The Value of Status: Exploring the Price of Relative Positioning

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Abstract

In the standard economics model, individual utility is a function of one's own consumption. Yet, the pursuit of status, which depends on the recognition of others and one's standing relative to them, is an important driver of human behavior. Motivated by literature in linguistics and psychology that correlates between one's vertical positioning and well-being, we explore the value of vertical status – one's physical vertical positioning *relative* to others. Using transactions in high-rise residential buildings in Vancouver (Canada), we find an economically significant price premium for being higher than other units in both one's own building and surrounding buildings, conditional on a unit's *absolute* height, view, and other unit and building characteristics. Our findings further suggest that people weigh more heavily the disutility from having others positioned above them than the utility from having others below them. Finally, we find that the marginal value of vertical status increases with height.

Keywords: Status, Vertical Hierarchy, Tall Buildings, House Prices

JEL Classification: D12, D91, R21

1 Introduction

Status is a fundamental characteristic and metric of hierarchy and power within societies and organizations (Weber 1922). Works as early as Smith (1759) and Marshall (1890) address status as one of the motivating factors for consumer behavior. Veblen (1899) and Duensberry (1949) place status respectively in implicit and explicit utility functions. Heffetz and Frank (2010) delineate distinct attributes of status: “desirability”, the resources that status brings along; “visibility”, being observable to others; and “positionality”, the position (or rank) relative to others. In this paper, we specifically explore the latter attribute – status originated from relative vertical positioning.

In their seminal work on metaphors in language and the mind, Lakoff and Johnson (1980) show that the use of metaphors that utilize the vertical dimension explicitly ties “up” to positive associations and “down” to negative ones. For example, “happy” is up whereas “sad” is down, as in “I am feeling up” versus “He is low these days,” respectively.[1] In Dr. Suess’s Yertle the Turtle (Geisel 1950), Yertle the King is not only concerned about being high per se, but rather seeks to be positioned *higher* than all he can see – being furious when the moon “dares to be higher than Yertle the King.” In line with Yertle’s aspiration and following Heffetz and Frank (2010), we empirically explore the value vertical status – i.e., the value of the *relative* positioning within the vertical space.[2]

To study vertical status (relative vertical positioning), we use the height of condominium apartments relative to the height of both the other units in the same building and relative to the height of nearby buildings. By exploiting the variation in individual condominium transaction prices attributable to *relative* vertical differentiation, we estimate the shadow price of the characteristic of status that is expressed in this vertical up-down paradigm. Specifically, we estimate the shadow price of vertical status using prices from more than 55,000 transactions in nearly 320 condominium towers in the Vancouver (Canada) downtown peninsula over the period 1992–2016, using controls for absolute floor level, view, unit’s

[1] Among the other numerous examples in Lakoff and Johnson (1980) are “control” is up, whereas “lack of control” is down, as in “I am on top of the situation” versus “he is under my control and “virtue” is up and “lack of virtue” is down, e.g. “she is an upstanding citizen” versus “that was a low-down thing to do.”

[2] The Oxford Dictionary defines vertical status as “the status of a person in relation to others at a different hierarchical level” Oxford University Press https://www.oxfordreference.com.

physical characteristics, as well as building and temporal fixed effects.

We find a significant value for vertical status. *Ceteris paribus*, we estimate the average vertical status price premium for a unit on the top floor relative to that on the bottom floor of the same building at about 6–7 percent of the average transaction price (equal to about 73K CAD or 56K USD – deflated to July 2018 condo values). Additionally, our evidence shows that the marginal value of vertical status rises convexly, so that the marginal value of moving up is greater, the higher the floor is in a given building. Furthermore, we find evidence that people weigh more heavily the dis-utility from having others positioned above them than the utility of being above others. Finally, we find that vertical status further holds in comparing unit's relative height with neighbouring buildings. Accordingly, the vertical status price premium of a unit that is higher than the tops of all other nearby buildings – as compared to an otherwise identical unit that is lower than the tops of all nearby buildings – is equal to 3–4 percent of the average transaction price. The results are robust to a series of sampling and test design specifications.

Our study contributes to the literature in several ways. First, we believe that our work is the first to rigorously and richly explore the vertical status paradigm.[3] Second, unlike previous empirical studies in this area, our assessment of the benefit from status is not based on surveys of subjective happiness and well-being related to income and job satisfaction nor on experimental evidence, but rather on actual observed transaction prices. This allows us to directly and explicitly estimate the shadow price of the vertical status. Third, we show that the status paradigm stems mainly from the negative effect (dis-utility) that is derived from being below the joneses rather than the positive effect (utility) of being above them. Finally, we find that the marginal price effect of relative status is non-constant, rather it increases with relative vertical position.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant status literature and work on vertical features of buildings. Section 3 presents the methodology for measuring vertical status and the estimating equation. Section 4 describes the data. Section 5 presents the results, including an analysis of non-linearity in the vertical status function, an

[3]As we discuss more fully in Section 2, Nase, van Assendelft, and Remoy (2019) and Nase and Barr (2022) include a relative status measure as a control in their estimation of office rents and apartment unit values.

assessment of asymmetry in one's utility and dis-utility from having others below and above her, respectively, status related to neighbouring buildings, and a series of robustness tests. Section 6 provides a summary and concluding remarks. Finally, the Appendix provides details on data construction (Appendix A), distribution of the measures of neighborhood vertical status (Appendix B), and a detailed description of our methodology for constructing view measures (Appendix C).

2 Literature Review

An extensive literature across the social sciences explores the role of status in individual well-being. In economics, following the seminal analysis by Duensberry (1949), more recent theoretical work that addresses social comparison and status in the utility function includes, among others, Becker (1974), Gilboa and Schmeidler (2001), Samuelson (2004), Rayo and Bcker (2007), and Rablen (2008). Empirically, Easterlin (1995) showed the role of positioning in happiness: relative (and not absolute) income drives the variation in happiness over time.[4] Other studies that examine relative positioning and status are often either experimental or utilize income ordering within a workplace as the position indicator of well-being. For example, Brown et al. (2008) find that satisfaction and well-being depend on individual wage ordinal rank within the comparison group; Boyce, Brown, and Moore (2010), using more general British survey data, present evidence that rank-income overpowers both reference-income and absolute-income in predicting life satisfaction; and Blanchflower and Oswald (2004) and Groot and Van den Brink (1999) find that happiness and satisfaction from wage income is associated with relative rather than absolute wages.[5]

Recently, Bursztyn et al. (2018) used a quasi-field experiment to document the preference for status, separating it from other features that both increase utility and may be correlated

[4]See also, the Easterlin (1974) paradox, by which happiness varies positively with income within and across countries, but does not rise within a country as income rises over time.

[5]While these studies indicate the imperative effect of (non-vertical) status on individual utility as one's relative position in the context of workplace and wages, they do not fully control for other factors – such as future income growth, non-wage benefits, work environment, and professional opportunities – that may determine job satisfaction and are likely correlated with current income and wage structure. In addition, see Heffetz and Frank (2010) for a survey of the extant empirical and experimental work on preference for status.

with status. Employing a credit card market setting in Indonesia, they show that adding the premium label to a credit card almost doubles its uptake, as compared to the control card, despite no change in fees or benefits. Their experiment design allows them to separate consumption benefits from status signals. [6] They also find that holders of the "status" premium card are more likely to use it in social situations, where it serves as a status signaling mechanism. In contrast to Bursztyn et al. (2018) who assess the *visibility* characteristic of status by credit card uptake and use, we focus on the *relative* vertical positionality characteristic of status and estimate its shadow price.

Our use of building height as a mechanism to express vertical status is not unique. In psychology, based on a series of behavioral experiments, Dorfman, Ben-Shahar, and Heller (2018) find a bi-directional causality between a subject's social power and her/his presumed apartment's floor in a fictional building.[7] In urban economics, Helsley and Strange (2008) explain the evolution of skyscrapers in a game-theoretic setting model, where developers compete for status by constructing the tallest building. Their model finds empirical support in works by Barr (2012) on height competition among developers in New York City and Ahlerldt and McMillen (2018) on land values and development in Chicago.

In our framework, we posit that vertical status is an element, along with view, sunlight, absolute height, and noise that are included in the bundle of height amenities. In the pricing of height, these amenities are offset by vertical transportation costs, time, and inconvenience, in determining the net height premium or vertical gradient. Estimates of height premium are not new; see, for example, Wong et al. (2011) for a detailed list of studies that include floor in hedonic estimations of property value. More recently, Danton and Himbert (2018), Liu, Rosenthal, and Strange (2018), Nase, van Assendelft, and Remoy (2019), and Nase and Barr (2022) estimate vertical rent and price gradients for commercial and residential buildings with varying degrees of control for the other amenities in the height bundle. The latter two also include a height-based measure of status, which they compute by the ratio of the floor on which the transacted unit is located to the total number of floors in the building.

[6]For example, while generating high status, a Lamborghini, is also fast, handles well, and may offer an excellent sound system.

[7]Tower-Richardi et al. (2014) show that people associate a subject's "social status" with living in a higher residential location (hilltop).

Nase, van Assendelft, and Remoy (2019) find no effect of a status measure on the rent price of commercial real estate leases; whereas Nase and Barr (2022) find small positive values for vertical status in residential data from Rotterdam but not from Manhattan. Our study substantially differs from these studies, as we use data and a framework that allows us to explore heterogeneity in the value of vertical status, the extent of preference for being above (below) others, and status effects associated with surrounding buildings.

Finally, in order to cleanly estimate vertical status, we must control for the effect of view on the transaction price. Pricing views has long been part of the real estate literature—e.g., see Bourassa, Hoesli, and Sun (2004) for a review of early empirical estimates of the value of view. Continuous measures of view—such as those in Hamilton and Morgan (2010), Hindsley, Hamilton, and Morgan (2013), Nase, van Assendelft, and Remoy (2019), Nase and Barr (2022), and Dai, Felsenstein, and Grinberger (2021)—are based on GIS software and developed databases of topographic features and urban forms. We follow and refine the approach of Dai, Felsenstein, and Grinberger (2021), estimating unit-specific view based on the information on building alignments and units per floor.

