Green Buildings

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8/23/2019

The case

Over the past decade, both investors and the general public have paid increasingly close attention to the benefits of environmentally conscious buildings. There are both ethical and economic forces at work here. In commercial real estate, issues of eco-friendliness are intimately tied up with ordinary decisions about how to allocate capital. In this context, the decision to invest in eco-friendly buildings could pay off in at least four ways.

1. Every building has the obvious list of recurring costs: water, climate control, lighting, waste disposal, and so forth. Almost by definition, these costs are lower in green buildings.

2. Green buildings are often associated with better indoor environments—the kind that are full of sunlight, natural materials, and various other humane touches. Such environments, in turn, might result in higher employee productivity and lower absenteeism, and might therefore be more coveted by potential tenants. The financial impact of this factor, however, is rather hard to quantify ex ante; you cannot simply ask an engineer in the same way that you could ask a question such as, "How much are these solar panels likely to save on the power bill?"

3. Green buildings make for good PR. They send a signal about social responsibility and ecological awareness, and might therefore command a premium from potential tenants who want their customers to associate them with these values. It is widely believed that a good corporate image may enable a firm to charge premium prices, to hire better talent, and to attract socially conscious investors.

4. Finally, sustainable buildings might have longer economically valuable lives. For one thing, they are expected to last longer, in a direct physical sense. (One of the core concepts of the green-building movement is "life-cycle analysis," which accounts for the high front-end environmental impact of acquiring materials and constructing a new building in the first place.) Moreover, green buildings may also be less susceptible to market risk—in particular, the risk that energy prices will spike, driving away tenants into the arms of bolder, greener investors.

Of course, much of this is mere conjecture. At the end of the day, tenants may or may not be willing to pay a premium for rental space in green buildings. We can only find out by carefully examining data on the commercial real-estate market.

We have data on 7,894 commercial rental properties from across the United States. Of these, 685 properties have been awarded either LEED or EnergyStar certification as a green building.

The goal

An Austin real-estate developer is interested in the possible economic impact of "going green" in her latest project: a new 15-story mixed-use building on East Cesar Chavez, just across I-35 from downtown. **Will investing in a green building be worth it, from an economic perspective? The baseline construction costs are $100 million, with a 5% expected premium for green certification.**

Initial recommendation

The developer has had someone on her staff, who's been described to her as a "total Excel guru from his undergrad statistics course," run some numbers on this data set and make a preliminary recommendation. Here's how this person described his process.

> I began by cleaning the data a little bit. In particular, I noticed that a handful of the buildings in the data set had very low occupancy rates (less than 10% of available space occupied). I decided to remove these buildings from consideration, on the theory that these buildings might have something weird going on with them, and could potentially distort the analysis. Once I scrubbed these low-occupancy buildings from the data set, I looked at the green buildings and non-green buildings separately. The median market rent in the non-green buildings was $25 per square foot per year, while the median market rent in the green buildings was $27.60 per square foot per year: about $2.60 more per square foot. (I used the median rather than the mean, because there were still some outliers in the data, and the median is a lot more robust to outliers.) Because our building would be 250,000 square feet, this would translate into an additional $250000 x 2.6 = $650000 of extra revenue per year if we build the green building.
>
> Our expected baseline construction costs are $100 million, with a 5% expected premium for green certification. Thus we should expect to spend an extra $5 million on the green building. Based on the extra revenue we would make, we would recuperate these costs in $5000000/650000 = 7.7 years. Even if our occupancy rate were only 90%, we would still recuperate the costs in a little over 8 years. Thus from year 9 onwards, we would be making an extra $650,000 per year in profit. Since the building will be earning rents for 30 years or more, it seems like a good financial move to build the green building.

Task at hand

The developer listened to this recommendation, understood the analysis, and still felt unconvinced. She has therefore asked you to revisit the report, so that she can get a second opinion. Based on your analysis of the situation, make a recommendation to the developer.

