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ANDREW LO: So far, the stock market is down. But on the other hand, if you look at the three-month T-bill rate, it's up about 60, 70 basis points. So that's not bad.

Looks like there is some sense that liquidity is going to be good for the market. And I guess we'll wait and see. But clearly, the Fed is making a-- the Fed is making every effort to maintain liquid markets.

We should keep in mind-- those of you who are starting to panic and thinking, gee, really, all hell is about to break loose-- keep in mind that interest rates are still pretty low overall.

Obviously, the Fed cutting rates is going to mean that the overnight borrowing rate between banks and the Fed is low. But if you look at commercial paper-- if you look at a variety of other indicators of borrowing rates, they're relatively low, to the extent that markets are, quote, "frozen."

It really means that the banks and other agencies are waiting to figure out what's going to happen with regard to the rescue package and other market events before they start to lend again. And there's nothing structurally wrong with their particular business models, nor is it the case that we somehow run out of money or we've all lost these assets. Investors right now are waiting on the sidelines.

And you can tell from market dynamics that there's enormous amount of fear that is really affecting markets. And this is exactly the kind of reaction that the Fed was trying to forestall two weeks ago when the money markets broke the buck. And hopefully, they will still be able to do so. But you can tell that it's building.

And market fear, as measured by things like the stock market and bond markets, that's still a concern. So we'll wait and see. But so far, it seems like the developments are as we pretty much expected. There really isn't any huge surprises going on.

Any questions? Yep?

AUDIENCE: I wanted to share my experience. It's like about six years ago in Argentina, we had this crises that it was similar to this, in the sense that the whole country disappeared.

We had five presidents in a week. We defaulted. The government defaulted. Half of the public

companies defaulted. We devalued our currency. It was really chaotic.

And still, I don't know how we survived. And two years afterwards, I went into working to this investment fund. And we just started buying companies that were really in sale.

And when he says that this creates opportunity, it sort of feels a little naive or something like that, but it really creates opportunities. So those who survive can have really good choices afterwards. So I don't know. What I'm doing now is trying to take a deep breath and flow through the crisis.

ANDREW LO:

Yeah, I think that's very good advice. And in fact, in terms of opportunities-- I think that right now, because everybody is transfixed on the problems with the economy, people aren't thinking about opportunity, because they're scared. And I wish I could fast forward and give you my last lecture for this course now, because it's actually pretty relevant.

The last lecture of the course is where I actually bring in some evidence about psychological biases that affect all of us. And in particular, there's some recent evidence in the neurosciences that explain why it is that when we are stricken with fear, it almost paralyzes us. Actually, physiologically it can paralyze us in terms of decision-making ability.

So I don't want to talk about it now, because that's going to be the last lecture. And I feel we have to cover the material. But it's true that when you're in the midst of it, it's very difficult to think rationally.

But I'll give you one example of, I think, a wonderful idea that nobody has mentioned but is perfect for an MIT audience or an MIT entrepreneur. One of the problems that we face right now is the unknown. We don't know what CDOs and CDSes and all these complex securities are worth.

Wouldn't it be wonderful to have a website that did nothing more than post the prices of transactions in these securities over a period of time, really as a means of providing information to the marketplace about what kinds of deals are being done and at what prices? We don't have an organized exchange. So that's another idea is to create a kind of an eBay for CDOs.

It may not work. It may be naive. It may be something that somebody has already thought of.

But these are the kind of innovations that the market is crying for. And I promise you, if you are

the first one to the market with one of these innovations, my guess is that that's going to be a billion dollar idea, because everybody right now is looking for some means of getting transparency and liquidity into these marketplaces.

And so if you could be the first, or second or third even, to come up with that mechanism for being able to provide pricing information just a little bit better than nothing at all, you can actually do incredibly well. That's an example-- very simple example-- of how technology can actually transform that market, because most of that market right now is still paper and pencil. It's just really relatively backward, from a technological perspective. OK. Yeah?

AUDIENCE: [INAUDIBLE] transparency, why do you think the banks push to get rid of mark-to-market accounting?

ANDREW LO: Well, I'm glad you brought that up. We're going to talk about that in this lecture. That's a very important point.

First of all, I want to define mark to market. And we're going to talk about that and the difference between forward and futures contract. But let me give you the short answer. And then I'm going to spend the rest of this lecture hopefully justifying it.

The idea that some banks have proposed to suspend mark-to-market accounting is probably the worst idea I've ever heard of in this entire crisis. Now let me not mince words and explain what-- the idea of not marking to market is a little bit like telling a crowded theater, where you smell smoke and you see flames on the stage-- instead of letting people get out of that theater, it's like telling everybody in the theater, all right, we're not really sure exactly what the smoke is from, but we want everybody to sit down, relax, take a deep breath, and let us think about it for another half an hour, and then we'll decide. That's what suspending mark-to-market will do.

AUDIENCE: So do you think when the SEC has come out and said that companies now can use their judgment to [INAUDIBLE] sale prices, do you think that's going to happen [INAUDIBLE]?

ANDREW LO: Well, it's a little too soon to tell, because we don't know exactly what the treasury will do. The SEC can say whatever they want. The bottom line is, is there a market for these securities at prices that these companies come up with?

I may think that my ideas are the most valuable in the world. That doesn't make it so. And in

the same way, corporations that feel that their securities are the most valuable in the world, that doesn't make it so.

What makes it so is what we said on the very first day of class. And that is, what? What determines the value of security?

Exactly. You all-- the market. And so if nobody wants to buy or sell at any price, then that's not really a price. A price is a number at which two mutually consenting adults agree to transact. And if you can't find two mutually consenting adults to agree to transact, you can come up with all sorts of really interesting numbers, but those aren't prices.

So we're going to talk about that exactly in this lecture, because what I want to do is to describe to you how forward contracts and futures contracts work. You've heard of both terms, I think.

We've talked explicitly about forward contracts, but we haven't talked about futures. The innovation of futures contracts is exactly this mark-to-market issue. So let's get to the topic for today and talk about forward and futures.

So in this lecture, what I'm going to cover is the definition of forward and futures contracts. And then I want to show how to value them. The valuations of these contracts will also use net present value formulas, but it'll be used in a somewhat different way. So that's why we want to spend extra time going over these kinds of securities. They're different from what we've looked at so far.

There's some motivation from why you might want to consider these contracts that I've got up here in the slide. But really, the motivation is pretty simple. And actually, the motivation is brought home by current events because of the uncertainty in markets right now.

The first example-- your company, based in the US, supplies machine tools to customers in Germany and Brazil. Prices are quoted in each country's currency, so fluctuations in the euro, dollar, and the Real dollar exchange rates have a big impact on the firm's revenue. How can the firm reduce or hedge these risks?

This is an example where you're making machine tools. You have no idea what exchange rate markets are going to do. And that's not really your job. You don't really care about that. But the fact is that it does have an impact on your company's performance, because a large part of your revenues are going to be coming in in these foreign currencies.