3 Method

3.1 Specification of Vertical Status

In this paper, we characterize vertical status as a specific physical form of hierarchy: positionality along the vertical dimension, as represented by an apartment unit's relative height within a building. Specifically, we adopt the functional form presented in Brown et al. (2008) and Boyce, Brown, and Moore (2010), mapping their characterization of utility from one's place in the hierarchy of income to a physical vertical ordering by discrete building floor. We express vertical status VS from locating on floor i in an N-story building by:

$$VS_{iN} = 0.5 + \frac{(i-1) - \eta(N-i)}{2[(i-1) + \eta(N-i)]} \tag{1}$$

.

The first and second terms in both the numerator and denominator of the right-hand side fraction in (1) are, respectively, the number of floors below i (i.e., $i-1$) and the number of floors above i (i.e., $N-i$), where the latter is multiplied by the parameter η, $0 \leq \eta < \infty$ (see the discussion that follows below). Equation (1) can be reduced to:

$$VS_{iN} = \frac{(i-1)}{(i-1)+\eta(N-i)} \tag{2}$$

.

The parameter η in (1) and (2) captures the degree of upward\downward comparison. That is, the extent to which vertical status is driven by i's dis-utility from being below other units vis-à-vis the utility gained from being above other units. As η increases, it increases (decreases) the relative weighting on the number of floors above (below) the reference unit, $N-i$ (i-1). Mapping into preferences, $\eta > 1$ ($\eta < 1$) indicates a greater weight on the loss (benefit) that is associated with the presence of those above (below) i.

In our initial estimation of the value of vertical status, we set $\eta = 1$ in equation (2). This imposes the assumption that vertical status is symmetrical in preferences, so that the utility of being above someone is equal to the dis-utility of being below her. We will relax this assumption later in the paper to assess the value of η, which will shed more light on the structure of preference for status. Note that when $\eta = 1$, equation (2) reduces to:

$$VS_{iN} = \frac{(i-1)}{(N-1)} \tag{3}$$

.

Equation (2), and by extension equation (3), generate a vertical status measure that is comparable across buildings, as its value lies within $[0, 1]$, where the vertical status of the first (top) floor is equal to 0 (1).

3.2 Estimating Equation

Following equation (3), we estimate a standard semi-log hedonic model of condominium apartment transaction prices:

$$lnP_{jimt} = \beta_0 + \beta_1 X_j + \beta_2 VS_{im} + \beta_3 V_{imt} + \beta_4 F_i + \beta_5 Z_m + \beta_6 Y_t + \epsilon_{it} \quad (4)$$

.

The dependent variable in equation (4), lnP_{jimt}, is the log transaction price per square foot of unit j located on floor i in (an N-story) building m and sold at time period (month-year) t. The independent variables in (4) include X_j, a vector of unit's structural characteristics (floor area, age, number of bedrooms, number of bathrooms, and a dummy for whether the unit has been renovated); V_{imt}, a vector of view variables, which provide a building-floor-year specific view measure for each compass quadrant (see the description below); F_i, a vector of floor fixed-effects; Z_m, a vector of building fixed-effects; and Y_t, a vector of month-year time fixed-effects. In addition, β_0 and β_2 are parameters, β_1, β_3, β_4, β_5, and β_6 are vectors of parameters, and ϵ_{jimt} is a random disturbance term. In estimating equation (4), our primary parameter of interest is the coefficient on vertical status β_2, so we leave the coefficient vectors β_3 and β_4 for view and the vertical price gradient simply as controls, rather than investigate their forms.

4 Data

Our data include the universe of condominium apartment transactions that occurred in downtown Vancouver, British Columbia (Canada) over the period Jan 1992 – July 2016.[8] Vancouver provides a natural framework for our analysis, as owner-occupied mid- and high-rise condominium apartment units are a significant share of the housing stock.[9] While

[8]The end date of July 2016 avoids a series of taxes and restrictions placed thereafter on short-term rentals, foreign buyers, and vacant properties.

[9]According to the 2016 Canadian census, about 24.6 percent of owner-occupied units in the City of Vancouver were in buildings of 5 stories or more. In comparison, according to the 2015 American Housing Survey, in the New York-Newark-Jersey City, Miami, and Seattle MSAs this estimated share was only 16.3, 8.0, and 2.8 percent, respectively.

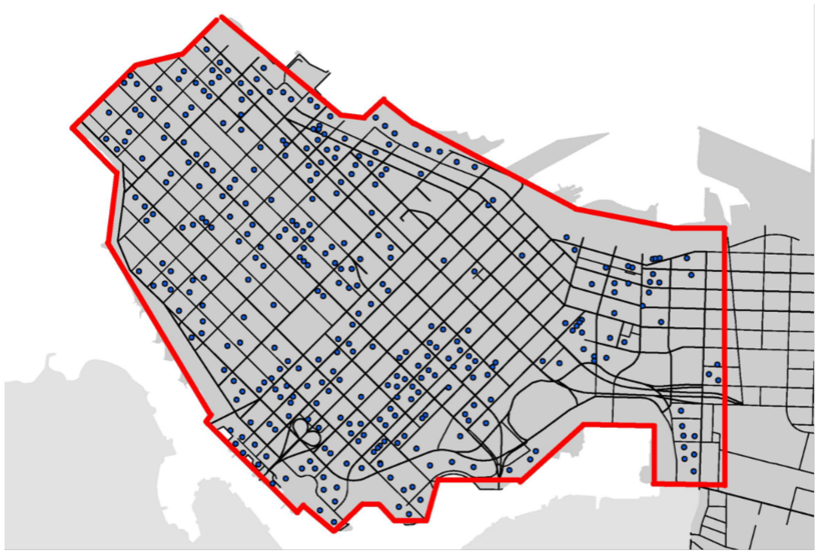


Figure 1: Building Locations

multi-family rental and condominium buildings are present in many different areas of the city and the metropolitan area, they are especially concentrated in the city's downtown peninsula. Figure 1 shows the location of the 318 condominium buildings in our dataset within the approximately 2x3 kilometer downtown peninsula. Our transaction information and building and unit characteristics data are drawn from British Columbia (BC) Assessment, the Province's assessment authority, and the City of Vancouver.[10] From the universe of about 76K observations, our final dataset includes 55,195 observations across 318 residential buildings, all of which are five floors or higher. Appendix A includes an accounting of the derivation of our sample from the universe of sales.[11]

Figures 2 and 3 present the distribution of the data by building height. As shown, there is considerable representation by building height across the distribution through buildings with 35 stories in height, both in individual buildings and by transactions. Above 37 floors, the sample turns somewhat sparse. Results on the vertical status effect, however, are robust to the omission of buildings above either 35 floors or 45 floors.[12]

[10]BC Assessment data include information on property characteristics and transaction prices. The City of Vancouver data provide information on property tax reports, GIS building footprint and shape, and parcel map.

[11]Nearly all of the reduction in the count from the universe is from units in buildings with four or fewer floors, pre-sales transactions, and transactions that are flagged as not suitable for data analysis by BC Assessment.

[12]The distribution of transactions by floor is approximately log-normal with a peak at floor 3, as there

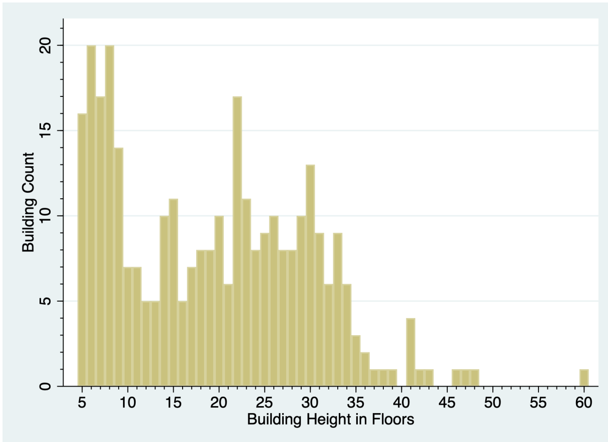


Figure 2: Building Count by Height

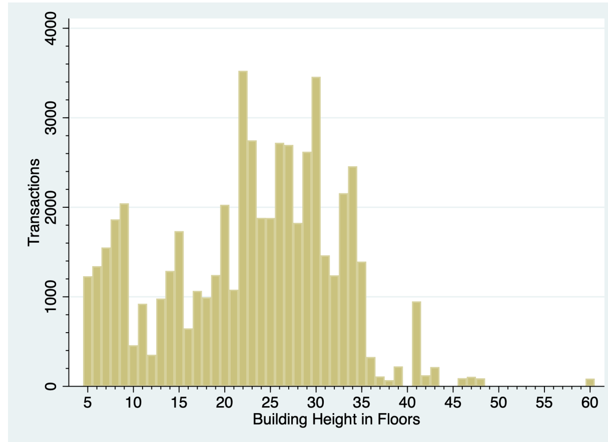


Figure 3: Transactions by Height

Estimating the effect of vertical status requires that we control for other amenities that are associated with floor level. For shared building attributes such as building height, status, location, quality, and shared amenities, we include a vector of building fixed-effects in the estimation. For individual unit height and view, we include floor fixed-effects and a set of view measures, respectively.[13] For the latter, we follow Dai, Felsenstein, and Grinberger (2021) and use geographic information system (GIS) software and files of building massing adjusted for year of construction to derive a continuous measure of view based on the total area of a plane of unobstructed lines of sight up to one kilometer. Our view measure is floor-building-year-compass quadrant specific.[14]

As we do not directly observe the orientation of apartment units on each floor, we use two alternative approaches to assess the unit-specific view measure. In the first, we assign all units on a floor of a given building in a given year the same value for view in each compass-quadrant. Assuming that all units on a floor have an equal probability of selling, the coefficients for the values of these views are unbiased estimates of the mean individual unit view effect on a given floor. We refer to this measure as an average floor view. In another approach, we impose the assumption that units with high positive residuals in a

are buildings with commercial units and/or amenity and service space on bottom floors.

