

[SQUEAKING]

[RUSTLING]

[CLICKING]

**SIQI ZHENG:** OK, let's get started. So today is the second class and also the first session of the economics in this class. So we are going to use two classes, today's and also next-- today's Thursday, right? OK, next Tuesday-- we will have two sessions on the economics of green buildings. Today is the first one.

So a little bit of recap-- in our intro session, we talked about why we're going to start at green buildings and what's a unique feature of this class compared to other sustainability classes. And remember, we talked about the triple bottom lines. So when we talk about climate change and sustainability, we care about the planet, which is carbon emission, how to reduce carbon emission, and how to better improve the quality of life, for example, healthy buildings and all these people's well-being.

But then we also have the third bubble here, the PPP. The third bubble is profit. This is important. Because we cannot just say we are going to do good things for the planet and for the people, but we are keeping losing money. So that doesn't work. And especially, it won't work for the private sector.

It's very clear for all the building stock in cities. More than 80% of the buildings, they are supplied by the private sector. So you must remember that we need to incentivize the private sector to supply those sustainable buildings in the cities.

So then this is basically our focus or our perspective for today's lecture, how to make a business case for the green buildings. That will be, remember, the big picture. I have this big picture for the entire course, so the fundamental driving forces of this sustainable real estate from these end users of us, of end users, these blue individuals, from the user's perspective, from the space market, and then also from this individual investors, also all of us from the capital market.

So this is the money. That is the people. And basically, the point is, if they want to live and use and if they will have a higher willingness to pay for green buildings from the user's perspective, either office or residential, then you have a better cash flow. That's a cash flow. Remember, the pro forma is a cash flow. Then you have higher this, NOI. And then you have a higher NPV. That makes sense for a business.

Or from the capital market, if those individuals, they really want to make impact investment, they want to invest in ESG, which aligns with their value, then they will push. They put their money in a pension fund and insurance. Then they will push those institutional investors to put money in greener areas investment. And then they will further push those market key players to invest in those green real estate.

So that's the idea of the sandwich story, the sandwich. We have the upper level of individuals, lower level of individuals. They push the middle layer, which are those developers and investors, to go green.

And today, we are going to start from the upper level. The upper level means those buildings, right? So today's focus will be a building because a building is a fundamental basic element of the entire thing. So we look at the building, and we look at the cash flow.

So that's the position. So when we look at building last session, in the intro session, remember Zhengzhen provided some examples at the beginning as a motivation. So several database companies, they build some buildings. Some are not green at all. Some are less LEED Platinum. Some are LEED Gold, like that.

And that's a very good story, that even for one developer, not always from the heart, see? All the buildings I'm going to build will be green buildings, will be the perfect LEED Platinum. They always have their own considerations. Those considerations will be changing over time and in different market context.

So I'm going to tell a similar story of this big developer here. It's Millennium Partners. So this Millennium Partners is a big developer. I'm not sure. Maybe some of you know this developer. Anyone know this developer? Please.

**AUDIENCE:** Millennium Tower [INAUDIBLE] high school.

**SIQI ZHENG:** Yes, Millennium Tower. Where?

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Boston, right? Yes. Anyone else who knows this developer? Oh, please. Go ahead, Andy.

**AUDIENCE:** Yeah, they're a big developer across the country in Boston. They have a number of high profile luxury condominium projects and some other projects. The big one right now is their Passive House building downtown.

**SIQI ZHENG:** Yes, what's the name of that building?

**AUDIENCE:** Winthrop Square?

**SIQI ZHENG:** I think it's a Winthrop Center. OK, good. So as just now some of you know, this is a very big developer. And they build luxury condos in gateway cities, luxury condos for rich people. So that's their key.

Their competitive expertise advantage is building luxury condos at very, very good locations, always in the center of the city in some gateway city, big cities and many buildings here in Boston. And this is a private company. This is not public. Private company, now they have-- they already built 2,900 condo units all over those big cities.

And they also build luxury hotels, hotels, and office buildings, and retail, et cetera. So this is three partners. Three founding partners and then later partners, they have this \$4 billion money in hold, assets in hold.

So this, I just want-- I have four buildings here. As you can see, I will have four buildings of Millennium Partners. So the first one is this one in San Francisco. Do you know the story of this building? Please.

**AUDIENCE:** Is this the one that was falling for-- the foundation [INAUDIBLE] have failed, and so there's been differential settlement in the foundation, and the building has completely shifted, and it's tied up in all kinds of lawsuits right now by the individual condo owners, [INAUDIBLE], developer?

**SIQI ZHENG:** Yes. So basically-- very correct. Although this Millennium Partners, now, they are building very green, passive house building here. But back to 2008, they built a Millennium Tower as a signature asset of their company.

At that time, they never thought about sustainability. Instead, they just focused on luxury condos because they can sell to the rich buyers. And even-- it's very, very bad news of this building, not good news of this company.

As Andy just mentioned, they didn't do a very good design and structural design. And later, because the foundation has some flaws, it started to tilt and sink into the ground. There's a structural problem. But they sold because they are developer. They sold this in 2013, I think.

But this problem still continued, and they cannot get away from this. Hence, the lawsuit-- and all go to the court, try to resolve this issue. So basically, this developer had, at the beginning, nothing to do with sustainability. And they even got into a big trouble of this, just wanted to make money, then got big trouble.

And then another one is this. Some of you, you know this. They have some luxury condo buildings. And here in the 2013, they came to Boston. They built this Millennium Place. And so this is another one.

Could you guess? It's also like a game. Could you guess at that time whether they said they are going to build sustainable or green or something like that, this building? You have some idea?

**AUDIENCE:** I don't think so.

**SIQI ZHENG:** OK. So what do you think at that time they marketed this building or they promoted this building? What was the selling point, do you think, at that time will be?

**AUDIENCE:** I would say the same as when they built the luxury condos.

**SIQI ZHENG:** Yes.

**AUDIENCE:** If there was even [INAUDIBLE].

**SIQI ZHENG:** Right. So that's why when a developer-- they are very rational. They're not going to-- just for society. Yes, that's true. But always, they need to be very, very clear about their own profit, the P bubble.

And then at that time-- of course, luxury condo always their selling point. But at that time, they need to get this permit from the city, this Boston city. At that time, the mayor Boston city is Menino. Do you know Mayor Menino for 10 years of Boston? And our very beloved Professor Kairos Shen, he was the chief planner of Boston for Mayor Menino for 10 years.

So basically, Kairos, our Kairos, and that mayor worked together for 10 years and built this seaport area and those places, all the permits. If Kairos said yes, then yes. They can get the permit at that time.

But how can they get permit? They cannot say, oh, we are going to build luxury condos. Then the city say, that's nothing to do with me. You want to make money.

And at that time, this Mayor Menino, he really care about job opportunities because that's still after some recession. This was finished in 2013 but started several years before. So it's just the financial crisis and the loss of jobs and the recession.

So they pitched to the city. They say focus on job creation and the downtown revitalization. So that was really needed at that time after the financial crisis. And the mayor was happy, and Kairos was happy. And they got the permit and start to build this. So that's nothing to do with sustainability of this company.

And then another-- then they got so successful, they made a lot of money. Then they start to build this Millennium Tower in Boston and finished in 2017. Again, condo, luxury condo, but how they pitch to the market and also the city at that time? It's not about job creation, but another idea. Anyone? Anyone knows some background of this? It's a huge building.

