Vertical Status: Evidence from High-Rise Condominiums

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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 others, is an important driver of human behavior. Motivated by the literature in linguistics and psychology that correlates between vertical hierarchy and well-being, we estimate the value of vertical status – one's relative vertical positioning. Using an extensive dataset of condominium transactions in mid- and high-rise buildings in Vancouver (Canada), we measure the price premium that reflects the *relative* height of an apartment unit compared to others in the same building and the height of nearby buildings. Controlling for unit absolute height, view, and other characteristics, we find that there is an economically meaningful price premium for being higher up relative to others. *Ceteris paribus*, moving from the bottom to the top floor of a building generates an average premium of 6.4 percent of the average transaction price. A unit that is higher than all surrounding buildings generates an additional average premium of 3.7 percent relative to a unit that is lower than all surrounding buildings. Evidence further shows that people weigh more heavily the dis-utility from having others positioned above them than the utility from having others below them and, correspondingly, that the marginal value of vertical status rises convexly within the building.

Keywords: Status, Tall Buildings, Vertical Price Gradients, 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 and producer behavior. Veblen (1899) and Duensberry (1949) place status respectively in implicit and explicit utility functions. Status, though, is multi-faceted. Heffetz and Frank (2010) delineate distinct attributes of status: "desirability", the resources that status brings along; "visibility", observable to others; and "positionality", the position (or rank) in relation to others. In this paper, we empirically estimate positionality in an explicit physical vertical form: the value of locating *relatively* higher than others.

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. He is 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 estimate the value of one's *relative* standing in the vertical space, which we refer to as vertical status. [2]

To estimate vertical status (relative vertical positioning), we use the height of condominium apartments relative to the height of both the other units in their building and the height of nearby buildings. By exploiting the variation in condominium apartment transaction prices attributable to relative vertical differentiation, we estimate the shadow price of the aspect of status that is expressed in this vertical up-down paradigm. Our dataset includes more than 55,000 transactions in nearly 320 condominium towers in the Vancouver (Canada) downtown peninsula over the period 1992–2016. We assess the value of verti-

[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.

cal status, controlling for a series of factors, including floor level, view, the unit's physical characteristics, and 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 relative to a unit on the bottom floor of the same building is about 6.4 percent. For the mean unit price, this implies a premium of about 73K CAD (56K USD – deflated to July 2018 condo values). Moreover, we find evidence that people weigh more heavily the dis-utility from having others positioned above them than the utility of being above others. Additionally, 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. That is, the loss associated with being below the Joneses, net of the benefit of being above them, is greater for those occupying relatively higher floors. Finally, vertical status holds in comparing a unit with the heights of neighbouring buildings. The vertical status price premium of a unit that is higher than the tops of all other nearby buildings is 3.7 percent, as compared to an otherwise identical unit that is lower than the tops of all nearby buildings. The results are robust to a series of sampling and test design specifications.

Our study contributes to the literature in several ways. First, 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 or experimental evidence, but on actual transaction prices. This allows us to explicitly estimate the shadow price of status. Second, we believe that our work is the first to rigorously and richly explore the vertical status paradigm.[3] Finally, we show that people place more weight on the negative effect (dis-utility) of being below others than the positive effect (utility) of being above others.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant status literature and work on vertical features of buildings, including vertical rent/price gradient, i.e., the premia for height and view. 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 assessment of

[3] As we discuss more fully in Section 2 Nase, van Assendelft, and Remoy (2019) and Nase and Barr (2022) include a simple relative status measure in their estimation of apartment unit values, but there are substantial differences between our papers.

asymmetry in utility/dis-utility between measuring positionality up or down, relative status compared 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), estimates of the vertical gradient, i.e., the price-vertical height function (Appendix C), and a detailed description of our methodology for constructing view measures (Appendix D).

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 that positioning has in happiness: relative (and not absolute) income drives the variation in happiness over time.[4] Much of the detailed work that examines relative, or reference point positioning, and status is either experimental or utilizes 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]

[4]See also, the Easterlin (1974) paradox where 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.

Recently, Bursztyn et al. (2018) used a quasi-field experiment to document the preference for status, separating it from other features that increase utility and are normally correlated 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, which a challenge for empirical estimation of status effects.[6] They also find that holders of the "status" premium card are more likely to use the card 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, we focus on the (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 high-rises 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 the premium are not new; see Wong et al. (2011) for estimates using Hong Kong data as well as a detailed list of prior work 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

[6]E.g., a Lamborghini, while generating high status, 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) and Meier et al. (2011) find that people associate a northern (associated with "up") versus southern (associated with "down") residential location with high versus low socioeconomic status individuals, respectively.

commercial and residential buildings with varying degrees of control for the other amenities in height bundle.[8] The latter two also include a height-based measure of status, which they compute as the ratio of the floor on which the transacted unit is located to the total number of floors in the building. Nase, van Assendelft, and Remoy (2019) find no effect of a status measure on the rent price of commercial real estate leases. Nase and Barr (2022) find that the price of vertical status is positive and varies in magnitude and statistical significance depending on city (New York vs. Rotterdam). Our study differs significantly by using 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 vertical status effects associated with surrounding buildings.

For clean estimates of status, we must accurately capture the effect of view on transaction prices. 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) use GIS software and developed databases of topographic features and urban forms to generate continuous measures of views from individual buildings. While we follow the approach of Dai, Felsenstein, and Grinberger (2021), we also contribute to this literature by presenting a refinement that estimates unit-specific views based on the more general floor-specific average view generated by the Dai, Felsenstein, and Grinberger (2021) method an the available information on buildimgf alignments and units per floor. Also, using a general specification of view quantity with different measures by compass quadrant, we capture the effect of sunlight in the same view measure.

[8]In Appendix C we present different parametrizations of the vertical price gradient that add to understanding the gradient form.

3 Method

3.1 Specification of Vertical Status

In this paper, we characterize vertical status as a specific form of hierarchy: positionality along the physical vertical dimension as represented by an apartment unit's relative vertical position 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., $(N-i)$) with the latter multiplied by the parameter η, where $0 \leq \eta < \infty$ (see the discussion that follows below). We can simplify equation (1) by reducing it to:

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

.

The parameter η (2) captures the degree of upward comparison; that is, the extent to which the measure of vertical status is driven by the dis-utility of units above one's own floor i, as compared to the utility gained from being above units that are below i. As η increases, it raises the weighting of the number of floors above the reference unit, $(N-i)$. Mapping this into preferences, the greater (smaller) η is, the more one is concerned by the loss (benefit) generated by the presence of those above (below) her.

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 values always lie in $[0, 1]$, where the vertical status of the first (top) has a value of 0 (1).[9]

3.2 Estimating Equation

Following equation (3), we estimate a standard semi-log hedonic model of condominium apartment transaction prices. For unit j located on floor i in (an N-story) building m and sold at time period (month-year) t:

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

.

The dependent variable in equation (4), lnP_{jimt}, is the log transaction price per square foot of unit floor area. 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 view variable, which is building-floor-year-view quadrant-specific (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. Also,

[9] In contrast, Nase, van Assendelft, and Remoy (2019) and Nase and Barr (2022) use $\frac{i}{N}$ as their relative status measure. The latter's lowest value varies across buildings. For example, it is equal to 0.25 (0.10) in a 4- (10-) storey building

β_0 and β_2 are parameters, while β_1, β_3, β_4, β_5, and β_6 are vectors of parameters, and ϵ_{jmt} is a random disturbance term. In estimating equation (4), our primary parameter of interest is the coefficient on vertical status β_2. In Appendices D and C, we investigate the coefficient vectors β_3 and β_4 to shed light on the functional form of the vertical price gradient and valuation of views.

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.[10] 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.[11] While multi-family rental and condominium buildings are present in many different areas of the city and metro areas, they are especially concentrated in the 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.[12] From the universe of 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.[13]

Figures 2 and 3 present the distribution of the data by building height. As shown, there

[10]The end date of July 2016 avoids a series of taxes and restrictions placed thereafter on short-term rentals, foreign buyers, and vacant properties by the city and provincial governments.

[11]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 16.3, 8.0, and 2.8 percent, respectively.

[12]Assessment includes data on property characteristics and transaction prices; and the City of Vancouver provides property tax reports, GIS building footprint and shape files, and parcel map datasets.

[13]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.