[13]Noise levels are concave in height (see Wu et al. 2019) and are captured by floor fixed-effects.

[14]We have distinct values for the view quadrant: 1-90 degrees (NE), 91-180 degrees (SE), 181-270 (SW), and 271-360 (NW). These are unique for each floor-building-year, where the latter controls for the timing of new construction over our study period. In addition to view, the quadrant-specific measures capture exposure to natural light by compass direction.

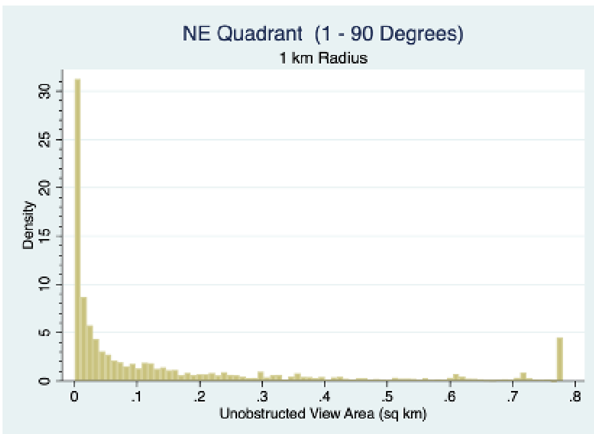
first-stage hedonic price regression that excludes view and status are those with the best views. We refer to this measure as an individual specific view, which may be an upwardly biased estimate of the view value. Detailed descriptions of the derivations of the average floor view and individual specific view measures are presented in Appendix C. [15]

Figure 4 presents the distribution of average floor view values by quadrant. As shown, many units have a limited view because they face an adjacent building. Given our lack of priors on the shape of the view valuation function, in the estimation we treat view non-linearly, converting the view values by quadrant into deciles so that we gave forty distinct view dummies (four quadrants by nine dummies for declines 2-10 per quadrant).

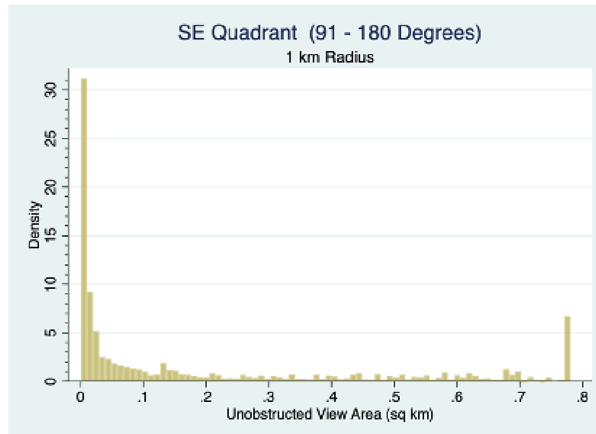
Table 1 presents descriptive statistics of the variables in estimated equation (4). As indicated in the table, the typical unit is a 1- to 2-bathroom, 880-square-foot condominium apartment located on the 12th floor of an 8-year-old structure. For convenience, we show price variables in nominal terms as well as indexed to July 2018 Vancouver Census Metropolitan Area (CMA) condo prices—both total price and per sqft.[16] Notably, the mean indexed price is \$C 1.15M (where \$C 1.00 = \$US 0.76 in July 2018), reflecting the high cost of real estate in Vancouver.

[15] As described below, our estimated value of vertical status is robust to the choice of the view measure. Also, while we report the view measures computed with a 1-kilometer radius, results are robust to increasing the view radius to 5 kilometers.

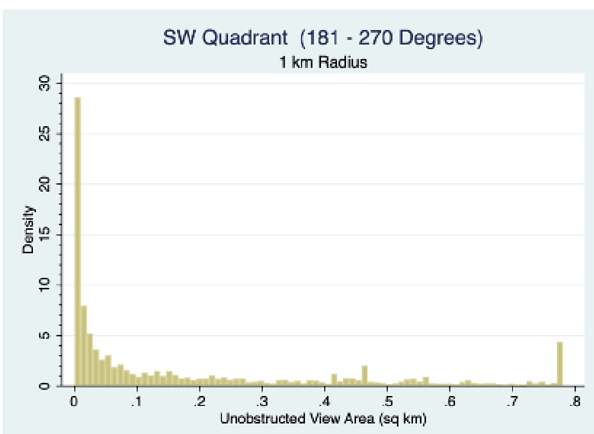
[16] To deflate to July 2018 condominium prices, we use a repeat-sales index for condominium transactions in the Vancouver CMA, excluding those in the downtown peninsula. These data are sourced from BC Assessment, using the assessment roll and their database of registered transactions deemed suitable for valuation. We windsorize using these deflated prices.



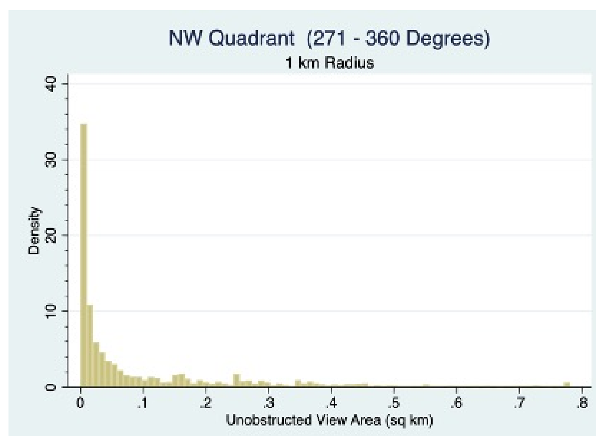
((a)) NE Quadrant



((b)) SE Quadrant



((c)) SW Quadrant



((d)) NW Quadrant

Figure 4: Distribution of Average Floor View Values by Quadrant

	count	mean	sd	min	max
Transaction price	55274	434947	432351.4	65000	1.50e+07
price per sq ft	55274	468.177	249.8523	93.56538	13691.64
ln sales price per sq ft	55274	6.024822	.495412	4.538661	9.524541
Real price - condo price index 7/18=100	55274	1146964	880629.1	304142	2.75e+07
Real price per sf - condo price index 7/18=100.	55274	1243.514	349.9701	339.18	27653
Floor area	55274	.8795179	.3890218	.305	4.469
# of Bedrooms	55274	1.548667	.7564196	0	4
# of baths (full+part)	55274	1.495875	.6161746	1	4
Unit effective age	55274	7.895896	8.245227	0	88
Dummy = unit renovated/updated	55274	.0703767	.2557831	0	1
Vertical Status, $\frac{(i-1)}{(N-1)}$	55274	.5044494	.2762962	0	1
Unit's floor - calculated	55274	12.07012	8.240589	1	60
Highest residential floor in building	55274	22.83327	9.389515	5	60
Dummy - unit is a penthouse	55274	.0069291	.0829532	0	1
Dummy, - unit is on top floor	55274	.0341028	.181495	0	1
Floor avg. view (sq km), NE quadrant	55274	.1502232	.2210233	.000071	.780326
Floor avg. view (sq km), SE quadrant	55274	.1995143	.261329	.000103	.780502
Floor avg. view (sq km), SW quadrant	55274	.1807022	.2335436	.000512	.78065
Floor avg. view (sq km), NW quadrant	55274	.1047762	.1579714	.000107	.780636
Estm unit specific view in NE quadrant	55274	.0812138	.1658972	0	.780326
Estm unit specific view in SE quadrant	55274	.1055159	.1961742	0	.780502
Estm unit specific view in SW quadrant	55274	.0868737	.1671448	0	.78065
Estm unit specific view in NW quadrant	55274	.0615936	.120923	0	.780636

Table 1: Summary Statistics

5 Results

5.1 Base Specification

Table 2 presents the results from the baseline estimation of equation (4), where $\eta = 1$.[17] Columns 1– 3 present the outcomes for the full sample and differ by choice of the view measure: no view, floor average view, and unit-specific view controls in columns 1, 2, and 3, respectively. We also repeat the estimation for the sub-sample of buildings with up to 40 stories in height, using average view and unit-specific view controls in columns 4 and 5, respectively. As indicated in columns 1–5, the estimated coefficient on vertical status is statistically and economically significant under all specifications. Specifically, *ceteris paribus*, a unit on the top floor of a building sells for an average price premium of about 9.0–9.4 percent, as compared to the same unit on the bottom floor of the building (equal to about \$C 103K–107K or \$US 78K—82K).[18] In all subsequent estimations, we use the full set of controls employed in Table 2, including the unit average view measure. All Results, however, are robust to using unit-specific measure (not reported and available upon request).

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[17] Standard errors are clustered at the building level. In addition, we use fixed-effects for the number of bedrooms and the total number of full and partial bathrooms. Results are robust to using the latter in a continuous form.

[18] While we do not show the height gradient constructed from these fixed effects nor view premia outcomes in the table, the marginal price effects in rising in both. Appendix C provides more detail on the view effects.

[19] Standard errors are clustered at the building level. In addition, we use fixed-effects for the number of bedrooms and the total number of full and partial bathrooms. Results are robust to using the latter in a continuous form.