Approach

After going through our excel guru's analysis of the situation, we felt that some important details were overlooked. We will look through those missing details and some more as we go ahead with our analysis. Once we determine the effect of the factors that are unaccounted for in the analysis, we can give an unbiased opinion, solely based on the data

Possible considerations

1. Outliers were removed based on intuition and not solid numbers
2. Occupancy as a dependant - Avg. occupancy rate assumed to be 100%/90% throughout the 8/9 year period (if changed, will affect investment recovery time)
3. Avg. rent calculation - rent can be calculated for smaller, more specific sections of the building population (by amenities, renovated, rating etc.).

1. EDA before outlier removal

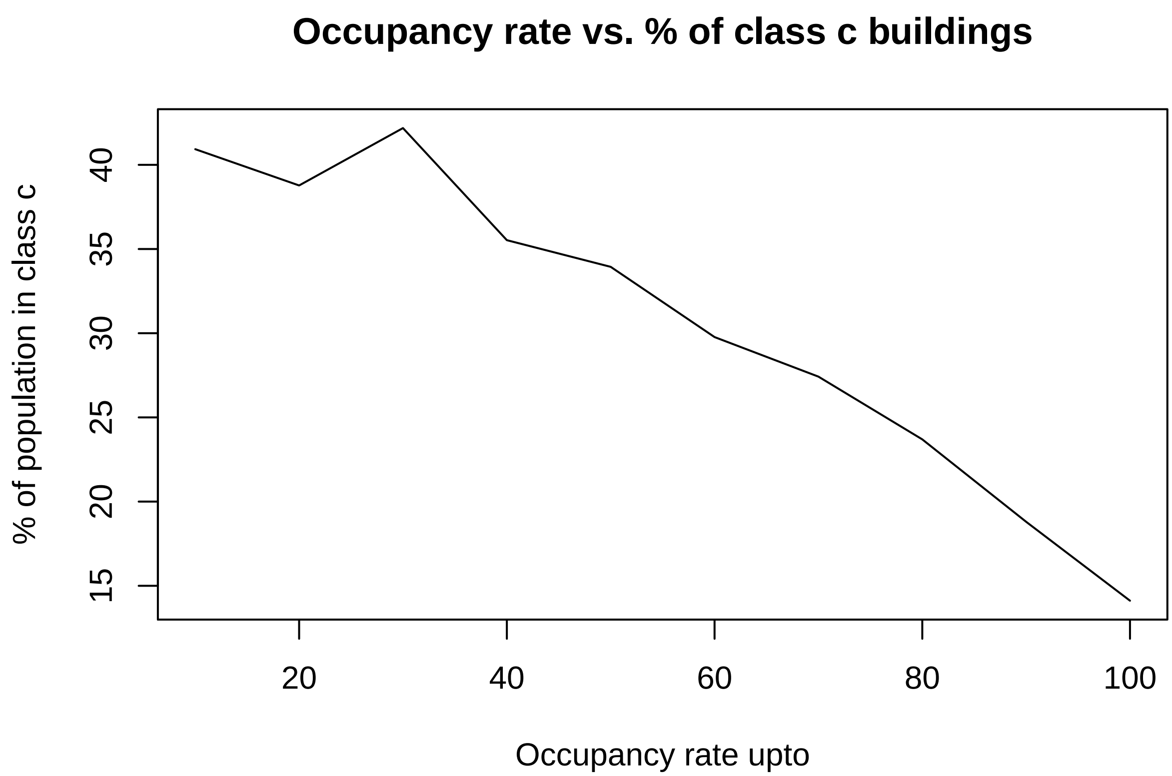
While the ability of these buildings to distort the analysis is real, there was no mention of an EDA for these buildings or any outliers. Let's just confirm if the intuition is right.

Upon checking the distribution of data in the different bins of leasing rate, we find that data is sparsely present for rates upto 60%. In the graph below, we can clearly see that majority of the buildings are on the higher side of the spectrum.