**AUDIENCE:** I guess they're marketing it as the landmark of the city, and they have the best view and the best condo in Boston.

**SIQI ZHENG:** OK, so you know some story about this? No? You guess.

**AUDIENCE:** I've heard something about it.

**SIQI ZHENG:** OK, yes. That's very good. Yes. So basically, at that time, I think the permit was issued still by that mayor, the same mayor. And at that time, the mayor really worried about the big hole there. Before the building, there was a very big hole, nothing and abandoned the area in a very good location in Boston. Nobody can really build something significant there.

And then the mayor said this is perhaps his number one development priority to solve this big hole area. Who can build a good thing and fill in this place and make this a better place of the Boston? And that's how they pitched to the city.

And then you cannot just have the city and also the buyers, they want to get people to buy in and pay money. And then at that time, it's about health and wellness. So this is the largest at that time for the entire Boston city, largest only residence-only. Only those luxury condo owners, they can use this fitness facility. And the fitness center is the ground floor of this building.

So at that time, they understand. I think at that time they understood a very good selling point to the buyers will be this health and the lifestyle. And they say wellness. And for the city, they just went to the city, say, we can help you solve this big hole problem. The mayor got happy, and they got this.

So that's different stories. And then the last one is the ongoing one. Andy just mentioned this. This is the Winthrop Center. So it's still under construction. I think they will finish very soon this year.

And this will be Zhengzhen 's first case that she will teach next week. So that's the Winthrop Center. And at that time, suddenly, they became such an advocate for sustainability, for green buildings.

So this one is different from this health or wellness is different from this, have job description. Of course, it is different from this, from a problem. And their important selling point is sustainability. And they got all kinds of certificates, as many as they can and the very top level of those certificates.

This is a passive house. For the office, this lower part is the office. The higher part is a condo and [INAUDIBLE] and the Gold, the LEED Platinum, all the things they can get because they understand, at this time, sustainability, climate change is so important and especially for their customers, who are rich people.

For rich people, they always have-- many of them, they really care. And they also have the ability to pay for that. So this is what they are doing. So this storyline told us it's not like the developer from the beginning to the end always put sustainability as the first priority. See? No matter what, I'm going to do this.

No, they are very rational. That's why we need to understand economics. They are very rational. And they understand fitness center is important for this. Now, the sustainability important for that. And jobs-- important for the city for them to get the permit. So that's the main takeaway message I want to you to learn from the Millennium Partners.

And then last week, we have critical thinking. The critical thinking is, for example, if we invite guest speakers from this to our classroom-- we will from Millennium Partners, who are the developer of this. And if they give you a talk, of course, they will say why. It will have different story, like me.

But he will say always sustainability is so important for them. From the very beginning, they put this in their heart. And it's so important for their company and business.

That's partially true. Yes, it's important. But then we need to have a critical thinking. I hope you can ask questions to our guest speaker when he is here why. And why in the past buildings you didn't say that? And why you are now saying that? What's the rationale? And how you align your social value and your business value together? If there is any misalignment, what you are going to choose?-- these kind of questions.

OK, so that's motivation of today's class, which means we really need this critical thinking instead of we just blindly accept this is such a good thing and everyone need to do that. That's nonsense. And then the structure of today's lecture-- two parts.

One is how market may work. Since I always advocate for market, that's true. Because in this classroom, in this MSRE real estate program, we emphasize the market force, the invisible hands make things happen, the invisible hand. Demand, supply, the invisible hands make things happen.

But we also have this critical thinking that market has limitations. Market has failures. Market failure is always exist. So I structure this session so that you have this very clear memory that sometimes the market may work. Sometimes the market may not work, market failure.

So first, let's be a little bit optimistic about the market and then say how market can work. What's the market mechanism-- to be optimistic of the entire thing. And then we will talk about several aspects the market may not work and how we can address those issues. So that's the structure.

Now, again-- some questions. So basically, when we talk about market now, we are all market advocates. Market, so let's think about market mechanisms. That's market [INAUDIBLE]. There's no free-lunch incentive. Always you need to understand every player's incentive and the behavior.

So then we look at the three key stakeholders. Now, we have three bubbles, another three bubbles. And let's think about-- hypothetically, let's say this is the office building. This is the office building. And office building is an income producing property. You have a hold period, holding period.

So we have three key stakeholders-- developer, which develop and then sell. And the owner, maybe an investor, who holds that office building for many, many years. And then tenants, some companies, they come to rent the space.

So if we think about, oh, all three, they are all the three stakeholders. They are thinking, "Green buildings, good. I'm going to pursue green building." And what are the benefits they can think of for each bubble?

Some may be intersection. Can you just randomly come up with some idea of these many elements in different bubbles? Any idea? Because there are different from different perspectives. Any idea?

**AUDIENCE:** The owners want to [INAUDIBLE] building will have lower cost to operate and to maintain it.

**SIQI ZHENG:** Lower cost of maintenance, operational cost, right? So do you think that also matters for tenant? Yes, if I need to pay some bills, right. So let's see, operational cost, lower.

So that may be in the intersection of the owner and the tenant. What else? Yeah, please, Carlos.

**AUDIENCE:** For the developer-- access to a different [INAUDIBLE] vehicles that-- for example, institutional investors that may have mandates of investing part of their endowment in green development or green efficiencies, something related to sustainability, which is very [INAUDIBLE].

**SIQI ZHENG:** Good, so lower financing cost you are saying, right? If you're a normal building, maybe get a loan of 5%. And if this is green, maybe get a loan about 4.5% like that. Those things that you mentioned, that matters for developers.

That also matters for owner. Yeah, right, intersection. Because developer need to borrow loans. And then the owner later also need to borrow a debt. So that will be lower financing cost, lower. Any other things? Christopher.

**AUDIENCE:** Easier permit for developer?

**SIQI ZHENG:** I'm sorry?

**AUDIENCE:** Easier permit.

**SIQI ZHENG:** Easier permit, OK, that's maybe the story of the Winthrop Center. Oh, this is green. And the current mayor is so happy, and they give them permit. So this permit, that's good. Permit, I think mainly the developers see, permit. And here?

**AUDIENCE:** [INAUDIBLE] also lower health costs. So maybe someone living in a green building, they might have to incur lower health costs in the future.

**SIQI ZHENG:** Health, right? The health, so in which bubble it will be in?

**AUDIENCE:** I mean, it depends both on owner and tenant who are living there.

**SIQI ZHENG:** Yeah, mainly this owner won't live there. This is just a remote investors, for example. So it will be tenants. If the tenants, they really care about their-- for example, their companies, they really care about their employees' health. And in such a building, they're healthier and happier and work so hard.

So that will be health, good. And similarly, maybe also productivity, right? So anyways, less sick days, for example, productivity, all increase. Please, you.

