK.

So Friedman would let you do that. But Friedman would say, how do you choose what charity? Who chooses? The
CEO's favorite charity. Maybe that's part of his or her compensation. Anybody else on Friedman. OK. What's
handy-- Yeah, go ahead, Maxwell.

AUDIENCE: Yeah. I was just going to say [INAUDIBLE] and then you have [INAUDIBLE]

RICHARD Yeah. It becomes a political entity, except that there's no voting. That it's making collective decisions like a
SCHMALENSEE: taxing authority. But it's basically taking money out of the owners' pockets. David?

AUDIENCE: So basically, they just don't have any right to choose where to donate to. And they don't have that [INAUDIBLE]
select CEOs that are good at policy [INAUDIBLE].

RICHARD Murray does make an interesting point, which is that if I give it to you in the form of dividends, it gets taxed at
SCHMALENSEE: the corporate level as well as at the personal level. Yeah, you can get a tax deduction personally, but you get
that corporate tax hit. So it's a little more efficient if the corporation contributes. But who's to let them decide
what to contribute. OK. Yes?

AUDIENCE: Also, a corporation's main responsibility is just to make a profit for itself and for shareholders. And so some
corporations have it in their mission statement that they do good will and good work, and stuff like that. And so
then I think it's more acceptable to have charity be part of the company because it's part of their mission
statement. But the majority of corporations, their mission is to make a profit for the shareholders, so.

RICHARD Well, they would usually have a mission statement that's a little more exalted than that if they have a mission
SCHMALENSEE: statement-- unless they're explicitly charitable, and some are, right? There are these corporations-- which are
very interesting-- that treat profits as a constraint, not an objective that are charitable. Well, Newman's salad
dressing, for instance. They maximize profits to give to charity.

There are companies-- what's the term-- social enterprises that basically say, we're going to make just enough money to survive. And we're going to do good in the following ways. You can think about a number of things like that.

What's Handy say? Handy disagrees. Handy's writing-- let me just see if we've got-- I think we've got the main points. Yup. Handy's writing after the dotcom bust. OK, Friedman's writing in a landscape where an issue of the day is, should the government step in and control prices? Handy's writing after the dotcom bust when stocks went up, stocks came down like a stone, lots of companies went broke. What's Handy say the firms should be about?

Benzi, you're writing down, and I'm not saying anything. So you must be preparing your answer to this question. So what does Handy say that the firm should the firm should be about?

AUDIENCE: I didn't get a chance to read it.

RICHARD OK. OK. Thank you for your honesty. Matthew?

SCHMALENSSEE:

AUDIENCE: I have the same [INAUDIBLE]

RICHARD You have to same-- somebody must have read it. I'm sure there's somebody in this group that read the Handy

SCHMALENSSEE: paper-- doesn't summarize easily. Veronica? Fire away.

AUDIENCE: It wasn't on Stellar.

RICHARD Was it really not on Stellar?

SCHMALENSSEE:

AUDIENCE: Yeah. It was only preview.

RICHARD I got it.

SCHMALENSSEE:

AUDIENCE: [INAUDIBLE]

AUDIENCE: This morning--

RICHARD No, I printed it out last week. It wasn't up? Was it marked staff only? Did we screw it up and mark it staff only?

SCHMALENSSEE:

AUDIENCE: [INAUDIBLE].

RICHARD No, no. It was posted. It was posted months ago. The only thing I can think of as it may have been inadvertently
SCHMALENSSEE: labeled staff only. Well, in which case, because I pulled it off to-- I mean, here it is, exactly from Stellar. So I'll tell you what Handy says and we can talk about it.

Handy's a funny article, right? He's writing in the-- so you could have just said, you couldn't get it. And then you would have been good. It's a lot of criticism of the short-term focus in stock options and all of that. He says profits are a means not an end. It's a completely different vision.

That a good firm is, "a community with a purpose." That's his phrase. And you should treat employees like-- as stakeholders. He's one of the coiners of the stakeholder view of the firm. That a firm doesn't exist to serve just its owners, it exists to serve the communities it operates in. It exists to serve its employees who've invested at least some-- made some investments of time and energy that will be lost if they leave the firm or if the firm fails.

So he would say, a good firm is about something, not just about making money to shareholders. And a good firm will go beyond minimal legal requirements for something like things like environment, and safety, and so forth. So you have two very different views.

You have a classical economic view from Friedman. You've been employed by the owners, you have a fiduciary responsibility for the owners. Don't spend the owners' money without authorization or instruction.

And the Handy view that says, that's too simple. Lots of other people have a stake in the firm-- the community, the employees, the environment, et cetera, et cetera, et cetera. So you really need to take a broader view of what you're about.

Now that you've had a complete clear exposition of what I must say is a little bit of a murky article, we'll make sure you can get it this afternoon. What do you think? Where do you come down? Sam? Handy's view is a little more humane, isn't it? Yeah.