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	(1) All	(2) All	(3) All	(4) <40 Flrs	(5) <40 Flrs
Vertical Status, $\frac{(i-1)}{(N-1)}$	0.089***	0.094***	0.090***	0.099***	0.094***
	(0.017)	(0.017)	(0.017)	(0.016)	(0.016)
Floor area	-1.34***	-1.34***	-1.28***	-1.40***	-1.36***
	(0.14)	(0.14)	(0.13)	(0.15)	(0.13)
Floor area - sq	1.13***	1.13***	1.06***	1.20***	1.15***
	(0.14)	(0.14)	(0.13)	(0.14)	(0.13)
Floor area - cubed	-0.35***	-0.35***	-0.33***	-0.39***	-0.37***
	(0.053)	(0.052)	(0.049)	(0.054)	(0.047)
Floor area - 4th	0.038***	0.038***	0.035***	0.043***	0.041***
	(0.0066)	(0.0066)	(0.0063)	(0.0068)	(0.0060)
Unit effective age	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(0.00081)	(0.00079)	(0.00080)	(0.00082)	(0.00083)
Unit effective age - sq	0.000057*	0.000047*	0.000041	0.000049*	0.000044
	(0.000024)	(0.000023)	(0.000023)	(0.000023)	(0.000023)
Dummy, unit renovated	0.028	0.028	0.027	0.028	0.028
	(0.015)	(0.015)	(0.014)	(0.015)	(0.014)
Floor Avg View	No	Yes	No	Yes	No
Unit Specific View	No	No	Yes	No	Yes
N	55274	55274	55274	53616	53616
adj. R^2	0.943	0.944	0.947	0.942	0.945

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year. The sample for regressions (4)-(5) is restricted to buildings with fewer than 40 floors. Vertical status is for $\eta = 1$. Standard errors are clustered at the building level.

Table 2: Vertical Status – Baseline Regressions

[20] While we do not show the height gradient nor view premia outcomes in the table, Appendix **??** and C, respectively explore these results in detail.

The above empirical specifications control for, *inter alia*, unit height, up to a fourth-degree polynomial of unit size, and average building effect. To address potential unique unobserved features of units on top floors, Table 3 presents outcomes from re-estimating equation (4), specifically controlling for these units. We include a dummy variable for whether a unit is identified as a penthouse (columns 1 and 3) or on the top floor (columns 2 and 3). Further, in columns 4 and 5 we exclude the top 10 and 15 percent, respectively, of vertical status values—which always include the top floor units whose vertical status equals 1.

	(1) All	(2) All	(3) All	(4) Status < 0.9	(5) Status < 0.8
Vertical Status, $\frac{(i-1)}{(N-1)}$	0.081***	0.042*	0.043**	0.048**	0.038*
	(0.017)	(0.016)	(0.016)	(0.017)	(0.019)
Dummy, unit is a penthouse	0.094***		0.061***		
	(0.014)		(0.017)		
Dummy, unit is on top floor		0.059***	0.048***		
		(0.0085)	(0.0092)		
Observations	55274	55274	55274	50578	44871
Adjusted R^2	0.944	0.944	0.944	0.946	0.948

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2, specification (2), along with the set of fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year and the building specific average floor view measures. Regressions (4)-(5) restrict the sample to observations with status values below the indicated threshold. Vertical status is for $\eta = 1$. Standard errors are clustered at the building level.

Table 3: Vertical Status Effect of Top Floors

The results from the specifications in Table 3 show that after controlling for penthouse and/or top floor (columns 1-3) or excluding the top 10-15 percent of vertical status values (columns 4-5), the effect of vertical status remains positive (significant at 1 to 5 percent depending on specification) with a range of magnitude between 3.8 to 8.1 percent. These lower estimates (as compared to 9.0–9.4 percent shown in Table 2) are consistent with the convexity of price in relation to vertical status, i.e., that top floor units are also those with the highest marginal status effect. Hence, controlling for those units or excluding them from the sample decreases the estimated average vertical status price effect.[21] Discussions

[21]Convexity of price with regard to vertical status would suggest that those with stronger (weaker)

with developers confirm that, other than for penthouses, unit features are essentially consistent throughout all floors of a building. In all further estimations, we therefore include a penthouse dummy.

To allow for varying vertical status preferences across floors, we re-estimate equation (4), stratifying the sample by units: (a) below/above the sample median floor (columns 1 and 2, respectively); and (b) short/tall buildings, i.e. buildings that are below/above the median building height floor count (columns 3 and 4, respectively), where the median is based on transaction count.[22] Results from these specifications are presented in Table 4.

	(1) Low	(2) High	(3) Short	(4) Tall
Vertical Status, $\frac{(i-1)}{(N-1)}$	0.094^{***}	0.27^{***}	0.087^{***}	0.11
	(0.018)	(0.070)	(0.021)	(0.076)
Observations	28233	27041	27096	28178
Adjusted R^2	0.944	0.945	0.946	0.944

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2 specification (2), along with fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3. "Low" are units on or below the 10th (median) floor. "High" are those above that floor. "Short" are units in buildings at or below the median building height of 23 stories. "Tall" are units in buildings above thisheight. Medians are for the total number of transactions. Vertical statusis for $\eta = 1$. Standard errors are clustered at the building level.

Table 4: Vertical Status – Lower vs Higher Floors and Short vs. Tall Buildings

As shown, outcomes indicate differences in preference for vertical status. The point estimate for the marginal effect of vertical status is approximately three times as high for units that are above the median floor (column 2), as compared to those below the median floor (column 1). The difference between units in shorter and taller buildings (columns 3 and 4, respectively) is smaller in magnitude and not statistically different from zero, though

preferences for vertical status sort into higher (lower) floors. While we do not formally show separation in equilibrium, intuitively, the single-crossing property required for separation maintains, as the net cost of occupying higher floors (i.e., the cost net of the benefit associated with vertical status) is lower, the greater is the preference for the vertical status.

[22]The median unit floor in the data is 10. The median number of floors in a building by transactions is 23.

the point estimates suggest that marginal vertical status may be higher in taller buildings. In summary, results suggest heterogeneity in the preference for vertical status that manifests in non-homogeneous marginal prices of vertical status across different floor levels. Below we explore the convexity in the price effect of status by allowing for both more nonlinearity in the relative floor effect and different η parameter for different floors.

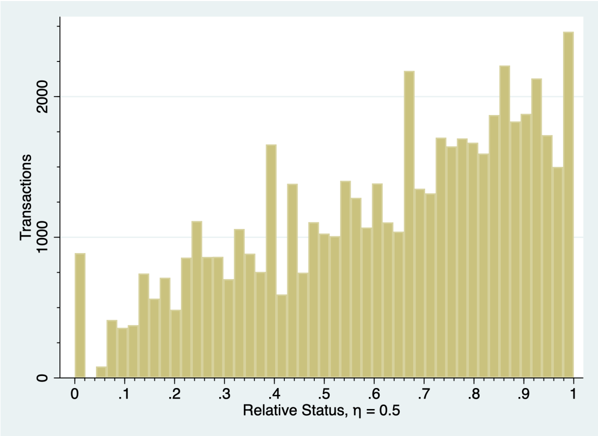
5.2 Vertical Status Functional Form

In the analysis above, we assume that $\eta = 1$ on the right-hand side of equation (2). This imposes that the vertical status effect is symmetric in individual preferences; i.e., that the disutility from being below some and the benefit from being above others are equally weighted in the utility function. We now relax this assumption and use the fuller expression of VS found in equation (2), using different values of η. In equation (2), note that as η approaches infinity, VS approaches a dichotomous variable with the value of 1 for top-floor units and 0 for all other units. In other words, all that one is concerned with is that there are no units above her. Similarly, when η approaches 0, then VS approaches a dichotomous variable with the value of 0 for the bottom floor unit and 1 for all other units; that is, all that one considers is that there are some units below her.

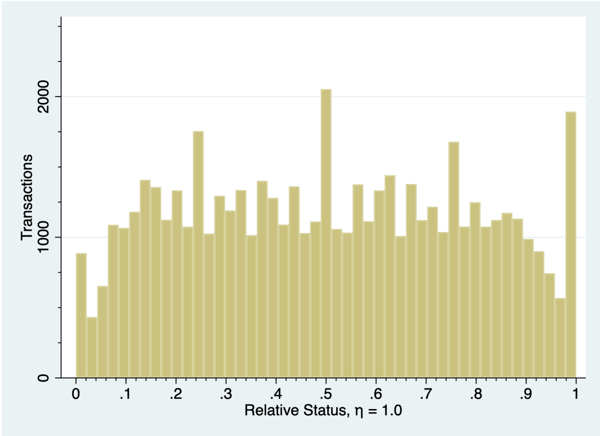
Figure 5 presents the sample distribution of vertical status for different levels of η ($\eta =$ 0.5, 1, 2, and 3) based on equation (2). As shown, while the distribution is roughly uniform for $\eta = 1$, the mass of the distribution shifts towards 0, as the value of η increases, except for the top floor units that remain at 1. In contrast, when $\eta < 1$, the mass of the distribution shifts toward 1, except for the bottom floor units that remain at 0.

Next, we examine how varying η changes the estimated marginal price effect of vertical status. To do so, we re-estimate equation (4) using different values of η. Following equation (2), we compute VS for η to varying from 0.5 to 5.0. Results from these estimations are presented in Table 5. As shown, the coefficient on the vertical status variable is positive and significant for all values of η. The estimated coefficient on vertical status declines in magnitude as η increases, though at a decreasing rate, stabilizing at $\eta = 3$.

