Is the Rent Too High?
Land Ownership and Monopoly Power*

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Abstract

We investigate the sources, scope, and implications of landowner market power. We show how monopolistic landownership creates contemporary scarcity and truncates future redevelopment relative to social optimum. We discuss how popular subsidies for redevelopment, zoning regulations, and ownership concentration restrictions interact with monopoly power. Using new building-level data from New York City, we quantify the scope and impact of monopoly power. A 10% increase in ownership concentration in a Census tract is correlated with a 1% increase in rent. Market power is a substantial economic force: markups account for at least a fifth of rents in the city.

Keywords: monopolistic competition, market power, concentration, housing demand, redevelopment subsidies, zoning

JEL Classification: R31, R38, L13

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1 Introduction

Property rights grant landowners exclusive use over parcels of land. Since Chamberlin (1933), and as far back as Adam Smith, economists have considered whether this arrangement endows landowners with monopoly pricing powers.[1] *A priori*, property rights need not generate monopoly power, and it is standard for models of real estate markets to assume competition is perfect.[2] Moreover, the empirical relevance of any potential landowner market power and, as a result, its policy implications are poorly understood.

This paper investigates the economic impact of market power due to land rights. We answer two questions: is this power economically meaningful, and how should this alter our understanding of urban land use policies? Using data on multi-unit residential rental buildings in New York City (NYC), we find that monopoly markups are at least a fifth of rental prices. We show how monopoly ownership interacts with redevelopment incentives and zoning regulations, and examine the possibility that restrictions on land ownership concentration can reduce rents.

We model the construction and rental of units in the presence of idiosyncratic preferences for locations, which (following Chamberlin, 1933) generates downward-sloping demand for units at individual plots. We show how, even as landowners purchase buildings in competitive markets which capitalize future rents into land, pricing power restricts supply on three margins: by reducing the size of newly redeveloped plots, by removing existing units from the market when demand is low, and by reducing the pace of redevelopment when demand outstrips existing supply, even when such redevelopment is socially optimal given costs. We call this third margin 'redevelopment failure.' For newly redevelopment buildings for which zoning and other constraints are non-binding, our model yields a Lerner index as a markup over the joint marginal costs of leasing and redevelopment.

We explore the implications for three types of urban policies: redevelopment subsidies, ownership concentration, and zoning. First, because of redevelopment failure, a social planner can improve welfare by subsidizing the decision to redevelop parcels. An optimal

[1]For Smith, that the landowners could rent unimproved land lead him to believe that rent was a "monopoly price" (Smith, 1776). Ricardo (1817) considered land a differentiated factor of production, so that rents reflected differentials in marginal product. Marx argued that monopoly land rents came from three sources: quality differences, markups designed to limit access to land, and extraction of rents from producers selling at markups (Evans, 1991).

[2]See Brueckner (1987) for a unified, formal Alnso-Muth-Mills model and Glaeser (2007) for standard modelling of competitive developers.

subsidy requires knowledge of costs and demand. We then explore a low-information alternative: a lump-sump subsidy equal to the reconstruction costs of the building that eliminates redevelopment failure paired with a requirement that rent reductions equal the subsidy size that eliminates wasteful subsidies. Interestingly, this two-part scheme mirrors many existing redevelopment subsidies, which stipulate new units are partially or fully low-rent. While these existing subsidies are generally viewed as equity-oriented, redevelopment failure offers a potential efficiency argument for such policies.

Second, we explore the potential for municipalities to reduce rents by limiting the concentration of land ownership. Restrictions on concentration have been recently proposed by Berlin housing activists (Stone, 2019). We apply the results of Nocke and Schutz (2018a), part of a growing literature on multi-product oligopoly (Affeldt, Filistrucchi, and Klein, 2013; Jaffe and Weyl, 2013; Nocke and Schutz, 2018a), to the impact of zoning on monopoly markups, and show that with non-decreasing marginal cost, landowners with higher concentration always raise markups. Intuitively, landowners with multiple lots can potentially internalize the impact of one parcel's pricing decision on that of their other parcels. When cost-related substitution effects between parcels are sufficiently small, this can lead to higher rents and markups. Furthermore, we extend the results of Nocke and Schutz (2018b), finding conditions under which increased concentration also generates increases in prices for all other products, or, in our case, parcels.

Third, while monopoly power attenuates the impact of up-zoning at up-zoned parcels themselves, as rent and quantity changes revert to monopolistic rather than efficient levels, we show that restrictive zoning regulations have an additional impact on rents at other locations through markups, as heavier zoning constraints in one parcel always raise rents at other unzoned parcels by raising markups.

While these theoretical channels may exist, a separate question, over which the literature is silent, is whether they are empirically relevant. The extent to which landowners' market power affect rents will depend on the strength of complementarities between renter and building types, as well as the degree to which consumers see housing at similar buildings as substitutes. To answer this question, we construct a new building-level dataset for multi-unit residential buildings in NYC. We obtain building rental income from a combination of scraped public owner communications and deconstructing formulas used by the NYC Department of Finance (DOF) for calculating tax assessment.

First, we find that patterns in the data are consistent with the predictions of our model. In particular, we find that over a seven year period, a 10% increase in Census tract concentration is correlated with a 0.9-1.3% increase in average building rents. The relationship holds even when fully accounting for time-invariant building characteristics. These correlations are not causal, but they are consistent with the existence of meaningful monopoly power.

Next, we estimate our model in order to ascertain the quantitative scope of markups.[3] The first step in our markup estimation is the estimation of building-level own-price elasticity of demand. The chief barrier to identification of the quantity-price equation generated by our model are unobserved amenities. We construct instruments based on two sources of variation. The first is based on competition from rival buildings with similar characteristics (i.e., 'BLP instruments') that affect the landlord's ability to markup rent. These are common in the literature. The second are cost shifters derived from other aspects of the data. Specifically, we construct estimates of building expenses and property taxes via assessed land values based on those of competitors that share certain (controlled for) observable characteristics. Both of these strategies yield similar parameter estimates corresponding to median OPEs of about -4.4.

We apply the results of our estimation to characterize markups. An important aspect of our empirical environment is the ubiquity of constraints on prices and quantities in the form of rent restrictions and zoning regulations.[4,5] Our model indicates that a markup can only be estimated using OPEs from the set of buildings in our sample which are neither rent stabilized nor constrained by zoning.[6] We call this sample policy-unconstrained. We find that in the policy-unconstrained sample, rents include an median markup over marginal costs of $312 per month, with the median markup being 23% of the rent in our preferred specification and sample. These markups are over "shadow" marginal costs including amortized purchase and maintenance costs and outside options.

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[3]Our estimation method is based on differentiated product demand estimation described by Berry (1994). Within urban housing demand literature, our work is most closely related to Bayer, McMillan, and Rueben (2004); Bayer, Ferreira, and McMillan (2007), who estimate housing demand and resident sorting within San Francisco. See Kuminoff, Smith, and Timmins (2013) for a literature overview.