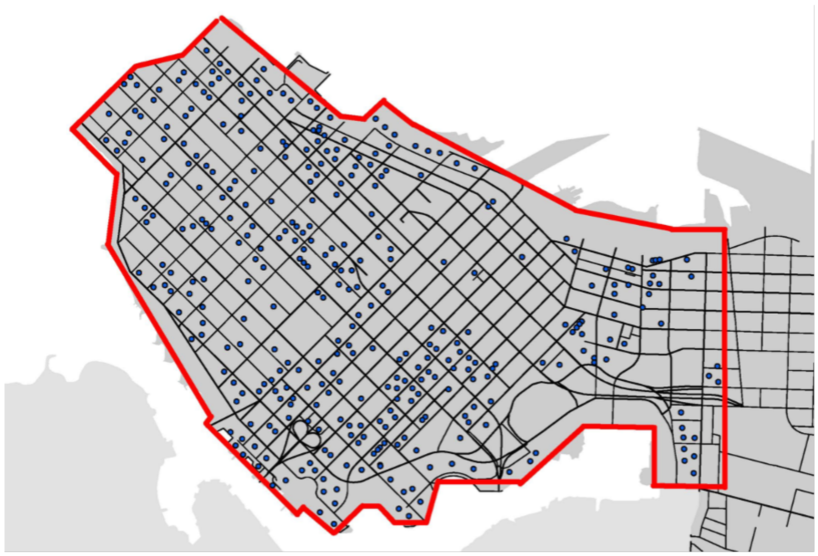


Figure 1: **Building Locations**

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. While the latter introduces noise into estimates of the vertical gradient, our results on the vertical status effect are robust to the omission of buildings above either 35 floors or 45 floors.[14]

Estimating the effect of vertical status requires that we accurately control for other amenities that are associated with floor level. For shared building attributes such as building height, status, location, quality, and shared building amenities, we include building fixed-effects in the estimation. For individual unit height and view, we include floor fixed-effects and a set of view measures, respectively.[15] 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

[14]The distribution of transactions by floor is approximately log-normal with a peak at floor 3. It is above 1 because there are buildings with commercial units and/or amenity and service space on bottom floors.

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

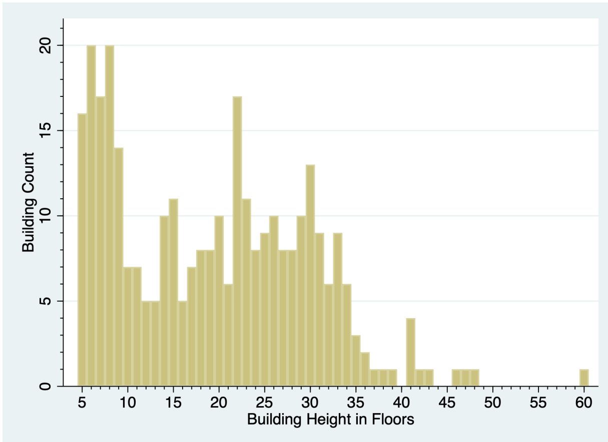


Figure 2: **Building Count by Building Height**

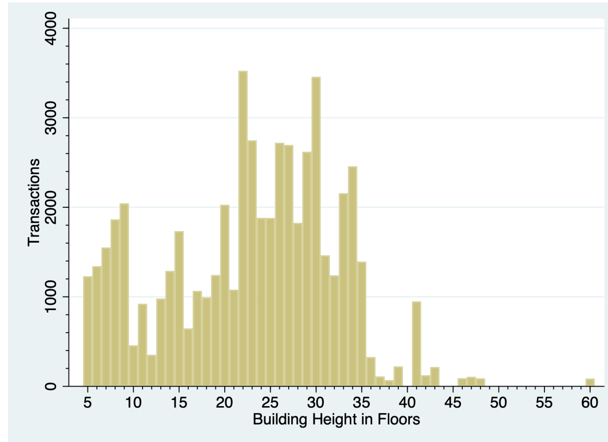


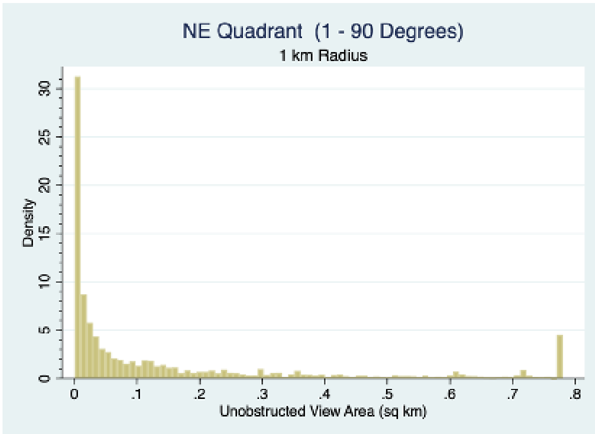
Figure 3: **Transactions by Building Height**

is floor-building-year-compass quadrant specific.[16]

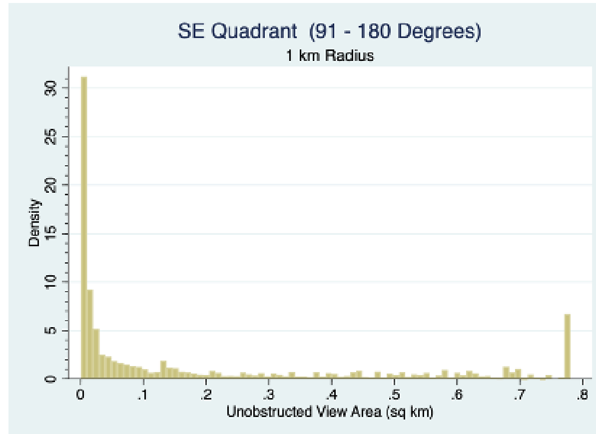
We do not directly observe the orientation of individual apartments on a floor. To address this, we use two alternative approaches to assess the unit-specific view measure. In the first, we assign all units on a floor of a given building in a given year the same value for view in each compass-quadrant. In the second, we estimate views for each unit. With the former, 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. The second approach imposes the assumption that units with high positive residuals in a 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 D. [17]

[16]We have distinct values for the view quadrant 1-90 degrees (NE), 91-180 degrees (SE), etc. These are unique for each floor of each building in each 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.

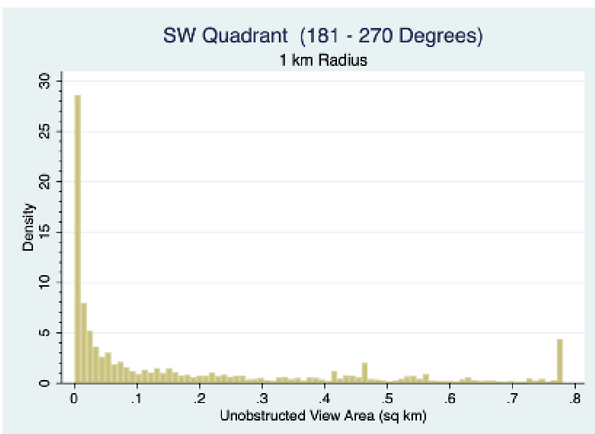
[17]As described below, our estimated value of vertical status is robust to the choice of view measure with very similar point estimates for the average floor view and individual specific view approaches. Also, while we report the view measures computed with a 1-kilometer radius, our results are robust to increasing the view radius to 5 kilometers.



