The Value of Street-level Greenness
The Financial Impact of Street-level Greenness on New York Commercial Real Estate
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with Juncheng Yang, MIT
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Dr. Andrea Chegut, MIT
Yuhao Kang, WISC
and Fan Zhang, MIT

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Helena H Rong is a Research Associate at the MIT REI Lab and studies the intersection of design, technology and finance.

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M.S/Ph.D student at GeoSpatial Data Science Lab, University of Wisconsin, Madison.

Dr. Andrea Chegut is the Director of the REI Lab and studies the value of design and technology for commercial real estate.

Fan Zhang
Postdoctoral Researcher at MIT Senseable City Laboratory.

Yang, Rong, Kang, Zhang, and Chegut
• “Cities will always need large—infrastructure projects, but sometimes small—scale infrastructure—from cycle lanes and bike sharing to the planting of trees for climate change adaptation—can also have a big impact on an urban area.”


Source: http://senseable.mit.edu/treepedia/cities/new%20york
How does street level greenery impact us and why would we consider it relevant for our urban future?

- Increased greenery is correlated with a decreased urban carbon footprint (Chen, 2015) and increased oxygen generation (Nowak et al., 2007);
- More urban greenery boosts the residents thermal comfort in a city (Norton et al., 2015) and the provision of more greenery has been tied to increased equity between neighborhoods and satisfaction (Ambrey and Fleming, 2014);
- Greenery is most closely aligned with public health and wellness, which is leading to enhanced cognition, increased perceived mental health and decreased all cause-mortality (Bratman et al., 2015; Perini and Magliocco, 2014; Van Dillen et al., 2012; Van den Berg et al., 2015; Kang et al., 2020);
- Access to parks has been correlated with higher residential property values (Nicholls and Crompton, 2005) and results already documented that street-level greenery had a positive value impact (Morancho, 2003);
- It’s also a prime indicator for social inequality, urban variation in access to trees is also a signal of inequality in social outcomes and racism (See NYTimes).
How much does street-level greenness affect commercial real estate prices?

- This research measures street-level greenness in Manhattan, New York City through computing a novel street-level green view index using images collected from Google Street View and assess its impacts on real estate pricing.

- The results show that street-level green view index is statistically significant and yields a positive coefficient for commercial real estate transaction prices, ranging from 8.9% - 10.5% per square meter, and for leasing prices, ranging from 4.1% to 7.8% per square meter, for offices with low to high street-level greenness relative to those building transactions spatially correlated with very low greenness.

- These results are robust to various specifications and robustness checks including: investment by Building Improvement Districts, household income levels, proximity to parks and metros, sidewalk width, various specifications of the Green Index as well as alternative measures to identify so-called "greenness".
How has urban greenery been evaluated in the past?

There is limited literature that focuses on the financial valuation of street-level greenness.

**LITERATURE**

- Real estate economists and planning researchers generally measure: green land use - park and greenway rather than human-scale street-level greenness data. Only in the recent years scholars started to use Street View images to measure urban greenery.

**Parks**

- Urban parks may yield a positive impact of up to 20 percent to adjacent properties compared to the average price in the same area (Crompton, 2001);
- Morancho (2013) concludes that every 100m further away from a green area equates to a drop of 300,000 pesetas (approximately USD 2,000) in the average home’s price;
- Good quality urban greenery improves the quality of life in cities enhancing their attractiveness to residents, employees, tourists, investors and firms (Arvanitidis, 2009).

**Green Trails**

- Lindsey (2003) documented pricing premiums due to urban greenways ranging from 2.4 percent to 14 percent using 2,157 samples in Indianapolis, Indiana;
- Crompton (2005), documented urban greenway’s positive impacts ranging from 5.3 percent to 20.2 percent on property values in multiple residential areas in Austin, Texas;
- The dominant prevailing sentiment was that the presence of a trail had a neutral impact on the saleability or value of property (Crompton, 2003).