AUDIENCE: Also, like, we have the kind of a [INAUDIBLE] their employees will be more happy. And that would just make it a better place to work, which will in turn be-- make the firm more productive. Where if you're trying to just like have like a ruthless, cost-cutting machine type thing, it's going to be a miserable place to work. And it's not going to be just a flourishing environment.

RICHARD Well, Friedman says, OK, I'll take that. I love that. We will be about something because that'll motivate people--
SCHMALENSSEE: that's profit maximization. You've just given me profit maximization.

I've given you-- a great example-- I'll mention two firms that I served on the boards of. The one was a startup, became the International Securities Exchange. It was the first all-electronic Options Exchange in the country.

And everybody made money, but the mission-- not quite chiseled in stone, but the mission that everybody talked about was, we're going to upset this market. Trading is slow, commissions are ridiculously high, we could offer a much better product to the world. Well, you can go to work-- you can get up and go to work for that.

The other is the International Data Group, which has a clear mission statement. It's to provide information about information technology so that technology can have more impact. Well, you can kind of go to work for that, too. The notion that we exist to make money for our owners a little hard to get up and get excited about.

So Friedman said-- Friedman will come along with you and say, yes. And there's a nice example. Handy mentions Merck. Beginning in 1988, they had invented this drug that cures river blindness, which is a very nasty disease that infects people in Africa. I mean, young people go blind from swimming, basically, but getting in the water.

And the stuff is reasonably expensive to make. They couldn't actually sell it into Africa. So they give it away. They give it away. It's free. They make it available free.

And you say, how can that be profit maximizing? Well, if you walk into the Merck headquarters, there's a large statue of a young boy with-- as I remember it-- somebody in a white coat with his hand on the boy's shoulder. And you say to anybody at Merck, what's that about? They tell you this story.

Well, you can get up and go to work for a company that says, yeah, we're about more than making money. We saw something that we could uniquely do for the world and we did it. We're not just about making money. So Friedman-- Friedman loves this. Anything-- would you go further? Julien. We've got your name corrected. That's fabulous. Good. Good.

AUDIENCE: Well, I mean, I would disagree with Friedman because he may be right in some cases that perhaps some companies would find it in their best interest to do social good. However, let's say-- let's take a look at McDonald's. I'm sure their workers aren't happy about their wages. And I'm pretty sure McDonald's could pay them a bit more

But I mean, that might be seen as a social good to earn more than minimum wage for your workers-- or pay more than minimum wage-- and I'm sure McDonald's could probably afford it. But seeing as they generally don't pay that much, it's not really in their interest for social good. So it's generally about profit, I would say. And so Friedman, I would say, is incorrect in that firms don't always do like social good for profit.

RICHARD Sometimes they do social good for social good. By the way, I think it's the local franchisee who makes the wage
SCHMALENSSEE: decisions, and whether that person can afford it or not depends.

AUDIENCE: OK, different example then. Let's say coal mines back in the day-- or like during industrialization, clothing factories. Like weren't people-- the labor-- they were people in horrible conditions and paid them horrible wages--

RICHARD But remember, we're talking prescription, not description. Friedman says, that's OK. Handy says, that's not OK.
SCHMALENSSEE: What do you say? You say it's not OK. Or do you say it's OK? What would you tell the executives to do?

AUDIENCE: Better working conditions.

RICHARD OK. Do coal mines ever fail? Go out of business, go broke? Yeah. Even with those lousy working conditions.
SCHMALENSSEE:

AUDIENCE: [INAUDIBLE] not necessarily an effect of the working conditions [INAUDIBLE]

RICHARD No, no. It's not. It's not. But if you raise costs, you raise the probability.
SCHMALENSSEE:

So here's another Merck example from-- that needs a paren-- from 1999 to 2004, close paren, Merck had information about the adverse health effects of a popular drug prescribed for arthritis. A friend of mine took it regularly.

And it had very-- it had bad side effects they had information on the bad side effects-- they hid it. They hid the information. And during that period, they sold a lot of Vioxx and made a lot of money. Was that profit maximizing? Handy would oppose it. Would Friedman oppose it? Charlotte?

AUDIENCE: But isn't that one illegal?

RICHARD Well, yes. There is that.

SCHMALENSEE:

AUDIENCE: But are we talking about things that are illegal? Or are we just talking about things that could be or couldn't be, like depending on the decision by the owners, like the legality of it.

RICHARD I actually don't know if it was illegal. They certainly were sued. I'm not sure of the legality. Suppose it was legal.

SCHMALENSEE:

AUDIENCE: [INAUDIBLE] to meet their legal requirements.

RICHARD Suppose it was legal. Suppose it was legal. Bad law. The law didn't actually say, you got to disclose bad effects.

SCHMALENSEE: The law was badly written, and it let them get away with it. Then, should they have--

AUDIENCE: I think they would both disagree with that because personally, if I were working for a firm that was hiding the adverse effects of a drug that someone I knew might be taking, that wouldn't be a reason for me to go to work every day.

RICHARD That would be hard. Rachel?