So what you'd like to do is to figure out a way to eliminate that kind of uncertainty, or at least reduce it. And there are many other examples here where an individual has a particular objective in mind, and market fluctuations are so extreme that they end up being a distraction and, in some cases, a decrement to the business opportunity. The idea behind a forward contract is to try to reduce or, in some cases, eliminate that kind of fluctuation by finding a counterparty that's willing to deal with you to eliminate that uncertainty, because that counterparty faces the opposite uncertainty.

So this is an example of just how big the uncertainty is that we're talking about. If you take a look at exchange rates from 1995 to 2003, you can take a look at the dynamics of these currency movements. They are extreme in some cases.

So if you're a company manufacturing machine parts, you have no idea how to deal with this. You're not a currency forecasting firm. And so what you'd like to be able to do is just get rid of it, or at least reduce it to the point where you actually don't have to think about it.

And to give you a sense of how significant this problem is, this is the sales for Caterpillar from 1980 to 1989. And most of you have heard of Caterpillar, right? They manufacture tractors and other kind of heavy machinery.

This is their sales figures. But you can take a look at what happens when you take their sales figure and you denominate it in US dollars. That's a pretty big difference between US denominated and foreign currency denominated levels. So what we want to do is to address that concern by using financial markets in a particular way.

Now there is an issue regarding futures and forwards as to whether or not the people who are in the markets are hedging or speculating. And so we're going to talk a bit about that a little bit later on. But before we do that, we need to develop some terminology for what these contracts are.

But I want to raise that as an issue upfront, because it's very controversial. There are some people that argue that it's all these evil speculators that are causing market dislocation and we ought to just get rid of them. And I'm going to argue that you really can't, because speculators provide an enormously valuable service.

They are the opposite side of the same coin. So it's like trying to do applause with only one

hand. The sound of one hand clapping is not particularly loud.

So there are a number of ways of hedging. Obviously, using futures, forwards, options, and swaps are what we're going to be focusing on in these next three lectures. But you can also think about insurance, diversification, you can match assets and liabilities in terms of their duration, or you can match sales and expenses across countries to try to reduce your currency risk. And frankly, that's one of the reasons why companies often set up production facilities in countries where they do a lot of business, because this is a natural hedge, in the sense that they're generating expenses, as well as revenues in the same currency. And so that cancels itself out.

But you can't always easily do that. And you certainly can't do that quickly. And if you're a foreign company trying to do business today, life is very, very interesting, shall we say. So you want to be able to hedge now. You don't want to wait a year or two when you are building that plant to be able to do that.

Now what we're going to talk about is whether or not it's possible to hedge with derivatives. But there are various different views on the impact of derivatives for non-financial firms. One extreme is that derivatives are extremely efficient tools for risk management. And the other, espoused by none other than Warren Buffett, is that derivatives are financial weapons of mass destruction.

And the truth is actually both. Both of these statements, I think, are correct. So from uranium-238, you can get a nuclear power plant that can provide power for huge areas of the country and that do today. Or from uranium-238, you can build a dirty thermonuclear bomb that can be very bad. So the point is that technology, in and of itself, has no particular good or bad properties. It's how you use it.

And so derivatives are definitely more complicated and more sophisticated. This is not the kind of thing you want to try at home, unless you are a professional in how you use these kind of instruments. And so that's one of the reasons why we want to spend time on these particular securities.

OK. There are a couple of other views, too, regarding whether or not hedging should be done at all. One view, which we'll talk about in more detail towards the latter part of the course when we get into corporate financing decisions, is that hedging for a company should be irrelevant. If you're running a company, even if your company's assets are in foreign denominated

currencies and changes in those currencies cause huge swings in your company value, there is an argument to be said that you shouldn't bother hedging, because as long as shareholders of your company have free access to the market, they can hedge.

So anything you can do, they can do. At least, that's the argument. Now the counterargument is that that's not true, because most people who buy shares, they don't know enough about what the company is doing to be able to hedge, nor are they set up to trade in some of these kinds of hedging vehicles. But the frictionless model would say that you shouldn't bother hedging, because what investors want you to do is to focus on your business. And hedging is just something that, if they are concerned about, they can do on their own.

The alternative view is that hedging creates a lot of value, because it reduces uncertainty for a company's cash flows. It focuses the company on its core competencies, as opposed to other factors in the marketplace that are causing volatility. It also reduces the chances of getting into financial distress. And if we believe that financial distress creates these huge costs that can't be easily recoverable, even through the bankruptcy process, then you ought to hedge.

Now there are lots of examples of all of these perspectives in the industry. I'll give you three of them. Homestake Mining is a mining company that mines precious and base metals. They have an explicit corporate policy that says, we do not hedge, because shareholders will achieve maximum benefit from such a policy of not hedging. OK. Sorry, yeah.

AUDIENCE: Is there a difference in hedging strategy when it's an input production versus production output? For example, an oil company hedging gasoline exposure versus [INAUDIBLE] company hedging gas [INAUDIBLE]?

ANDREW LO: Well, there is a difference in the sense that typically when you're producing an output, there's no point in hedging that, because that's actually the output that you're producing. You're a gold company. You're producing gold. The only question about hedging is whether or not you feel that there's some temporary mispricing that you want to be able to take advantage of, given where markets are today versus where you think they'll be three months from now.

But effectively, the output is what you're supposed to be producing. So their argument is that we're producing gold, why would you want us to hedge the price of gold? We're a gold company, so you're supposed to be getting the risk of gold with a gold company.

So it's typically the inputs that they're talking about. But on occasion, they may be talking about

outputs as well. And the argument here is that you shouldn't be hedging that.

Now the American Barrick has another view. Their view is that hedges-- they want to provide financial stability. And so by hedging their output exposure, they're actually providing that stability, because right now, for example, gold prices are extremely volatile, because there's a flight to quality, and then people change their mind, or another group decides to sell. And so the prices are moving back and forth and back and forth.

That output uncertainty creates volatility in earnings. And we all know that shareholders like stability in earnings. So that's another view.

Now the first company, Homestake Mining, would say, look, if you don't like the heat, get out of the kitchen. We're a gold company. If you don't want the volatility of gold, then don't buy a gold company. Put your money in T-bills. And so that's another view.

And then, of course, we've got Battle Mountain Gold, which is a company that hedges up to 25%. So their argument is that a recent study indicates that there may be a premium for hedging. But they're not quite sure, so they're just going to go partway.

It's not clear what the answer is, because largely, the issues depend upon how the public will react to this kind of uncertainty. There are some people that are quite rational about their exposures, and they want to have the volatility of gold. But they don't put all their assets in gold, because they understand that there's a limit to how much volatility they're willing to bear. So maybe 5% of their portfolio is in precious metals, 10% base metals, so on and so forth. They do the asset allocation.