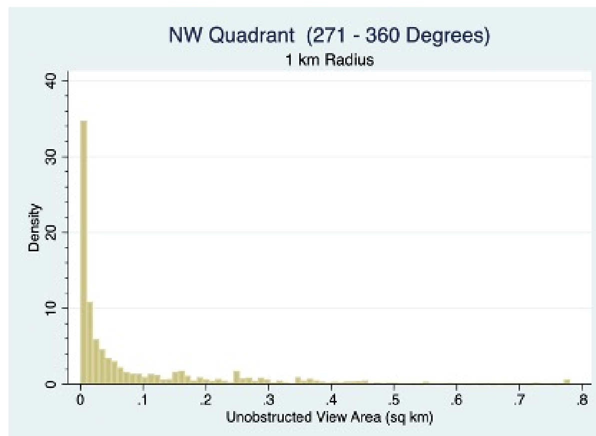
((a)) NE Quadrant



((b)) SE Quadrant



((c)) SW Quadrant



((d)) NW Quadrant

Figure 4: Distribution of Average Floor View Values by Quadrant

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 (four quadrants by nine dummies 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.[18] Notably, the mean indexed price is \$C 1.15M (where in July 2018 \$C 1.00 = \$US 0.76), reflecting the high cost of real estate in Vancouver.

	count	mean	sd	min	max
Transaction price	55195	434286.6	431680.2	65000	1.50e+07
price per sq ft	55195	467.4485	249.1176	93.56538	13691.64
ln sales price per sq ft	55195	6.023627	.494692	4.538661	9.524541
Real price - condo price index 7/18=100	55195	1146772	880614.4	304142	2.75e+07
Real price per sf - condo price index 7/18=100	55195	1243.295	349.9247	339.18	27653
Floor area	55195	.8795331	.3891076	.305	4.469
Floor area - sq	55195	.9249804	1.031069	.093025	19.97196
Floor area - cube	55195	1.192215	2.836717	.0283726	89.25468
Floor area - fourth	55195	1.918673	9.162419	.0086537	398.8792
# of Bedrooms	55195	1.548582	.7565405	0	4
# of baths (full+part)	55195	1.495914	.6162078	1	4
Unit effective age	55195	7.895896	8.245227	0	88
Unit effective age - sq	55195	130.3277	287.1424	0	7744
Dummy = unit renovated/updated	55195	.070423	.255861	0	1
Dummy - unit is a penthouse	55195	.006939	.0830121	0	1
# of units on floor	55195	8.053918	4.200046	1	33
# of units on floor - squared	55195	82.50566	103.3391	1	1089
Vertical Status, $\frac{(i-1)}{(N-1)}$	55195	.5044542	.2762869	0	1
Unit's floor - calculated	55195	12.06917	8.239573	1	60
Highest residential floor in building	55195	22.83104	9.389712	5	60
Floor avg. view (sq km), NE quadrant	55195	.150204	.2210046	.000071	.780326
Floor avg. view (sq km), SE quadrant	55195	.1995859	.2613793	.000103	.780502
Floor avg. view (sq km), SW quadrant	55195	.1807118	.2335602	.000512	.78065
Floor avg. view (sq km), NW quadrant	55195	.1047603	.1579618	.000107	.780636
Estm unit specific view (sq km), NE quadrant	55195	.0812079	.1658769	0	.780326
Estm unit specific view(sq km), SE quadrant	55195	.1055911	.1962465	0	.780502
Estm unit specific view(sq km), SW quadrant	55195	.0868463	.1671312	0	.78065
Estm unit specific view(sq km), NW quadrant	55195	.0615583	.1208812	0	.780636

Table 1: **Summary Statistics**

[18]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.

5 Results

5.1 Base Specification

We estimate equation (4), where VS is derived by equation (3) (i.e., where $\eta = 1$). Results from this estimation for the full sample are presented in Table 2. Specifications (1)–(6) in Table 2 differ by whether we use the floor average view measure (columns 1, 3, 4, and 5) or the estimated unit-specific view measure (columns 2 and 6); whether we control for penthouses (columns 4, 5, and 6); and whether we treat bedrooms and baths count linearly (columns 1–3) or by introducing bedroom and bathroom fixed-effects (columns 4–6).[19] All specifications also include floor, building, and year-month fixed-effects. Standard errors are clustered at the building level. In all subsequent estimations, we use the same set of controls as those used in column (5) (including structure characteristics, penthouse dummy, average floor view measure, bedroom and bathroom fixed effects, and floor, building , and year-month fixed-effects).

As indicated in Table 2, under all specifications, the estimated coefficient for vertical status is statistically and economically significant. Specifically, due to the vertical status factor alone, a unit on the top floor sells for a price premium of about 7.0%–8.7%, as compared to the same unit on the bottom floor of the building (at the sample mean, this premium is about \$C 80K–99K or \$US 61K-–76K, respectively). While we do not show the height gradient nor view premia outcomes in the table, Appendix C and Appendix D, respectively explore these results in detail.

[19] As a robustness check, we also included a top floor dummy in the empirical specifications. The coefficient on vertical status remained positive and significant, indicating that vertical status is not specifically generated from being on the top floor.

	(1)	(2)	(3)	(4)	(5)	(6)
Vertical Status, $\frac{(i-1)}{(N-1)}$	0.083***	0.082***	0.070***	0.087***	0.074***	0.072***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Floor area	-1.30***	-1.25***	-1.30***	-1.34***	-1.35***	-1.29***
	(0.13)	(0.12)	(0.13)	(0.14)	(0.14)	(0.13)
Floor area - sq	1.11***	1.05***	1.11***	1.12***	1.13***	1.06***
	(0.13)	(0.12)	(0.13)	(0.14)	(0.14)	(0.13)
Floor area - cubed	-0.36***	-0.33***	-0.36***	-0.35***	-0.35***	-0.33***
	(0.051)	(0.046)	(0.049)	(0.053)	(0.052)	(0.048)
Floor area - 4th	0.039***	0.036***	0.039***	0.037***	0.038***	0.035***
	(0.0066)	(0.0061)	(0.0064)	(0.0067)	(0.0065)	(0.0061)
# of Bedrooms	0.012*	0.011*	0.011*			
	(0.0052)	(0.0042)	(0.0052)			
# of baths (full+part)	0.021***	0.023***	0.021***			
	(0.0052)	(0.0046)	(0.0051)			
Unit effective age	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(0.00078)	(0.00079)	(0.00078)	(0.00078)	(0.00078)	(0.00079)
Unit effective age - sq.	0.000044	0.000038	0.000042	0.000044	0.000042	0.000036
	(0.000023)	(0.000023)	(0.000023)	(0.000023)	(0.000023)	(0.000023)
Dummy, unit renovated	0.032	0.030	0.031	0.031	0.031	0.030
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Dummy, Unit is a penthouse			0.093***		0.094***	0.098***
			(0.016)		(0.015)	(0.014)
# of Units on floor	-0.0077**	-0.0048	-0.0077***	-0.0077**	-0.0077**	-0.0048*
	(0.0024)	(0.0025)	(0.0023)	(0.0024)	(0.0023)	(0.0024)
# of Units on floor - sq	0.00026**	0.00016*	0.00027***	0.00027***	0.00027***	0.00017*
	(0.000081)	(0.000083)	(0.000079)	(0.000080)	(0.000078)	(0.000079)
[1em] Floor Avg View	Yes	No	Yes	Yes	Yes	No
Unit Specific View	No	Yes	No	No	No	Yes
of Bedroom and Baths FE	No	No	No	Yes	Yes	Yes
N	55195	55195	55195	55195	55195	55195
adj. R^2	0.943	0.947	0.944	0.944	0.944	0.947

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
The dependent variable is price per square foot. All regressions include floor, building, and month-year fixed effects. Standard errors are clustered at the building level.

Table 2: **Vertical Status – Baseline Regressions**

The specifications presented in Table 2 impose a constant marginal value of vertical status (β_2) across floors and buildings. However, one may expect that those with stronger (weaker) preferences for vertical status may sort into higher (lower) floors and taller (shorter) buildings.[20] To allow for varying vertical status preferences across floors, we re-estimate equation (4), stratifying the sample by units: (a) below (*Low*) and above (*High*) the sample median floor (columns 1 and 2, respectively, of Table 3); (b) below (*Bottom*) and above (*Top*) the mid-point of unit's own building (columns 3 and 4, respectively); and (c) in short vs tall buildings, i.e. buildings that are below (*Short*) and above (*Tall*) the median building height in floors (columns 5 and 6, respectively), where the median is based on the transaction count.[21] The results in Table 3 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 for those below the median floor (column 1), though the standard error is considerably higher for the latter. Also, the estimated marginal effect of vertical status is almost nine times higher for units in the top half of the building, as compared to units in the bottom half (columns 3 and 4, respectively). Finally, the difference between units in shorter and taller buildings (columns 5 and 6, respectively) is smaller in magnitude and not statistically different from zero, though the point estimates suggest that marginal vertical status may be higher in taller buildings. In summary, these results suggest heterogeneity in the preference for vertical status that manifests in non-homogenous marginal prices of vertical status.