SCHMALENSEE:

AUDIENCE: I feel like for in both cases, it just kind of depends for individual companies how much they value-- or how much consumer opinion of them matters to their business. I mean, this case, like it might not be profit maximizing if it's really, really important that the public have a good view of them in the first case.

It might be that the amount of money that they're losing by giving away the drug is overcome by the amount of goodwill they're earning. So it just kind of depends on the firm.

RICHARD Actually, one thing that's-- it'd be interesting to know there, and I don't know the details, is, at what level of the

SCHMALENSEE: firm was the decision made to conceal? It could be the person whose bonus depended on sales as opposed to the CEO. Samantha?

AUDIENCE: I was just going to I say that I think I'm more on the Handy side of things, that firms have an obligation-- a moral obligation, as well as an obligation to maximize profit. And something like hiding adverse of effects of a drug is, in my opinion, morally wrong. And it's not something that a firm-- I mean, I would think that Friedman would be OK with something like that, and Handy would not.

AUDIENCE: [INAUDIBLE] companies do balance like PR and public opinion with them with profit maximizing because public opinion of them affects the profits.

RICHARD And it's nice to have a mission when you can have a mission, but Wednesday, we're going to talk about a firm in

SCHMALENSEE: upstate New York that makes formaldehyde. And I just don't know how-- it may be technically interesting to run the firm, to run the plant, but I don't see how you get socially charged by that one.

Just one last, and than I do want to get on to capitol budgeting. And let's just think about this one because think about how much of an issue Romney's venture capital experience-- actually, a private equity experience-- has been in this campaign, where they closed plants, they closed firms. And it's portrayed as the wrong thing to do.

Sometimes there's no choice. Sometimes there is a choice. Is there a moral issue involved here? Is there not a moral issue. I'm a McDonald's franchisee, just to go to Julien's favorite dining establishment. And I've got six stores-- and I'm losing money on one of them. Do I have a moral obligation to keep it open because of the people or can I shut it down?

Or suppose, in fact, I'm not losing money on it. It's reasonably profitable. But I get a really good offer from somebody who wants to make it a parking lot. And I can take that money, open another restaurant in a better location across town, where, yeah, I could employ those people, but they won't be able to get there. So I'll take it. You had a reaction?

AUDIENCE: Yeah. I mean, there could be another company that could come in and do more good to the community than just another parking lot.

RICHARD Parking lot-- maybe. Maybe. Maybe the community is desperate for parking. Let me go to capital budgeting

SCHMALENSSEE: because I think this will take us a little while.

We're about firms for the next several sessions. And the diagram-- my favorite diagram that we started with-- firms supply energy, supply energy services, firms use energy-- that's where going to focus for a while. Firms supply products that use energy, and firms supply products that help supply energy. In all of these cases, the firms make decisions involving costs and benefits phased out-- spread out over many years with uncertainty.

I'm going to assume some version of Friedman because I don't know how to model Handy, other than as, you have to think carefully about the long term. And if I have a moral obligation, I'll add that on top of this. So the basic story is we're going to maximize value.

That's not maximizing today's share price. There's a nice phrase in Brealey, Myers, and Allen that talks about the honest share price. They don't mean, by that, in the absence of fraud. They mean in the presence of very good information.

So you want to maximize how much the firm is worth-- if everybody knows as much as you do and indeed knows that much about other firms. So in the case of Merck you'd want to assume they know about Vioxx.

If I could go to the capital markets, and I can invest, and I can borrow, and I can raise stock, and it's a simple world-- isn't that a lovely picture-- the rule to do this is straightforward. Again, we're going to talk about investments-- not operating decisions, but investment decisions.

You make all investments that have a positive net present value. This is net present value in discrete, not continuous terms. And we do this because continuous compounding doesn't simplify, particularly, when you've got flows that vary over time. It's nice in very simple cases.

I love the elegance, but if you want to work out the net present value of something like this-- this is an oil lease, hypothetically. So CAPEX-- Capital Expenditures-- are incurred early on, oil production ramps, levels declines. And to value this opportunity, you've got to figure, what am I going to get from selling oil?

What are the Operating Expenses-- OPEX-- associated with getting that oil out? What are the royalties I'm going to owe? And what are the taxes I'm going to have to pay? I take the net and I discount it.

And the opportunity cost of capital-- we'll spend quite a while on-- is what I could make on an investment of comparable riskiness. What's that mean? I'll come back to it.

But if I can do better investing in this oil lease, then anything else that's handy that's of comparable riskiness, I should make this investment. If I can make-- we'll see next time, the calculations for Wednesday have to do with an investment in energy conservation. So it's the same thing. I can invest in lots of things, but if I can invest in energy conservation, and it gives me a better return than an investment of comparable riskiness, I ought to do it.

Now that's a pretty simple formula, right? You just did something that the-- cash flows that occur in period J , take a discount rate, discount it back to the present at interest rate R , and you do this on a spreadsheet. And you'll see a spreadsheet Wednesday.