But there are other perspectives that say, you've got to worry about volatility of earnings, you want to have a stable share price. And then they engage in that activity as well.

There's some empirical evidence that I thought you might be interested in. A couple of academics, Guay and Kothari-- SP Kothari is a faculty member here in our accounting group who's on leave-- published a paper just about five years ago where they took a random sample of 413 large companies with average cash flows of about \$700 million. And 57% of those firms used derivatives in 1997.

Now that's 11 years ago. So this is dated information. If you went and re-did the survey today, my guess is that that number, 57%, will have gone up by quite a bit. But I don't know for a fact that it has. But the idea behind the survey was just to get a sense of how many companies

really are making use of hedging programs. And it's become much, much more significant than before.

Part of the reason that it's not 100%, I suspect, is that it's not that easy to implement some of these hedges, because the concepts are rather subtle. You'll see, when we go over it in this lecture, how straightforward you think it is to hedge. Some of the ideas are a little subtle. And so it's not a simple asset class purchase decision, like I'm going to buy bonds, I'm going to sell stocks. It requires a certain level of expertise and comfort.

So let's talk about that now. Let's talk about derivatives. There are going to be three kinds of derivatives we're going to focus on. Forwards and futures-- that's what we're going to talk about in this lecture and the next. Then in lecture 10, we're going to talk about options. And then there's a third class, which we probably won't get to in this course, but you will get to in 402, as well as in investments. And that is swaps.

The idea behind a forward and futures contract is that it's a contract to exchange something in the future. So today, we agree on engaging in a specific transaction sometime in the future. And the difference between a forward contract and a futures contract really has to do just with the issue that was raised the beginning of the class by [INAUDIBLE], which is mark-to-market. But let's not worry about that for a moment. Let's just focus on the contract itself.

So a forward or futures contract is, as the name suggests, an agreement that we enter into today-- you and I-- to engage in a transaction, say, six months from now. So all we do today is agree to do that transaction. And in agreeing to do that transaction, we have to specify a couple of things. One is we have to specify what we're going to transact and at what price. And the second thing we have to agree on is when we're going to do the transaction.

Once we sign the document, we are both obligated to follow through. So this is not an option in the sense that we can choose not to do it or to do it. Once we sign the forward contract today, it is a legal, binding contract so that we are agreeing today to engage in that transaction six months from now.

Now if it ends up that we default-- we don't have enough money, we declare bankruptcy-- then that contract, like all other contracts, will have to go to court and be dealt with by the legal system. But assuming that we are not in default, we will have to perform-- we are obligated to perform-- on that contract, like any other. It's a binding agreement.

With an option, on the other hand-- we're going to get to this in more detail in lecture 10-- with an option, we do not have to follow through with the transaction. In other words, the buyer of the contract has the right but not the obligation to exercise that option. That's why it's called an option. So that's a key distinction.

So let me be very explicit now and now focus on a forward contract. A forward contract is a commitment to purchase, at a future date, a given amount of a commodity or an asset at a price agreed upon today. So first thing we do, draw a timeline.

Today is date zero. That's when we enter into the agreement. And to be clear, because a forward contract always has two parties-- a buyer and a seller-- let's just use, as the convention, that the buyer of the forward contract is the party that has agreed to buy whatever in a future date.

So the price that we agree to is fixed, as of today. And that's known as the forward price. If the particular commodity that we're talking about happens to be a bond, then it will be a forward borrowing rate that we agree to today. So it's either a rate or a price. And it's typically called the forward rate or the forward price.

And the buyer of the commodity is said to be long the forward contract. And the other counterparty-- the counterparty that is selling the asset-- is said to be short the forward contract. Now these terms are, in some sense, arbitrary. But there is a logic to them that I'll explain in a minute. Yeah, question?

AUDIENCE: [INAUDIBLE] forward contract?

ANDREW LO: A revolving loan. Well, I would call a revolving loan a sequence of forward contracts, because it revolves and constantly updates. That's right. Yeah. So for the moment, let's just focus on one, and then we'll talk about how we can extend that.

So this is a very, very standard set-up. And in terms of long versus short, there's a reason why we use that terminology. Obviously, the ambiguity is the fact that a forward contract actually has no value on the day that it's struck.

So to say that one side is long and the other side of short is, in a way, a little bit unnatural, because in fact, the value of the contract that's struck is zero. So you're either long zero or short zero. Well, who cares?

But there's a reason why we call the buyer long and the reason we call the seller of the asset short. It's because tomorrow, if the value of the asset goes up beyond where the current price is, then the person who has agreed to buy the asset at this price is going to make money. So when the price goes up-- when the spot price, the price today and then the price tomorrow spot price-- when that goes up, the person who was holding it long will profit. And the person who is short will lose.

And so that makes sense. When prices go up, long positions tend to be profitable, and short positions tend to be unprofitable. That's why we use the normalization. Now right then and there, I think I've described something that may have slipped by you a little bit. So I want to just beat this down and make sure that we all understand it completely.

The price that I'm talking about going up or down is not the forward price. It's the futures price. Excuse me, it's the future spot price.

Today's spot price for oil is, let's say, \$100 a barrel. Suppose that we enter into an agreement six months from now to purchase oil at \$110 a barrel. So the forward price of that contract is 110. Today's spot price is 100.

When we have agreed to that contract, you and I, the value of that agreement is worth zero. It's got to be worth zero. The reason is that if it's not at all worth zero, then you and I aren't going to be willing to enter into that contract today, because that means either I'm losing and you're winning, or you're losing and I'm winning. So we won't strike that deal.

Let me give you an example. Suppose that I propose to buy oil from you six months from now at \$40 a barrel. Now that's a legitimate contract, right? In other words, I can propose that. And if you and I, we agree to that, that transaction will be carried out.

How many people would agree to that today? Nobody. You would? All right. Seriously? No.

AUDIENCE: You're buying?

ANDREW LO: I'm buying at \$40 a barrel. No. Because given that oil is at 100 and given that there's nothing in the news or in any kind of projection that suggests that we're going to find tremendously large, untapped oil reserves or that somehow oil is going to become less relevant in six months time, being able to buy oil at \$40 a barrel six months from now is an incredibly good deal.

If I can find a deal like that, it's got to have a lot of net present value to me today. If I can find a piece of paper that allows me to buy oil six months from now at \$40 a barrel, that piece of paper, we all agree, has positive NPV. So in order for you to agree to sell me that piece of paper, you're basically giving me money. You're not going to do that. So we're not going to get that deal done today.

On the other hand, suppose that we have a piece of paper that says, I will buy oil at \$250 a barrel six months from now. I suspect all of you would be delighted to sell me that forward contract. I'm not going to do that, because that's ridiculous. That price just makes no sense. And that means you're going to get a lot of value.