[4]NYC has two forms or rent regulation, rent control and rent stabilization; we use the term rent stabilization for all rent regulation. Control is now rare as it applies only to tenants in place before 1971 in buildings built before 1947. Stabilization by far more common based on a building having 6+ units and built before 1974 and and may pass between different tenants; stabilized units' rent annual growth set by NYC Rent Guidelines Board. We take the view that while rent controls prevent market clearing, and rent stabilization reduces the ability of rents to adjust upward in response to market conditions, rent stabilization does not prevent long-run market clearing.

[5]For zoning constraints, we ask whether a building could add one additional minimum sized residential unit based on floor-area-ratios and density limits.

[6]We calculate that 75% of NYC rental buildings are zoning constrained and 50% are rent stabilized.

The existence of pricing power in housing has been largely ignored in and may have wide implications for several strands of the housing literature. Counterfactual analyses typically assume competitive markets (Ahlfeldt et al., 2015; Severen, 2018) and do not account for the impact of changing markups. Estimates of the production function for housing typically assume competitive markets (Combes, Duranton, and Gobillon, 2021; Baum-Snow and Marion, 2009), and the existence of pricing power may lead to mispecification and require additional supportive assumptions.[7]

An exception to this characterization is a literature on monopoly power and urban policy, which has focused almost exclusively on a justification of rent control based on landowner monopoly power (Arnott, 1989; Arnott and Igarashi, 2000; Basu and Emerson, 2003). Our framework allows us to explore how monopoly pricing and a larger set of urban policies interact in general equilibrium.[8] To our knowledge, no other work discusses the interaction of monopoly power and zoning policies, the impact of ownership concentration, or the impact of pricing power on redevelopment.

Our paper also provides, we believe, the first set of own-price elasticities for individual buildings. Previous housing demand elasticity estimates focus on the housing-consumption trade-off (Albouy and Ehrlich, 2018).[9] However, the relevant elasticity for a landowner's pricing decision is the own-price elasticity that accounts for substitution *between* rival buildings. We estimate this elasticity and find median building own-price demand elasticity of -4.4 in our preferred specification. When we estimate the change in aggregate rental demand if *all* building rents increased by 1%, which is closer in spirit to previous estimates, we then find an inelastic result of -0.74.

2 Model

We first set up the optimization routines for each agent in our model. Developers are endowed with locations and decide whether to redevelop existing structures before selling them. Landowners buy buildings and rent apartments to renters, who are endowed

[7] In Combes, Duranton, and Gobillon (2021), the existence of pricing power alters the result in their equations (4) and (5) by a fixed proportion with the additional assumption of a constant (inverse) elasticity of demand.

[8] Diamond, McQuade, and Qian (2019) consider the equilibrium effects of rent controls on landowner entry and exit. Urban policies could also interact with monopoly profits through equilibrium entry and exit. We do not know of any paper that explores this interaction.

[9] Using hedonic approaches with building-level data, Gyourko and Voith (2000) and Chen, Clapp, and Tirtiroglu (2011) find elasticities compatible with monopoly pricing, but only the latter notes the connection with monopolistic landowners.

with income and choose residence locations. This structure allows us to consider how redevelopment may respond to long-run changes in demand and explore how pricing, leasing, and redevelopment decisions are impacted by pricing power.

2.1 Setup

Parcels, Developers, and Landowners The space, a city, is comprised of a set $\mathcal{A} = \{a_0, a_1, a_2, \ldots, a_J\}$ discrete parcels, which differ according to their underlying quality a, drawn without replacement from a distribution $G_1(a)$. Higher values of a have higher amenity value to renters. We refer to a as "location quality" and differences in a as vertical differentiation in parcels. A location's realized quality a will also be used henceforth to index each location in the set $\mathcal{A}$. We make the simplifying assumption that a is exogenous, while noting that in the data building and parcel characteristics are a mix of endogenously chosen and exogenously given.[10] We set a_0 as living out of the city (i.e., an outside-option).

Each parcel has a building with an initial number of units, $q_{a,o}$. A unique developer, indexed by $\mathsf{d} \in \mathsf{D}$, owns each parcel and chooses whether to sell the parcel and building 'as-is,' in which case the number of units remain $q_{a,o}$ or redevelop it. Redevelopment requires a cost $C_a^{\mathsf{d}}(q_{a,d})$ that is a-dependent, strictly positive, and differentiable with non-negative marginal cost denoted $c_a^{\mathsf{d}}(q_{a,d})$. $C_a^{\mathsf{d}}(q_{a,d})$ may include some fixed cost $C_a^{\mathsf{d}}(0) > 0$. Developers choose whether to redevelop and conditional on redevelopment, quantity $q_{a,d}$ to maximize profits

$$\pi_a^{\mathsf{d}} = \max_{\mathbb{1}_{redev}, q_{a,d}} \begin{cases} s_a(a, q_{a,o}) & \text{if } \mathbb{1}_{redev} = 0 \\ s_a(a, q_{a,d}) - C_a^{\mathsf{d}}(q_{a,d}) & \text{if } \mathbb{1}_{redev} = 1 \end{cases} \qquad (1)$$
$$\text{s.t. } q_{a,d} \leq q_{a,z}$$

where $\mathbb{1}_{redev}$ is an indicator function for the choice to redevelop, s_a is the realized sale price of the building, which would be $s_a(a, q_{a,o})$ if sold 'as-is' or $s_a(a, q_{a,d})$ if sold after redevelopment to size $q_{a,d}$. Redevelopment is constrained by a plot-specific maximum quantity $q_{a,z}$ set by zoning regulations.

For each building, a competitive fringe of potential landowners, indexed by $\mathsf{f} \in \mathsf{F}$, bid

[10]Because we allow marginal cost to be arbitrarily a-dependent, our assumption of exogenous quality is isomorphic to a model with endogenous quality with increasing complements in location and building amenities, where our assumed marginal costs are identical to marginal cost at the endogenously chosen amenity value according to an envelope condition.

on buildings and charge rents to maximizes profits by choosing the rent level at their location. Landowners who purchase buildings provide a mass of renters housing at a positive, differentiable cost $C_a^{\mathsf{f}}(q_{a,f})$, where $q_{a,f}$ is the mass of renters the landowner accommodates in equilibrium.[11] Landowner f's profits from parcel a are

$$\pi_a^{\mathsf{f}} = r_a \cdot q_{a,f} - C_a^{\mathsf{f}}(q_{a,f}) - s_a \quad \text{s.t.} \quad q_{a,f} \leq q_{a,d} \tag{2}$$

where total revenue is rent r collected times the quantity offered to renters $q_{a,f}$, which is constrained to be at or below the quantity chosen by the developer.

Renters A unit mass of heterogeneous renters, indexed by $i \in N$, with utility derived from consumption and location amenities. Renters draw idiosyncratic tastes for each location, $\epsilon_{i,a}$, from a standard type-one extreme value distribution $G_2(\epsilon)$.[12] Thus, utility at location a for renter i is:

$$U_i(a) = F(a, r_a) + \epsilon_{i,a}. \tag{3}$$

Rent is in the utility function because we have implicitly substituted the budget constraint for consumption. Renters choose among all locations a to maximize utility taking amenities, rents, and personal income as given.