**AUDIENCE:** To build off that last point about health and productivity, from the tenants' perspective, it could be employee recruitment and employee retention. Because employees are happier, and they feel more comfortable and--

**SIQI ZHENG:** And that's very important.

**AUDIENCE:** --safe in the office.

**SIQI ZHENG:** Yeah, talent retention. Rohid.

**AUDIENCE:** Higher valuation on rent prices that the owner or developer provides.

**SIQI ZHENG:** Please be clearer, in which bubble?

**AUDIENCE:** High valuation for the owner.

**SIQI ZHENG:** Evaluation? The market value, right?

**AUDIENCE:** Yeah.

**SIQI ZHENG:** Market value. And why the market value will be higher?

**AUDIENCE:** It would be a more desirable product because of the benefits to the [INAUDIBLE].

**SIQI ZHENG:** Yeah, tenants have higher willingness to pay. So that means higher rent, so higher rent, then higher market value. And another-- why? Because higher rent per square feet. But other things that can lead to a higher NOI?

**AUDIENCE:** Lower occupancy?

**SIQI ZHENG:** Higher occupancy, lower vacancy.

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Yes, that's right. So vacancy go down because you are very popular and higher occupancy. And the rent maybe go up. So all this NOI will go up. And then market value will go up. Market value will go up good for the owner and also good for the developer. So market value go up. Anything else? Please.

**AUDIENCE:** Just [INAUDIBLE] I think they also care about the maintenance cost.

**SIQI ZHENG:** Yeah.

**AUDIENCE:** It's also by classic [INAUDIBLE].

**SIQI ZHENG:** Yes, yes. Maintenance costs, let's say operational costs is both the utility costs and the maintenance cost. Wilson, you want to say something?

**AUDIENCE:** Just I'll add a little bit about market value. Nowadays, people are being able to recognize the sustainable and green [INAUDIBLE] ESG factors as an important [INAUDIBLE] to invest or [INAUDIBLE]. Tenant may want to live in this building because they do value [INAUDIBLE].

**SIQI ZHENG:** ESG in the heart, so those in ESG we put where? This bubble, that bubble? That bubble? Or in the middle?

**AUDIENCE:** I think in the middle.

**SIQI ZHENG:** In the middle-- so OK. Good, ESG. And what else? Yes? Yeah.

**AUDIENCE:** Similar to the Millennium Partners, the marketability, like the branding of the developer [INAUDIBLE].

**SIQI ZHENG:** Reputation thing? Reputation thing? Is that a reputation thing?

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** But also, that also matters for owner, for example. I own the greenest building in the city. Yeah.

**AUDIENCE:** It's also good for the tenant.

**SIQI ZHENG:** Good for tenant. OK, so maybe that's a ESG and reputation.

**AUDIENCE:** Longevity of the building, so a lifetime, I think that's good for the developer's reputation. The owner who's holding the building is also a tenant.

**SIQI ZHENG:** Yes. So that's still in the middle, the reputation and the long-term value. And do you think for developers? Developer's circle still a little bit not so full. Yeah?

**AUDIENCE:** I think it's easier to sell when you want to [INAUDIBLE].

**SIQI ZHENG:** Yeah, easier to sell or sell faster, right? Faster and easier sell-- OK almost there.

**AUDIENCE:** [INAUDIBLE] for the owner faster sell?

**SIQI ZHENG:** Faster sell, yes, yes because the owner may be later sell to another one, resell. And also, another thing is when you resell the market value means now and not later, so which means depreciation lower, slower depreciation. It won't depreciate that much. So depreciation is lower, et cetera.

OK, good. So overall, it's almost there. I have some small things. And we covered almost all of them. So still remember, now we are in a very optimistic state. We think, oh, to the very, very best scenario. The best case scenario will be like this.

So now, we are going to dive into all those items and see what will happen and some empirical evidence, whether it will be true. We cannot just say higher or lower like that-- empirical evidence.

So first of all, will be this cost benefit analysis. And this I don't need to go through, but you learn all this in the basic finance course or economics course. That's still this no free lunch thing. Benefit, cost, and then you decide whether to go ahead or not. And so that's basically the methodology.

The key thing is it's not static view, but it's dynamic view. Because always the building, we have a holding period of many, many years. That's different from the other products. So you have year  $t$  50 years, from 0 year to 50 year. So you always need to discount.

So that's a unique feature of the real estate discount because you need to discount for many, many years cash flow using discount rate  $r$ , which is the cost of capital to discount. So that's why you need to understand this dynamic view. To have a very, very precise way to show, I use a hypothetical office building.

This is totally hypothetical, but not so fake. We still use the numbers relatively real. And relatively real I mean for those rent and the vacancy rate and net operating income, et cetera. But it's easier for us, first, to look at a hypothetical thing.

See, recap a little bit of your finance class or any of this cash flow analysis, engineering, economics class. Let's first look at the-- because the owner will hold the building for many years. I say 10 years. So 10 years, then always you have a pro forma like in this way. Remember Excel like in this way?

We have year zero that you buy. In year zero, you invest and buy that from a developer. That's your year zero. And year one, you start to operate the building. You start to operate the building. Then now, for example, you have a potential gross income. Let's assume that you lease out all the space. That's 50,000.

And then, of course, you have some vacancy, then minus some vacancy. Then you get effective gross income. That's your income. Then you need to operate. So you spend money. You spend money on this operational expense, for example, some bills, energy bills. And you hire some labor to operate the building and et cetera.

And then you have NOI, your Net Operating Income of this \$28,500. So that's the very traditional way. And then you have a capital improvement expenditure. For example, the elevator you need to really change to a new elevator, all this capital reinvestment, capex.

And then you have a nice cash flow. That's NOI minus a capex, so that you have this. And then you repeat this over and over for 10 years, then after 10 years, you sell. You sell.

And always, we know how we decide on the resale price is assume another owner, the subsequent owner, the 11th year's cash flow. And you see last year, 11 year's cash flow. And these two, divide by the cap rate at that time. That's a willingness to pay for the subsequent owner to you as a resale price. So you get this resale price.

And then you have all the cash flows you discount. Then you decide on discount rate. Now, we assume 8%. So that's the discount rate. Because you evaluate the risk, and that's your cost of capital.

Then you get this NPV. So this is NPV. So this NPV helps the owner to understand if they want to buy the building and how much they are willing to pay to buy this building from the developer.

So if this NPV is higher than the developer's willing to accept, then they will just buy. Otherwise, they won't buy. So that's the basic idea.

Now, the point is the following. This is like a baseline. This is not a green building at all. So if this is a green building and which sells, all this pro forma will be affected. And to which direction? Just now, we discussed the three bubbles and how these quantitative ideas will affect these quantitative numbers on this pro forma.

**AUDIENCE:** [INAUDIBLE] there may be a couple of ways. One, maybe the cap rate at the end, there could be a cap rate compression considering you have a green building if you retrofit it. So you have higher value at the end compared to the assets on the market. And also, your opex might not go at a higher rate as you have been at this pro forma.

**SIQI ZHENG:** OK, so you pointed out that this opex may go down. Because you have a smaller bills, for example. You use less energy. And then you said this retail price may go up. But could you be clear why it will go up? Which number will go up or go down?

**AUDIENCE:** The sale price at year 10?

**SIQI ZHENG:** Yes, the sale price.

**AUDIENCE:** [INAUDIBLE] the year 11's cash flow. And you'll divide it for, well, a more compressed cap rate, maybe not 6%, but maybe 250 base points, 500 base points even.

**SIQI ZHENG:** Right.

**AUDIENCE:** Just because you have a premium on sustainability, ESG.

**SIQI ZHENG:** Good. So the cap rate may go down a little bit because lower risk. And it's more favored by the market, et cetera, although it has a lower cap rate. Please.