Occupancy	Percent_Data
10	2.723587
20	3.103623
30	4.294401
40	5.776539
50	8.652141
60	11.641753
70	17.798328
80	27.514568
90	50.975424
100	100.000000

Since the dataset does not mention the class and amenities of the new building, for simplicity of computation we assume that our building will belong to class a, have amenities=1, rent as net=0 (Since green buildings can lower costs, this can be a potential addition to the income stream)

Further looking at how many class c buildings are present in different data sections,



After some eyeballing on the summary statistics, we can say the following about buildings with less than 60% occupancy(set60):

1. These are smaller buildings, with lesser floors on an average.
2. These builduings are generally older - their mean and median age are much above those of the mean and median of the population, even though the max(population)>max(set60)
3. 30% of these buildings belong to class c as compared to 14% in the overall population
4. 2% of set60 buildings are green rated vs. almost 10% of population
5. Majority((70%) of these buildings do not have amenities

Based on our assumptions and observations, we extend the outlier removal to buildings with less than 60% occupancy.

2. What all affects occupancy?

One big underlying assumption behind the prediction of the ~8yr time frame for recovering the premium amount is that the building operates at a 90% if not 100% occupancy from day 1. We will run a linear model to find the factors that significantly affect our occupancy rate.

From our model, we found that out of the significant ones, the positive are:

1. Size
2. Rent/sq.ft. / Cluster Rent
3. Class a/b
4. net
5. Gas costs

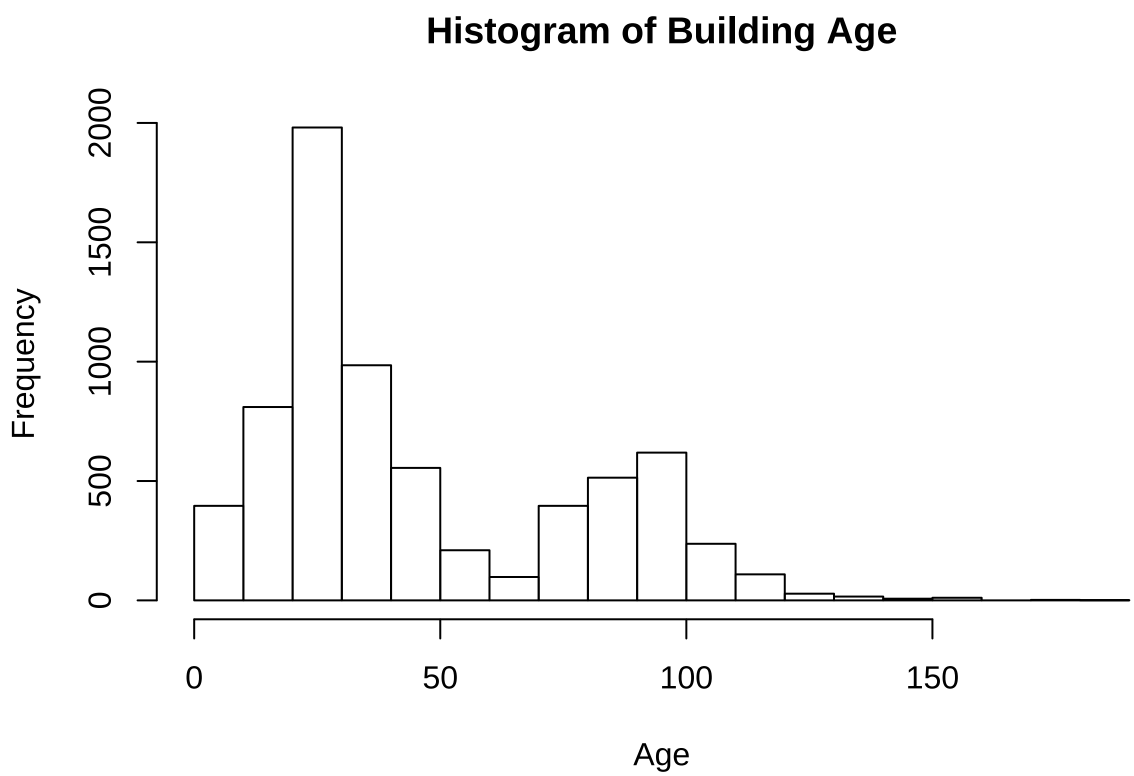
The ones that affect occupancy negatively are:

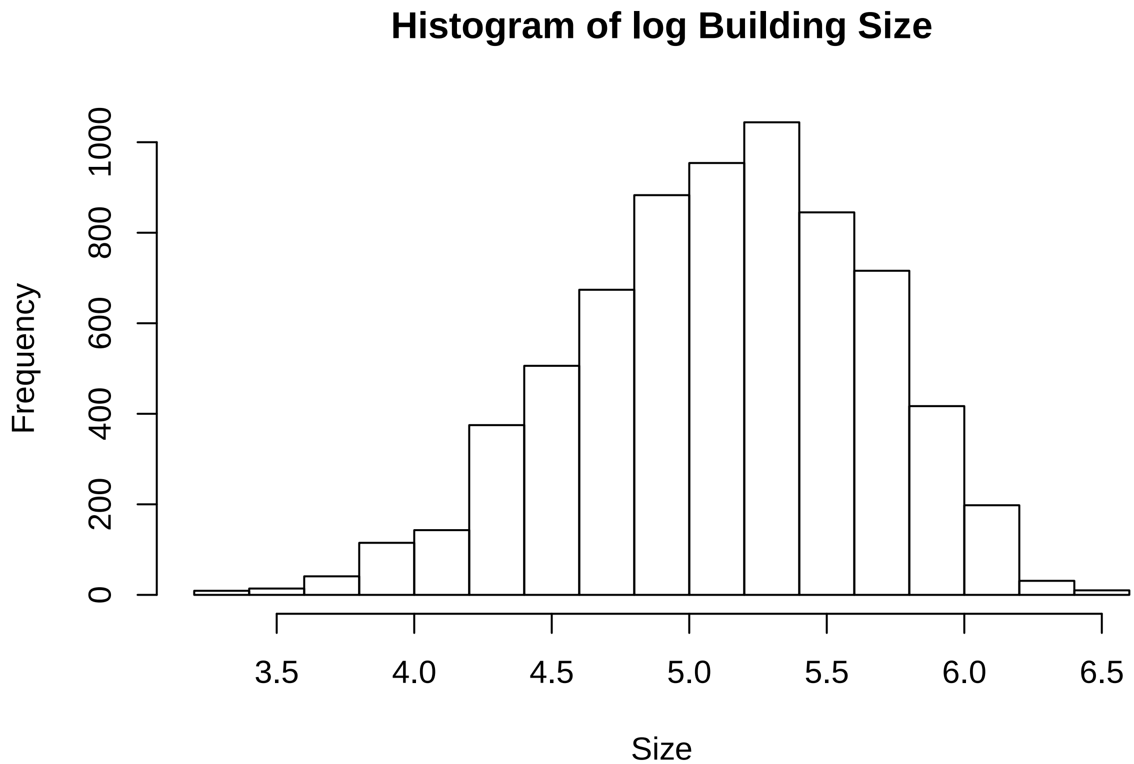
1. Employement Growth Rate
2. Age of the building
3. Having net contracts
4. Precipitation
5. Electricity costs

Since we do not have exact numbers for these factors for our building, we will assume our rent to be 90% as a safer bet than a complete 100%.

3. Average rent for specific building types

After observing the distribution of the variables, we will assign buckets for different variables to our data based and couple data points to compare similar buildings for rent as time progresses.





We grouped our data into segments, and based on those our building lies in the following group:

1. Amenities = 1 (Assumption)
2. net = 0 (Assumption)
3. Class = a (assumption)
4. Size = Between 100k and 500k (Given as 250k)
5. Age = Less than 20 years (new building)

And we will compare green vs. non-green average rents for this cut of the data. Since we do not have any information about the cluster that this building will lie in, we rely on the randomness of the data to give an answer close to real.

green_rating	LEED	class_a	mean	sd
0	0	1	36.39089	12.24439
1	0	1	34.09885	13.23243
1	1	1	34.93200	21.58111

We can observe from the computations above that the mean rent for green buildings of class a is lesser than the mean rent for non-green buildings of class a. Same is the case with the median. What's more is that the standard deviation is higher for green buildings, making the investment riskier in short term.