**Street Greenery**

- Yang et al. (2009) were the first to develop the Green View Index (GVI), which used color images captured from four directions as representative of human perception from the street-level to measure the visibility of surrounding urban greenery.
- Lu (2019) assessed street-level greenery using GSV images in Hong Kong and found that the quantity and quality of street-level greenery were positively associated with the likelihood of engaging regular physical activity.
Existing Literature on Greenery

There is limited literature that focuses on the financial valuation of street-level greenness.

LITERATURE

- Most studies of street-level urban greenery focused on methodology without providing a comprehensive, theoretical understanding of the street-level urban greenery metric.
- Existing real estate research that studied human-scale greenery focused on residential property transactions but not commercial real estate.

How has urban greenery been evaluated in the past?

- Passive recreation tend to have a positive impact on nearby property values and parks mainly for active recreation are more likely to introduce disturbance and therefore a negative impact on adjacent property values (Lin, 2016);
- Proximity matters a lot, more than park size (Morancho, 2013);
- Usually might contain more diverse activities (Arvanitidis, 2009).

- Trails could be controversial. If it is perceived that the trail may facilitate the movement of economically disadvantaged residents through a relatively affluent neighborhood, then the trail may be supported by the former, but resisted by some people in the latter group, who fear a decrease in their property value (Crompton, 2003);
- The dominant prevailing sentiment was that the presence of a trail had a neutral impact on the saleability or value of property (Crompton, 2003).

- Yang et al. (2019) were the first to develop the Green View Index (GVI), which used color images captured from four directions as representative of human perception from the street-level to measure the visibility of surrounding urban greenery.
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How has urban greenery been evaluated in the past?

There is limited literature that focuses on the financial valuation of street-level greenness.

**NOTE**

- Street-level greenness is a major source for people’s perception of urban greenness, and it is widely accepted as a source of ecological, social, and cultural benefits. However, due to the difficulty of measuring human perception of street-level greenness, few research has attempted to assess the economic value of street-level greenness.
- Existing real estate research that studied human-scale greenery focused on residential property transactions but not commercial real estate.

**LITERATURE**

- Zhang and Dong, 2018 - Impacts of Street-Visible Greenery on Housing Prices Evidence from a Hedonic Price Model and a Massive Street View Dataset.
- Fu et al, 2019 - Do street-level scene perceptions affect housing prices in Chinese megacities? An analysis using open access datasets and deep learning

More nascent research has been conducted on the relationship between street-level greenness and housing prices using GVI calculated through street-view images. The results show that visible street greenery and street accessibility at global scale hold significant positive coefficients for housing prices, meaning there is a positive economic impact of street level greeness (Zhang et al, 2018; Ye et al, 2019; Fu et al, 2019).
Identification Strategy
At each assigned coordinate, we calculated the average percentage of green pixels from collected Google Street View images that were taken from April to October in New York City.

Can we measure how "green" the street experience is?

Collect Google Street View images within 30m, 50m, 80m, and 100m from the target building coordinates.

For each Google Street View panorama, there are four images, on each of which we will calculate the green view index.
Can we measure how "green" the street experience is?

Measuring the "Greenness" of Streetscape

At each assigned coordinate, we calculated the average percentage of green pixels from collected Google Street View images that were taken from April to October in New York City.

<table>
<thead>
<tr>
<th>Green View Index</th>
<th>Green View Index</th>
<th>Green View Index</th>
<th>Green View Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0163875</td>
<td>0.0237125</td>
<td>0.0242125</td>
<td>0.02455625</td>
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Name
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3FON0VJ2Vw_nshwpYDwjsg_90.jpg
3FON0VJ2Vw_nshwpYDwjsg_180.jpg
3FON0VJ2Vw_nshwpYDwjsg_270.jpg
Can we measure how “green” the street experience is?

What is the Green View Index?

At each assigned coordinate, we calculated the average percentage of green pixels from collected Google Street View images that were taken from April to October in New York City.

Green View Index (80m radius) 0.00907472 (mean of all green view indexes)

Rank (out of 1467 samples) 393

Address 979 3rd Ave

Number of GSV dots 64
What is the Green View Index?

At each assigned coordinate, we calculated the average percentage of green pixels from collected Google Street View images that were taken from April to October in New York City.
Can we measure how "green" the street experience is?