2.2 Equilibrium

An equilibrium is defined by a schedule of rents, quantities, and redevelopment decisions $\{(r_a, q_a), \mathbb{1}_{redev}\}_{a \in \mathcal{A}}$ that maximize developer and landowner profits, assign renters to locations a such that no renter can increase utility by choosing to pay rents at any other parcel, and clear the real estate market.

Demand As is standard with choice models, market demand equals the demand probability:

$$D_a(r_a) = \Pr(\mathsf{a}_i = a \mid \vec{r}) = \frac{\mathsf{e}^{F(a,r)}}{\sum_{\tilde{a} \in \mathcal{A}} \mathsf{e}^{F(\tilde{a}, \mathsf{r}_{\tilde{a}})}}. \tag{4}$$

[11] We assume each landowner owns a single parcel; although, we explore consequences of ownership concentration later on. Denote landowner marginal cost as $c_a^{\mathsf{f}}(q_{a,d})$.

[12] We follow Chamberlin (1933) in founding pricing power for individual plots in heterogeneous preferences. Several alternative micro-foundations are possible, including search and matching frictions. Adopting these isomorphic stories would not change our estimation results, although doing so would naturally change their interpretation.

Anticipating the price-setting decision, the equilibrium price elasticity of demand is:

$$\varepsilon_a = \frac{\partial D_a(r_a)/\partial r_a}{D_a(r_a)/r_a} = F_r(a, r_a) \cdot r_a \cdot (1 - D_a(r_a)) < 0. \tag{5}$$

2.2.1 Joint Landowner-Developer Problem

Because it most closely tracks the canonical monopolist problem where quantities are set to maximize revenue, we first consider the case of a single landowner-developer, who maximizes the joint profits of the two agents.

With the sale price transfer cancelling, the joint landowner-developer maximizes profits from renting net of costs of any redevelopment:

$$\pi = \max_{\mathbb{1}_{redev}, q_a} \begin{cases} r_a(q_a) \cdot q_a - C_a^{\mathsf{d}}(q_a) - C_a^{\mathsf{f}}(q_a) & \text{if } \mathbb{1}_{redev} = 1 \\ r_a(q_a) \cdot q_a - C_a^{\mathsf{f}}(q_a) & \text{if } \mathbb{1}_{redev} = 0 \end{cases} \tag{6}$$

where quantity chosen is $q_a \equiv q_{a,0} \leq q_{a,o}$ if $\mathbb{1}_{redev} = 0$ and $q_a \equiv q_{a,1} \leq q_{a,z}$ if $\mathbb{1}_{redev} = 1$.

If the landowner-developer chooses not to redevelop, their maximum quantity is fixed at $q_{a,o}$, but they may choose not to rent all units. They will price on the demand curve at or below $q_{a,o}$, conscious of the fact that the per-unit price is falling with quantity $d(r_a(q_a))/dq_a < 0$. The problem becomes the typical monopolist problem with marginal cost $c_a^{\mathsf{f}}(q_a)$ and inelastic supply above $q_{a,o}$.

Redevelopment and Redevelopment Failure Redevelopment occurs if the difference between the maximal marginal profits with and without redvelopment exceeds the cost of redevelopment.

$$C_a^{\mathsf{d}}(q_{a,1}^*) < [r_a(q_{a,1}^*) \cdot q_{a,1}^* - C_a^{\mathsf{f}}(q_{a,1}^*)] - [r_a(q_{a,0}^*) \cdot q_{a,0}^* - C_a^{\mathsf{f}}(q_{a,0}^*)] \tag{7}$$

for an quantity $q_{a,1}^* \leq q_{a,z}$ that is optimal conditional on choosing redevelopment and a quantity $q_{a,1}^* \leq q_{a,o}$ that is optimal conditional on not redeveloping.

An immediate implication is that redevelopment only occurs when the optimal leasing quantity is higher than the original quantity $q_{a,1}^* > q_{a,o}^*$. Furthermore, when zoning constraints bind on the initial building $q_{a,z} < q_{a,o}$, there is no redevelopment in this setting.

If this criterion for redevelopment is met, then the problem becomes the typical monopolist problem with composite marginal cost $c_a^{\mathsf{d}}(q_a) + c_a^{\mathsf{f}}(q_a)$, so that the landowner-developer sets q_a^* such that $r'(q_a^*)q_a^* + r(q_a^*) = c_a^{\mathsf{d}}(q_a^*) + c_a^{\mathsf{f}}(q_a^*)$. If the market was perfectly competitive, then landlords would set $q_a > q_a^*$ such that $r(q_a) = c_a^{\mathsf{d}}(q_a) + c_a^{\mathsf{f}}(q_a)$. This leads us to the following proposition on the possibility of what we term redevelopment failure:

Proposition 1. *For any positive redevelopment cost $C_a^{\mathsf{d}}(q_{a,o}) > 0$, there exists a demand system such that a city planner maximizing total welfare prefers the redeveloped supply level $q_{a,1}^*$ to $q_{a,0}^*$, but the landowner-developer does not.*

Appendix A provides a proof. Intuitively, when costs are especially high, neither the social nor private benefits of moving to $q_{a,1}^*$ out-weight the redevelopment costs. Conversely, if demand is especially high or redevelopment costs are especially low, redevelopment can be both socially and privately optimal. However, the reduction in rents from moving from $q_{a,0}^*$ act as an additional friction that may prevent landowner-developers from pursuing redevelopment in certain intermediate cases. If, for example, a neighborhood is somewhat more in demand than it was when the building was originally constructed, then it could be the case that a planner may want to see redevelopment, with the total social benefits outweighing the redevelopment costs, but profits are maximized for the landowner-developer by renting the building *as-is*.

Notably, this discrepancy between socially optimal and privately optimal decisions only occurs with finitely elastic (i.e., downward sloping) building-level demand.

Finally, we note that while social planners may also want to change the quantity set by the monopolist conditional on redevelopment, i.e. set $q_{a,1} > q_{a,1}^*$, we have defined redevelopment failure as regarding the decision to redevelop or not, taking $q_{a,1}^*$ as given. As such, redevelopment failure never applies to buildings where the quantity provision decision is interior to the existing size of the building – where the monopoly-optimal quantity is below the size of the existing structure. For those buildings, even if redevelopment did occur, developers would set $q_{a,1}^* < q_{a,0}$.