So a couple simple basics here. The first is cash matters. Profits don't matter, except insofar as they affect taxes. So this is-- when you do present value for a firm, the question is, what are my actual returns, not what does the accountant put on the bottom of the paper?

And the main example is depreciation. Depreciation is not a cash expense. It affects your taxes. And you'll see for Wednesday, you have to consider that. But it doesn't directly impact the cash in the bank. It's something the accountant writes down. So you use cash flows-- relentlessly focus on cash flows.

There are a couple of simple formulas. That's the formula for a perpetuity, something that starts with a constant payment one year out, goes forever. You'll see it's the same formulas for continuous compounding, but obviously, the interest rate's different. This is compounded once a period.

And this is nice in Brealey, Myers, and Allen. Suppose you have a bond that pays c per year for capital T years, what's it worth? Well, if the interest rate's R , that's equivalent to a perpetuity starting today-- starting in one year-- minus a perpetuity starting in year T plus 1. I subtract that and I get this simple little formula on the right. I could also do a T period power series, but that's cleaner.

This is the formula you'd use-- that's the formula for a mortgage, except you use a monthly interest rate. So if you know what the value of the mortgage is and you know the yield on the mortgage, R , you can solve for the monthly payment. That's a standard bond or mortgage formula.

The last point I want to make on this slide is-- is all this clear? Questions, or comments, or reactions? OK.

Suppose prices are going up at 10% and the bank is-- at 10% a year-- and the bank is paying 5% a year. You're not making money on the investment in the bank, right? You're losing purchasing power. The real interest rate, whatever it is, is negative.

You put \$100 in the bank today, a year from now, you get something that's worth less because of inflation than that \$100. Even though it's \$105, inflation's gone up. Well, to figure out the relation between the market or nominal interest rate, capital R , the inflation rate I and the real interest rate, it's pretty straightforward.

I put the money in the bank at 5%, I get \$1.05. I basically got to knock that down by the amount of inflation that's occurred. And this gives me the increase in purchasing power. So another way to think about it-- or another example, suppose the bank's paying 5%, inflation is 5%.

I get \$105, which is worth exactly, in terms of what I can buy, what \$100 was today. So the interest rate-- the real interest rate, the increase in the purchasing power is zero. If those two are equal, this is zero, and that makes sense. Inflation has wiped out the earnings.

If you just multiply this through, you get this relationship. Normally, the product of these two rates, i and little r , is negligible. Although, I'm told in periods of high inflation in Israel, people actually do carry this second term. It's normally very small.

And you get the result that the real interest rate, in any sane circumstance, is the market interest rate minus the inflation rate. OK. And that's the relationship every everybody uses.

It's important to understand which interest rates you're using, whether you're using a real rate or a nominal rate. But are we OK on this? Everybody nods, everybody's happy.

Almost all interest rates are nominal, right? You look up interest rates in the newspaper, they are, here's what we'll pay you in a year. They don't depend on the rate of inflation. All else equal, of course, they're going to be higher the higher inflation is expected to be.

We had breathtaking interest rates in the late '70s, early '80s when inflation was running. We had mortgage rates of 18%, for heaven's sake. If you expect high inflation, you're going to want to get more dollars back.

Now you can look at real interest rates in the past, of course. You can look at what was the rate-- what was the one-year bond rate-- on a one-year bond rate, government bond rate, let's say, on January 1, 1956. What was the inflation between January of 1956 and January of 1957? I can subtract and get the real interest rate.

What do I do going forward? Going forward, it's a little trickier. There is a bond sold by the Treasury-- you can buy them-- called TIPS, Treasury Inflation Protected Securities. They adjust so they pay you in real dollars. So the interest rate is a real interest-- interest rate quoted is a real interest rate.

So last Friday-- when I was able to download Handy-- last Friday, I checked the 20-year rate on regular government bonds. That was 2.83% from the Treasury's website. And the rate on 10-year TIPS was a half a percent. These are breathtaking numbers, historically. It's a half a percent. So I'd say the market in some sense has an inflation expectation over 10 years of just a little over 2%, which is sort of a reasonable number, historically.

But it's a bit of a thin market, and TIPS have special characteristics, and not everybody buys them. So I wouldn't say you can always look up the market's inflation expectations this way. But it gives you a sense. It gives you a sense. Not a sharp tool, but a tool.

The biggest mistake people make in doing present value in almost any setting is to confuse which interest rate they're using. Are you using a real rate or a nominal rate? Now the normal thing you do when you're doing a present value calculation, and it involves so many pounds of cement per year over 10 years, you use today's pound of-- today's price for cement.

That's the normal thing to do. Today's price for steel, today's price for whatever, figure out physical quantities, and get cash flows. If you do that, you need to use a real discount rate because you've assumed zero inflation by using today's prices.

If you use a nominal rate from the market, then you need to adjust-- then you need to say, well, the rates I use are 5%, 10%, whatever they are, but I expect 2% inflation. So I'll build in 2% inflation. I mean, you could do it either way, right?