What does the Green View Index measure?
The visually perceived density of greenery at the street-level.

GSV Images

Processed Images

High Low
Can we measure how "green" the street experience is?

What does the Green View Index measure?
The visually perceived density of greenery at the street-level.
Selecting the Viable Green View Index

We compared the total number of Google Street View coordinates for each buffer area and decided to rule out the 30m-radius dataset due to its insufficient data.
Selecting the Viable Green View Index

Selecting the viable green view index dataset that we should focus on required us to go beyond comparing numeric values.
Selecting the Viable Green View Index

Selecting the viable green view index dataset that we should focus on required us to go beyond comparing numeric values.
Green View Index (50m Radius)

Selecting the viable green view index dataset that we should focus on required us to go beyond comparing numeric characteristics.

A buffer area with 50m radius is a site-specific choice for the Manhattan blocks.
Green View Index (50m Radius)

Selecting the viable green view index dataset that we should focus on required us to go beyond comparing numeric characteristics.

A buffer area with 50m radius is a site-specific choice for the Manhattan blocks.
Green View Index (50m Radius)

Selecting the viable green view index dataset that we should focus on required us to go beyond comparing numeric characteristics.

A buffer area with 50m radius is a site-specific choice for the Manhattan blocks.

NYC Urban Block Length: 274 m (900 ft)
NYC Urban Block Width: 80 m (264 ft)
Green View Index (50m Radius)
Analyzing the green view index through different value categories.
We also included other relevant variables that related to urban greenery studies - the distances to the closest park and metro station.

**Relevant Variables**

**Park Distance**

- Obs: 3209
- Sum of Wgt.: 3209
- Mean: 169.5832
- Std. Dev.: 108.0166
- Variance: 11667.58
- Skewness: 0.7907341
- Kurtosis: 3.030394

**Metro Distance**

- Obs: 3213
- Sum of Wgt.: 3213
- Mean: 171.1437
- Std. Dev.: 131.0948
- Variance: 17185.85
- Skewness: 1.930016
- Kurtosis: 8.714695
Incorporating context-specific considerations.

• A Business Improvement District is a formal organization made up of property owners and commercial tenants who are dedicated to promoting business development and improving an area’s quality of life. BIDs deliver supplemental services such as sanitation and maintenance, public safety and visitor services, marketing and promotional programs, capital improvements, and beautification for the area—all funded by a special assessment paid by property owners within the district.

• In our dataset, there are over 1900 samples (out of 3213 samples) that are within BIDs in Manhattan.

• While some BIDs invest generously into streetscape maintenance and beautification, some BIDs deploy their funds to focus on other aspects of business improvement.

NOTE

- A Business Improvement District is a formal organization made up of property owners and commercial tenants who are dedicated to promoting business development and improving an area’s quality of life. BIDs deliver supplemental services such as sanitation and maintenance, public safety and visitor services, marketing and promotional programs, capital improvements, and beautification for the area—all funded by a special assessment paid by property owners within the district.

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Accounting for External Factors - Business Improvement Districts (BIDs)

Incorporating context-specific considerations.

NOTE

- A Business Improvement District is a formal organization made up of property owners and commercial tenants who are dedicated to promoting business development and improving an area’s quality of life. BIDs deliver supplemental services such as sanitation and maintenance, public safety and visitor services, marketing and promotional programs, capital improvements, and beautification for the area—all funded by a special assessment paid by property owners within the district.

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- While some BIDs invest generously into streetscape maintenance and beautification, some BIDs deploy their funds to focus on other aspects of business improvement.

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Yang, Rong, Kang, Zhang, and Chegut
## Descriptive Statistics - Transaction Price Data

A sample of 1,414 transaction records of commercial buildings in New York over the 2011-2018 period.