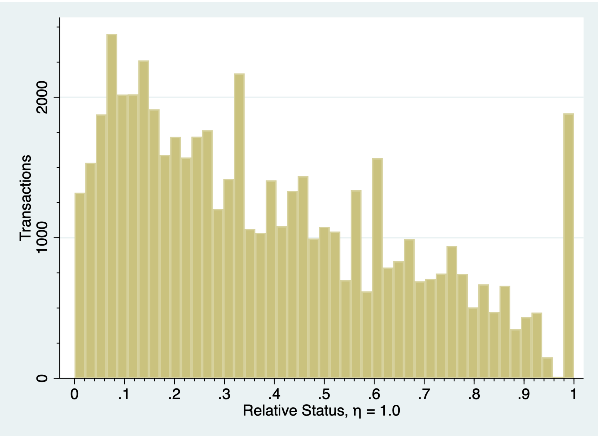
To assess the appropriate value of η, Figure 6 presents the coefficient on VS obtained



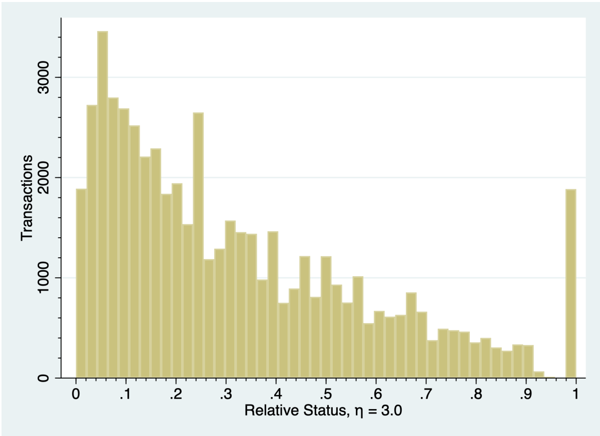
((a)) $\eta = 0.5$



((b)) $\eta = 1$



((c)) $\eta = 2$



((d)) $\eta = 3$

Figure 5: Distribution of Vertical Status by η

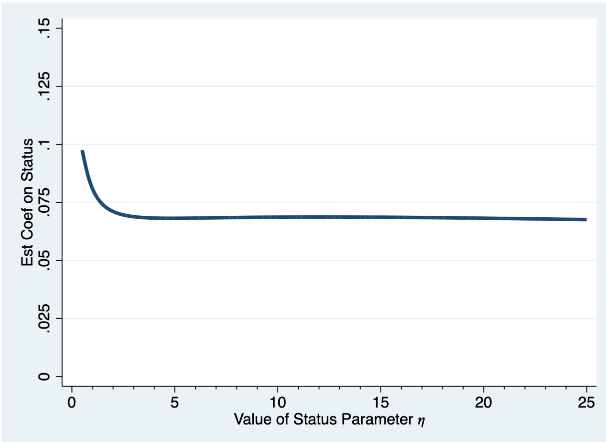
	(1)	(2)	(3)	(4)	(5)	(6)
Vertical status, $\eta = 0.5$	0.089^{***}					
	(0.025)					
Vertical status, $\eta = 0.75$		0.080^{***}				
		(0.019)				
Vertical status, $\eta = 1.0$			0.074^{***}			
			(0.017)			
Vertical status, $\eta = 2.0$				0.065^{***}		
				(0.013)		
Vertical status, $\eta = 3.0$					0.064^{***}	
					(0.012)	
Vertical status, $\eta = 5.0$						0.064^{***}
						(0.011)
Observations	55274	55274	55274	55274	55274	55274
Adjusted R^2	0.944	0.944	0.944	0.944	0.944	0.944

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2, specification (2), along with the set of fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3. Standard errors are clustered at the building level. regressions vary by the value of η used to calculate VS for each unit.

Table 5: Vertical Status – Allowing for Variation in η

from estimating equation (4) for $\eta = [0.5, 25]$. As shown, the level of the coefficient flattens beginning with $\eta = 3$. Also, Figure 7 plots the change in the estimated vertical status coefficient in units of standard deviation against the same set of η values and highlights the same pattern in stability of the estimated coefficient around $\eta = 3$. Finally, Figure 8 presents , regression adjusted-R^2 for the same set of η, demonstrating that a maximum level of adjusted-R^2 is reached at about $\eta = 3$. Taken together, these results suggest that the appropriate value for η is greater than 1, implying that the preference for vertical status is more heavily weighted towards the loss from being below some than the benefit from being above others.[23] This conclusion is also consistent with a higher marginal value of vertical status for units above the median floor, shown earlier in Tables 4 and 3.

[23]Our evidence according to which $\eta > 1$ for vertical status is also consistent with Boyce, Brown, and Moore (2010) who find that $\eta = 1.75$ for rank-income.



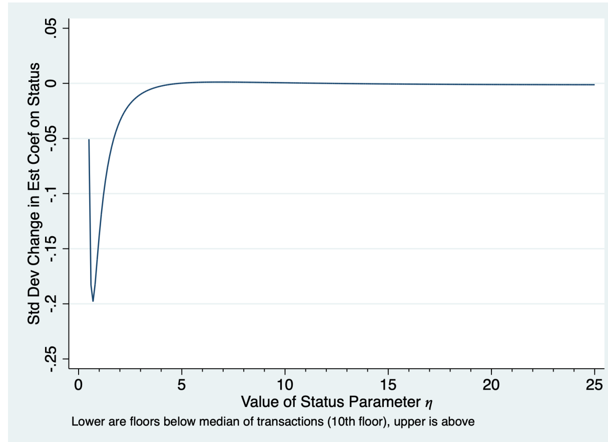


Figure 6: Status Coefficient by η

Figure 7: Std. Dev. Change in Est. Coeff.

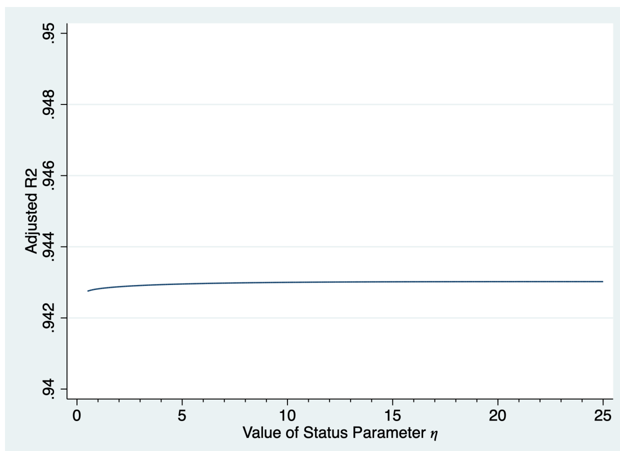


Figure 8: Adjusted R-Sq by η

Recall that Tables 4 and 3 indicate that the marginal effect of vertical status varies between lower and upper floors for $\eta = 1$. Correspondingly, we now vary η in the range of 0.5–25 and re-estimate equation (4), stratifying the sample by units on floors below/above the median floor within each building (i.e., own building lower versus upper floors). Results from these estimations are presented in Figure 9. As shown, consistent with previous outcomes, the marginal price effect of vertical status is greater for upper floor units, as compared to lower ones for all values of η. Also, as discussed above, the coefficient point estimates stabilize at $\eta > 1$.

Finally, we allow the marginal price effect of vertical status to vary non-parametrically,

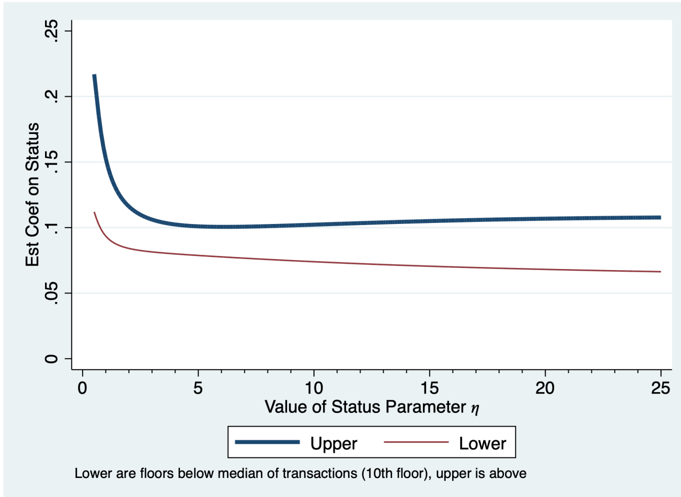


Figure 9: Upper vs Lower: Status Coefficient by η

relying on the above results to evaluate this relaxation of the parametric form for $\eta = 3$. Specifically, we allocate the vertical status measure (for $\eta = 3$) into 10 bins of equal number of observations by value, creating VS decile fixed-effects. We then re-estimate equation (4), replacing the continuous measure of vertical status with the VS decile fixed-effects. Figure 10 plots the point estimates and their 95 percent confidence intervals. As shown, vertical status is lower in magnitude for lower deciles of vertical status value, higher and at a plateau for the mid-range deciles, and increasing convexly for the top three deciles. These findings reinforce the separation pattern in vertical status preferences indicated earlier in Tables 4 and 3.