You can use today's prices, take 2% off the market. But what you can't do is mix. You can't take a rate from the capital market like that 2.83 up there, and then assume price is constant because that 2.83 is based on people's expectation that prices will rise-- that prices will rise. So it's a very common mistake.

Just don't do it. And know to look for it when people show you, as they will in later life, present values because it's common, it's easy to make. And it can certainly get you the wrong answer if there's any inflation going on or the time period is of any length at all. OK. That's issue one, get the rates right. The rates matter. Well, let's do this one first.

The question is, where does that R come from? And I said it's an opportunity cost of capital. It's what you can get on an investment of comparable riskiness.

Well, if there's no risk-- even though the US government was downrated-- it's normal to treat a riskless rate as the government borrowing rate. There's essentially no risk of repayment unless you're a real pessimist. And again, you'd use the US rate, not necessarily the Greek rate these days after the write-off.

But suppose there is some risk. Well, as I say, it's an opportunity cost. So that says you would expect-- if you're going to bear more risk, your expectation of a return has to be higher to compensate. So you would expect a higher risk means a higher discount rate. That sort of makes sense.

So-- that's cute-- so you normally discount the expected cash flows at a risk-adjusted discount rate-- I'm going to come to, what do I mean by risk? Because that's the \$64,000 question here. But so far, I assume this is fairly intuitive. And if a project has some things that are certain and some things that are uncertain, you might want to use different discount rates.

If part of the cash flows are returns on government bonds, those are riskless and I ought to discount them using the government bond rate. Part of it is sales of Teslas, I might use a higher discount rate for sales of Teslas, or Chevy Volts, or tickets to John Carter, or almost anything else. I'd use a use a higher rate.

But what do I mean by that? How do I think about risk? OK, two points to make. One, it matters. This is not particularly on point, but I like it. It illustrates the importance of discount rate choices you go out in time.

This equivalent cash-flow haircut says, OK, a dollar in one year at 7% is worth \$0.71. At 10%, it's worth \$0.62. That's equivalent to taking 13% off, right?

Raising the discount rate from 7% to 10% is equivalent to a 13% haircut on what you're going to get. And 30 years out, it's a huge haircut. 30 years out it, more than cuts it in half. So the discount rate matters.

The choice-- again, a nice picture-- is you've got project A, Project B. Project B looks very safe, project A looks very risky, but has a higher-- let's take that to be the expected value. The distribution's a little asymmetric. Which do you choose? Which do you choose? How do you think about risk?

Well, it turns out the right answer isn't variance or anything quite like variance. I'm going to walk you through a bit of finance much too quickly. So listen for the concepts, don't listen for the details. I just want you to get the basic notion here, not the mechanics. We're not going to do the mechanics. The mechanics will not be on the quiz. But the concept is important. Jessica?

AUDIENCE: Which would you say is safer?

RICHARD Hmm?

SCHMALENSSEE:

AUDIENCE: Which one of these two would you say is safer?

RICHARD B is safer. Sure. Much less spread in the possible outcomes. A's got huge spreads in the possible outcomes. And

SCHMALENSSEE: we don't even know where the zero point is on that graph.

So just looking at it, you'd say A is safer. That says, well, a nice measure might be the dispersion, the variance, the range, whatever-- not quite. So here's the basic story. I can't believe I set this to fly in, I hate that. It's distracting.

It's easy to show that investors should always diversify. If you read anything about investment-- you can make it mathematical, but if you read anything about investment, it says you should diversify.

OK. This was made very fancy in the '50s by Harry Markowitz. Second step, was Tobin-- Jim Tobin-- James Tobin-- let's be fair-- in the '60s, who said, well, if you have really well-functioning capital markets that every investor should hold some of all risky securities and then some safe security.

So let's suppose I've got a bunch of risky stocks, let's say, and US government debt. Then everybody's portfolio should be composed of some of all the stocks-- that is, to say the market portfolio-- and then some government debt. And how much of each you hold would depend on your tolerance for risk.

All right. So that says you want to think about-- again, everybody's efficient, everybody's optimizing, nobody listens to my broker, everybody's very efficient and holds the market portfolio, right? Some shares of each one.

Now you can sort of do that, index funds come close. But of course, in theory, the market portfolio isn't just the stock market. It also would include real estate, and gold, and anything else you think of as an asset you might hold in your portfolio.

But if you think about rational investors holding diversified portfolios, and the risky part of the portfolio having the same composition for everybody, then you would expect-- again, if you're dividing your holdings between government securities that are riskless, and a bunch of stocks and whatever else that's risky, the more you tilt toward that risky portfolio, you better get a higher expected return. You better have a higher average expected return to compensate for bearing the risk.

So this was Sharpe-- and we'll jump to his answer. That's just a general statement of the expectation-- that the market portfolio, all the risky stuff, should yield a better return in expectation-- not every day, as we know. But in expectation, it better do better than government debt or why would you ever hold it? It's risky? So you would expect there to be a risk premium.