Mark-ups and quantity restrictions Depending on demand, the landowner-developer sets quantities at one of three levels. First, if demand is low enough relative to $q_{a,o}$, the landowner-developer both chooses not to redevelop and further restricts quantities by holding units back from the market. In this case, they set $q_{a,0}$ such that $r_a'(q_a) \cdot q_a + r_a'(q_a) = c_a^{\mathsf{f}}(q_a)$. Here, the equilibrium price is a markup over the marginal cost of leasing, and can be calculated according to the Lerner Index: $1/\varepsilon_a$. Second, in the case where demand is high enough relative to $q_{a,o}$ to merit redevelopment, landowner-developers set $q_{a,1}$ such that $r_a'(q_a) \cdot q_a + r_a'(q_a) = c_a^{\mathsf{f}}(q_a) + c_a^{\mathsf{d}}(q_a)$. Here, the equilibrium price is a markup over the marginal cost of leasing and redevelopment, and can be calculated according to the Lerner Index. Finally, if demand is high enough such that $q^*_{a,0} = q_{a,o}$ but redevelopment is still suboptimal for the landowner-developer, no units will be held back and the price will be $r_a(q_{a,o})$. At this corner solution, the Lerner Index as a measure of markups does not apply.

2.2.2 Separate Landowner and Developer Problems

To solve the disjoint problem, we begin with the landowner's optimal pricing and supply strategy and work backwards to the redevelopment problem. If the developer can anticipate the landlord's problem, then we argue the problems are equivalent as the competitive fringe of landlords bid the price to the optimal monopolisitic profit amount.

Once a building is sold, a landowners maximum possible supply is fixed at $q_{a,d}$. As above, they price on the demand curve at or below the quantity $q_{a,d}$ to maximize monopoly profits according to the rule $r'_a(q_{a,f}) = c^{\mathsf{f}}_a(q_{a,f})$. Because landowners bid competitively on each plot, the sale price of such a plot becomes

$$s_a(q_{a,d}) = r_a(q^*_{a,f}) \cdot q^*_{a,f} - c^{\mathsf{f}}_a(q^*_{a,f}) \quad \text{s.t.} \quad q^*_{a,f} \leq q_{a,d}. \tag{8}$$

Substituting the expression for $s_a(q_{a,d})$ into the landowner's profit condition (eq. 2), it becomes clear that the profit maximizing choice of $q_{a,d}$ in this case is the same as in the joint landowner-developer decision. Although the landowner makes a separate decision, units above the optimal number to rent do not increase the sale price of the building. Were the joint decision maker to choose not to redevelop, the landowner chooses a quantity $q^*_{a,f} \leq q_{a,o}$, and the developer sees no benefit from redevelopment. Were the joint decision maker to redevelop, the chosen quantity q_a is exactly the point at which the marginal increase in sale price equals the marginal increase in cost $c^{\mathsf{d}}(q_{a,d})$. In this case, the landowner always chooses the corner $q^*_{a,f} = q^*_{a,d}$.[13] While the landowner appears to be choosing a quantity where marginal revenue is above marginal cost, the joint decision maker case instructs us that the quantity is at the point where marginal revenue equals the combined marginal cost of both landlord and developer.

2.3 Summary Discussion

The price-setting power of landowners and developers affects supply in three ways. First, in cases where demand is low, landowners withhold units from the market. While it

[13] Note of course that redevelopment $q^*_{a,f} < q^*_{a,d}$ would imply over-development.

may seem unrealistic to imagine large numbers of mothballed units, this may take the form of enduring nonzero or higher levels of vacancies when lower prices would find renters sooner. Second, redevelopment may occur in fewer cases than would be the case if redevelopment decisions were made on a socially optimal basis.

Third, when buidlings are redeveloped, developers reduce quantities relative to an efficient benchmark in order to maximize the combined profits of redevelopment and leasing. Developers build to the size at which marginal increase in sale value meets marginal costs, and landowners rent out the full building at market rates, while making no profits. However, the joint problem demonstrates how this behavior is equivalent to a reduction in quantity relative to an efficient baseline. While in any given period of time, few buildings are redeveloped, the model instructs that at the time of construction, those buildings were constructed in a manner which restricted supply relative to the contemporary housing demand.

An implication of these findings is that the traditional monopolist rule for markups only applies in cases where redevelopment has recently occurred, where units are withheld from the market, and where buildings are not zoning constrained. This informs the set of buildings on which we calculate markups in Section 7.

3 Policy Implications

In this section, we assess the effects of several policies in the context of monopoly markups. First, we discuss redevelopment subsidies. We find that, due to monopoly distortions, subsidies are less impactful relative to the competitive benchmark, but are generally welfare improving when conditioned on observable rent and occupancy measures. Second, we discuss how, under non-decreasing marginal costs, concentration of land ownership raises markups and rents at all parcels. Lastly, we discuss the impact of zoning. We show that zoning raises rents of parcels that are *not* constrained by zoning, even when marginal costs are constant.

3.1 Redevelopment Subsidies

In this subsection, we discuss subsidies for redevelopment in the context of redevelopment failure. Redevelopment failure occurs when the difference in monopoly rents (in the case of the joint developer-landowner, or building sale price otherwise) do not overcome the costs of redevelopment, while the difference in social surplus does. We consider the effects of redevelopment subsidies, but we ignore distortions that finance these policies, which are beyond the scope of this paper.

Existing Policies Subsidies for redevelopment exist at the federal, state, and local levels. At the Federal level, the Low-Income Housing Tax Credit gives tax credit for the construction or rehabilitation of low-income housing and has been given for over 36,000 buildings accounting for nearly 2.5 million housing units (HUD, 2021). Opportunity Zones subsidize construction and investment in targeted areas. While there is no central accounting of the number or size of subsidies given by state or local governments for redevelopment projects, with our understanding of the scope of the latter being especially poor, ad hoc tabulations indicate these redevelopment subsidies may also be quantitatively relevant.

While such policies are typically analyzed as place-based policies (Glaeser and Gottlieb, 2008) and rationalized under an equity-efficiency tradeoff, the presence of landowner monopoly power and resulting redevelopment failure creates a potential pure-efficiency argument for their existence.

Of note, these subsidies are often linked to reductions in rents or targeted towards low-rent units, including the above-mentioned federal programs.[14] Our analysis below points to an interesting possibility that, while equity may be the impetus for these, operationally, price restrictions may improve subsidy efficiency in low-information environments.

We first discuss an optimal policy, and then move to a discussion of an implementable policy.

Optimal Redevelopment Policy Eliminating redevelopment failure can be achieved by aligning the developer's profit function with the social surplus. This is achieved by subsidizing redevelopment to any quantity $q_{a,1}$ by the change in consumer surplus:

$$\text{Subsidy}_a^{\text{Opt}} = [r(q_{a,0}) - r(q_{a,1})] \cdot q_{a,0} + \int_{q_{a,0}}^{q_{a,1}} D_a(q)dq.$$

While straightforward to consider, it is unrealistic to believe this subsidy, requiring measurement of the willingness to pay for individual spaces in the city, would be implementable.

[14]See Inclusionary zoning (Baum-Snow and Marion, 2009; Soltas, 2021) and (Thaden and Wang, 2017).

Implementable Policy Instead, we consider subsidies targeted at redevelopment failure that use only information attainable by policy makers. Proposition 2 shows how a sufficiently sized subsidy eliminates redevelopment failure, and how rent reduction requirements on subsidized plots eliminate sub-optimal redevelopment, which we define as redevelopment that is undertaken when the total social benefits of redevelopment are outweighted by the social costs.