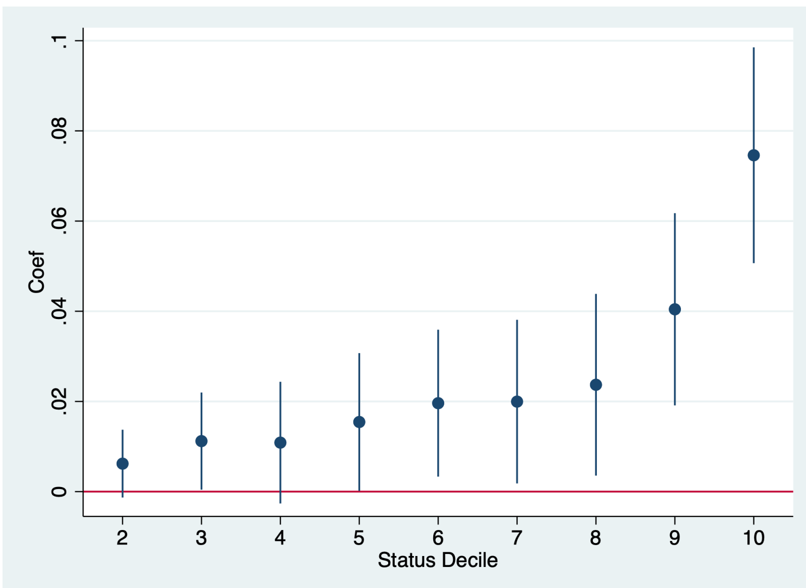


Figure 10: Non-Linear Status, η=3

5.3 Vertical Status and Neighboring Buildings

We complete the exploration of relative status by estimating the price effect generated from the vertical position of one's own *unit* relative to the heights of the collection of *neighboring buildings*. For apartment j on floor i in building m, let R_m be the total number of buildings in the ring of a defined radius around the reference unit's building and k_{im} be the number of buildings (among R_m) whose maximum elevation is **below** that of the reference apartment unit j, as defined by its floor i, i.e., $k_{im} = [0, R_m]$. We then define the area vertical status, AVS_im, as:

$$AVS_{im} = \frac{k_{im}}{k_{im} + \eta(R_m - k_{im})} \tag{5}$$

Equation (5) is analogous to equation (2), where k_{im} and R_m in (5) respectively replace $i - 1$ and N in (2). Similar to the distribution of VS in equation (2), in equation (5) $AVS = [0, 1]$. Specifically, when unit j on floor i is above all neighboring buildings, then $k_{im} = R_m$, yielding $AVS_{im} = 1$ for all η. When all buildings in the neighboring ring are higher than i, then $k_{im} = 0$ and $AVS_{im} = 0$ for all η. The values for k and R for any unit typically fall and rise, respectively, with the size of the ring radius used in defining neighbouring buildings. In Appendix B, we show the distribution of AVS and its descriptive statistics for different values of η and different ring radii.

We re-estimate equation (4) adding AVS on the right-hand side of the equation. Results from this estimation are presented in Table 6, where columns 1–3 (4–6) are based on an AVS computation under a 100- (250-) meter ring and within each triplet we vary the value of η used in computing the vertical status (area vertical status) measure (η equals either 1, 3, or 5). As show, both vertical status and area vertical status are generally positive and significant (with the exception of the area vertical status for $\eta = 1$ and 250-meter ring). Specifically, estimated coefficients on the area vertical status measure suggest a price premium of 2.2–4.7 percent for a unit that is higher than all surrounding buildings, as compared with one that is lower than all surrounding buildings. For $\eta = 3$, the range of this price premium is 2.6–3.7

percent. The outcomes for the (within-building) vertical status coefficient are robust to the inclusion of the area vertical status measure, ranging from 6.0–7.2 percent with all coefficient estimates statistically different from zero at the 1 percent level.

	(1) 100m Ring	(2) 100m Ring	(3) 100m Ring	(4) 250m Ring	(5) 250m Ring	(6) 250m Ring
Vertical Status, η=1	0.068***			0.072***		
	(0.017)			(0.016)		
Area Vertical Status, η=1	0.022*			0.018		
	(0.011)			(0.017)		
Vertical Status, η=3		0.060***			0.061***	
		(0.012)			(0.012)	
Area Vertical Status, η=3		0.026*			0.037*	
		(0.011)			(0.017)	
Vertical Status, η=5			0.060***			0.060***
			(0.011)			(0.011)
Area Vertical Status, η=5			0.028*			0.047**
			(0.011)			(0.017)
Observations	55195	55195	55195	55195	55195	55195
Adjusted R^2	0.944	0.944	0.944	0.944	0.944	0.944

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2, specification (2),along with the set of fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3.Standard errors are clustered at the building level. Regressions vary with the value of η and the radius of the ring used to define the set of neighbouring buildings for the "Area Vertical Status" AVS measure, which like VS is [0,1].

Table 6: Vertical Status Relative to Neighbouring Buildings

To further gauge the price effect of area vertical status, we re-estimate equation (4), considering AVS non-parametrically. Specifically, for $\eta = 3$ and a ring radius of 250 meters, we allocate the computed AVS into 10 bins (of equal number of observations) based on value, creating AVS decile fixed-effects (lowest decile as the base group). Figure 11 presents the estimated coefficients and their 95 percent confidence interval. As shown, while AVS decile coefficients are all positive and generally increase with deciles, only the two highest deciles are statistically different from zero with 95 percent confidence – implying that being taller than all of the surrounding, *ceteris paribus*, generates about 5 percent price premium.[24]

[24]We see these outcomes as confirming Dr. Suess' insights on status: King Yertle (the turtle) revels in being the king of the pond but additionally so for being king "as far as he could see," (if his eyesight is good enough to see up to 250m).

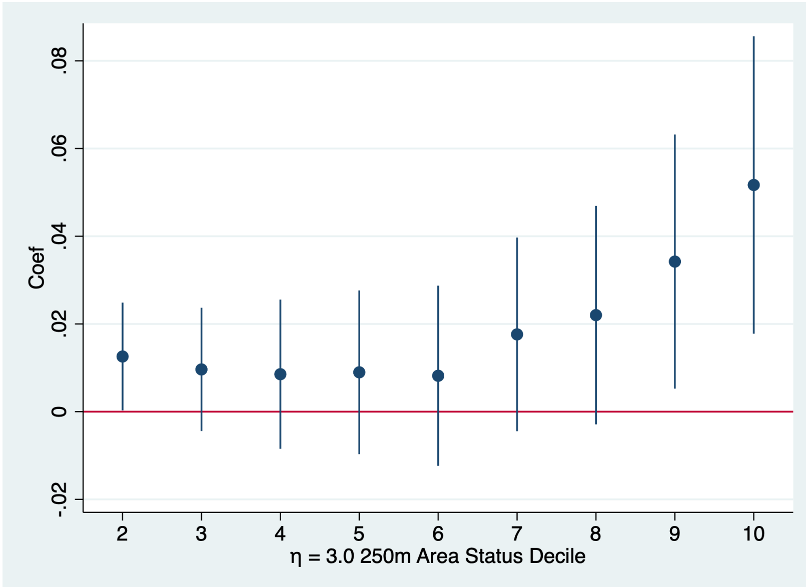


Figure 11: Area Status Coefficient by Deciles

5.4 Additional Robustness Tests

We present a series of additional tests that assess the robustness of our findings to sampling-related issues. Specifically, we test whether our results are driven by: (*a*) the inclusion of foreign buyers/investors in the sample; (*b*) data period and building vintage; (*c*) unobserved unit quality; and (*d*) higher priced neighbourhoods who might have greater preference for status. In these tests, we re-estimate equation (4) for $\eta = 3$ with various sample specifications in order to validate robustness.

Miyakawa, Shimizu, and Uesugi (2022) and Devaney and Scofield (2017) report that foreign buyers pay more for commercial properties. While we do not observe the residency status of the buyers in our data, the Canadian Housing Statistics Program reports that condominium apartments built in 2015/2016 in the Vancouver CMA exhibit higher foreign ownership (15.7 percent) than for all condominium apartments (8.4 percent).[25] To test whether foreign buyers drive the vertical status effect in our data, we thus stratify the sample by structure age: 75th percentile and higher (12 years or more); 50th percentile and higher (6 years or more); 50th percentile and lower (5 years or less); and 25th percentile and lower (2 years or less). Results from re-estimating equation (4) for the stratified sample with

[25]See Statistics Canada, Cansim database Table 46100018.

$\eta = 3$ are presented in Table 7. The results are robust to these specifications. The estimated coefficients on the vertical status variable for all sub-samples are not statistically different from one another and are generally similar to the those obtained for $\eta = 3$ in Table 5.

	(1) All	(2) Older	(3) Old	(4) Newer	(5) New
Relative Status,	0.069***	0.078***	0.081***	0.072***	0.071***
= 3.0	(0.012)	(0.012)	(0.014)	(0.017)	(0.020)
Observations	55274	28074	14841	27200	15489
Adjusted R^2	0.944	0.951	0.948	0.944	0.935

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2, specification (2), along with the set of fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3. Standard errors are clustered at the building level. Regression (1) includes observations; in Regression (2) ("older") the sample is limited to transactions of all units above median age (≥6 years); in Regression (3) ("Old") the sample is for transactions of units in the top 25th percentile of age (≥12 years); "Newer"; and "New" in Regression (4) and (5), limit the sample to units below the median unit age (≤5 years) and to the newest 25 pct (≤2 years) of units, respectively.

Table 7: Robustness - Newer vs Older Buildings

Existing evidence suggests that the share of foreign investment in the real estate markets has increased during our sample period.[26] To further test for the possible effect of foreign buyers on the vertical status coefficient, we stratify the sample by transaction year with periods before 2005, before 2011, after 2009, and after 2012. Results from the estimation of equation (4) for these specifications are presented in Table **??**. As indicated in the table, outcomes on the vertical status effect are robust to these specifications, as all vertical status coefficients are once again of similar magnitude and statistically different from zero.

Above we controlled for or excluded top floors. Here we segment the data by age and exclude renovated units to address age-related unobservables. The underlying rationale is that the market value of higher-grade finishings relative to baseline features may decline

[26]Data on foreign investment in residential real estate in Australia, for example, shows a significant increase in the volume of investment beginning in the 2013–2014 reporting period. Most of the increase is from Chinese registered companies and citizens. See Australia Foreign Investment Review Board, Annual Reports, `https://firb.gov.au/about/publication/`.

with property age (e.g., a fashionable kitchen countertop may matter substantively when the unit is new but less so for older units, where that counter top has become dated). Also, by omitting renovated units, we exclude units that have been upgraded.[27] Table 9 presents the outcomes for the following sub-samples of our transactions data: column 1 excludes units built prior to 1970; column 2 further excludes units that had a building permit for renovation; column 3 includes units older than median age (transactions of units at least 6 years old); and column 4 includes the oldest quartile (transactions of units at least 12 years old). As indicted in the table, the point estimates for status are robust to these specifications, as all coefficients on vertical status are significant and within one standard deviation of one another.