### Variable

<table>
<thead>
<tr>
<th></th>
<th>Very Low GVI (Quartile=1)</th>
<th>Low GVI (Quartile=2)</th>
<th>Medium GVI (Quartile=3)</th>
<th>High GVI (Quartile=4)</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
</tr>
<tr>
<td><strong>Street-Level Greenness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green View Index (Percentage)</td>
<td>0.21 (0.06)</td>
<td>0.40 (0.06)</td>
<td>0.64 (0.10)</td>
<td>1.78 (1.10)</td>
<td>0.76 (0.82)</td>
</tr>
<tr>
<td><strong>Building Prices</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>PSM</td>
<td>8,051.06 (6,042.50)</td>
<td>8,273.41 (6,487.08)</td>
<td>8,569.88 (6,521.32)</td>
<td>9,242.28 (6,405.71)</td>
<td>8,542.94 (6,376.92)</td>
</tr>
<tr>
<td>logPSM</td>
<td>8.81 (0.57)</td>
<td>8.84 (0.56)</td>
<td>8.88 (0.57)</td>
<td>8.95 (0.59)</td>
<td>8.87 (0.57)</td>
</tr>
<tr>
<td>Price (Millions)</td>
<td>119.78 (176.14)</td>
<td>119.49 (198.41)</td>
<td>147.86 (240.45)</td>
<td>148.33 (268.78)</td>
<td>133.95 (224.17)</td>
</tr>
<tr>
<td>logPrice</td>
<td>17.71 (1.42)</td>
<td>17.69 (1.4)</td>
<td>17.66 (1.61)</td>
<td>17.58 (1.63)</td>
<td>17.66 (1.52)</td>
</tr>
<tr>
<td><strong>Urban Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parkdistance</td>
<td>183.7 (110.58)</td>
<td>181.99 (111.16)</td>
<td>169.22 (116.26)</td>
<td>142.85 (98.74)</td>
<td>149.36 (110.46)</td>
</tr>
<tr>
<td>metrodistance</td>
<td>153.18 (119.13)</td>
<td>154.47 (112.95)</td>
<td>166.85 (121.02)</td>
<td>207.65 (157.70)</td>
<td>170.64 (130.76)</td>
</tr>
<tr>
<td>within250park</td>
<td>0.77 (0.42)</td>
<td>0.79 (0.41)</td>
<td>0.73 (0.44)</td>
<td>0.84 (0.37)</td>
<td>0.78 (0.41)</td>
</tr>
<tr>
<td>within250metro</td>
<td>0.88 (0.33)</td>
<td>0.88 (0.32)</td>
<td>0.81 (0.39)</td>
<td>0.67 (0.47)</td>
<td>0.81 (0.39)</td>
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<tr>
<td>sidewalkwidth</td>
<td>4.07 (0.73)</td>
<td>4.28 (0.85)</td>
<td>4.16 (0.8)</td>
<td>4.13 (0.98)</td>
<td>4.16 (0.85)</td>
</tr>
<tr>
<td><strong>Building Awards</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awarded Architects</td>
<td>0.01 (0.07)</td>
<td>0.01 (0.09)</td>
<td>0.00 (0.05)</td>
<td>0.02 (0.15)</td>
<td>0.01 (0.10)</td>
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<tr>
<td>Awarded Architects &amp;</td>
<td>0.01 (0.09)</td>
<td>0.00 (0.05)</td>
<td>0.01 (0.11)</td>
<td>0.00 (0.05)</td>
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<tr>
<td>Awarded Firms</td>
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<td>0.03 (0.17)</td>
<td>0.01 (0.12)</td>
</tr>
<tr>
<td><strong>Building Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>82.02 (31.06)</td>
<td>86.22 (28.44)</td>
<td>78.01 (32.17)</td>
<td>77.02 (32.98)</td>
<td>80.78 (31.41)</td>
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<tr>
<td>Number Floors</td>
<td>17.66 (12.1)</td>
<td>16.36 (12.94)</td>
<td>16.35 (12.33)</td>
<td>15.58 (13.49)</td>
<td>16.49 (12.73)</td>
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<tr>
<td>SqM mb</td>
<td>22,760.94 (34,090.33)</td>
<td>17,848.28 (23,456.03)</td>
<td>22,501.95 (32,549.80)</td>
<td>22,421.59 (40,472.37)</td>
<td>21,413.06 (33,302.72)</td>
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<tr>
<td>Class A</td>
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<td>0.19 (0.39)</td>
<td>0.34 (0.47)</td>
<td>0.35 (0.48)</td>
<td>0.3 (0.46)</td>
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<td>Class B</td>
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<td>0.57 (0.5)</td>
<td>0.42 (0.49)</td>
<td>0.50 (0.50)</td>
<td>0.49 (0.50)</td>
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<td>Class C</td>
<td>0.20 (0.40)</td>
<td>0.24 (0.43)</td>
<td>0.24 (0.43)</td>
<td>0.15 (0.36)</td>
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<td>Renovated</td>
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<td>0.10 (0.29)</td>
<td>0.12 (0.32)</td>
<td>0.11 (0.31)</td>
<td>0.12 (0.33)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Notes</th>
<th>Very Low GVI (Quartile=1)</th>
<th>Low GVI (Quartile=2)</th>
<th>Medium GVI (Quartile=3)</th>
<th>High GVI (Quartile=4)</th>
<th>Full Sample</th>
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<tbody>
<tr>
<td></td>
<td>Renovated</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Notes