To further gauge the difference in the vertical status parameter among units located on upper/lower floors of taller/shorter buildings, we re-estimate equation (4), stratifying the sample into four categories of upper and lower floors in taller and shorter buildings (we cross units on floors in the bottom vs. top half of building by above or below median building

[20]While we do not formally show separation in equilibrium, intuitively, the required 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.

[21]The median unit floor in the sample is 10 (*Low/High*) and the median number of floors in a building by transactions is 23 (*Short/Tall*).

	(1) Low	(2) High	(3) Bottom	(4) Top	(5) Short	(6) Tall
Vertical Status, $\frac{(i-1)}{(N-1)}$	0.086***	0.27***	0.068	0.55***	0.079***	0.084
	(0.017)	(0.069)	(0.037)	(0.11)	(0.020)	(0.077)
Observations	28194	27001	26463	28732	27061	28134
Adjusted R^2	0.944	0.945	0.946	0.945	0.945	0.944

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views.
All regressions are clustered at the building level. Low are units on or below the 10th (median) floor.High are those above. Bottom are units below their building mid-point. Top are units above the mid-point in their building.
Short are units in buildings at or below the median height of 23 stories.
Tall are units in buildings above this height. The medians are determined by the total number of transactions not by building.

Table 3: **Vertical Status – Sub-Samples: Lower vs Upper Floors and Shorter vs. Tall Buildings**

height). Results from these specifications are presented in Table 4. As indicated in the table, while the estimated marginal price of vertical status is substantially greater in floors located at the top of the building, the difference between higher and lower floors of taller versus shorter buildings, while positive, is not statistically different from zero. Also, noteworthy is the absence of a statistically significant difference in the vertical status price effect among units on lower floors of shorter and taller buildings. This suggest that premium for vertical status is reflected in all buildings, and not just taller, higher profile structures.

5.2 Vertical Status Functional Form

In the analysis above, we assume that $\eta = 1$ on the right-hand side of equation (2); namely, that the vertical status effect is symmetric in individual preferences, such that moving up or down carries the same status effect. We now relax this assumption and use the fuller expression of VS found in equation (2), using different values of η. In equation (2), as η approaches infinity, VS approaches a dichotomous variable with the value of 1 for top-floor

	(1) Bottom/Short	(2) Bottom/Tall	(3) Top/Short	(4) Top/Tall
Vertical Status, $\frac{(i-1)}{(N-1)}$	-0.0033	0.12	0.57***	0.64***
	(0.052)	(0.10)	(0.15)	(0.17)
Observations	12935	13528	14126	14606
Adjusted R^2	0.948	0.948	0.947	0.945

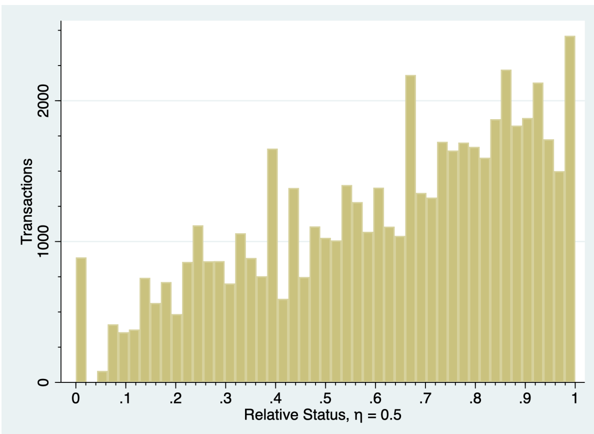
Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views. Standard errors are clustered at the building level. Bottom/Short are units in the bottom half of short buildings ($\leq$ 24 stories). Bottom/Tall are units in the bottom half of tall buildings (> 24 stories). Top/Short are units in the top half of short buildings. Top/Tall are units in the top half of tall buildings. View is estimated unit specific view.

Table 4: **Vertical Status – Sub-Samples: Lower Floors in Short Buildings vs Upper Floors in Tall Buildings**

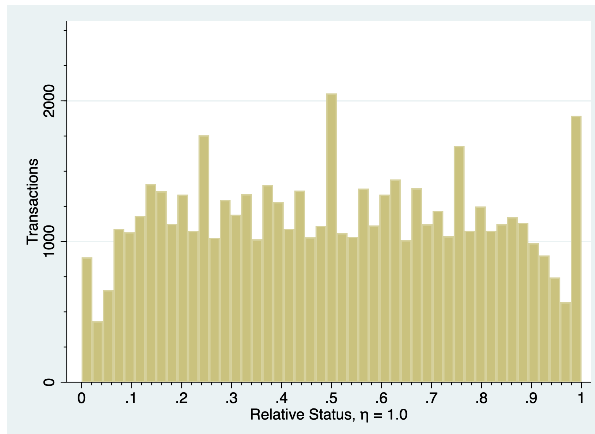
units and 0 for all other units. In other words, all that one is concerned with is that there are no units above her. Similarly, when η approaches 0, then VS approaches a dichotomous variable with the value of 0 for the bottom floor unit and 1 for all other units; that is, all that one considers is that there are some units below her.

Figure 5 presents the distributions of vertical status in our data for different levels of η (η = 0.5, 1, 2, and 3), all using equation (2). As shown, for $\eta = 1$, the distribution is roughly uniform. The figures further highlight the shift of the mass of the distribution from 1 towards 0, as the value of η increases. Specifically, the figures demonstrate that for values of $\eta < 1$, the mass of the distribution shifts to the right, except for the bottom floor units that remain at 0. Similarly, when $\eta > 1$, the mass shifts to the left, except for top-floor units that remain at 1.

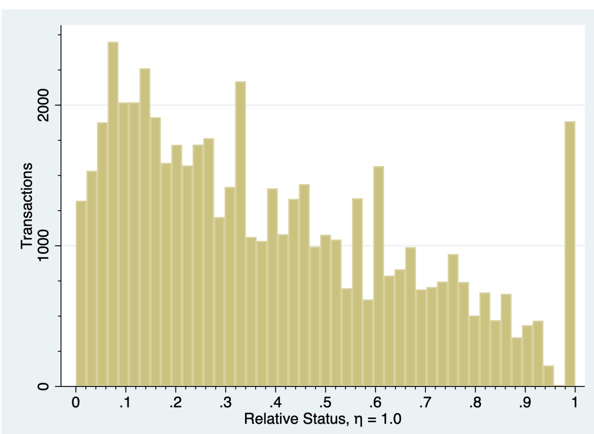
To examine how varying η changes the estimated marginal price effect of vertical status, we re-estimate equation (4) using different values of η. From equation (2), we compute VS, allowing η to vary from 0.5 to 5.0. Results from these estimations are presented in Table 5. As shown, the coefficient on the vertical status variable is positive and significant for all presented values of η. The estimated coefficient on vertical status declines in magnitude as



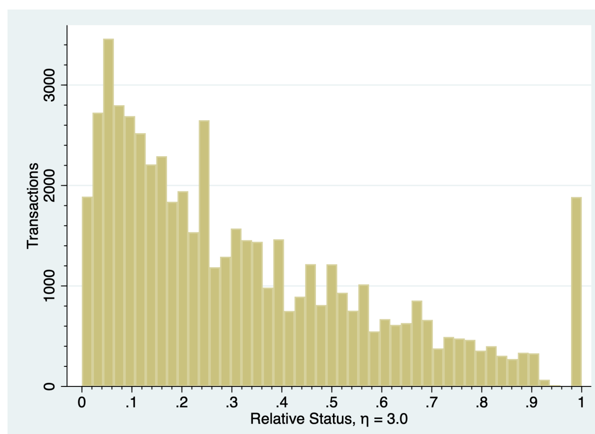
((a)) $\eta = 0.5$



((b)) $\eta = 1$



((c)) $\eta = 2$



((d)) $\eta = 3$

Figure 5: Distribution of Vertical Status by η

η increases, though at a decreasing rate, stabilizing at $\eta = 3$.

	(1) est1	(2) est2	(3) est3	(4) est4	(5) est5	(6) est6
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, $\eta = 2.0$				0.066***		
				(0.013)		
Vertical Status, $\eta = 3.0$					0.064***	
					(0.012)	
Vertical Status, $\eta = 5.0$						0.064***
						(0.011)
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 price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views. Standard errors are clustered at the building level.