	(1) Post 1970	(2) No Reno	(3) Older	(4) Old
Relative Status,	0.064***	0.064***	0.074***	0.074***
= 3.0	(0.012)	(0.012)	(0.013)	(0.014)
Observations	53562	52516	25943	13902
Adjusted R^2	0.944	0.944	0.951	0.948

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is log price per square foot. All regressions include the unit characteristic controls from Table 2 specification (2), along with fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3. Regression (1) is for all units built after 1970 to exclude those most likely to have been renovated. In regressions (2)-(4) the sample excludes all units that can be identified as having been renovated or updated. Regression (3) further limits the sample to units above median age (≥6 years). And in regression (4) the sample is constrained to units in the top 25th percentile of age (≥12 years). Standard errors are clustered at the building level.

Table 9: Robustness – Older without Renovation

Finally, we test whether the vertical status price effect is driven by a greater preference for status in more expensive neighborhoods. To do so, we estimate a first-stage regression that is a variation of equation (4), replacing building fixed-effects with census tract fixed-effects.

[27] Renovation is measured by the presence of a building permit having been drawn. Strata (condominium) board rules generally require permits for substantive renovations because of risk to common property.

We then stratify the sample by census tract value based on the distribution of the census tract fixed-effect point estimates: up to the 25th percentile; up to the 50th percentile; above the 50th percentile; and above the 75th percentile. Results from re-estimating equation (4) for the stratified sample are presented in Table 10. As indicated in the table, outcomes are robust to these specifications, as all vertical status coefficients are significant and roughly of the same magnitude.[28]

	(1) All	(2) 25th Pct	(3) 50th Pct	(4) 75th Pct	
Relative Status,	0.069***	0.077***	0.076***	0.071***.	.
= 3.0	(0.012)	(0.021)	(0.016)	(0.013)	.
Observations	55274	16427	28874	45263	
Adjusted R^2	0.944	0.959	0.954	0.950	

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The variable is log price per square foot. All regressions include the unit characteristic controls from Table 2 specification (2), along with fixed effects for # of bedrooms, # of bathrooms, floor, building, and month-year; the building specific average floor view measures; and the penthouse dummy from Table 3. Percentiles for each regression (1)-(4) are is based on a unit'scensus tract fixed effect CDF from a 1st stage hedonic regression to identify census tract fixed effects. The samples are the units at or below these percentile values. Standard errors are clustered at the building level.

Table 10: Robustness - Higher vs Lower Price Neighbourhoods

6 Summary

The economics, psychology, and sociology literatures have long recognized and substantiated the fundamental role of status in individual choices and behaviour. In this paper, we contribute to this literature by establishing, exploring, and pricing the relative vertical positionality aspect of status; namely the desire to (not to) be vertically positioned above (below) others. We refer to this as vertical status, designating hierarchy in the physical

[28]Census tracts do not have equal numbers of transactions among our buildings so that the distribution by census tracts is different than the distribution of transactions.

vertical space.

To estimate the value of vertical status, we use an extensive dataset of condominium apartment transactions from Vancouver (Canada). We show that, *ceteris paribus*, vertical status composes an average premium of 6–7 of the average unit price for the highest vertical status housing unit relative to the lowest one within the same building. In addition, we find that vertical status is convex in floor level, implying that those with greater (lesser) preference for vertical status tend to sort into higher (lower) floors. We also find evidence that people weigh more heavily the dis-utility from having some positioned above them than the utility from having others below them. Finally, results indicate that the preference for vertical status persists not only in relation to other floors in one's own building, but further extends in relation to other buildings in one's neighborhood. Overall, our outcomes are consistent with Dr. Suess' allegory on Yertle the Turtle (Geisel 1950) regarding human preferences and behavior: it is not only that we desire to be above others in the vertical dimension, but also it is particularly our strong distaste for seeing others above us.

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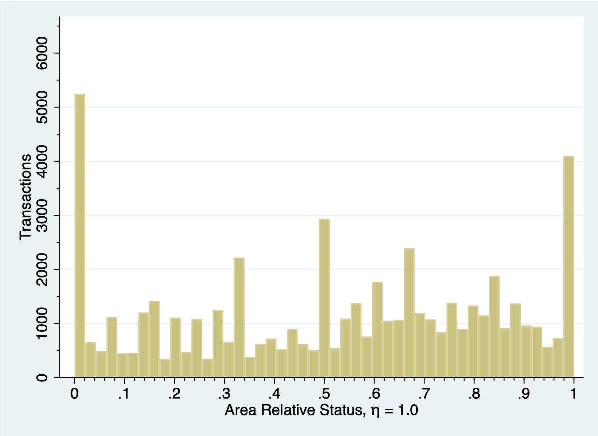
Appendix

A Data Set Construction

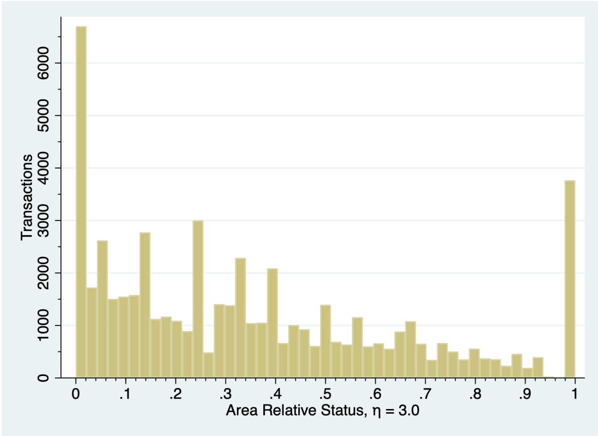
BC Assessment reports 76,799 individual unit transactions with a reported price that occurred in 1992–2016 and are registered in the Land Title Office. We limit the data to one price per transaction per day such that if multiple prices are recorded on the same day, we use the highest among them. Of these reported transactions, 3,950 are in buildings that are four stories or lower and are dropped from the sample. We also remove sales that are not fee-simple or that BC Assessment internally deems invalid for statistical appraisal, removing another 5,515 observations. We further drop transactions that likely reflect the price of a pre-sale contract, i.e., transactions that occur on the first three days of occupancy – thus removing 5,197 additional transactions. Due to missing data for control variables, we further drop 6,804 observations of which 5,521 are due to unobservable bedroom count. We also windsorize by price (using real house prices), dropping the top and bottom 0.05 percent of the sample (prices under $C30,412 and over $C10,800,000). Finally, we remove outliers, including units with more than four bedrooms or more than four bathrooms, a total of 50 transactions, as well as 79 transactions that occur in buildings without neighbouring buildings over three stories in the 100m radius. This leaves a sample of 55,274 transactions, out of which 55,195 are with neighbouring buildings.

B Vertical Status and Area Vertical Status Measures

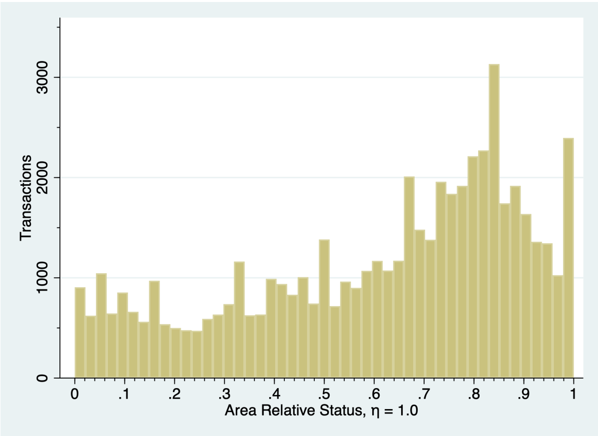
Figure B-1 depicts the distribution of AVS by η and ring radius. Table B-1 further presents summary statistics of VS and AVS for different levels of η and ring radius. As indicated in the table, VS and AVS do not exhibit substantial difference in the first and second moments for the 100-meter radius. For the 250-meter ring, there are some differences in the mean value, however, the standard deviations remain similar in magnitude.



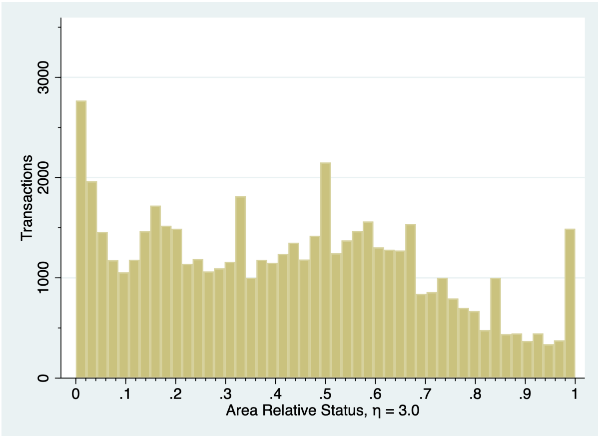
((a)) $\eta = 1$, 100m ring



((b)) $\eta = 3$. 100m ring



((c)) $\eta = 1$, 250m ring



((d)) $\eta = 3$, 250m ring

Figure B-1: Distribution of Area Relative Status by η and Ring Radius

	count	mean	sd	min	max
100m Ring					
Relative status, η= 0.5	55195	.623045	.2632138	0	1
Relative Status, η= 1.0	55195	.5044542	.2762869	0	1
Relative Status, η= 2.0	55195	.3865195	.2709012	0	1
Relative Status, η= 3.0	55195	.322631	.2605718	0	1
Area relative status, η=.5	55195	.6203229	.3143381	0	1
Area relative status, η=1	55195	.5198933	.3144282	0	1
Area relative status, η=2	55195	.4145633	.305706	0	1
Area relative status, η=3	55195	.3556963	.2971714	0	1
# of buildings in ring	55195	18.12729	11.8293	2	57
# of buildings in ring above unit	55195	7.701513	7.491203	0	52
250m Ring					
Relative status, η= 0.5	55195	.623045	.2632138	0	1
Relative Status, η= 1.0	55195	.5044542	.2762869	0	1
Relative Status, η= 2.0	55195	.3865195	.2709012	0	1
Relative Status, η= 3.0	55195	.322631	.2605718	0	1
Area relative status, η=.5	55195	.7133793	.2608983	0	1
Area relative status, η=1	55195	.6099331	.2782066	0	1
Area relative status, η=2	55195	.493679	.2792871	0	1
Area relative status, η=3	55195	.4240944	.2722462	0	1
# of buildings in ring	55195	96.26222	50.98937	6	264
# of buildings in ring above unit	55195	35.05127	33.39329	0	259