- Table on the right highlights the mean and variation of building characteristics for the transaction sample over quartiles of GVI and the full sample. Each transacted building reflects neighborhood, temporal and other contract characteristics that we have categorized for our model. However, transacted building market locations by submarkets, time period of transaction, buyer and seller types as well as lending characteristics are not shown, but are available upon request.

### DATA SOURCES:

- Real Capital Analytics
- Compstak
- NYC DoITT
- NYC Planning

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**The Value of Street-level Greenness**

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Descriptive Statistics - Lease Rent Data
A sample of 7,403 lease records of commercial buildings in New York over the 2011-2018 period.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Very Low GVI (Quartile=1)</th>
<th>Low GVI (Quartile=2)</th>
<th>Medium GVI (Quartile=3)</th>
<th>High GVI (Quartile=4)</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
<td>Mean (Std. Dev.)</td>
</tr>
<tr>
<td>Street-Level Greenness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green View Index</td>
<td>0.20 (0.05)</td>
<td>0.40 (0.06)</td>
<td>0.64 (0.10)</td>
<td>1.78 (1.10)</td>
<td>0.76 (0.82)</td>
</tr>
<tr>
<td>Rent Prices</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective Rent (USD)</td>
<td>478.46 (152.57)</td>
<td>567.98 (203.66)</td>
<td>560.81 (211.05)</td>
<td>613.34 (232.90)</td>
<td>554.87 (207.78)</td>
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<tr>
<td>Log Effective Rent</td>
<td>3.75 (0.31)</td>
<td>3.91 (0.35)</td>
<td>3.89 (0.36)</td>
<td>3.98 (0.36)</td>
<td>3.88 (0.35)</td>
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<tr>
<td>Urban Infrastructure</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>parkdistance</td>
<td>172.5 (93.18)</td>
<td>192.41 (101.83)</td>
<td>178.96 (115.24)</td>
<td>146.2 (95.59)</td>
<td>172.61 (103.19)</td>
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<td>metrodistance</td>
<td>122.01 (105.62)</td>
<td>110.97 (72.45)</td>
<td>134.53 (88.44)</td>
<td>141.36 (105.79)</td>
<td>127.17 (94.77)</td>
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<tr>
<td>within250park</td>
<td>0.81 (0.39)</td>
<td>0.77 (0.42)</td>
<td>0.72 (0.45)</td>
<td>0.85 (0.36)</td>
<td>0.79 (0.41)</td>
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<tr>
<td>within250metro</td>
<td>0.89 (0.31)</td>
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<td>0.89 (0.31)</td>
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<td>sidewalkwidth</td>
<td>4.07 (0.67)</td>
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<td>4.32 (0.74)</td>
<td>4.19 (0.97)</td>
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<td>Building Awards</td>
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<tr>
<td>Non Awarded</td>
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<td>0.95 (0.22)</td>
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<td>0.95 (0.21)</td>
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<tr>
<td>Awarded Architects</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.05)</td>