Table 5: **Vertical Status – Allowing for Variation in η**

To assess the appropriate value of η, we re-estimate the coefficient on VS along with other regression statistics for $\eta \sim [0.5, 25]$. The distribution of the estimated coefficient on VS is presented In Figure 6. As shown, the level of the coefficient flattens beginning with $\eta = 3$. 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. Finally, as shown in Figure 8, regression adjusted-R^2 reaches a maximum in the same region. Taken as a whole, these results suggest that the appropriate value for η in high-rise buildings is greater than 1, implying that the preference for vertical status is more heavily weighted towards the loss from being below others than the benefit from being above them. This is consistent with a higher marginal value of vertical status for

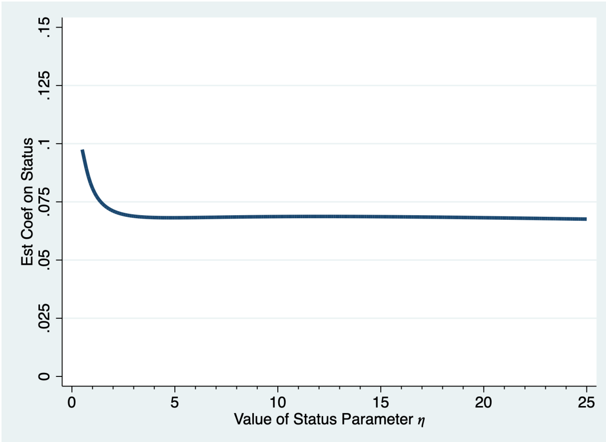


Figure 6: Status Coefficient by η

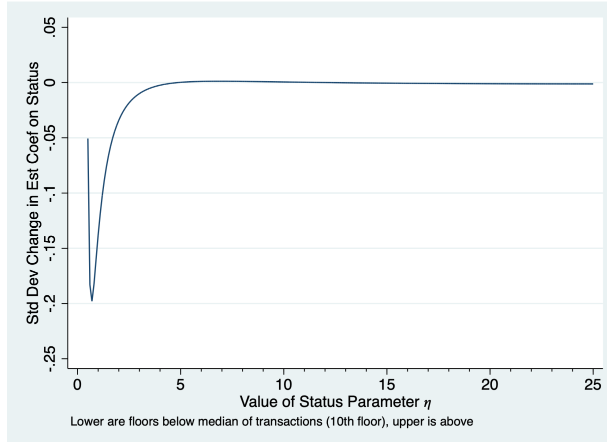


Figure 7: Std. Dev. Change in Est. Coeff.

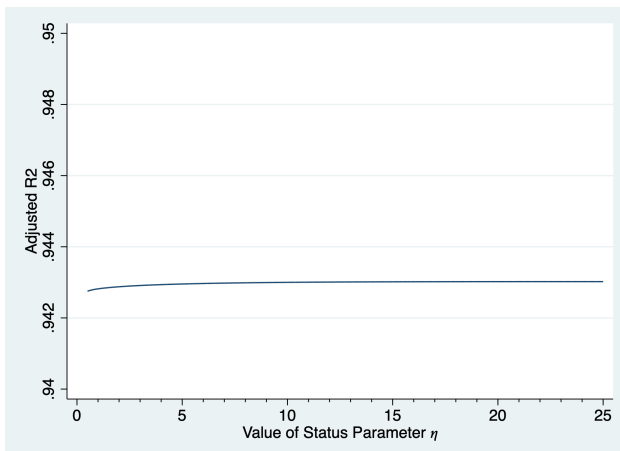


Figure 8: **Adjusted R-Sq by** η

units above the median floor in Tables 3 – 4

Recall that Tables 3 and 4 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 or 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 in the figure and consistent

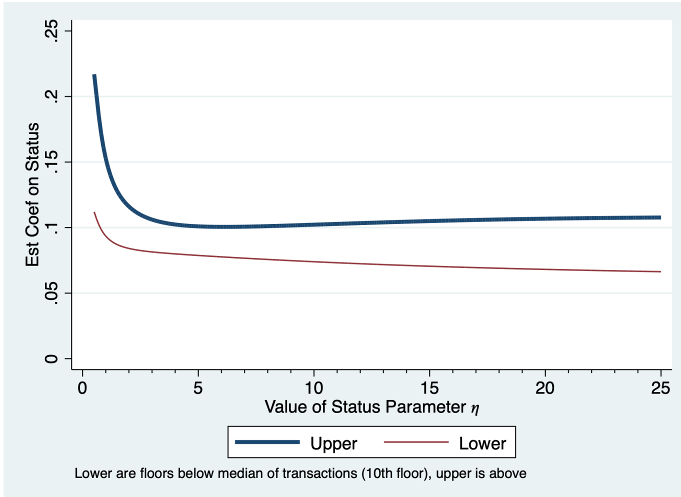


Figure 9: figure
Upper vs Lower: Status Coefficient by η

with previous outcomes, for every value of η, the marginal price effect of vertical status is higher for units on upper floors than lower ones. As mentioned above, the coefficient point estimates are relatively more stable for $\eta > 1$.

Finally, we allow the marginal price effect of vertical status to vary non-parametrically. 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% confidence intervals. As shown, vertical status is lower in magnitude and flatter 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 3 and 4.

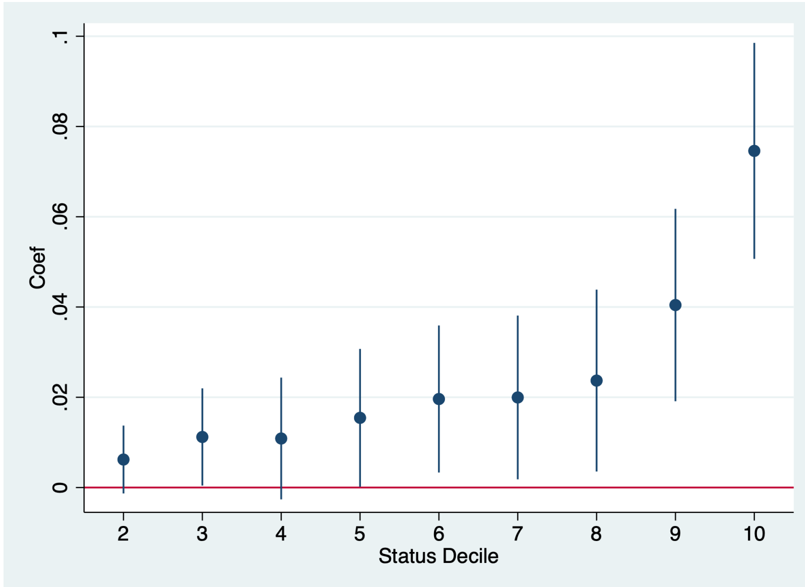


Figure 10: figure
Non-Linear Status, η=3

5.3 Vertical Status and Neighboring Buildings

In this section, we estimate the vertical status price effect generated from the relative vertical position of one's own *unit*, as compared to the heights of the collection of *neighboring buildings*. This is in addition to any own-building comparison with neighboring structures that is subsumed in the building fixed effects.

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. Let k_{im} be the number of buildings (among R_m) whose maximum elevation is **below** the reference apartment unit j's elevation as, as defined by its floor i. Thus, $k_{im} \sim [0, R_m]$. We then define the area vertical status, AVS_im, as:

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

Comparing equation (5) for neighbouring buildings to equation (2) for a unit's own building, k_{im} and R_m in (5) are respectively analogous to i and N in (2). Similar to the distribution of VS in equation (2), in equation (5) $AVS \sim [0, 1]$. 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 will 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 descriptive statistics of AVS 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. Columns (1)–(3) calculate AVS using a 100-meter ring around the transacting unit's building, while columns (4)–(6) use a 250-meter ring. Within each group, we allow η to vary with values equal to 1, 3, and 5. The point estimates vary, though with one exception (250m ring and $\eta = 1$), all estimated coefficients on the area vertical status measure are positive and statistically different from zero. They suggest a price premium of 2.2–4.7% for a unit that is higher than all surrounding buildings, compared with one that is lower than all surrounding buildings. For $\eta = 3$ the range of the price premium of 2.6–3.7%. 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% with all coefficient estimates statistically different from zero at the 1 percent level.