What this goes to, if you think about this world in which people are holding mixtures of government securities and lots of risky stuff, then comes another asset. Is it risky or not? How do I think about its risk?

Well, I think about its risk in terms of what it does to my portfolio. I don't care what it does by itself. I'm holding all these other assets because I'm a rational diversified investor.

So what matters to me if I'm going to buy it is, what difference does it make to my portfolio before and after? That's not just a question of variance. That's a question of correlation. And the example here is a stock that moves against everything else, even if it moves a lot, can be a great thing to own. Because if I own some of this and something that moves in the opposite direction, I can construct a risk-free security. That's pretty good.

So it doesn't matter that-- in this view of the world, what matters is how the returns on an asset, returns on a security, relate to the returns on everything else. Basically, that two-fund theorem says, you're going to hold something of everything else. That's going to be the risky part of your portfolio. That's going to move.

And if I pick up another risky asset, what matters is, how does that affect the movement of that whole bundle? Which says that the picture I had before-- this one-- asks the wrong question. That just tells me maybe something about variance. It doesn't tell me anything about correlation.

If the world consists of Apple stock-- blast-- if the world consists of US government debt and Apple stock, then the question of whether an oil well is risky or not is, does it move with Apple stock? Does it move against Apple stock? If it moves against Apple stock, I can reduce my risk. If it moves with Apple stock, I'll increase it by adding it to my portfolio.

So that's the sort of key insight that-- now I made a lot-- there are a lot of assumptions floating around here, and I'm going to relax them orally in a little bit. I can't relax them mathematically and get done. But the assumption here is we're dealing with a world in which there are very few transactions costs, investors are behaving rationally, everything is smooth, it's a very competitive world-- in the financial market.

That's probably wrong. But it's not clear where you would go from there to a better model. So let me not defend this model as truth, let me just defend this model is the best one we have at the moment. And it says to a reasonable approximation, smart people diversify. When smart people diversify, what matters isn't just, does it move, but what does it move with?

So the Sharpe model has this implication-- oh, sorry. I need to go back to that last point. This is a very interesting point that comes out of this model. It says not only do I care-- if the world is a risk-less asset and Apple stock, comes another investment that has uncertain returns, if it moves with Apple stock, getting it would increase my risk. If it moves against Apple stock, getting it would decrease my risk.

What if it's uncorrelated? What if it's uncorrelated with the other risk in the economy-- in that case, with the market? Well, if it's uncorrelated and it's on the market, everybody holds a little bit of it, it doesn't affect the movement of your portfolio much. I'm just going to have to let you-- you're going to have to take that one on faith.

But risk uncorrelated with the market can be diversified away. It doesn't justify a risk premium in this world, where what matters is the portfolio. Holding it by itself would be risky. Holding a little piece of it, uncorrelated with anything else, turns out to have effectively zero impact on portfolio risk.

So we talk about risk that's uncorrelated with the market as diversifiable. And it doesn't demand a risk premium-- in this world. I'll give you a little bit about another world in a minute. But in this world, it doesn't demand a risk premium.

So we're flying along-- concepts, concepts, portfolio is what matters, correlations matter. This is Sharpe's model that, again, under reasonable assumptions widely used, if something has a zero-- it turns out the measure of risk now is beta. The whole market has a beta of 1 by definition, risk-free rate has a beta of zero because it doesn't move, it has no risk.

Things that move against the market have negative betas, things that move toward the market-- with the market depending on the correlation and the movement, will have a positive beta. Beta is the measure of covariance is not quite right-- of covariance with the market. And higher beta securities have a higher required or expected return, higher beta assets.

So an example-- this is the cost of equity for BP. It's an estimate. Basically, by definition, it got identically equal. By definition, the beta on the market as a whole is 1.

It turns out that BP and other major oil producers are less risky in this regard than the average stock. Beta is 0.8 for BP. You can estimate it, and here would be an example of calculating the required-- or the opportunity cost for investments that look like BP's investments. So we look at what the market requires from BP.

Well, we know it's beta. We can estimate that-- no point going into it here. Suppose the risk free rate is 3%. The market as a whole has a risk premium of 5.4%-- that, again, you can calculate-- that gives a cost of equity for BP-- opportunity cost-- of 7.3%. That's what investors would take to own BP stock in terms of expected return or another investment of comparable riskiness. Comparable riskiness-- beta 0.8. So the measure of riskiness becomes a simple number, beta.

Now that's-- again, it's a simple model. I'm not expecting you to understand anything other than that beta involves not variance, but covariance and correlation-- it involves comovements with other assets. As I say, this is the opportunity cost of investing in projects is risky as BP.

So if you-- are we semi-OK so far? The concept here. We're in a world where everybody diversifies, everybody diversifies as much as they can. It turns out the rational way to do that is for everybody to hold the same proportion of risky assets. So if you have two shares of Apple and one share of GM, I might have four shares of Apple and two shares of GM. But I don't reverse the proportions because we're both owning pieces of the market in the same percentage.