**AUDIENCE:** For the potential growth, income will be increased because of the red price in [INAUDIBLE].

**SIQI ZHENG:** Very good.

**AUDIENCE:** So [INAUDIBLE] go down.

**SIQI ZHENG:** Go down.

**AUDIENCE:** Yeah.

**SIQI ZHENG:** Yes, because it's more popular, as this has a lower vacancy.

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Yeah, last one.

**AUDIENCE:** [INAUDIBLE] capex would increase. But I would guess maybe because you would have more equipment. Let's say, solar panels.

**SIQI ZHENG:** Yeah.

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Don't know, right? And how about this, this cap rate for now? This discount rate may also go down if lower risk.

If this building is in Boston city, for example, or in New York City-- let's say New York City. Because last session, we talked about New York City's Local Law 97. They are so stringent.

And then if you have green building later, you know, you will pay less penalty to the city. Or you will pay zero penalty. But you are bronze building, then you need to pay penalty. So the owner understand the risk. And this is green. So they have a lower risk and, thus, a lower cost of capital.

So I think we covered all. So we talked about this increase of the potential gross income and decrease of vacancy and decrease operational, opex. And here, I'm more optimistic that will be a lower capital improvement expenditure. Later, we will explain a little bit on this. And also-- lower risk, then you have, too, lower discount rate.

So that's how we materialize these impacts of the green building benefit and cost onto the cells and numbers on the pro forma, so you understand how this work out. Because of this, then, finally, because you are calculating your NPV, then will be higher NPV. This one will go up. Because all of these changes, this NPV will go up.

The NPV goes up, and thus higher willingness to pay. The owner will say, OK, I'm so happy with this green building. I have a higher Willingness To Pay, or WTP, for the green building. So that's basically the point of this entire circle.

So now, we have a very, very good diagram here. It's a cash flow, conceptual level cash flow. This conceptual level cash flow will always show up later. So I just want to every time reiterate and reiterate so that you understand this.

So we know three stakeholders. I always like to call this a chain process. It's a chain. They're connected. They're a chain process, these three stakeholders.

We have the developer. Then we have the investor, who is the owner. Then we have the tenants. Just now, I use a pro forma. Then you understand the most, most important guy, the investor's point, the owner's point of the pro forma.

And then let's look at-- just now, we're still showing numbers, numbers, numbers. But let's look at the behaviors. When we talk about behaviors, we will use a way. We will reverse the thing. And we will first look at tenant.

Because, remember, in my big picture, the green individuals in top are users. From the very, very end, those end users, they are happy, the green building. So they have a higher willingness to pay. If they have a higher willingness to pay-- this is the high willingness to pay-- then that will be translated to the higher rent that the owner can charge.

So this is symmetric. This is owner. So this is owner. This part is owner. This part is a developer. This part is the tenant.

So the tenant's cash flow out will be the owner's cash flow in. Is that right? Because the tenants pay the rent, and the owner will receive that rent. So the logic is the following.

If the tenant has a higher willingness to pay for rent, then the owner will get more, higher, rent revenue from the tenants. So that's why we start from the end.

**AUDIENCE:** What was that last thing you said? You said tenants have the what?

**SIQI ZHENG:** The tenants have a higher willingness to pay for the rent.

**AUDIENCE:** Willing to pay.

**SIQI ZHENG:** Yes, we call it WTP. That's the terminology. Later, maybe I will just say WTP. There's a willingness to pay. You are willing to pay how much money. Yes, so this is the willingness to pay.

So this is chain, a chain process. If this is longer, then that one will be longer. And then, later, that will be further translated to the developer. But let's look at the end user.

If this won't happen, if this story is fake, if this won't happen, nothing will happen. This won't work. This is the fundamental driving force.

OK, let's look at it. So here is like then just now we discussed the potential benefits are higher productivity, better health benefit, and easier-- the retention of your employees' talents. And also, if you need to pay energy bills, maybe some lower operational cost.

So here, let's look at every atom. First, operational cost, so you can see that this is from the reading. I think this is also from the reading. I just need to emphasize again, you need to read the readings before you come to the class. I already simplified the readings. Last year, we had more readings. Each session, we had two or three. Akrisht will remember that.

Now, we understand. I became more and more realistic of you. So OK, if I put three, you will read zero. No, I put one. So at each session, I have one reading. Please read, OK? Please read that.

Then you say, oh, the report is so long. Oh, so it's one reading, this 100 page. It's no problem. Glance over that, right? Grasp the meaningful information from that report because our report is very important. They show up in that report.

So it says, the green buildings have smaller operational costs. And they use some data of all this data of many, many buildings. They show you the maintenance and operational cost, operations that will save money.

So we will save money. And it's easier to understand that energy and resource savings. For example, you use less electricity. You use less gas, et cetera, and better insulation.

And for the maintenance cost reduction from the statistics, not all buildings are like that. Statistics is also lower. Do you have any intuition why the maintenance costs may also be lower for green buildings? Any idea?

**AUDIENCE:** [INAUDIBLE] total depend on the tenant's need of higher rent. Also, the tenants every year maybe pay more payment about the early [INAUDIBLE].

**SIQI ZHENG:** Yeah.

**AUDIENCE:** That actually in some developing countries, especially in China, we also know [INAUDIBLE] developer as one who lacks motivation to build the current building--

**SIQI ZHENG:** Market failure, later, I will touch on that. Let's now believe in market for now. And later, I will discuss China. I have two papers of China, why this won't work. Then we will answer your question. But for now, let's still believe in China-- not-- believe in market. Now, why is the maintenance cost may be lower in some cases?

**AUDIENCE:** If there's more electrical systems than gas or oil heated, there's fewer moving parts that could eventually fail, just like in a car. An electric car is less maintenance than gas.

**SIQI ZHENG:** Good, yes. So basically, the system, this building management system or green building system, they have better monitoring technologies or sometimes smarter. Because there's new technology, and they run more efficiently and with less hiccups. So that's one possibility.

And they can hire less people. For example, this building, to operate, we need a team of 10 people. Now, we may need a team of three people because it's more efficient and smarter. So you can reduce your salary.

And also, because the lifespan always will be longer for these green buildings. Because they depreciate less. And then they have less wear and tear over time. Every five years or every several years, you need to-- there's capital investment.

And then think about this. Think about this. Who will pay the bills? Who will pay? Yes, of course. When we look at physical building, yes, it will be less. But who are going to pay that? Who will benefit? Who will recoup that benefit of reduced energy bills?

So that's a little bit complicated. It's a little bit complicated because that depends on the lease structure. Then next session, we will touch on this lease structure. Who will pay which part of the energy? So that's different types.

But let's see. Now, without going into the details, let's say they split some part of a common part. Like lobby and those common space, owner need to pay because it's so hard to attribute to tenants. But for tenants, maybe tenants also need to pay the inside of the space.

OK, so then you will see I have 01 and 02. If you observe, if you look at my cash flow carefully, I have a 01. That's owner's operational cost. We have 02. That's tenants' operational cost. So that's why we have the subscript of 1 and 2.

So the owner have this 01, reduce maybe. And tenants have a 02. So the 02 will not directly reflect into the owner's cash flow. But because 02 will become smaller, then tenants save money.

If tenants save some money, they are willing to pay higher rent. That's the logic. So I put this channel. This is the middle channel. But the point is they are going to pay higher rent.