Next, we estimate the price effect of the area vertical status (AVS) non-parametrically. We use the same approach as used in generating Figure 10 above, allocating the area vertical status measure into 10 bins (of equal number of observations) based on value, creating AVS decile fixed effects (lowest decile as the base group). These AVS deciles are computed for $\eta = 3$ and a ring radius of 250m. Figure 11 presents the estimated coefficients and their 95% confidence intervals. As shown, AVS decile coefficient point estimates are positive, though only the highest deciles are statistically different from zero with 95% confidence. The point estimates imply that being taller than all of the surrounding buildings, *ceteris paribus*, adds

	(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 price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views. Standard errors are clustered at the building level.

Table 6: **Vertical Status Relative to Neighbouring Buildings**

a 5% price premium. Hence, our outcomes on Dr. Suess' intuition regarding King Yertle's (the turtle) are robust: he not only 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).

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) a sub-set of consumers: either foreign buyers or those in higher priced neighbourhoods who might have greater preference for status. In these tests, we re-estimate equation (4) with adjustments in the sample to validate robustness using $\eta = 3$.

Miyakawa, Shimizu, and Uesugi (2022) and Devaney and Scofield (2017) report that foreign buyers pay more for commercial properties. In the former, they overpay, while

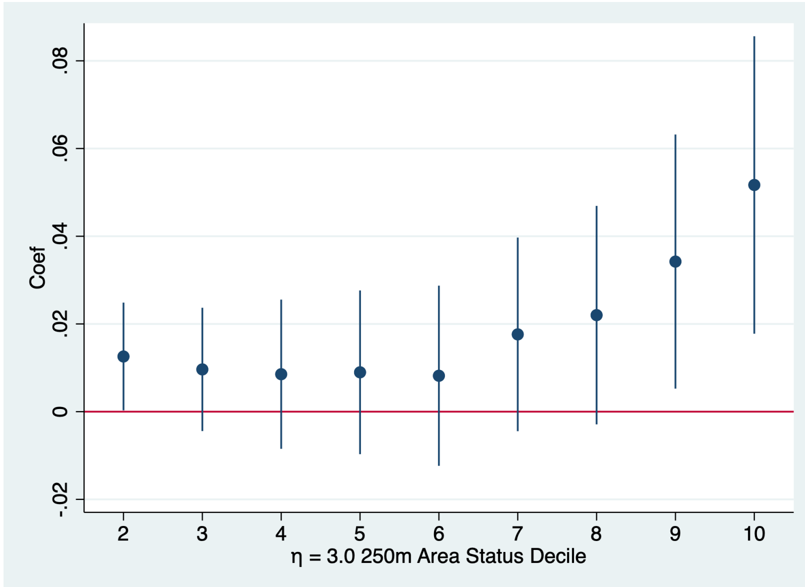


Figure 11: Area Status Coefficient by Deciles

in the latter, they buy properties with unobserved (to the econometrician) positive value attributes. In our sample, we do not observe the residency status of a buyer, but data from the Canadian Housing Statistics Program reports higher foreign ownership in 2017 for condominium apartments built in 2015/2016 in the Vancouver CMA (15.7%) than for all condominium apartments (8.4%).[22] To test whether foreign buyers drive the vertical status effect in our data, we stratify the sample by structure age: old (75th percentile and higher; 12 years or more), older (50th percentile and higher; 6 years or more), newer (50th percentile and lower; 5 years or less), and new (25th percentile and lower; 2 years or less). Results from re-estimating equation (4) for the stratified sample are presented in Table 7. As shown, the estimated coefficients on the vertical status variable for all sub-samples are not statistically different from one another and are similar to the results for $\eta = 3$ in Table 5.

It has also been argued that the share of foreign investment in the real estate market increased over our sample period.[23] To further test for the possible effect of foreign buyers

[22] Statistics Canada, Cansim database Table 46100018.

[23] 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

	(1) All	(2) Older	(3) Old	(4) Newer	(5) New
Vertical Status,	0.064***	0.072***	0.078***	0.068***	0.072***
$\eta = 3.0$	(0.012)	(0.012)	(0.014)	(0.017)	(0.021)
Observations	55195	27999	14789	27196	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 price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views. Standard errors are clustered at the building level. Older are 50th percentile (≥6 years), Old are 75th percentile (≥12 years),Newer are newest 50 pct (≤5 years), and New are newest 25 pct (≤2 years).

Table 7: **Robustness - Newer vs Older Buildings**

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 8. As indicated in the table, all vertical status coefficients are once again of similar magnitude and statistically different from zero.

	(1) All	(2) Pre 2005	(3) Pre 2011	(4) Post 2009	(5) Post 2012
Vertical Status,	0.064***	0.066***	0.063***	0.069***	0.058***
$\eta = 3.0$	(0.012)	(0.015)	(0.013)	(0.015)	(0.016)
Observations	55195	27645	43087	14232	7947
Adjusted R^2	0.944	0.818	0.925	0.870	0.866

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The dependent variable is price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views. Standard errors are clustered at the building level.

Table 8: **Robustness - Pre vs. Post Foreign Investment Boom**

Another robustness test addresses the issue of whether relative unit height is correlated

from Chinese registered companies and citizens. See Australia Foreign Investment Review Board, Annual Reports, `https://firb.gov.au/about/publication/`.

with unobserved unit quality, such that units on higher floors potentially have better unobserved quality. We segment the data by age and exclude renovated units. The underlying rationale is that the market value of higher-grade finishings relative to baseline features should decline with property age. For example, 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.[24] Table 9 presents the outcomes from this estimation by building age. Results are robust to this specification, as the point estimates on the vertical status variable are all different from zero and are within one standard deviation of each other.

	(1) Post 1970	(2) No Reno	(3) Older	(4) Old
Vertical Status,	0.060***	0.060***	0.069***	0.074***
$\eta = 3.0$	(0.012)	(0.012)	(0.013)	(0.014)
Observations	53486	52440	25871	13853
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 price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views.
Standard errors are clustered at the building level.
Older are 50th percentile (≥6 years), Old are 75th percentile (≥12 years), Regressions (2)-(4) exclude units that can be identified as having been renovated or updated.

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. We estimate a first-stage regression that is a variation of equation (4), replacing building fixed effects with census tract fixed effects. 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

[24]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.

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 this specification, as all vertical status coefficients are roughly of the same magnitude and are all statistically different from zero – suggesting that the vertical status price effect is not particularly driven by wealthier neighborhoods.[25]

	(1)	(2)	(3)	(4)	(5)
	All	25th pct	≤50th pct	>50th pct	75th pct
Vertical Status,	0.064***	0.090***	0.071***	0.068***	0.069*
$\eta = 3.0$	(0.012)	(0.020)	(0.017)	(0.016)	(0.031)
Observations	55195	14010	28770	26425	8769
Adjusted R^2	0.944	0.941	0.946	0.946	0.952

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
The dependent variable is price per square foot. All regressions include the controls from regression (5) in Table 2, with floor, building, and month-year fixed effects and building specific average floor views.
Standard errors are clustered at the building level.
Percentile is based on a unit's census tract fixed effect ranking and obs. frequency from the first stage hedonic regression to identify census tract fixed effects.

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 vertical space.

[25] Census tracts do not have equal numbers of transactions among our buildings so that the distribution by census tract, shown in Table 10, is not the same as the distribution of transactions, which generates the number of observations.

To estimate the price of vertical status, we use an extensive dataset of condominium apartment transactions from Vancouver (Canada). We show that vertical status composes an average of about 7% premium 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, implying that those with greater (lesser) preference for vertical status tend to sort into higher (lower) floors. We also show that people weigh more heavily the dis-utility from having others positioned above them than the utility from having others below them. Finally, 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 about 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

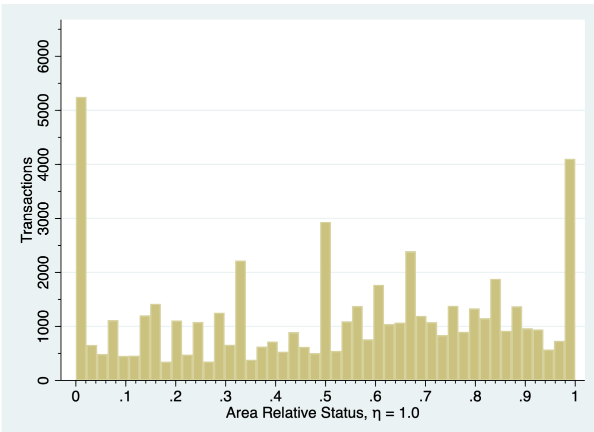
A Data Set Construction

BC Assessment reports 76,799 individual unit transactions registered in the Land Title Office between 1992-2016 with a reported price. We limit the data to one transaction per day; thus, if multiple transactions are recorded on the same day, we use the highest price. Of these, 3,950 are in buildings that are four stories or lower and are dropped from the sample. We also reject sales that are not fee-simple, or BC Assessment deems invalid for statistical appraisal, removing another 5,515 observations. We further drop transactions that likely reflect the price of a pre-sales contract by dropping all transactions on the first three days of occupancy, which removes another 5,197 transactions. Missing data for control variables reduces the sample by a further 6,804 observations, of which 5,521 are due to unobservable bedroom count (although we do include studios if the bedroom count is zero). We windsorize on price (using real house prices), dropping the top and bottom 0.05% of the sample (prices under $C30,412 and over $C10,800,000). Other removed outliers include units with more than four bedrooms or more than four bathrooms, a total of 50 transactions. This leaves a sample of 55,274 transactions.