So if both you and I agree that we want to do a deal regarding oil-- you're an oil producer, I'm an oil user, I want to lock in some price for oil six months from now-- we're going to haggle until such time as we reach a price for that transaction six months from now that seems fair to both you and me. When we do that-- when we reach that price-- \$110, let's say-- that's a price where the present value of that contract is worth nothing. So both you and I have found a price, such that we're happy to take it or leave it.

If we made it 115, then I might not be so willing to do it. You might be happy about that. If we made it 105, I'm happy to do that, but you think that you're not getting a good deal. So the way that a forward price is established is like any other price.

We put it up for auction. We set a system where supply and demand determines that price. And when that price is struck, the contract is worth nothing. Question?

AUDIENCE: Could you argue that it's based on the price of a futures contract and not of the market [INAUDIBLE]? Let's say they're in the range [INAUDIBLE] \$130 and we enter into [INAUDIBLE], wouldn't that create a little bit of a problem there?

ANDREW LO: Yeah, it would. Let's not talk about that yet, because we haven't talked about futures prices yet. So we're only talking about forward prices right now. We're going to come back to future prices, and arbitrage is going to come into it. But I want to do it step by step. So let's hold off on that for a minute. Yeah?

AUDIENCE: So when there's like a natural gas company that sells [INAUDIBLE] for next year, that's forward contract [INAUDIBLE]?

ANDREW LO: Exactly. That's right. And companies are delighted to do that, because this way, they know

what their costs are going to be, as opposed to who knows, it depends on what happens with this rescue package, or it depends on whether or not we get hit with a terrorist attack or not. That creates so much uncertainty, companies don't want to deal with that.

So if I use oil in my production facilities and I can lock in at 110 for a six month period, that's OK with me. I'm willing to do that. Yeah?

AUDIENCE: Considering that the trend of the global market is upwards in the long term, I suspect that it makes sense, especially to try to short in the short term, that would be there-- exceptions when I want to try and do it in the long term as well?

ANDREW LO: Well, that's a very tough question to answer, because it depends upon what your forecast is for long term prices. And the longer the term is for your forecast, the more inaccurate your estimate goes. So the question is whether or not you really want to take that risk and make those projections.

In fact, this is one of the reasons why companies don't want to do that and they'd rather lock in the price. Companies feel like they're not in the business of forecasting prices in the long term. They're producing oil, or they're using oil as an input to their production process. So they basically just want to eliminate that uncertainty if they can get a reasonable price. And by reasonable-- I just gave you an example-- a \$10 premium over a six month period where we have uncertainty about both supply and demand may be reasonable to certain corporations. Yeah?

AUDIENCE: Is there a limit on how much can be done in a forward contract? And the example I sort of have in mind is over the past few years, we keep reading how Southwest has hedged on its fuel, but the other airlines haven't. So was there some sort of financial or legal perspective [INAUDIBLE]?

ANDREW LO: Certainly not anything from a legal perspective. For a financial perspective, that depends upon the particular company and the shareholders and the balance sheet and so on. But no, there's no limit, as long as you can find a mutually consenting adult that's willing to do the deal with you. That's it. All right. Yeah?

AUDIENCE: Does it have to be more expensive than the current price?

ANDREW LO: Well, no, it doesn't have to be more expensive. So the question is, does the forward price

always have to be more than the current price? No, it doesn't. It depends upon what the expectation is for what's going to happen in the future.

It turns out with oil, typically it goes the other way-- that these oil prices generally are rising over time. However, there are situations. For example, it may be that within the next few weeks, if there is more of an expectation that business will slow down worldwide, then we would expect oil prices to decline over time, because the demand is going to decline.

If that's the case, then oil producing companies may be delighted to do a deal at par. So if the current price of oil is \$100 a barrel, they may be delighted to say, OK, six months from now, I think the economy is going to go down, I'm willing to sell you oil at \$100 a barrel six months from now, let's lock it in. That's possible.

So what does that tell you about the price of oil today versus the price of oil six months, in terms of the forward prices? That tells you that the market is providing information about the future. So future price forecasts are implicit in these forward prices.

In just the same way that when we look at the yield curve and we see the implicit forward rates for future borrowing, when you look at forward prices of commodities and other instruments, that's giving you information about what the market is telling you that it thinks will happen six months from now. So if you see forward prices for oil at \$90, whereas today it's at 100, that's telling you either people are expecting to find lots of oil in the next six months, or it's telling you that there's a forecast that demand will decline precipitously over the next six months.

OK. So the features of forward contracts are the following. They're customized. So we have to enter into this contract counterparty by counterparty. In other words, this is not a share of IBM that anybody can buy and sell and is the same whether you trade it in the New York Stock Exchange or in London or anywhere else. A forward contract is a customized agreement between two parties.

The second feature is that it's typically nonstandard, so we can do as much of it or as little of it as we want. And also, it doesn't trade on exchanges. These are known as over-the-counter securities. It doesn't trade on an organized exchange. Two people trade with each other over a counter. That's the customization part. Yeah?

AUDIENCE:

You said that there's sometimes a circular effect on prices on certain commodities. For example, if I think that copper is going to be more expensive six months from now, then I'm

going to buy more copper today, which is going to drive up the price, then it's going to make it lower in the future?

ANDREW LO: If you drive up the price, why would you make it lower in the future?

AUDIENCE: Because my demand for it would be substituted now instead of six months from now.

ANDREW LO: Well, it's not clear that it would make the price lower, because if you're doing it, that may indicate that there's going to be a shortage, because you're trying to get ahead of that curve. And therefore, the price may stay that way.

So I'm not sure I understand your question. Are you worried about price manipulation, or are you worried about the fact that the futures prices or forward prices don't reflect current supply and demand conditions?

AUDIENCE: I'm just trying to think that if I expect a certain price to go up in the future, rather than hedging against-- the inflammation that's in that price is based on the inflammation of the price right now, so I'm going to substitute my demand for--

ANDREW LO: OK, I see what you mean. So let me rephrase the question. Your question is, if you think the prices are going to go up for a particular input-- say, copper-- then rather than buy it six months from now at the potentially higher price, you might decide to do it sooner by buying it now. Right.

That's a perfectly sensible thing to do with one exception. And that is that when you buy it now, you have to store it. And copper, oil, other kinds of factor inputs are typically not the kind of things that are costless to store.

So you can either do that, buy it now, store it, and then use it later, or you could do a financial transaction that will have the same effect. And so that idea is going to be exactly how we price these things. So I'm going to come back to that. Hold onto that thought, because we're going to use that approach to figure out how to price a forward contract.

So far, I haven't told you how the forward price comes about. All I've said is, the market determines it. Like before, we're going to want to work out the logic for what the market is doing when it figures out what that price is. And it will actually be exactly the calculation that you just proposed.

So in other words, either we transact in the forward market, or we do it directly in the spot market. Those are our two choices. And in the end, it's going to have to be the case that those two choices, which lead to the same cash flows, they have to have the same price. And that's how we're going to get the forward price. Yeah?