More importantly, let's look at this pie. The pie is important. I think, just now, you also mentioned this retention of the talents, right? This is so important. Because if I'm a tenant, I'm not a real estate person. I'm a tenant. I'm Google, for example.

You know, Google, just rent a big space on the main street very close Kendall Square, this Boston Properties building. That's a new renovation of the Kendall Square. There's a Boston Properties building. Google rent all the building. And you saw the Google headquarters logo there.

So if I'm Google, I'm not a real estate company. And then I look at my cost, the pie. Then always the important thing is, for a company, energy is so little-- 1%, because I'm not an energy company. If I'm just an IT company, this will pay my office energy 1%; and rent-- 10%-- rent, 10%; and the rest, the wage. Wage is the largest, largest component of the cost of the company.

And then this is so important, the human capital, to a company, not the physical energy bills or the rent. Yes, rent will be high if you want to have good, fancy office building. But here is the thing.

And then if you pay money, if you pay wage to employees and all the employees always get sick, won't show up, always sick days, this is the loss. You pay money. You pay wage. Then they all get sick because the building is so bad. They always get sick, no good.

So if you can help them keep their health and productivity, you'll pay wages. You'll gain a lot from their productivity. That's good. So that will be more important from the tenants' perspective. And we will have healthy building lecture to dive into this.

But you understand why this building is good. They're not just the direct thing, but also indirect thing. The tenants get so happy and willing to pay higher rent in the rent space. Question?

**AUDIENCE:** [INAUDIBLE] I worked in building operations for a long time. And especially when COVID hit, sometimes the human capital, the health and the well-being, came into conflict with maintenance costs and energy reduction and savings, specifically looking at the HVAC systems. So recycling the air is a good way to save energy because you don't have to heat it or cool it as much.

And then the thing is you're recycling that air so it's not as clean or fresh. So sometimes it's hard to keep going in the same direction with both of these goals. Sometimes they come into conflict [INAUDIBLE].

**SIQI ZHENG:** Very good point, very good point. So you are saying this ventilation cost and the maintenance cost, they are like trade off, right? You cannot just, oh, save money and save cost and save energy, no ventilation or a very low ventilation. But then it will cost more for the healthy part.

**AUDIENCE:** Yeah.

**SIQI ZHENG:** I think that's very clear. It's not always win-win. It's sometimes trade off. And if you look at the higher level, that's basically three circles, PPP. That's some tension between the planet and the people.

Yes, we want insulation, for example. Installation is good for energy saving, but we don't want to live in a plastic bag. Plastic bag-- bad. We cannot breathe. Although, it's very good insulation. So that's the idea. Nobody want to live in a plastic bag. So that's a very good point.

And then give you empirical evidence, there's a paper, very good paper. This is the meta analysis. Meta analysis means they collect many, many empirical studies from different countries, different context, different data. Then they summarize.

And they say, OK, for all the green real estate studies-- there's so many studies, you can see-- overall, they-- these studies find significant rent premium of on average 6%. So that's the evidence. And you can see this more on the residential side and 5% on the commercial side.

Keep in mind this number. But also, this is not a universal. This is just those studies. And for the scholars, like me, we found some papers. And actually, they summarize all the papers if you can see. But I'm sure you cannot see.

This is one paper called Zheng here, it's my paper. I feel so proud that my paper got into this analysis. That's the most exciting time, moment of a scholar.

I publish a paper, and then my paper got some impact attention. Then they summarize. They have Zheng's paper here. So, yes, that's mine. That's my first paper of the green buildings.

OK. Now, we talked about just now, remember, there's a tenant. That's the end user point. Then we move on to the owner.

We are so optimistic. Assume tenants are so happy they have higher willingness to pay for green buildings. Then they have a longer-- like this arrow of rent. That rent be translated into the owner perspective. It's a cost for the tenant, but it's benefit for the owner, this symmetric thing.

Then look at this. Now, we look at the owner. Owner is not stupid. They are also rational. They understand maybe higher, effective rent, lower, we can see an higher rent per square feet.

And then if we are so optimistic, we think about the operational cost, energy reduction, then this O1 will also become smaller. And then suppose later this will be more and more appreciated by the market. So there is a lower depreciation and higher resale price. So all to the positive side-- higher, higher, lower cost.

And then we already mentioned that, because of some risk consideration, then the cost of capital is also low. So this is higher than this absolute value. This [INAUDIBLE] is a smaller thing. That will be bigger. All these are bigger, this bigger.

So that's so good. Then that all translated to a higher purchase price. So I'm willing to pay higher price to buy that building from a developer. If this is true, then this will be later translated as a chain to the developer's sale price. So that's a point. That's a chain.

So now, we have this cash flow. We know this one higher, this one higher. And how about the risk? We kind of intuitively think the risk may be lower. The i may go down. But why?

Can we have some solid examples of why this risk may go down some? What kind of risks? What kind of risk you can think of?

**AUDIENCE:** Energy cost?

**SIQI ZHENG:** Energy cost, why this is a risk?

**AUDIENCE:** If you [INAUDIBLE] prices increased every year.

**SIQI ZHENG:** OK, but if we invent some nuclear energy things, the energy may be cheaper. But no, it's true that there's uncertainty, especially the Ukraine and Russia war. Then the gas more and more expensive. It's a lot of uncertainty here. OK.

**AUDIENCE:** There's the exit risk, the risk of not being able to sell the [INAUDIBLE].

**SIQI ZHENG:** What's risk?

**AUDIENCE:** The exit?

**SIQI ZHENG:** Exit risk?

**AUDIENCE:** Yeah.

**SIQI ZHENG:** Yes, if you have a brown building nobody want to buy, then you get stuck.

**AUDIENCE:** Yeah.

**SIQI ZHENG:** OK. [INAUDIBLE]?

**AUDIENCE:** Risk, policy.

**SIQI ZHENG:** Policy. What kind of policy?

**AUDIENCE:** Government may impose higher tax innovation.

**SIQI ZHENG:** Sure. You want to say?

**AUDIENCE:** Yeah, I had the same.

**SIQI ZHENG:** Policy?

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Yes. So now, we have a big category of policy, regulation. And we also have something-- let's see. So basically, we have three baskets. I'm not sure whether these can cover all, but at least the big baskets.

First-- policy risk, for example, local law 97. We have this also in Boston and Cambridge, as you know. And market risk-- like get stuck, cannot sell if you are so brown. And if the market really value the green buildings, then green buildings, no matter whether you're premium-- remember 6% premium? But if you are so brown, you may have a brown discount.

So if all other your counterparts they are so green and only one building is so bad in the market, then you have a discount. And actually, this is really real. It's not speculation.

There's a paper. They started after financial crisis, 2009 financial crisis. They say, in good times, green buildings have the premium. Bad times, all people were losing money in bad times, financial crisis. But they found the resilience are much higher in the down times even for green building.

So if all the buildings were losing tenants, the green buildings are relatively better. They are keeping a little bit more tenants. The paper was very famous. And now, I think there's some other papers after this pandemic.

So that's a financial crisis. They are more resilient. After the pandemic, healthy buildings, they are more resilient. Because now, work from home, right? All the CBD buildings, they become weakened.

But if you compare those relatively better, greener, and healthier buildings, they can keep more tenants. For example, the tenants, they still need to keep some office in downtown. They will go to the healthy buildings.