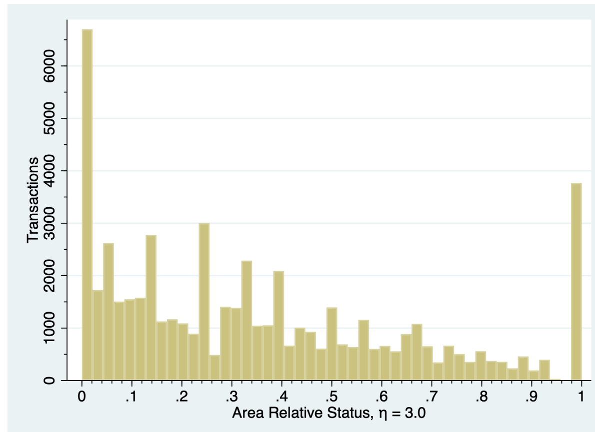
B Measuring Own Building and Area Relative Status

As noted in the text, the neighbouring building comparison is calculated slightly differently than the own building's relative status, though it still lies on $[0, 1]$. In Figure B-1 below, we show these distributions for $\eta = 1$ and $\eta = 3$ and for rings of 100m and 250m in radius. Relative to the within-building relative status measure, the area relative status measures have more mass at the $0, 1$ endpoints and are not distributed as uniformly for $\eta = 1$.

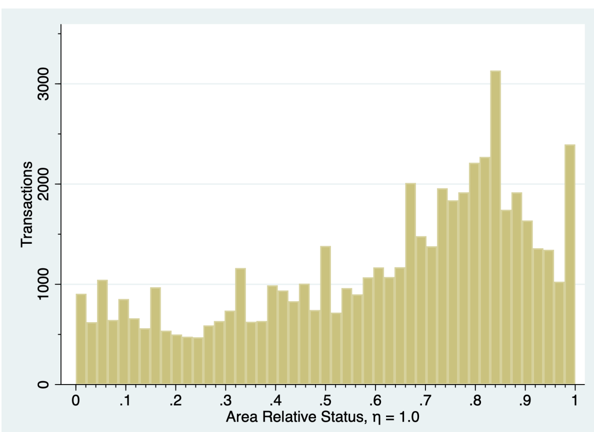
Table B-1 below shows summary statistics for the within-building and area ring relative



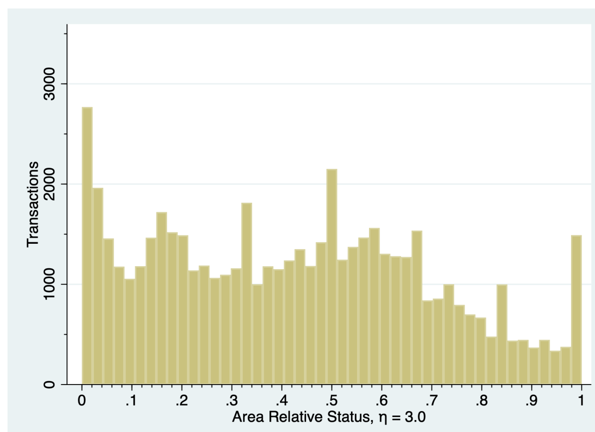
((a)) $\eta = 1$, 100m ring



((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 status measures. Though the distributions shown above in Figures 5 and B-1 differ clearly, these differences are not significantly different in the first and second moments for the 100m radius measures. However, for the 250m ring, we observe differences in the mean value, but the standard deviations remain close in magnitude.

	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 Vertical Gradient

The focus of this paper is the effect of relative status. However, our rich data set of geographically concentrated condominium apartment transactions with good controls for views offers an opportunity to investigate the residential vertical rent gradient. In Figure C-1, we plot the values of the floor fixed effect coefficients. As in other papers in the literature, the small number of transactions and likely higher unobserved heterogeneity of high floors yields

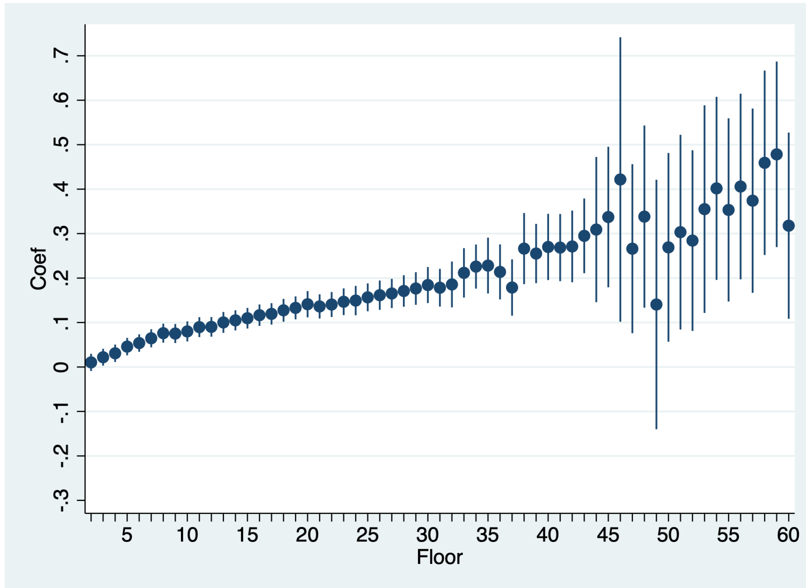


Figure C-1: **Floor Fixed Effects, η=3**

dramatically greater volatility in the point estimates for higher floors.[26]. The plots in Figure C-1 suggest breaks at the 9th floor, 21st floor, and 31st floors, so below we parameterize floors into our base specification to identify the form of the vertical rent gradient.

The regressions in Table C-1 provide linear and linear spline estimates of the vertical price gradient for residential buildings. In columns (1)–(3), floor enters linearly into the hedonic price equation. In columns (4)–(6), we allow for a linear spline with four breaks. Within each group, we estimate the vertical gradients with no view measure [columns (1) and (4)], with the average floor view measure [columns (2) and (5)], and with the estimated unit-specific view [columns (3) and (6)]. The point estimates for the gradient drop with increasing view specificity. Our results differ somewhat from the findings for commercial rent gradients. First, the estimated vertical price gradient coefficients in Table C-1 are smaller (flatter gradient) 0.43–0.63% per floor in the linear and nearly all spline coefficients below 1.0%. With the spline, we get a concave gradient through floor 34, before the gradient turns convex. In contrast, for commercial leases, Liu, Rosenthal, and Strange (2018) and Nase, van Assendelft, and Remoy (2019) both report convex gradients. Nase and Barr (2022) also find convexity for residential prices above the 30th floor in their sample of Manhattan

[26]In our sample there are 1,421 observations on the 20th floor, 807 on the 25th, 314 on the 30th, 175 on the 33rd, and 86 on the 35th. Above the 40th there are fewer than 20 observations per floor.

condominium units. However, their small sample size yields noisy point estimates.