Proposition 2. *A redevelopment subsidy* $\textsf{Subsidy}_a = C_a^d(q_{a,0})$ *eliminates redevelopment failure. Requiring subsidized plot* a *to to reduce rents such that* $q_{a,0} \cdot [r(q_{a,0}) - r(q_{a,1})] \geq \textsf{Subsidy}_a$ *eliminates socially sub-optimal subsidized redevelopment.*

The first statement in Proposition 2 states that project-specific subsidy that eliminate redevelopment failure is equal to the cost of reconstructing the existing structure. The intuition for this subsidy is that redevelopment failure occurs because of the combination of rents on existing structures and positive redevelopment costs. Without the latter, e.g. when no structure exists *ex-ante*, the monopolist always chooses $q_{a,1}^*$. Such a subsidy will always lead to profitable redevelopment. Crucially, these rebuilding costs are already calculated and readily available on a building basis via insurance.

While such a subsidy eliminates the possibility of redevelopment failure, it does not fully align the developer and social planner incentives. For example, minor increases from $q_{a,0}$ might be profitable for a subsidized monopolist even in the presence of extremely high fixed redevelopment costs. The second statement in Proposition 2 states that such cases are eliminated by pairing subsidies with a rent reduction requirement. Imposing the additional constraint ensures that the social surplus gain is substantial enough so that subsidies are only taken when socially desirable. The intuition is that under the subsidy, redevelopment is optimal when the infra-marginal rent reductions are smaller than the marginal increase in producer surplus. When the infra-marginal rent reductions exceed the subsidized building costs, we can be sure the latter are also smaller than the marginal increase in producer surplus, and therefore smaller than the total gain in social surplus as well.

We highlight six points. First, similar to existing policies, Proposition 2 hints at an efficiency argument for pairing redevelopment subsidies with rent reductions.

Second, as opposed to existing policies, Proposition 2 prescribes a precise size for both the subsidy and rent reductions with existing information: ex ante rents, units, and rebuilding costs (which are observable on insurance records).

Third, because the subsidy is based on rebuilding costs of existing structures, there is no efficiency argument in our framework for development subsidies on empty lots.

Fourth, when the rent reduction condition is imposed, the subsidy no longer necessarily eliminates redevelopment failure (i.e., some buildings remain under-developed from the city planner's perspective).

Fifth, while we show that the rent reduction constraint eliminates subsidies which produce projects with less social gain than cost, a separate question is whether such a policy can be guaranteed to be welfare enhancing relative to laissez-faire. In particular, the subsidy and rent reductions could distort the size of subsidized structures that would have redeveloped with no policy. Appendix A gives sufficient condition to guarantee the policy in Proposition 2 is always welfare improving.

Sixth, we reiterate that both the optimal and implementable policies discussed here pertain to aligning incentives regarding the decision to redevelop, but take the quantity provided by the monopolist conditional on redevelopment, $q^*_{a,1}$ as given. We do not consider policies attempting to set $q_{a,1} > q^*_{a,1}$ such that $P = MC$. Recall that redevelopment failure as we define does not apply to buildings where the monopoly-optimal quantity is below the size of the existing structure, and this policy does not impact those buildings.

3.2 The Impact of Market Concentration

Under monopoly pricing, higher rents can generate a positive pecuniary externality on other landowners, and, by increasing demand and affecting elasticity, monopoly markups at one parcel may positively impact markups, rents, and profits at other locations. When landowners own multiple parcels, they internalize these pecuniary externalities, which may result in higher markups and rents overall. Intuitively, monopolists with greater market share may reduce quantity to a greater extent in order to maximize total profits.

In general, however, the impact of changes in land ownership concentration is analogous to mergers in the multi-product oligopoly setting. As in that setting, we cannot make statements on the effects of concentration on the equilibrium without additional assumptions. We extend Nocke and Schutz (2018b) to generate the following proposition:

Proposition 3. *All else equal, landowners with higher market share have higher markups and rents; an increase in the ownership share of one landowner will generate increases in markups and rents at all the landowner's parcels, and increases in rents at all other parcels.*

Because we cannot assume marginal cost is constant, we introduce an even more flexible cost function than those found in Nocke and Schutz (2018b,a). That, in turn, requires an extension to the result on the relationship between own share and others' share on markup and rent. Appendix A provides a proof.

Note that Proposition 3 is only guaranteed to hold when we can exclude the possibilities of scale economies and when there are no systematic variations in individual valuations by individual characteristics; i.e., no sorting. Intuitively, if landowners can raise profits by forcing more individuals into one parcel, generating scale, or if they can affect the sorting equilibrium through manipulations to the rents of multiple parcels, they may find it optimal to reduce, rather than increase rents and markups.

An important implication of this result is that manipulating the ownership structure of parcels affects rents through monopoly pricing. In particular, under specific conditions, reducing ownership concentration will reduce rents. In Section 5, we look for evidence of scope for such policies in our New York City dataset.

3.3 New Implications for Zoning

An immediate implication of the above model is that, even in the absence of spillovers, a policy of no zoning is not first-best. Because a monopolist landowner restricts quantity, the quantity difference between zoning-restricted and an identical, unrestricted parcel with a monopolist landowner is less than the difference between zoning-restricted parcels and a competitively priced parcel. Height minimums could reduce rents.

What happens when zoning constraints are not binding everywhere? To the extent that zoning constrains bind at a particular parcel, the quantity must be restricted beyond the monopoly-optimal quantity, and rents as a result must be higher. However, in a city where only some parcels are constrained by zoning rules, those constraints also impact rents at unzoned parcels by affecting equilibrium monopoly power at unconstrained parcels. The rent at a given parcel is inversely proportional to rents at other parcels. This leads to the following statement:

Proposition 4. *The imposition of binding zoning constraints on a given parcel increases the rent at all other parcels, including unzoned parcels and parcels where zoning constraints do not bind. When marginal cost is constant, markups at those parcels go up as well.*

Appendix A presents a proof. By raising rents at competing locations, binding zoning constrains have spillover effects on rents at policy-unconstrained locations through monopoly pricing. Likewise, relaxing zoning constraints at one parcel brings down rents everywhere. Of course, even when units are priced competitively, if marginal costs are increasing, by limiting supply at one location, zoning can impact rents and quantities at other locations. But Proposition 4 points out that monopoly power exacerbates the price effects by changing optimal markups. In other words, even in a world of constant marginal costs, zoning constraints at one parcel would raise rents at all other parcels in the city by increasing monopoly markups.

4 Data

Sources Our main data are derived from public administrative building-level records, as well as scraped data, from several New York City departments, including the Departments of City Planning, Finance, and Housing Preservation & Development. This dataset combines the Primary Land Use Tax Lot Output (PLUTO) and the Final Assessment Roll (FAR) for all buildings in NYC, as well as Multiple Dwellings Registration and Contacts (MDRC) datasets (with prior years graciously provided to us by the NYU Furman Center). The PLUTO provides location, zoning, and building characteristics, the FAR provides market values, land values, and building ownership, and the MDRC links building owners to shareholders revealing common ownership across buildings.