And then finally-- physical risk. So this is, for example, Miami or Boston Seaport. That's will be our project, final project and the piece at number two. If you happen to be in place that maybe next 10 years you will have flooding rates will be something higher, then you really have this. You have this physical risk. But if you are in high land, you are on high land, that's not so much for you. But you still are exposed to this type of risk.

OK. Now, we have the entire-- almost we close the loop. We almost close the loop from the tenants, from the owner, then go to owner. Then we will soon go to the developer.

**AUDIENCE:** Just about the previous line about the risk, so I think it makes perfect sense when you develop a new building for the risk to be lower. But what if you're buying a new building and retrofitting it to become a sustainable building?

**SIQI ZHENG:** Yeah, that's very good. You reduce the risk.

**AUDIENCE:** Or increase it because you have to make a capital investment to renew the building. And you don't know if it's going to work out.

**SIQI ZHENG:** That's a good point. Actually, another case study that Zhengzhen will teach will be a private equity who has very strong expertise in retrofitting older buildings. And that company understand. They have the special expertise. They are specialized. They have energy team, et cetera, better than other teams.

So they are more brave to do this kind of business. For others, they don't know. As you said, this is higher risk. But for some, they have done so many buildings. Then they go, OK, we will buy this building. We know we will get things done.

**AUDIENCE:** So in a higher resilience during down times, you mentioned earlier that these buildings would have higher rents. So if I have a company and our employees are not coming to work because of COVID, wouldn't I just choose to buy or rent a lower cost building instead?

**SIQI ZHENG:** So for the pandemic, if the tenants really value healthier indoor air quality, for example, so they will shrink their office space. For example, at first, they rent a lot of space in Boston downtown. Now, they don't need it. Because 80% of the employees, they don't come in every day. So they shrink, or they move to a smaller space.

And then when they move to smaller space, they have more choices. And they will go to greener and healthier buildings. So that's why those buildings, they are more resilient. But other brown buildings and the bad buildings, they lose totally, completely all the tenants.

OK, now, there's a table in your reading. Please read. So to summarize, why green buildings have higher asset value? Remember, asset value good for owner and also for the developer. Because developer will sell at a higher value.

Basically, higher rent, higher occupancy-- lower turnover, always keep the tenants. That's delta R go up. Lower operational cost, the delta O1, go down. That's for the owner perspective. And the lower expected return, the cost of capital in the denominator becomes smaller. Altogether, think about the cash flow. Think about this discount equation, higher WTP. Willingness to pay-- WTP.

And then if the owner has a higher willingness to pay, then developer is so happy. Because they can sell at a good price. So this is a summary of the empirical studies. Then you always say it's not like only one value. That would be stupid. Always a range, right?

Rental sometimes no premium at all, 0% to 23%. Mean-- 6.3%. And the occupancy-- also, big range, which gives you a sense in operational cost. See? I think someone, you, just asked a question about operation cost go up and down.

So it's very clear, inconclusive. Sometimes it goes up, sometimes goes down. It's very hard to see definitely will go down or go up because ventilation, for example, like those things.

So then you can see it's negative 14% to positive 25%. So there's a big range. And overall, sales price may be some 0% and 43%, but with a mean. Our optimistic view is a mean still positive.

So that gives you a very clear understanding is that you cannot think about this in the deterministic way, always positive, always negative. No. But in this way, it's a range. So this is a perfect time to talk about this again.

Remember, in the intro section, I used this to show you how to connect economics and business. Economics we will show a lot of statistics and the overall big picture like that. But business, we look at cases, this company, this building, that building.

So just now, we show all these parameters. All these parameters has a range, means they always have a distribution, not one point. The cost side have a distribution. The benefit has a distribution, cannot think in a very, very narrow way.

And then those guys, those companies or buildings, they are distributed in this space in this way. So you understand some think green building is very, very good business. Some they don't think so.

Because for some of them, the cost is much higher. And the benefit is so low, no rent premium at all. Maintenance cost is much higher. Then you will end up here. High cost, no benefit, why I'm going to do this? So stupid-- doesn't make sense.

So then business case, maybe we look at this one. This is a business case. So [INAUDIBLE], no matter whether it's a so brilliant investor or these market conditions so good or this just have a very good skill or expertise, no matter what-- higher benefit, lower cost, go green, no-brainer. So this will be your case.

But you cannot use that to apply to all. Because that guy thinks this is a good deal, all of us willing to go there. No. So be clear in this thing when we look at a specific company or specific case. And think about the range. And the range is confirmed by the scientific study. This is a range.

So now, we already went through all this. I think that's all very clear that the green building case is the same pro forma, but I already changed the numbers. I already changed the numbers in the way that, now, we use mean value, mean value. Then higher rent and lower vacancy, like that-- higher sale price and lower discount rate.

Then you will see clearly and NPV become higher. The greener is the new one-- become higher because all the parameters that use the mean value, so all this. Now, it's very clear. If you were the owner in this case, just in case that you are the medium person-- you are the average person in our space-- then you have this green NPV.

Another brown building, baseline building, have this brown NPV. A green NPV-- much higher than the brown NPV. So if you are buyer, you look at two developers. One is building a green building, this green. The other is a brown building, all else equal.

Are you willing to pay higher price to buy the green building? From a rational perspective, yes, right? Brown building NPV is so small. Green building is so big. Buy the green building. And they are willing to pay higher price. So that's basically the rationale.

Then I show this again. And again, I have my paper here. I just want to highlight. That's the little guy here. But they summarize all the papers, overall price premium of 7.6% of those papers. And you give the numbers. So this is still average person. Remember, average, average, average.

And actually, I think for my purpose, zero, no price premium in China's case. As I said, in China, your [INAUDIBLE] China market failure maybe. So my paper is a data point of zero. But on average, it's still positive.

So that's a point. And finally, we go to the developer. Remember, we have the tenants just now show up here. And the owner showed up here. Oh, go here, and then go here. This is a chain.

The chain is a following. If an average person would have a higher sale price, then the developer understand, oh, if I anticipate that later I can sell higher price of a green building. But it's not like, oh, then I must build.

Because it's still benefit the cost analysis. It's no free lunch, not like green building, higher price. But you also higher cost. Construction cost, upfront cost may be higher. So you need to compare the upfront, the construction cost, and the later sale price.

If the sale price go up 5% and for the construction cost it's 10% higher, then no, still no. So I need to compare. Why is it higher? I think there's no question why the construction cost is higher. Because we need more technology, like the insulation passive house, more advanced HVAC ventilation, and some lighting, new technology things. So those are all actual things you need to invest and you can buy.

Here, from studies again, you will find this in your report. For new buildings, 0% to 12.5%-- wide the range of the cost premium. And then these are a little bit higher for the retrofit because you need to retrofit from a very old building, cannot control.

Question, why there's any chance that there's no cost premium. That's like a free lunch thing. Why? Why, in some cases, the green buildings even have no cost premium? Any guess on this? OK, please.

**AUDIENCE:** Could be [INAUDIBLE] government subsidies to help [INAUDIBLE].

**SIQI ZHENG:** But the actual thing, if you have some free money from the government, yeah. But besides that?

**AUDIENCE:** Passive house [INAUDIBLE].

**SIQI ZHENG:** Passive house, you need to invest more. That's very clear. Yeah.

**AUDIENCE:** They got some [INAUDIBLE] that [INAUDIBLE] change from traditional lights then for LED lights. The expense is not very high.