AUDIENCE: Do you have to have cash on hand now to enter into a forward contract?

ANDREW LO: No.

AUDIENCE: So that could be another reason why, if you're an airline, for example, you wouldn't want to buy millions and millions of dollars worth of gas if you can't afford it now?

ANDREW LO: That's right. But if you can't afford it now, you're really talking more about a short term kind of a borrowing situation, because presumably, you're going to have to pay for it at some point, particularly when you use it. But you're right that if you don't have the cash now, then one way you can do it is enter into a forward contract when you know you'll have the cash later.

AUDIENCE: Right. Because American Airlines, I'm sure, couldn't afford to buy five years' worth of fuel today, because they just don't have enough assets to do that.

ANDREW LO: Right. So you can't buy that-- not only that, where are you going to put it? Five years' worth of oil is a lot of oil. And it's very, very expensive. So your consideration is absolutely right. The borrowing cost, or the opportunity cost of capital, is also part of the equation.

So if we think about all the ingredients that have to go into determining the forward price, one is the cost of storage. The other is the borrowing cost implicit in that-- the cash-- because a forward contract requires no money down. So this is one of these true financial deals with no money down. The problem is that it's not always a short profit. Yeah?

AUDIENCE: You may also not have the product to sell. For example, in the case of soybean or food, you may enter into a six month forward and I still did not harvest a product.

ANDREW LO: That's right. So you may want to wait for the uncertainty to resolve and get a better sense of what your needs are. Yup?

AUDIENCE: So if between the buyer and seller they have a different or asymmetric information, is it possible that the overall forward contract has positive NVP?

ANDREW LO: Well, let me put it to you this way-- the forward contract may have an expected value for one

party or the other based upon what they know. But in principle, the NPV-- that's an objective NPV-- has to be zero, because if it's not zero, then one party can take that contract and basically sell it to a third party and make money off of it. See what I mean?

In other words, your question is, if two parties have different information, is it possible that the contract has different value? Well, certainly they have different value to each party. In other words, if I'm willing to buy oil forward contracts from you, I must think either that oil prices are going to go way up-- that's my view-- or I just need the oil, and I want to get rid of the uncertainty. But both of those are possible.

If you're selling me this oil forward contract, the two possible reasons you might want to do it is because you've got a lot of oil and you want to lock in a price for selling that oil six months from now-- that's one possibility-- or you have some asymmetric information-- some private information-- that oil prices are going to go down. So both of those interpretations are legitimate.

But the statement that I made that the price of that contract has to be zero, that's a statement not about your views or my views or her views. It's a statement about the market price of that contract if we were to auction it off to people in the marketplace. If we were to auction it off to people in the marketplace in general, it would have to sell for zero, because if it were positive, then I would be benefiting and the person who's selling it to me would be losing out and vice versa.

So we can have our own speculative motives for doing the deal. But when the price is set, the way that it's set is not just based upon simple expectations of you and me. But it's the market that's determining the forward price. Yeah?

AUDIENCE: Then what's the function of the over-the-counter market for the forward contract?

ANDREW LO: The over-the-counter market is that you and I are the ones that are entering into the deal. And so we're signing the contract. So it's between us.

But my point is that if the forward price that we are using to strike that deal is so one-sided, then it's going to be very clear from the market that that's a stupid contract for one of us to enter into. So it's a private transaction between you and me. And for that matter, if it's a private transaction, you're right that it could be the case that we can make up any price.

Let's say \$200 a barrel. Would you ever see a contract that's at \$200 a barrel? No, because

that would mean that either you or me is being really stupid. Now we're perfectly allowed to be stupid. The Constitution guarantees that right.

But it's unlikely, because we know, both you and I, how oil is doing. And therefore, the price will be set to make that contract worth nothing. If it were not worth nothing, then one of us is making a very bad deal. And money is going to be exchanged from one party to the other. Yeah?

AUDIENCE: Does this always have to happen between a buyer and a seller, or could that be in communities?

ANDREW LO: Could it be what?

AUDIENCE: Could it be in communities?

ANDREW LO: I'm going to get to that in two minutes. Right now, it's only between buyer and seller. That's a forward contract. With the futures contract, that's a different story. Another question?

AUDIENCE: I'm just wondering, does this actually assume physical delivery of the asset?

ANDREW LO: Yes, it does. Yes, it does, although if it doesn't have to. If the contract that you strike as a forward contract is one where you don't want physical delivery, you can make it a pure bet-- a side bet. But in fact, typical forward contracts that are entered into are for physical delivery of the actual commodity being agreed upon, because that's why people enter into them. They need the oil or the gas or the copper. Yeah?

AUDIENCE: What does [INAUDIBLE]?

ANDREW LO: So let me get to that. I want to make sure we get all the other questions answered, though, before I go down.

The last point that I want to make is that with a forward contract, because it's a contract between two parties, there is significant counterparty risk, meaning there is a risk that you don't pay up on your end of the deal or that I don't pay up on my end of the deal. There is a significant risk that one of the parties reneges.

So this is not a riskless kind of a contract. It has significant default risk. How significant depends upon the counterparty.

If you're dealing with-- I hate to say this-- but a AAA counterparty, then the risks should be small. But we all know what AAA means these days. It used to be the case that when you're dealing with a AAA counterparty, you had very little counterparty risk.

But if you're dealing with a counterparty that doesn't have the same kind of financial wherewithal, then you're going to have to bear that risk. And it's up to you to decide, is it worth it to you to take that risk? Yeah?

AUDIENCE: So in event of the very [INAUDIBLE] market fluctuation [INAUDIBLE], somebody will lose in the end upon the settlement. So is it common for people that participate in this to hedge their positions as well? [INAUDIBLE]

ANDREW LO: To hedge counterparty risk?

AUDIENCE: Yes.

ANDREW LO: It is common. And you know how they do it? They don't use a forward contract. They use a futures contract. So we're going to get there in just a few minutes. Maybe I should go faster, given that there are all these questions that are anticipating the futures contract. Or maybe it's just that all of you are scared to death of counterparty risk, given what's going on, that you just want to get rid of it.

So let me go quickly through an example of a forward contract. Then I'll get to your point, and I'll show you how you go about hedging that risk by essentially doing a transaction every day.

But I want to make sure we all understand the concept of a forward first. So here's an example. The current price of soybeans is \$160 a metric ton. That's the current spot price-- the price today.

And there's a tofu manufacturer that needs 1,000 tons, not now but three months from now. And they want to make sure they can get that 100,000 tons at that time. So they might enter into a three-month contract to buy 1,000 tons at 165 tons. So they're going to offer the seller of the soybeans-- the soybean farmer-- they'll offer them a little bit of a premium-- a \$5 premium-- in order to lock in that price.

Now it doesn't have to always be a premium. In certain cases, there could be a discount. And there are different names for those that I'll talk about in a few minutes. But for now, it's at 165. And it's what the market seems to agree is an appropriate price three months from now.