We merge these with data derived from communications between the DOF and building owners, scraped off the Property Tax Public Access web portal, which we call the Notice of Property Value (NPV) dataset. It includes information mailed to building owners including gross revenue and cost estimates and the number of rent stabilized units.[15]

We use the American Community Survey to allocate rental households to buildings to estimate building vacancies.[16] To determine the size of each rental market, we use the total number of renter households that are in buildings with four or more units relative to renters in the borough.

Sample Our data spans from 2007 to 2015, where we are able to link all datasets together. We use all private buildings classified as multi-family rental buildings in the Bronx, Brooklyn, Manhattan, and Queens with four or more units, where all units are residential

[15]The NPV dataset was originally web-scraped by a third-party from the DOF's Property Tax Public Access web portal. Full details about this process are available at http://blog.johnkrauss.com/where-is-decontrol/.

[16]To allocate rental households, we multiply building residential units by the block-group level rental occupancy rate. This method assumes that vacancy rates are uniform within Census block-groups.

units and there is no missing data. We exclude mixed-use buildings because we cannot separate building income due to residential versus commercial tenant sources.

For the ownership concentration results, we additionally drop buildings where the listed building owner in the FAR data did not match the MDRC data and buildings from 2007.[17] Based on Section 2.2, we create an unconstrained subsample that excludes zoning constrained or rent stabilized buildings.[18] For more details, see Appendix B.

Geographic Units We use Census tracts as a unit of observation for ownership concentration. The large number of tracts provides us greater variation in the data. In addition, as discussed in Appendix C, ownership concentration is more easily calculated at the tract level, a feature which will help us in Section 5. An obvious downside to this choice is that markets are likely geographically continuous. Individuals at the borders of tracts are more likely to search at adjacent tracts than in other neighborhoods. Our choice will likely attenuate results.

Building Rental Income For 80% of our multi-year sample, we use scraped data from communications between the city and landowners about building income. For the rest of our sample, we rely on public data on assessments records from the DOF, which include methodologies for generating assessments from building income, that allows us to back out income from the assessment data.[19]

In NYC, rental buildings are assessed based on their income generation. The DOF collects annual revenue and cost information for all rental buildings and then applies a statistical formula to translate annual revenue into 'market value' (MV) of the building if it were sold, which is the basis of a building's tax assessment. Importantly, MV is determined by a simple Gross Income Multiplier (GIM) formula:

$$\frac{\text{Market Value}_j}{\text{SQFT}_j} = \text{GIM}_j \cdot \frac{\text{Annual Revenue}_j}{\text{SQFT}_j}, \tag{9}$$

where the GIM is determined by the DOF based on actual sales in a given income decile

[17]We drop buildings from 2007 for data quality reasons; after this, we match over 80% of all building owners across years.

[18]Specifically, a building is zoning constrained if the building would not be allowed to create an additional unit based on building floor-area-ratios and minimum unit area requirements, and is rent stabilized if more than 10% of units are rent stabilized.

[19]See – `nyc.gov/site/finance/taxes/property-assessments.page`.

range and location.[20] The DOF reports MV and SQFT for all buildings in the FAR dataset, and so for 80% of the sample we observe both income and MV. We non-parametrically estimate the GIM term as a function of MV/SQFT, borough, and year based on DOF guidance documents.[21] We assess our procedure by using the estimated GIM and reported MV to calculate a fitted income value for the matched sample, and find a correlation of 0.99 and coefficient of determination of 0.98. For more details, see Appendix D.

Once we have building income for all buildings, we must subset the data to single-use residential buildings due to our inability to distinguish between residential and commercial income. We divide building income by the number of units for average annual unit rent in a building, and again by twelve for average monthly rent. A limitation of this approach is that we rely on building averages as we do not see individual unit income.

Other Variables We link buildings based on their "borough-block-lot" (BBL) identification that is uniquely assigned to real estate parcels, with additional verification based on lot characteristics.[22]

The building-level characteristics that we include are ten-year building age group indicators, log miles to nearest subway station, log years since the last major building renovation, log average unit square-feet, and whether the building has an elevator, and lot size quartiles. For location controls we use Census tract by year fixed effects.

An important limitation of our data is the inability to control for unit-level characteristics. We approach this issue as an omitted variables issue. In our analysis of concentration changes, building fixed effects will be an important control that, together with information on renovations, help us control for these unobservables. In our elasticity estimation, unobsevable unit characteristics will show up as building unobservables and will be an important motivation for our instrumental variable approach.

For this, we construct instruments based on two sources of variation. The first is based on competition from rival buildings with similar characteristics (i.e., 'BLP instruments') that affect the landlord's ability to markup rent. The second is based on landlord costs that shift rent directly. We describe these variables and how they identify demand parameters in more detail in Section 6 and Appendix E.

[20]Effectively, if a building's MV/SQFT is in the q^{th} quantile, then its AR/SQFT is also in that quantile, and all buildings in a given quantile and location will have the same GIM.

[21]For each borogh-year, we estimate the empirical GIM within 50 quantile bins of MV/SQFT (which we observe for all buildings) and then apply this to the unmatched buildings.

[22]Most parcels contain a single building, but large parcels can contain multiple buildings with open space between them. We refer to buildings, parcels, plots, and BBLs interchangeably throughout.

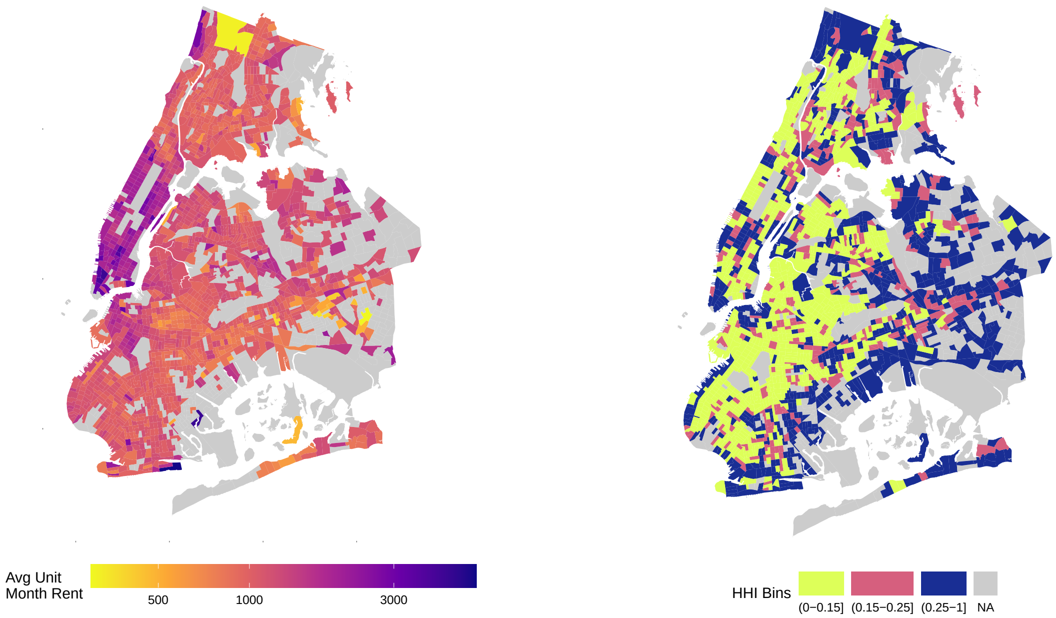
Summary Statistics Table 1 presents summary statistics for NYC rental buildings. Each column represents a cut of the data that we use. The first is the single-use residential sample of buildings that we use in the paper (i.e., excluding mixed-use and non-residential buildings), the second is the set of policy-unconstrained buildings, and the third is a subset of the policy-unconstrained buildings that are 10 years old or less in a given year. Figure 1 plots the mean unit rents and concentration by Census tract.