And in that world, what matters is how things correlate with the market and also how big the moves are. And beta captures both of those. As that earlier slide says, it captures both the correlation and the volatility. It captures the correlation and the standard deviation of its own movements.

So if we're going to do discounting, figure out what the cash flows are, probably use the expected cash flows. We might want to be conservative and use the lower bounds of revenues and upper bounds of costs, or be optimistic. Figure out how risky the thing is-- and frankly, this is very-- it's very easy for common stocks. It's a little harder for an investment project.

If I say, well, I think this project has a beta of 0.8, how do I get there? You could see that the key thing that people usually do-- so this is the split of a particular project. The first thing you ask is, is the risk diversifiable or not? Is it correlated to a first approximation with movements in the rest of the economy or not?

So there's some uncertainty. We're going to put in-- let's say it's a wind farm. We're going to build a wind farm. There is some uncertainty-- we've got the equipment under contract. There's uncertainty about how difficult it's going to be to put the thing in place, to do the installation, to do the construction.

That's not going to be correlated with the rest of the economy. That's just local. That's a local risk. That's diversifiable. If I can get enough people to hold that risk, it's not going to matter to anybody because it's not going to move their portfolio.

The wages I have to pay will be correlated with the rest of the economy. So if I haven't fixed wages and I haven't fixed prices for materials, then maybe that does need to be discounted because it is correlated. Again, it's diversifiable versus nondiversifiable. Is it correlated with the market, with the rest of the economy? Or is it just something random that's going to happen to me?

I don't know the wind conditions very well, or the reservoir conditions, or a variety of things like that. Is that going to be correlated with the rest of the economy? Probably not. That's probably diversifiable risk, and I shouldn't worry about the beta because it's probably zero. It's not correlated with other things.

Oh, how much am I going to get out in terms of kilowatt hours? The wind is uncertain. I don't know what my annual production is going to be from the wind farm. That's probably diversifiable. That is to say it, whether the wind blows or doesn't blow isn't going to be correlated with the rest of the economy, probably.

Unless I have a long-term contract, the price at which I sell power will for sure be correlated with everything else. That's not diversifiable, right? The market moves up, the economy moves up, the wholesale price of electricity goes up. So that's going to have a significant beta.

This other stuff, not so much, so I'm not going to worry too much about the risk. So I would treat the two differently. OK so far?

Now-- let's do slightly different. There are different degrees when you're doing this exercise. We will see a cost-saving project on Wednesday. We'll do the spreadsheet. We won't come back to beta again, but you need to see it and hear it. We come back for a while, at least.

That exercise, you will see it's done assuming there's a certain level of activity in the plant. Well, how else are you going to do it, really? You could simulate other levels of activity, but it's done in a pretty straightforward, pretty standard fashion.

If you have the wind farm and you've presold the power, then, again, the revenue-- revenue's fixed. You don't need to discount the revenue to allow for risk. And the cost risks are probably diversifiable per the example I said. And you probably don't want to treat costs as a high beta item.

Suppose you don't know the revenues. Suppose you're going to build a gas-fired power plant and you're going to sell into the New England wholesale market. Oh, well, now your revenues are definitely correlated with the rest of the economy. Your revenues will have a significant beta.

Now suppose you're developing a new widget. Well, the game changes now completely, right? It's a new toy, it's a new video game, it is whatever it is. You worry much less-- and we'll get to this after vacation-- you worry much less about the beta on the revenue from your video game than on whether you're actually making something worth selling, and can you retain the value?

Lots of great ideas do not enrich their owners. The person who invented the-- I always pronounce it "kor-ig". It's pronounced something differently. The little thing that you use to make bad coffee with the capsules-- made essentially nothing. So created value, didn't capture value.

Then all of this stuff about beta, and discounting, and so on, takes a back seat to strategic considerations about, well, how to do I ensure I-- how do I ensure I sell something? How do I ensure I capture value? How do I ensure that my strategy makes sense?

And finally, suppose you're a small business with limited capital market access. You can't do this borrowing, and lending, and raising money, and alternative investments. Do you know that first acronym? Has anybody ever heard it?

This used to be the mantra of the former head of the Entrepreneurship Center here. And it's short for Cash Is More Important Than Your Mother. Which, for small businesses, is often true, right?

We didn't talk about cash constraints in all this. We didn't talk about project size in any of this stuff I did. Take positive net present value projects, it's all swell. Well, that assumes you can basically diversify risk.

It assumes you have access to the market. It assumes you can borrow and lend. It assumes if you have a bad day, you can get a loan. It assumes diversifiable zero beta risks don't matter really. If you're a small business, however, a zero beta risk can kill you, right?

I mean, you're building this plant. The construction is uncertain. You don't know whether you're going to get it online. That's uncorrelated with the rest of the economy. But if it fails, you're done.