So you've all identified, I think, the issues with a forward contract. There are two issues. One is illiquidity, and the second is counterparty risk.

Illiquidity means, suppose that I no longer want to be in the contract-- I want out. Well, it's not easy for me to get out. I can't sell my contract unless I find somebody else who wants to buy soybeans at 165 tons three months from now. I can't get out of it easily.

I can go back to the farmer and say, would you mind canceling the contract? And they'll probably say, well, it depends, where is the price of soybeans today? If the price of soybeans is at \$180, I'm happy to cancel the contract. If the price of soybeans is at \$50, sorry, you're stuck with the agreement. So the illiquidity is an issue.

But then of course, counterparty risk is another issue that we have to deal with. Yeah, [INAUDIBLE]?

AUDIENCE: [INAUDIBLE] trying to hedge the quantity. It's not the actual price. Do companies do that where they want to guarantee that there will be a supply?

ANDREW LO: Yeah. Well, it's both. They want to guarantee that they have enough to be able to produce whatever they need to produce. So they need a certain amount of input. But they won't want to guarantee it at any price. They want to be able to figure out a reasonable price.

So in this example of the tofu manufacturer, they need 1,000 tons in three months. That's definite. That's the quantity that they need.

The question is, what's the price? If the current spot price is at \$160, then they need to make a decision. In three months time, do they think that the price will be greater or less than 165? If they think that it may be much more than 165, then they'll enter into it.

But if they think that there's going to be a huge crop of soybeans, because we've had a lot of rainfall and a lot of sunshine and there's no problem and we're going to have a glut of soybeans, then they may not do this at all. They may just say, huh, we're going to wait three months to see what happens.

Of course, if it turns out that between now and three months from now there is some kind of bacteria that kills half the soybean crop, now it's \$190 a ton, then they're in trouble. So as a tofu manufacturer, you got to ask yourself the question, how well do you know the soybean

market, how much are you willing to bet your firm's franchise on soybeans being available at the price that you want to pay three months from now? OK. So it's both price and quantity.

All right. Now we're going to get back to [INAUDIBLE] point about being worried about counterparty risk. And let's just talk about counterparty risk in very, very plain detail.

Suppose that we enter into that soybean contract. So today, we agree to buy soybeans three months from now, as a tofu manufacturer, for \$165 a ton. All right, now let's fast forward one month.

We've got two months to go in our agreement-- in our forward agreement-- and all of a sudden, something happens in the soybean market, and the spot price for soybeans has now dropped to \$100 a ton. Huge glut that has hit the market, because the weather was unexpectedly nicer, lots of rainfall, just tremendous crop output. So we got \$100 a ton for soybeans.

Now to the tofu manufacturer who's looking to do this deal, is he in better shape or worse shape in that circumstance? Why? Why is he in worse shape?

He's agreed to buy it at \$165, price is at 100. But what's the big deal? He was willing to do that a month ago. What's that? Same shape. Same shape. We agree? Worse-- why is it worse?

AUDIENCE: Because his competitors already have access to [INAUDIBLE].

ANDREW LO: Right. So what do you think the competitors are going to do? Exactly. The competitors are going to drop the price of tofu. Soybeans have come down in price. The competitors are going to cut the price of tofu.

And here you've got a manufacturer. If you argue that he's in the same shape, that means that he's going to keep the same price of tofu and he's going to pay \$165 for what's worth \$100. Basically, he's going to go out of business, because his competitors are going to eat his lunch. They're going to charge 40% less, and he'll have zero market share. And he may be able to withstand that for a period of time, but not for a sustained period of time.

So this particular manufacturer of tofu is thinking, well, I could buy soybeans at \$100 on the market now and I got two months before I have to make good on this, what if I just walk away from this forward agreement? Now legally, he's not supposed to do that. So what that means is that if he does do that, he can be sued.

And from the tofu manufacturer's point of view, he might be thinking, well, they can sue me and we can figure it out, or I can follow through the contract and I'll go out of business, so if I'm faced with those two choices and that's my only choice, I'm going to renege on that contract and let them sue me and see what they get, maybe we'll settle out of court, maybe we won't, who knows what will happen, I'm willing to take that risk.

That's a calculation. It's a business decision that has consequences. But it's got consequences for both parties.

Now imagine you're the soybean farmer dealing with this tofu manufacturer. And you're rubbing your hands, because you locked in at \$165 a ton. But two months from now when you go to deliver these soybeans, you find out the warehouse is not accepting it. And you can't get this tofu manufacturer on the phone. He's not returning your calls. What do you do? Yeah?

AUDIENCE: This is currently happening with oil. A lot of people locked in at \$5.00 a gallon and now it's above \$4.00. So the oil companies are scared that everyone's going to stiff them.

ANDREW LO: Absolutely. There's counterparty risk that comes about when you've got dramatic changes in economic conditions. Yeah?

AUDIENCE: But as far as I know, the system only gave you the [INAUDIBLE] deposit [INAUDIBLE] amount of the risk that you want to buy.

ANDREW LO: Right. So now you're talking about collateral. In order to be able to enter into a forward agreement, you might, before you even start talking, say, you know what, I'm not going to do business with you unless you put up some money-- so money as a kind of collateral for making good on it. And if you don't make good on it, I get to keep the collateral.

Now the question is, how big is the collateral, and what is it worth?

AUDIENCE: So you say, what reason do you want to buy? If you just want to buy a \$30 risk [INAUDIBLE], so you put \$30 [INAUDIBLE] want to buy. But you, from the beginning, can say, how much [INAUDIBLE] do you want to buy?

ANDREW LO: Well, but the thing is that they may not be willing to do it. So let's do the example of soybeans. Soybeans at \$165 a ton multiplied by 1,000 tons is \$165,000. Right?

AUDIENCE: I can put [INAUDIBLE]

ANDREW LO: Right. So in order to do the deal, maybe you would agree to put \$5.00 a ton of deposit as collateral. OK? That sounds good, right? And as a counterparty, I might be happy with that.

OK, now say the price of soybeans drops to \$100 a ton. And you've put \$5.00 down as earnest money as collateral. And so from your perspective, as long as the price goes down by more than \$5.00, you're going to walk away.

AUDIENCE: [INAUDIBLE] but I lose the \$5.00.

ANDREW LO: Right. You lose the \$5.00. I'm the soybean farmer. Great, I got \$5.00 a ton. What's that going to do? That pays for my postage. That doesn't do anything for me.

So given that I'm worried about your counterparty risk, I'm going to say, you know what, I don't want \$5.00 a ton, I want you to pay me \$160 a ton now, I want you to deposit that in the bank and put it in collateral. Would you be willing to do that?

AUDIENCE: Depends on the rate and the--

ANDREW LO: Exactly. It depends upon what you think the risks are that the price is going to go down quite a bit. But in general, you're not going to want to tie up \$160 a ton for three months if you don't have to, because that costs you something. The opportunity cost is the interest rate. Yeah?