Table 1: Summary Stats:
2007-2015 NYC Rental Buildings

	Tract Level		
Aggregate HHI	0.25		
	Building Level		
	Residential	Unconstrained	Uncon., New
Owner Share in Tract	7%	7%	11%
Leave-Out HHI in Tract	0.12	0.12	0.19
Median Monthly Rent	$928	$1,157	$1,401
Median Rent by Median Income	20%	25%	30%
Median Monthly Expenses per Unit	$459	$608	$673
Median Land Value per Lot SqFt	$24	$40	$55
Res.Units per Building	17.9	15.2	17.2
Years Since Construction	84.5	83.3	4.3
Years Since Renovation	68.4	63.2	4.3
Avg Unit SqFt	810	1,000	1,259
Pct w/ Elevator	8%	6%	22%
Pct w/ Any Tax Abatement	25%	7%	4%
Miles to Subway	0.3	0.3	0.3
Zoning Constrained	78%	0%	0%
Pct Units Rent Stabilized	45%	3%	0%
Pct Built in Last 10 Years	3%	6%	100%
Unique Buildings	57,537	8,559	1,122

Note: The table reports summary statistics for all single-use residential buildings with four or more units and sub-samples. The first column, residential, contains all residential buildings. The second column, unconstrained, contains buildings where less than 50% of units are rent-stabilized and that are able to add an additional unit according to zoning regulations, uilding floor-area-ratios, and minimum unit area requirements. The third column, unconstrained & new, is a further subset of the unconstrained buildings which are less than ten years old. Building data from PLUTO, NPV, FAR, and MDRC files. Census tract HHI defined using shares in equation 10. Owner share in tract is building level average. Leave-out building HHI defined using adjusted shares in equation 11. Note: HHI measures only for 2008-2015 due to data limitations. Monthly rent is building income divided by residential units divided by 12. Median borough income from American Community Survey. Monthly expenses per unit is [Expenses / (12 x Units)]. Monthly land value per lot area is [Land Value / (12 x Lot SqFt)]. All dollar values in nominal terms. Years since construction and renovation equal the year minus the construction year and most recent major renovation year. Avg Unit Sqft is total building area divided by units. Geodesic distances are in log miles based on building (lat,lon) coordinates.

Figure 1: Distribution of New York City Rents & Concentration



Note: The figure displays the geographic distribution of monthly rent and ownership concentration (measured by HHI) for 2010 Census tracts minus Staten Island. The top plot is the 2007-2015 average building monthly rent tract average in 2019 dollars. The bottom plot is the 2008-2015 average tract HHI value; note, according the the US Federal Trade Commission, HHI values between 0.15-0.25 are 'moderately concentrated' and above 0.25 are 'highly concentrated.' Dark blue tracts indicate higher rents (log scale) and concentration. Missing values (in light-gray) are Census tracts where we have insufficient data, in part due to the exclusion of mixed-use buildings. Data from PLUTO, FAR, NPV, and MDRC as described in text.

5 Concentration and Rents in New York City

We now examine the correlation in the data between ownership concentration and rents. We note that results in this section are not causally identified. Nonetheless, we find, reassuringly and in line with predictions of Proposition 3, that increases in concentration are correlated with modest increases in rents. Our results are strongest for the set of policy-unconstrained buildings, which we expect to be more responsive to short-run market conditions.

To examine whether the data are consistent with the predictions of Proposition 3, we first construct ownership shares at the Census tract level from 2008 to 2015. Section 4 summarizes the trade offs of tract-level analysis, as well as our construction of tract-level ownership data, in tandem with Appendix C. As noted in Section 4, we calculate concentration, which will be a Herfindahl-Hirschman Index (HHI), off of the full sample of buildings in each year but for rents, our outcome variable, we restrict our sample here to single use buildings with matched ownership information.

Using our constructions of ownership, we calculate tract-level concentration. Let $\mathcal{A}_{f,g,t}$ be the set of buildings owned by landowner f in tract g in year t, and let $\mathsf{F}_{g,t}$ be the set of landowners in that tract and time. We thus calculate landowner market shares as:

$$\mathsf{s}^{f}_{g,t} := \frac{\left(\sum_{j\in\mathcal{A}_{f,g,t}} D_{j,t}\right)}{\sum_{f'\in\mathsf{F}_{g,t}}\left(\sum_{j\in\mathcal{A}_{f',g,t}} D_{j,t}\right)}. \tag{10}$$

Figure 1, plots tract-level HHI measures for NYC, where HHI is the sum of squared owners' shares, $\mathsf{HHI}_{g,t} := \sum_{f'\in\mathsf{F}_{g,t}}\left(\mathsf{s}^{f'}_{g,t}\right)^2$.

To more closely match the predictions of Proposition 3, which links ownership concentration elsewhere to rents, we construct a modified "leave-out" HHI index. For each landowner f, we recalculate the market share of a rival landowner, h, as:

$$\tilde{\mathsf{s}}^{h}_{f,g,t} := \frac{\left(\sum_{j\in\mathcal{A}_{h,g,t}} D_{j}\right)}{\sum_{f'\in\mathsf{F}^{-f}_{g,t}}\left(\sum_{j\in\mathcal{A}_{f',g,t}} D_{j}\right)}, \tag{11}$$

where $\mathsf{F}^{-f}_{g,t}$ is the set of rivals to landowner f, and then calculate the leave-out HHI for landowner f as the sum of these rival landowners' squared shares: $\mathsf{HHI}_{f(j),g,t} := \sum_{h\in\mathsf{F}^{-f}_{g,t}}\left(\tilde{\mathsf{s}}^{h}_{f,g,t}\right)^2$.[23]

[23]In Appendix C, we probe robustness using the more standard construction of HHI and shares in

We then test the basic prediction that rent increases in concentration. Our main specification estimates

$$\ln[\mathsf{r}_{j,g,t}] = \alpha_0 + \alpha_1 \cdot \ln[\mathsf{HHI}_{f(j),g,t}] + \alpha_2 \cdot X_{j,g,t} + \epsilon_{j,g,t}, \tag{12}$$

where $\mathsf{r}_{j,g,t}$ is the average unit rent of building j in tract g at time t, $\mathsf{HHI}_{f(j),g,t}$ is described above, and α_2 is a vector of coefficients on controls $X_{j,g,t}$. We also include $\ln[\mathsf{s}_{g,t}^{f(j)}]$ in some specifications to separately test for the impact of owners' shares on rents at their own buildings. Note that while we use general subscripts $\{j, g, t\}$ for $X_{j,g,t}$, in specific specifications some controls will be time invariant, e.g., when using building fixed effects.