<td>0.01 (0.11)</td>
<td>0.02 (0.13)</td>
<td>0.01 (0.09)</td>
</tr>
<tr>
<td>Awarded Firms</td>
<td>0.00 (0.05)</td>
<td>0.01 (0.12)</td>
<td>0.02 (0.16)</td>
<td>0.00 (0.00)</td>
<td>0.01 (0.1)</td>
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<td>Awarded Architects and Firms</td>
<td>0.03 (0.17)</td>
<td>0.02 (0.15)</td>
<td>0.01 (0.12)</td>
<td>0.05 (0.21)</td>
<td>0.03 (0.16)</td>
</tr>
<tr>
<td>Building Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>74.19 (28.07)</td>
<td>71.32 (29.61)</td>
<td>67.93 (29.15)</td>
<td>52.7 (27.92)</td>
<td>66.64 (29.87)</td>
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<tr>
<td>Age Squared</td>
<td>6,291.46 (3,456.3)</td>
<td>5,991.56 (3,943.66)</td>
<td>5,463.71 (3,916.41)</td>
<td>3,556.14 (3,366.6)</td>
<td>5,332.74 (3,829.88)</td>
</tr>
<tr>
<td>Building less than 5 years old</td>
<td>0.03 (0.16)</td>
<td>0.01 (0.11)</td>
<td>0.01 (0.07)</td>
<td>0.03 (0.18)</td>
<td>0.02 (0.14)</td>
</tr>
<tr>
<td>Renovated</td>
<td>0.77 (0.42)</td>
<td>0.74 (0.44)</td>
<td>0.74 (0.44)</td>
<td>0.55 (0.5)</td>
<td>0.70 (0.46)</td>
</tr>
<tr>
<td>Number Floors</td>
<td>31.34 (15.82)</td>
<td>32.6 (20.91)</td>
<td>26.01 (13.8)</td>
<td>32.35 (13.2)</td>
<td>30.57 (16.44)</td>
</tr>
<tr>
<td>Class A</td>
<td>0.54 (0.5)</td>
<td>0.51 (0.5)</td>
<td>0.56 (0.5)</td>
<td>0.81 (0.4)</td>
<td>0.6 (0.49)</td>
</tr>
<tr>
<td>Class B</td>
<td>0.42 (0.49)</td>
<td>0.47 (0.5)</td>
<td>0.38 (0.48)</td>
<td>0.18 (0.39)</td>
<td>0.36 (0.48)</td>
</tr>
<tr>
<td>Class C</td>
<td>0.04 (0.19)</td>
<td>0.02 (0.14)</td>
<td>0.06 (0.24)</td>
<td>0.01 (0.11)</td>
<td>0.03 (0.18)</td>
</tr>
<tr>
<td>Log(SqFt)</td>
<td>12.95 (0.94)</td>
<td>12.83 (0.98)</td>
<td>12.71 (1.19)</td>
<td>13.01 (1.05)</td>
<td>12.87 (1.05)</td>
</tr>
<tr>
<td></td>
<td>1862</td>
<td>1853</td>
<td>1859</td>
<td>1829</td>
<td>7403</td>
</tr>
</tbody>
</table>

NOTE
- Table on the right highlights the mean and variation of building characteristics for the transaction sample over quartiles of GVI and the full sample. Each transacted building reflects neighborhood, temporal and other contract characteristics that we have categorized for our model. However, transacted building market locations by submarkets, time period of transaction, buyer and seller types as well as lending characteristics are not shown, but are available upon request.
- **DATA SOURCES:**
  - Real Capital Analytics
  - Compstak
  - NYC DoITT
  - NYC Planning

The Value of Street-level Greenness
Yang, Rong, Kang, Zhang, and Chegut
Explaining Transaction Prices

We employ a regression framework to explain transaction price with a series of relevant variables.

\[ \log P_i = \alpha + \beta X_i + \delta GVI_i + \varepsilon_i \]

The logarithm of the transaction price (and the logarithm of the net effective rent per square meter) commercial office transactions (and leases) \( i \)

\( X \) is a vector of hedonic characteristics including transaction, contract, building and neighborhood amenity features for building transactions \( i \), and lease contract terms, exogenous location fixed effects by submarkets, and time fixed effects by quarter and year executed between 2010 to 2018 for rental contract \( i \).