So for small businesses with limited capital market access, all of this beta stuff is lovely. Large corporations do it, lots of companies do it, consultants do it. It's a lot of fun. If you're a small business, however, cash is more important-- well, not more important than your mother, but it's very important.

And worrying about running out of it will dominate. And to say to a small business owner, well, it's true that you go broke if this thing fails, but that's a zero beta risk. It's not correlated with the rest of the economy. You shouldn't treat it as risky. That's nuts, right?

So the story about beta and the appropriate measure of risk for which we have good theory applies to large-- it applies to ventures with capital market access, large or small. How you think about risk for a small business with limited or no capital market access really depends on the exact circumstances of the small business.

If you've raised \$1,000 from venture capital and you think it's going to take you \$900 to bring the thing to market, you better get it to market for \$900 or you either go broke or give away a large part of your ownership to raise additional money. So I just want-- I don't want anybody dealing with a small business to say, yes, but what really matters is diversifiable and not diversifiable risk. It does for a big company, it does for a company with capital market access.

It's not the dominant consideration for a small business. And it's not the dominant consideration in evaluating a project that really is innovative because there the real question is, can I capture value? And that's a post-vacation question.

So I'll take questions. Let me say a little bit about Wednesday. Wednesday's a case. We're going to spend almost all the time on the case. I hope you can get the spreadsheet down from Stellar. It involves an actual decision-- an engineer, a plant manager, finds a solution that will save energy, he thinks.

Well, solution will save energy, the question is, is it a good investment? You will see a spreadsheet that lays out a net present value analysis. I invite you to look at that spreadsheet, look closely at the formulas. Is it right? Is the analysis right?

Then the question is-- you will also see in the case a bunch of objections. I think the spreadsheet has mistakes. I think the spreadsheet fixed shows it to be a positive net present value investment. You will also see in the case-- so it's all the stuff we all like.

It's an investment that will save energy, no animals will be harmed. They won't be venting steam into the environment. They won't have an icing problem. Life will be good. But there are a long list of objectors-- a long list of objections, and probably a long list of objectors, also.

And read that and answer the question, given those concerns, what's he do? Here's a positive net present value investment in all probability. Again, we'll go through the spreadsheet just to see how it's done. It's a positive net present value investment that will save energy, be good for the environment-- more ducks, whatever-- but he may not get to do it.

He may not-- and not because they don't have any capital in the bank, any cash in the bank. He may not get to do it. So think about what he should say. And think about how the firm from the top management might want to structure things so that projects like that don't get blocked. So take a look at that.

And let me take questions for a few minutes. And again, I'll let you go-- let you go early. Yes?

AUDIENCE: Yeah. Related to this, when people talk about having compensation for executives and people on the board be based on like a risk-adjusted income? Would that be based on nondiversifiable risk as well, or? I mean, that's like-

RICHARD SCHMALENSEE: Well, they don't do formal adjustments. When people talk about compensation to try to avoid a focus on today's share price, they usually do things like, OK, we'll compensate you in stock options. But you can't cash the options until five years after you've left the company.

Things like that to say the stock price is \$100 today, that's great. What we care about isn't what it is tomorrow, we care about what it is in five years. So we want to take away from you the incentive to boost profits today if it's going to hurt profits tomorrow. So it's not a matter of risk-adjusted compensation. It's a matter from the point of view of the top executives to give them incentives not to add to risk, right?

I mean, one of the issues with all the investment banks was if there is no downside-- right-- you take a huge position, that position comes through, you make a lot of money, you get a lot of profits. That position doesn't come through, they fire you. OK, you go to another company.

Well, that's not a great-- that's not a great model. The idea is we ought to compensate you based on performance over time, not on performance last week because if the worst outcome is you lose the company a billion dollars, you get fired, you go to another company-- where you do it again.

So they want to-- you want to give people incentives not to put companies at risk. You want to give executives incentives not just to think about the short term. It's a difficult matter. We will talk a little bit about compensation, but I will say, one of my favorite sayings from Jack Welch when he taught here was any fool can manage for the short term only. And it's also true that any fool can manage for the long term only. The difficulty is balance. Anything else? That's the wisdom for today. Yeah, Julien.

AUDIENCE: If there's like net market growth, [INAUDIBLE] is for an entire market normalized for 1.

RICHARD Yeah. Yeah. Because remember, in a well-diversified-- if you are well-diversified, you own a piece of everything.

SCHMALENSEE: That's the best you can do. You could hold less of that risky stuff. But the best you can do in terms of holding risky stuff is to hold a little bit of everything.

And if you do that, then the risky part of your portfolio moves up and down with the market by definition because you're holding it, so you normalize that to 1 and the riskless part doesn't move, so that's zero. You could normalize it to 16.7 if you wanted to, but normalizing it to 1 is the simplest thing. And then intermediate-- then mixtures of the two will have values between zero and 1. Yeah.

I mean, the 1's the normalization, zero is natural. Anything else? Deep philosophical questions? I will need to talk more slowly in the future. And I will do that. But I'm done. Thank you.