AUDIENCE: Why don't I just make a contract saying I would buy at a 10% markup instead of setting a specific price? Does it no longer [INAUDIBLE]?

ANDREW LO: Well, no. You could certainly do that. But it's not clear that that really makes any difference. 10% markup over what? You have to define something.

AUDIENCE: The price at the time.

ANDREW LO: Over the prevailing market price. You could do that.

[INTERPOSING VOICES]

Right. What's the benefit of that? That doesn't lock in anything. It may lock in the supply, but it doesn't lock in the price. You still have price uncertainty.

So if you do that, unless you're worried about a shortage, you can always get something for 10% above the price, at least I think you can. Markets are pretty crazy. But if I were to tell you

that no matter what commodity we're talking about, I'm willing to pay 10% more than the market price, my guess is that everybody here would be pretty happy to sell to me. Right? Yeah?

AUDIENCE: But these [INAUDIBLE] evaluated by anybody. So are these just contracts between producer and supplier?

ANDREW LO: Yes.

AUDIENCE: So they're like longstanding agreements and I'm just--

ANDREW LO: Right. That's right. These are not governed by any agency or any kind of standardization. And you now see the problem with these contracts.

These contracts work if the two parties know each other, they've done business for years, there's a lot of trust, you don't have to worry about counterparty risk, you've got the right amount of collateral, you've got the right rating, on and on. It's complicated.

Isn't there a way to make this simpler? And the answer is that there's a way to deal with all of your objections-- all of them. Let's create a new contract called a futures.

A futures contract is exactly like a forward with a few exceptions. Exception number one, we're going to standardize a futures contract. One contract applies to a fixed amount of the commodity of a fixed quality that is known in advance and is decided objectively.

It expires, or it settles, on a fixed date. And there is a futures price. And the price is determined on an exchange. OK, so that's one set of changes.

But the other set of changes is really important, which is that we are going to mark to market every day. Now what does mark to market mean?

If you've got a futures contract-- or rather, if you've got a forward contract that expires in three months, initially it's worth nothing. But over time, as the spot price fluctuates, that forward contract has value. But no money changes hands.

And so because no money changes hands, and apart from collateral, you can have a really big mismatch in the value of the contract to one party or another. So let's go back to the soybean example. I start out by agreeing to buy soybeans from you at \$165 a metric ton three months from now. And the spot price today is 160.

All right. A month from now, let's say, the spot price is down to 150. What do you think that contract is going to be worth at that point? Yeah?

AUDIENCE: [INAUDIBLE]

ANDREW LO: That's right. \$15. How did you get \$15?

AUDIENCE: It's the difference between the future price and the spot today.

ANDREW LO: That's right. I've agreed to buy it for \$165. The spot price two months from maturity is \$150. That's \$15 difference. And so this piece of paper obligates me to buy it for \$15 more than today.

So from my perspective-- the buyer-- the contract is worth not zero, but it's worth negative \$15 divided by the rate of interest, because I don't have to pay the \$15 today. I have to pay the \$15 at maturity, at settlement. For you, the farmer who sold me that contract, that contract-- to you, it's worth \$15 per 1,000 metric tons divided by the appropriate discount factor-- the interest rate-- for that three months.

Now to say that it's worth that really means it's worth that. For example, if you decide that you want to get out of the soybean farming business and you want to take that contract and sell it to one of your fellow farmers, they'll pay you \$15 divided by the appropriate interest rate per 1,000 metric tons. You will be able to sell that contract for that amount of money.

So after date zero, as the spot price fluctuates, this forward agreement ends up taking on economic value, because the prices fluctuate. If we allow that price fluctuation-- if we allow the value of that contract to get really, really big-- in my crazy example, if the spot price goes down to 100-- well, then that piece of paper is worth a lot to you, the farmer. And it's worth a lot to me to be able to get rid of that loss. That's a big loss.

The bigger the loss, the more likely it is that one of us is not going to perform. Why? Because the collateral-- if we have a collateral of \$5.00 per 1,000 metric tons, that \$5.00 is going to become meaningless pretty soon, because I'm looking at a loss of \$50.

If it goes down from \$165 to \$100, I'm looking at a really big loss-- \$65 per metric ton. \$5.00 means nothing to me. So the bigger the fluctuations away from the initial forward price, the bigger the potential for counterparty risk.

So if that's the case, let's you and I agree on something. Why don't we agree that every single day, we will strike a new contract with a new forward price, and then we'll just pay each other the difference day by day? So in other words, in your example, let's say it's \$165 today. We agree on that. The spot price is at \$160.

Let's say tomorrow the spot price goes down to \$155. OK, you know what, let's you and I agree I'm going to just pay you \$5.00 divided by the interest over the next three months minus a day, and then let's cancel the contract. And let's start a new one. And let's say that now, today, we're going to agree to not \$165, but \$160.

The spot price is at \$155. Let's agree to \$160. OK? And now another day passes by. And let's see the price goes down yet again, now down to \$155.

AUDIENCE: [INAUDIBLE] \$5.00.

ANDREW LO: Yes. Right. Or I give you \$5.00, you give me \$5.00. Every single day, we exchange money. And every single day, we get rid of the old contract and we do a whole new one with a new forward price that reflects current market conditions.

If we do that-- well, first of all, it's going to be a pain in the neck, because we have to do a lot of contracts every day. But suppose we did that. If we did that every day, then what we would be doing is essentially always figuring out what today's market price is for soybean delivery on that settlement date.

That's what it means to mark to market. At every single day, the price of the contract reflects today's market valuation, not when we did the contract at the beginning of that three-month period. Every single day as we get closer and closer to settlement, we are revising the forward price to reflect all the information that's accumulated up to that point.

And I'm either paying you, or you're paying me. We're changing money every day so that the value of the agreement is never that far out of sync from the market's value. That way, we can protect this kind of counterparty risk, because then the only risk I'm going to have with you is the risk that comes from a one-day fluctuation, not three months.

Prices can move a lot in three months. But by that time, we will have changed money back and forth. And so you know what? When you add up all the money that's changed hands over the course of the entire three months, if we struck a new forward contract every day and then we

added up all the money that went back and forth and did the interest rate just right, you know what we would get? We would basically get the same thing as if we had gotten a forward contract on day one and held it to maturity.

But the difference is that during that three-month period, you and I, we've never had to worry about either party reneging, because the amount of cash that is owed to one party or another has gotten so big that it makes it worthwhile to walk away. So a forward contract is a situation where you don't mark to market every day. You allow the value of that contract to go up and down and up and down to wherever the spot price determines that it does, in relation to that forward price.

With the futures contract, you can think of a futures as a sequence of forward contracts where you cancel the forward contract every period but pay the difference that was won or lost relative to the day before.

So there's one more piece that I have to tell you about. And that is that-- somebody asked about an intermediary with forward contracts. Forward contracts have no intermediary. But futures contracts do.