NOTE

Estimation Strategy:

- We estimate a hedonic model, with robust standard errors;
- We control for special features of the transaction event such as buyer, seller, and lender types;
- We also control for location and time of the transactions.
- We observe individual transactions over the 2011 to 2018 period across Manhattan, New York. The time period overlaps with the period during which Google Map took street view images.
When controlling for location and transaction time, building features and transaction features, we find an **8.9% to 10.5%** statistically, economically and positive transaction premium and a **4.1% to 7.8%** rent premium for offices with low to high street-level greenness relative to those building transactions spatially correlated with very low greenness.

**Results**

We explain the log transaction price per square meters by location and time, building features and transaction features fixed effects.

**Results**

**Transaction Price**

- Low GVI (Quartile 2): 10.5%**
- Medium GVI (Quartile 3): 10.0%**
- High GVI (Quartile 4): 8.9%**

**Lease Rent**

- Low GVI (Quartile 2): 7.8%***
- Medium GVI (Quartile 3): 4.1%***
- High GVI (Quartile 4): 5.6%***

**DATA SOURCES:**
- Real Capital Analytics
- Compsatak
- NYC DoITT
- NYC Department of Planning
- MapPLUTO

**SIGNIFICANCE***

Asterisks in a regression table indicate the level of the statistical significance of a regression coefficient.

*** p<0.01, ** p<0.05, * p<0.1

**COEFFICIENT %**

The standard error is our estimate of the standard deviation of the coefficient.

**NOTE:**

The regression model controls for location and transaction time, building features (age, number of floors, building area, land parcel area, building class, renovation, and walk score), and transaction features (buyer type, seller type, and lender type). The operationalized transaction price model explains 88 percent of the variation of the logarithm of transaction prices, while the operationalized effective rents model explains 50 to 51 percent of the variation in the logarithm effective rent per square meter.
### Results with Visualization

**Green View Index (50m) Quartile 2**

<table>
<thead>
<tr>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>699</td>
<td>0.0039976</td>
<td>0.0005676</td>
<td>0.0030078</td>
<td>0.004939</td>
</tr>
</tbody>
</table>

GVI = 0.0039976

1373 Broadway, New York

**Green View Index (50m) Quartile 3**

<table>
<thead>
<tr>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>699</td>
<td>0.0063914</td>
<td>0.0009465</td>
<td>0.004964</td>
<td>0.0083292</td>
</tr>
</tbody>
</table>

GVI = 0.0063914

95 Wall Street, New York

**Green View Index (50m) Quartile 4**

<table>
<thead>
<tr>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>697</td>
<td>0.0171655</td>
<td>0.0101531</td>
<td>0.0083504</td>
<td>0.0797365</td>
</tr>
</tbody>
</table>

GVI = 0.0171655

145 Sixth Ave, New York

Visualize the green view index categories through Google Street View Images.
Conclusions

Why urban designers/planners, developers, and city officials should both pay attention to this subject.

NOTE

- CONTRIBUTION: This creates and expands understanding of the impact of street-level greenness on the value of real estate and a city.
- NEW DATASET: With increasing computational power to measure and assess the built environment, we can create new data (street-level greenness based on Google Street View images) to include in our pricing model.
Some Takeaways

- Integration of street view images at a big data scale and deep learning image recognition algorithms allow for a new approach to human-scale measurement of urban greenery in the urban environment at full scale.

- Results of the analysis document a 8.9% to 10.5% transaction price premium and a 4.1% to 7.8% rent premium for offices with Low to High GVI relative to those building transactions and leases spatially correlated with Very Low GVI.

- The expanding role that image recognition has in the measurement of asset values.

- This research is the first to study street-level greenery from a commercial real estate standpoint. Corporate and institutional investment portfolios in office real estate are highly correlated with urban planning and institutional investment in the urban landscape.

- Real estate developers are incentivized to align with landscape architecture and urban planning experts on this value enhancing urban amenity.