Table B-1: Summary Statistics - Relative Status Measures

C View Estimation

C.1 Floor Average View Measure

For the GIS 3-D modelling, floors in each building are identified in meters of elevation. The City of Vancouver property footprint database includes the elevation of a building's base, its massing, and the height of the tallest point of the structure. Heights are allocated to floors with an assumption of a lobby height of 4.7 meters, a mechanical floor every 30 floors with a height of 4.65 meters, and a roof and equipment height of 6.2 meters. The remaining height is allocated evenly by floor. On each floor, the view level is assumed to be 1.7 meters above the floor height.[29]

The same database allows us to construct the massing of all other buildings in a given year based on the year of completion. We make the following assumptions for the temporal variation in the city's built form: (a) prior to construction of the current building, the lot was occupied by a three-story building, as we have no data on earlier urban built forms and it is reasonable to assume low density development; (b) tower podium form is 3-story tall base, where we use the building tower footprint for tower and podiums; (c) a building's massing is completed one year prior to the year of completion; and (d) within the completion year, date of completion is July 1.

This approach should yield an unbiased estimate of the view effect on price but with higher standard errors, as all units on a floor in a given building in a specific year are assigned the same view for each quadrant. We relax the latter assumption by further estimating a unit-specific view measure, as described next.

C.2 Unit-Specific View Measure

To generate an estimate of unit-specific views based on average floor views, we assume that the rank ordering of unobserved differences in prices among units on a given floor in a given building is a one to one mapping of the rank ordering of the view value. Based on building alignment, the number of units per floor, and view values for each quadrant, we rank estimated views for units on a floor from highest to lowest and then assign these to units in the same ordinal ranking based on residuals from a first-stage regression. The view values are generated in a first-stage regression as per column 4 in Table 2, however, with census tract replacing building fixed-effects. For each unit, we thus estimate the amount of view in each quadrant that a unit might exhibit, depending on (a) building's alignment relative to 0 degrees due north; (b) number of units on a floor; (c) how the view is allocated among the units on a floor; and (d) an estimation of the arc of view that the unit exhibits.

- *Building's alignment.* If the building alignment is due north (0 degrees) and a unit facing that direction has a 180-degree arc of view, then it would have a view equal to 100

[29] These are taken from the "CTBUH Tall Building Height Calculator" (Council on Tall Buildings and Urban Habitat https://www.ctbuh.org/) and then using the eye height of an average individual.

percent of the N.W. and N.E. quadrant view values for its floor. If the alignment is 45 degrees, then said unit would have 50 percent of the N.W., 100 percent of the N.E., and 50 percent of the S.E. view quadrants. The building alignment is 0-89 degrees under the assumption that a building has four 90-degree corners. For simplicity, we restrict the possible unit alignments to 0, 25, 45, and 70 degrees. These reflect the orientation of the street grid on Vancouver's downtown peninsula, which runs roughly on a N.W. to S.E. axis: 82 percent of units are within 3 degrees of one of these alignments, with 72 percent of units aligned between 42 and 48 degrees.

- *Number of units on a floor.* The number of units on a floor summarizes their potential view arc. For example, one unit on a floor would get 100 percent of the views in all directions. For 2 units, we assume that each gets get half of the floor view and that the floor is divided into N-S and E-W. Translating these shares into degrees of view depends on the number of units per floor and whether the unit is a corner unit or not. Roughly: i) a unit that occupies the entire floor receives 360 degrees of view; ii) a unit on a corner – 250 degrees; and iii) a unit that faces only a single direction – 160 degrees. In the sample, 78 percent of the transactions are on a floor with six or more other units (with a mode of eight units per floor). With eight units on a floor there are four corner units and four units that face a single direction

- *View arc.* Discussions with an architect suggest that one loses 10 degrees of angle of view when looking out a window, as one cannot see along the building's edge. Hence, facing one direction implies a 180-degree arc of view net of 10 degrees on each side. Therefore, if facing due east (90 degree orientation), the view is 10-170 degrees. For a corner unit, this generates 250 degrees (170 + 80). A unit that occupies half a floor includes two corners and would be 180 (not 170 because of the second corner) + 80 + 80 = 340 degrees. We assume that it is the midpoint between a corner unit (250) and a whole floor (360) rounded to 300. This yields the following view arcs based on the number of units per floor: i) 1 unit per floor – 360 degrees for the unit; ii) 2 units per floor – half floor each – 300 degrees each; iii) 3 units – a half floor unit (300 degrees), and two corner units of 250 degrees each;, iv) 4 units per floor– 4 corner units (250 degrees each); and v) 5+ units per floor – 4 corner units (250 degrees each), and then 160 degrees for each of the units above the count of 4.

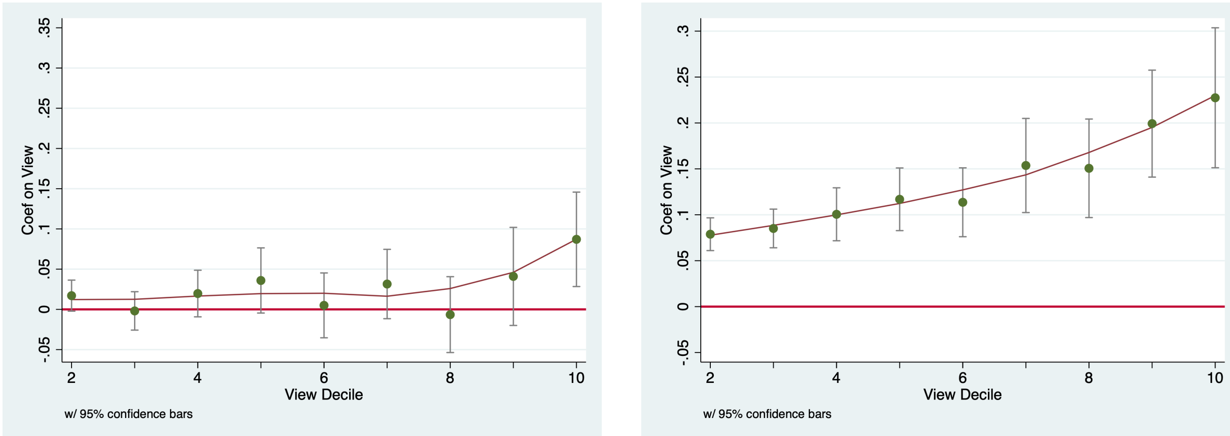
Combining the building's angle with the number of units on a floor we can generate the set of possible views for each unit on a floor. We further assume that for floors with 2, 3, and 5+ units, the division in the building is aligned either N-S or E-W. We test for both N-S and E-W, and find no meaningful quantitative difference in results. We thus report based on the estimation of the E-W alignment.

The first-stage estimation of equation (4) generates view coefficients for the value of view in each quadrant. Following this first-stage estimation, we use coefficients for the maximum view value in a particular direction, i.e., the estimated coefficient for the top decile of view quantity, typically an unobstructed view in a direction. Multiplying these shadow prices by the estimated view arc from above (based on building alignment, number of units per floor, and estimated view arcs) and the actual view amount in a quadrant for the floor from the GIS analysis, yields estimated view values for each unit on a floor. We then create their ordinal ranking and, thus, for each floor in each building, based on the number of units per floor, we have an ordinal ranking of the view value for each unit, though we do not know which unit has which view value.[30]. From the same first-stage estimation of equation (4), we also get a residual for each transaction. Using the mean residual by unit (most units transact multiple times over the sample period), we create an ordinal ranking of mean residual value by building and floor.

The final stage is matching ordinal rankings by building by floor. For a floor on a building, the unit with the largest mean residual is assigned the first ranked view for that floor, the unit with the second highest mean residual is allocated the second highest estimated view, and so on. If there are six units on a floor, the unit with the lowest residual gets the lowest estimated view value. The lowest possible view type is the sixth highest as we only have six-unit types for views in a building with six or more units. Hence, if there are more than six units on a floor, all units from the sixth down in residual value receive the same view value. In aggregate, under this approach with building fixed-effects, a unit with the top view decile in every direction has a 21 percent higher value than one with the lowest view decile.

Figure C-1 shows the difference in view values between the average floor view (panel *a*)

[30]While we generate different estimates based on whether the first stage uses census tract or building fixed-effects, we also test for the outcomes with and without the four buildings over 44 stories and with both 1- and 5-kilometer rings. The final results in the hedonic regressions are robust across these different criteria



((a)) Avg Floor View ((b)) Est unit-specific View

Figure C-1: Comparing View Coefficients

and the estimated unit-specific view (panel *b*). For presentation, the view effects in a decile are summed across all four quadrants so that we present the estimated effect of view on value for a unit with 2nd decile view values across all quadrants. Estimated view effects are substantially larger with the unit-specific estimates. Using the floor average view, a unit with top decile views in each direction would have an 11 percent higher value than a unit with the lowest decile view. In contrast, using the estimated unit-specific view, this difference is approximately 25 percent. Importantly, as noted above, the estimated relative status price effect is robust to the approach used for estimating unit view.