	(1) est1	(2) est2	(3) est3	(4) est4	(5) est5	(6) est6
Vertical Status, $\eta = 3.0$	0.074***	0.080***	0.081***	0.063***	0.067***	0.066***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Unit's Floor	0.0062***	0.0057***	0.0043***			
	(0.00054)	(0.00052)	(0.00051)			
Floor, for Floors 1-8				0.010***	0.0095***	0.0089***
				(0.00091)	(0.00084)	(0.00084)
Floor, for Floors 9-20				0.0055***	0.0048***	0.0039***
				(0.00058)	(0.00058)	(0.00056)
Floor, for Floors 21-34				0.0057***	0.0046***	0.0019
				(0.00083)	(0.0010)	(0.0010)
Floor, for Floors 35-44				0.015**	0.011*	0.0075
				(0.0052)	(0.0052)	(0.0064)
Floor, for Floors $\geq$ 45				0.0075***	0.0084***	0.0075***
				(0.0016)	(0.0019)	(0.0019)
Floor Avg View	No	Yes	No	No	Yes	No
Unit Specific View	No	No	Yes	No	No	Yes
Observations	55195	55195	55195	55195	55195	55195
Adjusted R^2	0.943	0.944	0.947	0.943	0.944	0.947

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
All regressions include unit characteristics from Table 2 specification 5 and
floor, building, and month-year fixed effects. Standard errors are clustered at the building level.

Table C-1: **Vertical Gradient**

The estimated effect of height directly (coefficient on floor measure) is affected by how we measure views. The vertical gradients are lower at all levels when we use the estimated unit-specific view measure instead of the floor average view. As we explain in the Appendix, the former is upper bound on the contribution of views to value, but it does clearly indicate that much of what is assigned to height is likely to be because of views.[27]

[27]The difference between having no view and a complete 360-degree unobstructed view with the estimated unit-specific measure adds about 26% to a unit's price. In the linear specification in regression (2) this is equivalent to being on the 52nd floor.

D View Estimation

D.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 highest point of the structure. Heights are allocated to floors with an assumption of a lobby height of 4.7m, a mechanical floor every 30 floors with a height of 4.65m, and a roof and equipment height of 6.2m. The remaining height is allocated evenly by floor. On each floor, the view level is assumed to be 1.7m above the floor height.

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 building currently on a parcel, the lot occupies a three-story building; (b) podium form is 3 stories tall, 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 year of completion, date of completion is in 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. However, bias in the point estimate may arise if, for example, lower-quality view units (i.e., less expensive ones) turn over more frequently, leading to a non-random sample of units on a floor. Additionally, building fixed-effects can absorb view values when all units on a floor get the same view value, irrespective of direction, and many floors share the same view. In order to address this, we further estimate unit-specific views per floor as described next.

D.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 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 regression 4 in Table 2, but with census tract rather than building fixed-effects. As we assign high view value to high residuals, this is likely to yield upward biased unit-specific view coefficients and should be understood as an upper bound. For each unit, we estimate the amount of view in each quadrant a unit might have. This depends on (a) the building's alignment relative to 0 degrees due north; (b) the number of units on a floor; (c) how the view is then allocated among the units on the floor; and (d) an estimation of the arc of view that a unit has.

- *The 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% of the N.W. and N.E. quadrant view values for its floor. If the alignment was 45 degrees, then said unit would have 50% of the N.W., 100% of the N.E., and 50% 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 these to 0, 25, 45, and 70, as 82% of units are within 3 degrees of each of these alignments, with 72% of units aligned between 42 and 48 degrees.

- *The number of units on the floor.* The number of units on a floor will define their potential view arcs. For instance, one unit on a floor would get 100% of the views in all directions. 2 units we would assume get half each, subject to an assumption that the floor is divided N-S or 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 – 360 degrees of view, ii) a unit on a corner - 250 degrees of view, iii) a unit that just faces a single direction – 160 degrees of view. In the data, 78% of transactions are for units on a floor with six or more other units, with the mode of eight units per floor.

- *View arc.* Discussions with an architect suggest that one would lose 10 degrees of angle of view because when looking out a window, one does not see along the building's edge. So, facing one direction implies a 180-degree arc of view, but you lose 10 degrees from each side. Hence, if facing due east (90 deg orientation), the view is 10-170 degrees. For a corner unit, this generates 250 degrees (170 + 80). The problem in estimating for a unit that occupies half a floor because of the blind spot created by the building mass is larger than just the 20-degree arc loss (by the system above used for a corner unit, a building on half a floor is like two corner units 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 – $\frac{1}{2}$ floor each, 300 degrees each; iii) 3 units – a $\frac{1}{2}$ 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 the floor. This requires one additional assumption, which is for floors with 2, 3, and 5+ units, the division in the building aligned N-S or E-W, i.e., in which direction is the axis separating one-half of units from the other half. We test for both, and there is no meaningful quantitative difference in results, so we report using the E-W alignment.

The first stage generates estimated view coefficients for the value of a view in each quadrant. From the first-stage regression, 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 take these and create their ordinal ranking. Thus, for each floor of each building, based on the number of units per floor we have an ordinal ranking of the view value for each unit.[28]. From the same first-stage regressions we also have residuals for each unit. Using the mean residual by unit (most units transact multiple times over the period of analysis), we create an ordinal ranking of mean residual

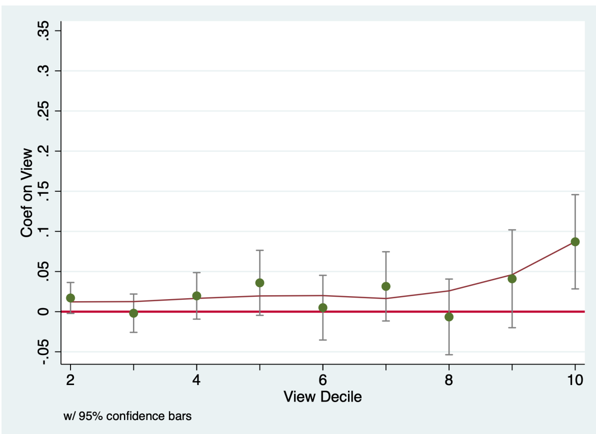
[28]While we generate different estimates based on whether the first stage uses census tract or building fixed effects, We also test with and without the four buildings over 44 stories and with 1 and 5 km rings. The final results in the hedonic regressions are robust across these different criteria

value by building by floor.

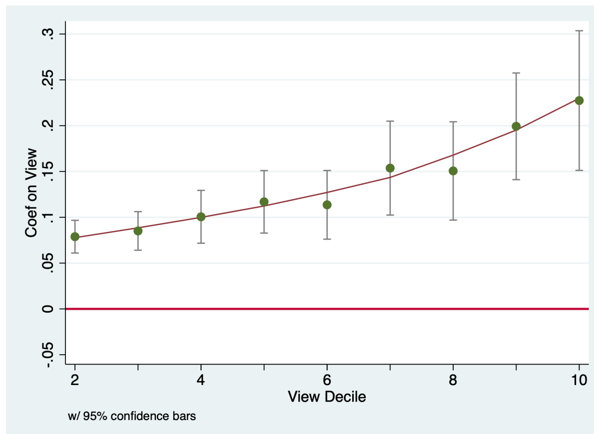
The final stage is matching ordinal rankings by building by floor. For a floor on a building, the unit with the largest mean residual gets the 1st ranked view for that floor, the unit with the second highest mean residual gets allocated the second highest estimated view, and so on. If there are six units on a floor, the unit with the lowest residual gets the lowest estimated view value. This approach assumes that the primary missing variable and source of error is the value of the view. The lowest possible view type is the 6th highest (just six-unit types for views in a building with six or more units), so if there are more than six units on a floor, all units from the 6th down in residual value receive the same view value.

The bias that this introduces is to force all unexplained variation onto view. As such, this should be an upper bound on the value of view as we correlate view value with residual. In aggregate, with this approach using building fixed effects, a unit with the top decile view in every direction has a 21% higher value than one with the lowest decile.

Figure D-1 shows the difference in view values between the average floor view (panel *a*) 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% higher value than a unit with the lowest decile view. In contrast, using the likely upward-biased estimated unit-specific view, this difference is approximately 25%. As noted above, the estimated relative status coefficients are not meaningfully affected by the approach to estimating views because the floor average is an unbiased measure of the average effect. The choice does, however, affects the estimated floor gradient coefficients shown above in Appendix C, where the gradient as a single coefficient or in the spline terms, primarily for higher floors, is lower when we used the estimated unit-specific views than it is with the floor average view measure.



((a)) Avg Floor View



((b)) Est unit-specific View

Figure D-1: Comparing View Coefficients