**SIQI ZHENG:** Not very high, OK.

**AUDIENCE:** [INAUDIBLE]

**SIQI ZHENG:** Yes. Do you have any thought?

**AUDIENCE:** Technology advancement [INAUDIBLE].

**SIQI ZHENG:** But taper to zero?

**AUDIENCE:** A more stringent permitting-- which actually requires them to reach closer to green building status.

**SIQI ZHENG:** But more stringent permitting will get higher cost, I guess. Not material cost, but you will delay. Song.

**AUDIENCE:** Even if you assign a third party contractor to the construction, then you pay them a fee. But the [INAUDIBLE].

**SIQI ZHENG:** OK, if you can get a very good contractor, say, I don't care. I can do this for you without any actual cost. Do you have any thoughts?

**AUDIENCE:** I was going to echo what Catherine was saying, which was I think it's a question of definition. So if you're building in Boston and they're requiring you to do LEED certifiable, your baseline is green. If you're defining that as a cost premium, it's sort of an error the way you're defining that. But the technology is still advanced versus a more basic [INAUDIBLE] and, therefore, premium cost.

**SIQI ZHENG:** OK. So, yes, I think you already covered most of this. But I just want to give you a sense. But I'm not an expert on building technology, I need to say.

And we have Carlos-- not you, but another Carlos. A guest instructor later will come after midterm to teach three sustainable design sessions. I know, some of you, you are very good designers.

But the conceptual level is the following. For the green design, sustainable design, there are at least two levels, one called passive, passive sustainable design. The other is active sustainable design.

Passive design sometimes is really free, really you don't need money. For example, you use nature. You use nature.

For example, your orientation, your window, and you just do this daylight and orientation. You have better design that will fit into this natural environment. You get better air flow in a building. And it doesn't cost too much money.

But active design, you need mechanical systems. You need HVAC. You need all the mechanical systems and purchase the energy. If you cannot just use a nature to give the very cool environment, then you have to do AC. If you do AC, you spend money.

So if you can use nature in the best way, in some cases, then they have 0% cost premium. Because you just use the nature. But if you have all these mechanical things, then you just spend money.

But you said very clearly that's true. Cost premium is going down, on average is going down if you look at the time series. For example, later in Zhengzhen 's case, the Winthrop Center passive house cost premium, when they design that time, they made the decision. They found 3% to 10% when planned, the cost premium.

And when they implement it-- because they need to get a permit, and it takes some time like that. And after about two years, it went to 3%. Because this technology become more mature, and they may find another good contractor construction team.

They build other passive house, accumulate some expertise. They know how to do this. At first, they didn't know. They need to send people to Germany to learn. Because, that is the Germany thing. They sent team to Germany to learn how to build a passive house.

And later, in Massachusetts, more and more passive house projects, like 10 or 20, then it's more like material technology. And [INAUDIBLE] they go one, two, three. So the key point is the following. It's still dynamic.

Think about this. A function, the cost premium is a function of skills, as I said, more and more skills. At first, the system they design is not easy. They need to hire external design firm to do so, the developer, like KPF, like our Carlos instructor.

And then later, they did several passive house or other things. And they have their internal team to do so, no need to hire. Innovation, more new technology pop up. And the new technology become cheaper and cheaper.

Supply chain, you need new materials. Now, it's a disruptive because the pandemic. Then you're so hard to ship the parts from the supplier to you. Then you add wait, wait, wait with a new window. And if the supply chain become better, that can reduce cost.

So that's all the things. So you need to think about in a very dynamic way, cannot say, oh, always 5%, always 10%. So now, I'm going to summarize the market side.

So this cash flow chart always will show up in my class to remind you how market works. Three stakeholders-- end user as tenant, owner, and developer. And this is a chain process.

The chain is this one and this one. They are chained. This one and this one, they are connect. One stakeholder's cost is the other stakeholder's benefit. And the other one's cost is the other's benefit.

If this work-- should go this way, not like developer speculate. Oh, if I build this, and it will be so popular. I can sell. No, it's from the market fundamentals, from the end users. They are willing to pay and then trigger the investors, then trigger the developers.

That's the point. OK, so then we put all the things in the three bubbles as a recap that we-- every item in here, here and there and all the things. So that's the point.

Now, I still have some minute left. I'm going to touch a little bit on how market may fail. Now, we cannot be always, oh, market perfect. If we have this three stakeholders all chained together, everything will happen. No. Market may fail in some circumstances, and that is the market failure.

So basically, the McKinsey-- very famous report. I'm not sure whether you read that or not. They raise a question, this McKinsey report. This is a so-called energy efficiency dilemma or something, energy efficiency curve.

In this one, they point out many, many building energy efficiency technologies, they are NPV positive, means additional cost. But later, we will see more energy, additional benefit. And always the benefit will exceed cost.

So that's why, when you look at the cost, they are negative, means positive NPV. So all the things are negative. Cost means negative lifetime cycle. Upfront, of course, you have cost.

But if you think about life cycle-- negative cost, positive NPV, NPV positive. For example-- I'm not sure it's too small. But it's a retrofit HVAC system, residential commercial. And the retrofit buildings, water, heating, and this and that-- all here. Only a few very expensive ones are positive cost.

Then they ask question. Since it's so good and NPV positive, why it's not that easy, that not all buildings suddenly start to retrofit themselves? No. Why not all the market suddenly becomes all green? No.

So why those opportunities were left there without exploited? So that's their question. So they raise this question.

The point is the following. We always say PPP, oh, intersection, all win, win, win solution. No. In many circumstances, they will diverge like three bubbles. Three balloons will just diverge and with no intersection at all, no intersection.

If you care about the planet, you'll lose money. If only look at people, you cannot make profit. If you make profit, you cannot protect the environment, so like that.

So then there's three major market failures. But today, I will just start with the first one, which is information asymmetry, the information problem. That's the information problem.

And the second one is a split incentive. Next class-- split incentive. Tenants and landlords are fighting with each other. That's a problem. Third will be externality. That will policy need to step in. The city mayor need to step in. The government need to step in. So three major market failures make your hope become like this, no solution.

Then, of course, we are not so a completely pessimistic. We understand. We know this. After we know this, we try to fix the problem. We try to fix those market failures with some new innovative ways. So thus, we have different ways to fix.

Let's look at information problem first. So the point is, all of you-- of course, I have been doing this research for more than 10 years. Now, you are in a class, a core class, then you learn this.

All of us, we are more sophisticated than the average market person, every person in the market. Because we are here learning this in a professional way, in a sophisticated way, in the classroom. But not all the home buyers they understand this. We cannot assume everyone understand immediately, oh, green is good.

So that's why if we have supply-- but if the demand for the consumers in the market, they don't understand the benefit, they won't have a higher willingness to pay. Then that will lower the demand. That's a problem. But how to educate the market? If market dysfunction, how we educate the market? So that's one paper I did back to 2016.

So at that time, China's green building market, residential market, was so immature. And only me, like a professor, we knew. But the common buyers, they didn't understand. They didn't understand.

Especially in that market, the first [INAUDIBLE] problem is housing affordability. So high housing price, they cannot buy a small house. How can I have some luxury [INAUDIBLE] about the environment? That's not my business. How I have a luxury [INAUDIBLE] about this environment protection? No.