Some clever person figured out that all of these other changes that we want to implement to create a futures contract is great, except that there is still this lingering concern that somehow you don't show up tomorrow when I want to basically do a deal and update my contract. So they came up with a brilliant idea of establishing an intermediary called the Futures Clearing Corporation.

The Futures Clearing Corporation is an organization that sits between you and me. And what it does is simply serve as the counterparty. So I'm not dealing with you or you or you. I'm dealing with one organization that stands in the middle of everybody.

I'm dealing with that organization, and you're dealing with that organization. And as long as that organization makes sure that there are two sides to every transaction-- more or less, two sides to every transaction-- then that will reduce the risk even more.

So not only are the contracts standardized, not only are they mark-to-market every day, and not only do we re-establish this price every day, but we then now have the safety of a clearing corporation that we know will always be there to transact with us. So the market is highly, highly liquid.

OK. Now-- question? Yeah?

AUDIENCE: Are there any industries or companies that use forwards rather than futures?

ANDREW LO: There are some. In fact, oil companies, airline companies, and other major producers or suppliers, they prefer forwards, simply because they don't want to deal with these mark-to-market issues. And they've dealt with their suppliers long enough that they trust them. And so they've got standardized forward agreements that are customized to exactly what they want.

For example, a futures contract has very specific settlement dates. If those settlement dates don't correspond with when you need the particular input, then you don't want to use that. But by and large, the futures contracts eliminates a lot of these issues with forward contracts so that for liquidity, for transparency, for safety-- all of those reasons-- they are actually preferred to forward contracts. But forward contracts are still very popular.

For example, there are some markets where forward contracts are actually even more popular than futures. One example-- currencies. For a variety of reasons, currencies-- where you trade with banks for different foreign currencies in the future, the futures exchanges have much lower volume, in terms of dollars traded or yen traded or cable traded, than the banks dealing with these forward contracts. Yeah, [INAUDIBLE]?

AUDIENCE: Looks like in this case the interest rate risk is also a [INAUDIBLE] of the future. Is that right?

ANDREW LO: The interest rate is what?

AUDIENCE: Interest rate risk is also a risk.

ANDREW LO: Yes, interest rate risk is definitely a part of it, because remember, we have to divide implicitly by the interest, because we're getting paid not now, but in three months or two months or 29 days and so on. So we're going to get to that. In fact, let me do some examples, and then we're going to talk about how interest rates figure into this explicitly.

So here's an example of a futures contract. NYMEX-- the New York Mercantile Exchange, it's called NYMEX-- trades crude oil futures. Now there are lots of different kinds of oil. And there are futures contracts that are designated for a particular kind.

So crude oil light is one. Another one is Brent crude oil-- oil from the Brent Seas. And each different kind of oil has a different contract. Remember, we have to standardize the underlying

commodity.

So NYMEX crude oil futures with delivery in December 2007 at a price of \$76.06 a barrel on July 27, 2007 where there's 51,475 contracts traded. So this is a simple example of an actual contract that was traded in the good old days when oil was only \$75 a barrel a year ago. Each contract is for 1,000 barrels. So that's part of the standardization.

The tick size-- tick size meaning, what is the denomination that prices will change when they change up and down-- it's a penny a barrel. So in other words, with 1,000 barrels, if it moves a penny a barrel, that means the contract, which is for 1,000 barrels, moves in \$10 increments. So when you buy one of these contracts, you are buying 1,000 barrels of oil to be delivered to you in December. That's what one of these contracts means.

Now you actually have to put up some collateral for these as well. But think about it. If it's \$75 a barrel and it's 1,000 barrels per contract, then how much oil are you controlling with one contract in dollar terms? Yeah, it's \$75,000. That's a lot of money for one contract.

Look at how much collateral you have to post. The amount of collateral that you have to give your broker to buy one of these contracts is \$4,050. Now by the way, that collateral has increased by about 50% as of this morning. The New York Mercantile Exchange, Chicago Board of Trade, and other futures companies have increased margins across the board for most of the futures contracts because of concerns about liquidity and viability.

Maintenance margin says that once you establish an account and put the \$4,000, they know the money is going to go down or up as the price of oil goes down or up. But at all points in time, you have to keep at least \$3,000 in there. So in other words, the \$4,000, you could lose some of that and it could go down to \$3,500 or \$3,250. But if it goes below \$3,000, you're going to get a phone call from your broker that says, you need to deposit more money, you need to bring it up to \$3,000, that's what you need to do to maintain the account.

And you know what happens if you don't return that phone call? They get rid of the contract. You're out of the market.

If you don't wire that money into the account by end of business on the day you get the margin call, they have the right, and they will close out your contract.

AUDIENCE: [INAUDIBLE]

ANDREW LO: Well, it depends on what your position is. No, you have whatever money you have left. But you no longer have the position in oil.

So if that \$3,000 goes down to \$2,500, that's still your \$2,500, but you no longer have a position in oil anymore at the end of business. That's one of the beauties of a futures contract, from the perspective of the counterparty. It's that they don't have to worry that you're going to run away. The most they can lose is one day's worth of fluctuation in the value of the contract.

That's why for a \$75,000 agreement, you only have to put down \$4,000 earnest money. In the case of that soybean farmer, think about how much money you really would be comfortable requiring the counterparty to put down if you're going to exchange no money for three months. Three months, you never see the other person.

You don't know whether they're still alive. You don't know what's going on with their business. You're going to actually have them put up a lot more money.

With the futures contract, you only have to put up enough money to make sure that on a daily basis, you're not getting taken advantage of. Yeah?

AUDIENCE: How's that initial margin set?

ANDREW LO: The initial margin is set exactly the same way that the margin was going to be set with collateral for that soybean contract. It's the amount of money that they think is enough to cover any daily fluctuations in the underlying futures contract. So if the underlying price moves by a lot, what do you think that will do to the margin-- make it go up or down? Up.

So now do you know why all of the exchanges decided to increase their margin? Fluctuations have started going up. And also, people's credit, in general, have gone down. Yeah?

AUDIENCE: Just going back to your answer to [INAUDIBLE] physical goods, if you and I can enter into a futures contract [INAUDIBLE] traded, isn't physical delivery not really expected, especially with the margin cost? Just by [INAUDIBLE].

ANDREW LO: Yes, so with futures contracts, the majority of the people that use futures are not looking for physical delivery. But with most of the commodity futures contracts, you actually have to specify. So there have been stories of speculators that forgot to check the box that says Cash Settled Only that have gotten tons and tons of corn dumped on their front lawn. That has happened. It's been a while, but it's happened.

Most futures contracts are cash settled. Cash settled means no physical delivery. But there are certain people that actually want the physicals. And so they will transact in the future markets to get physical delivery.

OK, that's it for today. We will see you not Monday, because that's Columbus Day. But I'll see you a week from Monday.