If we go ahead and observe this for older buildings:

green_rating	LEED	class_a	mean	sd
0	0	1	32.59567	12.70760
1	0	1	32.01176	12.81916
1	1	1	24.00000	0.00000

Slightly longer term projections of rent from the given data for comparable (green) buildings in size bucket and amenities are much lesser than those for non-green buildings.

Conclusion

Solely based on the data, our suggestion is against the green building for now. If we are able to obtain some more data and information about the location of the clusters and the building in questions, we might be able to further refine the analysis to revise the answer. While from an environmental point of view, a green building sounds sustainable, future-proof and a PR generating asset, we are **unable to monetise the effects of electricity costs, PR costs and returns, CSR costs and returns etc on our building with this data.** With this kind of a situation and uncertainty due to lack of data on a lot of the important variables that can tell a better story, our recommendation is not to invest an extra $5 Million as there is no guarantee of any extra returns.

Appendix

Data description

A group of real estate economists constructed the data in the following way. Of the 1,360 green-certified buildings listed as of December 2007 on the LEED or EnergyStar websites, current information about building characteristics and monthly rents were available for 685 of them. In order to provide a control population, each of these 685 buildings was matched to a cluster of nearby commercial buildings in the CoStar database. Each small cluster contains one green-certified building, and all non-rated buildings within a quarter-mile radius of the certified building. On average, each of the 685 clusters contains roughly 12 buildings, for a total of 7,894 data points.

The columns of the data set are coded as follows:

- CS.PropertyID: the building's unique identifier in the CoStar database.
- cluster: an identifier for the building cluster, with each cluster containing one green-certified building and at least one other non-green-certified building within a quarter-mile radius of the cluster center.
- size: the total square footage of available rental space in the building.
- empl.gr: the year-on-year growth rate in employment in the building's geographic region.
- Rent: the rent charged to tenants in the building, in dollars per square foot per calendar year.
- leasing.rate: a measure of occupancy; the fraction of the building's available space currently under lease.
- stories: the height of the building in stories.
- age: the age of the building in years.
- renovated: whether the building has undergone substantial renovations during its lifetime.
- class.a, class.b: indicators for two classes of building quality (the third is Class C). These are relative classifications within a specific market. Class A buildings are generally the highest-quality properties in a given market. Class B buildings are a notch down, but still of reasonable quality. Class C buildings

are the least desirable properties in a given market.

- green.rating: an indicator for whether the building is either LEED- or EnergyStar-certified.
- LEED, Energystar: indicators for the two specific kinds of green certifications.
- net: an indicator as to whether the rent is quoted on a "net contract" basis. Tenants with net-rental contracts pay their own utility costs, which are otherwise included in the quoted rental price.
- amenities: an indicator of whether at least one of the following amenities is available on-site: bank, convenience store, dry cleaner, restaurant, retail shops, fitness center.
- cd.total.07: number of cooling degree days in the building's region in 2007. A degree day is a measure of demand for energy; higher values mean greater demand. Cooling degree days are measured relative to a baseline outdoor temperature, below which a building needs no cooling.
- hd.total07: number of heating degree days in the building's region in 2007. Heating degree days are also measured relative to a baseline outdoor temperature, above which a building needs no heating.
- total.dd.07: the total number of degree days (either heating or cooling) in the building's region in 2007.
- Precipitation: annual precipitation in inches in the building's geographic region.
- Gas.Costs: a measure of how much natural gas costs in the building's geographic region.
- Electricity.Costs: a measure of how much electricity costs in the building's geographic region.
- cluster.rent: a measure of average rent per square-foot per calendar year in the building's local market.