And then they also don't understand. They say, oh, green building is good for the society. But it's nothing to do with me. How can I benefit from this? No idea.

And then I send my student teams. I send my student teams to-- well, there were some scattered around the green building, new green building project. As the very first movers of the developer, they build some green buildings here and there, but very few.

I send students to three green buildings and three nongreen buildings which appeared together. One green building-- and, nearby, find a very similar location but nongreen building. I send my students to those complex and then to interview the residents for the green building residents and the nongreen building residents, interview them.

And I interview them-- our students interviewed them. And we found out, for the green buildings, they have really a high willingness to pay for greenness, for this energy efficiency, these 300 RMB per square meter like that. So we ask questions, hypothetical question.

If you later have another chance to buy a house, buy a green house, are you willing to pay a higher price for the next one? We asked that question. The green building residents, they understand the benefit. They have this willingness to pay.

The brown building residents, they didn't have any idea. They don't have. So I have it low. And then the following is the same. We show our information card. We educated them.

Green building is not just about carbon. It's about this and that, the light, the indoor air quality, your energy bills, and this and that. And we had some technology students who really it mattered a lot.

And then we asked them again. Then you can see it jump up for these nongreen building residents, that they got some new information. They adjusted their understanding of this. And they have a higher willingness to pay.

So that was my paper, just a small example to show information really matters. But of course, this is all hypothetical question. That's a limitation of this questionnaire approach, right?

When you say so, maybe you won't do so. But anyway, as a first try to show, so many people they are less educated about the benefit of the green building. And if you give them information, they will change their mind.

This is very true for real estate. Because as we understand, these are some different goods, so-called experience good. That's some good you cannot immediately judge whether good or not. You need experience.

And even for some mature building materials, credence good means even you experience you don't know unless you are an expert. Because you cannot say you cannot feel. So that's even further information became a problem.

But real estate is very clear, the building's indoor air quality and energy efficiency. If you only look at the brochure of the marketing materials from the builder, you cannot just really believe in that, or you will be cheated. And after you live in a house for a few years, you really understand that. So that's called an experience good.

What other examples of experience good can you think of? Experience good besides real estate, do you have another example in the real world that you must experience? Otherwise, you don't understand the quality. That brings a lot of uncertainty when you decide.

**AUDIENCE:** Food?

**SIQI ZHENG:** Food, yes.

**AUDIENCE:** Because you can't judge it until you--

**SIQI ZHENG:** Until you eat-- I think another example is people. I have a lot of experience people. So now, we are in an admission cycle right now. I work to midnight the day before to review all the applications to our MCP DUSP program. And then later, we will admit [INAUDIBLE] students.

So now, all MIT professors are busy with reviewing all these applications. And then we can only read, you know, CV, and the statement, and the transcript, and these three reference letters. However, a person is an experience good in the labor market.

So basically-- if you only read a CV and a reference letter so good. This person is perfect, so good, all the As, and all this and this, and all this, and all awards, of 10 publications like that. However, when you meet the person, later you found out, oh, that's not that true.

So I feel it's very hard to judge a CV. That's an experience good. So if I want to admit a student, I really prefer to have a short period of together, being together, work together on something. Then we can experience. And that student can also experience whether I'm a very bad professor or OK professor.

So real estate is the same thing. So that's why some developers, some real estate people, they take advantage of this information asymmetry. Because the buyer is so blinded, especially common people. Then they do greenwashing.

I think you heard this word so many times, greenwashing, greenwashing, greenwashing. So greenwashing means is you are not green building, but you just plant some trees. And you put some plants on your balcony, say, oh, so green. That's green building.

So that's greenwashing. It's no energy efficiency. And you just see the image or you print this brochure fancy marketing materials, so green. That's called greenwashing. Greenwashing is not good.

But why greenwashing exist? We understand because the information problem. That's an information problem. So if you have a very good CV, but actually you are not that good, you are greenwashing yourself. That's a way. And some smart professor will find out.

OK my research, too, studied greenwashing in Beijing. But I won't go into details because we are going to run out of time. But the point is, at that time, even earlier than my last paper, the information paper, China had no green certificate at all, no green certificate.

All the developers, they self-advertise. Oh, my building is a green building. Green building is so good. And you will have so much benefit from my building. So for those developers, they self-advertise without any certificate, without any data.

And in that time, the market was presale stage, no building at all, vacant land. And they are building the foundation maybe, a big hole. And then they-- oh, so good. Look at the pictures. Then the consumers got so excited and bought the building.

And then the buyers got into the building and, after a few years, found out the energy bill is so high and not good at all or plastic bag problem. All the things happened. And then when they resell their buildings, they resell their houses on the resale market, the developer is already gone, disappeared. I don't know where the developer is.

And then it turned out that they couldn't sell any premium. So the first round of buyers will become victims of this. For later, they found out. But the first round of the buyers got this problem and got stuck in.

So the key point of this, I'm going to only show two slides right now for the sake of time. Understand this because there's no market signal. There's no market certificate.

For example, this cost, this word selection, that's a very important economic concept. Suppose we have a good developer. We have a bad developer-- not bad, average developer. We have green developer. And we have an average developer.

We know that when we build a green house, there's a cost premium. There's no free lunch. Suppose every house is 0.95 million, and the green is 1.25 million. That's a cost.

And if the buyers are so sophisticated and we have a very good certificate system, then they can tell. The buyer is not blinded. They can tell the green building is good and the nongreen building is not good. Then they have a willingness to pay. This one is higher. This one is lower.

So you can clearly see, at any time, at this time, this one is higher than the cost. So that gives you an incentive for the builder to build because they know they can sell at 1.4 million, the cost 1.25 million. And this market also exists because some people, they don't care. And they don't want to invest. That's fine. They go to this market. So a differentiated market exists. That green building will exist.

However, if it's so blinded-- no certificate like that. And then the buyers couldn't tell which one is which. They couldn't tell which one is built green, which one is not green. And they don't want to be cheated.

Then they say, OK, I don't know. They just say that. They say, how can I believe? I just put them together. It's no difference. Then they have 1.2 million.

So this creates a problem that will de-incentivize this part. Because, now, all put together, they are willing to pay the same 1.2 million no matter whether you're green or not. Because I don't know. Then for this part, they don't want to build. They have no incentive because the cost exceeds the benefit.

So that will crowd out the good guys. And only the lemons, the bad guys, will stay in the market. So that's a problem. To solve that problem is certification.

So I want to give credit. Of course, many people, they are criticizing. LEED has this problem, that problem. But the fundamental, the first order benefit of this certification, is to solve this information asymmetry. At least you have a certificate instead of China's case in 2012, nothing. You just promote by yourself.

You have the certificate on the wall. And you show this, the LEED Platinum and the LEED Gold. Then you understand this one is not a cheater. So that's to help with the information asymmetry.

And then this is just a first impression of what's the problem of information problem and how to solve. And when they solve, they say, oh, the limitation of this, the limitation of this, the limitation of this. And they improve, gradually, this certification.

But first, the first order thing is this good thing. This is a public good. The government provides, or the non-NGO, provides this, will help the buyers to be not so blinded and become like this and kill this good market and to solve this adverse selection problem. OK, I'm going to stop here.