Table 2 presents our estimates of equation (11) for New York City buildings. Columns (1-3) use the log of the leave-out HHI measure and columns (4-6) add the log of the building owner's market share as a control. All columns use year fixed effects, five-year building age bin indicators, ten-year bin indicators for years since a major renovation, and average unit square-foot decile indicators.

Panel (A) includes all single use buildings with matched owners, and Panel (B) subsets the sample to only policy constrained buildings (i.e., less than 10% of units rent stabilized and not zoning constrained). As discussed above, we only expect to see full responses to short-run changes in market conditions in the latter sample. We discuss results for both samples in tandem. In line with expectations, effects on the unconstrained sample are consistently more economically and statistically significant.

Columns (1) and (4) include borough fixed effects. We report modest positive correlations. However, because these columns treat the data as a repeated cross section, and suffers from clear unobserved variable bias, we refrain from interpreting the small and insignificant resulting coefficient.

Columns (2) and (5) introduce tract-level fixed effects, which remove unobserved time-invariant tract-level variation like neighborhood quality. In both panels, begin to see a meaningful association. In column (2), we estimate that a 10% increase in tract concentration index is associated with a 0.15% increase in rents across all buildings and a 1.2% increase in rents for unconstrained buildings.

Columns (3) and (6), our most stringent specifications, include building-level fixed effects. Because of the difficulty in observing key building characteristics, this specification ensures that estimates are not due to unobserved time-invariant differences in building quality. In column (3), we estimate that a 10% increase in tract concentration index is

Equation (10).

Table 2: The Relationship Between Ownership Concentration and Rent

	$\ln[\text{Average } r_{j,g,t}]$					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (A): Full Sample						
$\ln[\text{HHI}_{f(j),g,t}]$	0.004	0.018	0.021	0.016	0.001	0.019
	(0.008)	(0.028)	(0.013)	(0.008)	(0.027)	(0.013)
$\ln[\text{s}_{g,t}^{f(j)}]$				-0.020	-0.012	-0.013
				(0.005)	(0.003)	(0.005)
Borough FEs	Y	N	N	Y	N	N
Tract FEs	N	Y	N	N	Y	N
Building FEs	N	N	Y	N	N	Y
Observations	239,625	239,617	238,650	239,625	239,617	238,650
Panel (B): Unconstrained Sample						
$\ln[\text{HHI}_{f(j),g,t}]$	0.034	0.123	0.097	0.034	0.124	0.092
	(0.014)	(0.057)	(0.037)	(0.017)	(0.056)	(0.037)
$\ln[\text{s}_{g,t}^{f(j)}]$				0.018	0.002	-0.020
				(0.013)	(0.011)	(0.013)
Borough FEs	Y	N	N	Y	N	N
Tract FEs	N	Y	N	N	Y	N
Building FEs	N	N	Y	N	N	Y
Observations	13,639	13,563	12,734	13,639	13,563	12,734

Note: The table reports the results from regressions of log of building average unit monthly rent on the log of the 'leave-out' HHI index, calculated at the building level by leaving out the building owner's units. Regressions are at the building-year level and are weighted by building units. Panel (A) uses all single use and matched buildings in New York City, and Panel (B) subsets this to unconstrained buildings, defined as having less than 10% of units be rent stabilized and not zoning constrained. In particular, while we may not expect rent stabilization, which is distinct from rent control, to have a long-run impact on prices, we expect this sample to be less likely to pick up year-to-year fluctuations in market conditions, and chiefly rely on the unconstrained sample in Panel (B).[24]

associated with a 0.21% increase in rents across all buildings and a 0.95% increase in rents for unconstrained buildings.

Finally, Columns (4)-(6) introduce controls for building owners' own share of the tract as a control. According to Proposition 3, we expect owners with growing shares and thus market power to increase rents. An important condition in the Proposition is that costs be non-decreasing, which would be violated if there were scale economies in ownership. Across specifications, the coefficient on this parameter is small but noisy and inconclusive. The coefficients on the HHI parameters remain mostly the same.

An important caveat in this analysis is the inability to observe changing tract and building conditions that are correlated with both rents and ownership concentration. Tracts with improving overall neighborhood qualities may experience rising rents and rising ownership concentration in tandem. We therefore caution against interpreting these coefficients causally, but instead take reassurance from the stylized fact that increases in concentration are correlated with increases in rents. We use this stylized fact as motivation for our identified estimation results.

6 Estimating Elasticities and Markups

To empirically assess the monopoly forces described above, we estimate own-price elasticities (OPE) for the NYC rental market. If the rental market is based on monopolistic price competition, then, where landowner-developers set quantities and prices, the negative inverse OPE equals the proportion of rent that is increased due to markups, known as the Lerner Index. Our strategy will be to estimate demand parameters from our model using our NYC data, generating building-level OPEs without imposing any specific firm conduct assumptions, then using our results in Section 2, to isolate the set of buildings for which the OPE provides relevant information on the markup.[25]

First, we estimate utility parameters using the logit demand structure from Section 2.1 to calculate building-level OPEs. To identify the renter demand parameters, we use variation from two sources. In one, we use variation based on competition from similar buildings using 'BLP instruments' adapted to our urban setting. This approach is common in the literature (Bayer, Ferreira, and McMillan, 2007; Davis et al., 2021; Almagro and Domınguez-Iino, 2019). To allay concerns of potential exclusion restriction violations to

[25]The ability to derive building-specific OPEs and markups for only the correct set of buildings stems from our model's structure. An alternative theory-free approach is to find a single OPE as a local average treatment effect in a standard log-log two stage least squares regression. We include these specifications in Appendix G.2 because they may yield a more easily interpretable and model-free result. While these log-log regressions point to a similar average OPE as our main results, we caution against their use in calculating an average markups, as they are identified off of constrained and non-redeveloped buildings for which the OPE is not informative for markups.

these standard instruments, we embark on a second strategy, using variation related to landlord costs and taxes using local-leave-out averages of building expenses and land values. These strategies are identified off of changes in group-level correlated costs which we assume to be orthogonal to demand when group fixed effects are included. The results of these two approaches complement each other, with the leave-one-out instruments generating slightly more conservative results. Below, we describe our empirical model and identification strategy.

6.1 Demand Model Specification and Variables

Empirical Specification Let (j, b, t) index building j in borough b in year t, s be the building market share, r be the average building rent, and X be building controls. Our estimation strategy follows that of Berry (1994). We specify that each borough-year is an urban rental market. Individuals, $i \in N_{bt}$, choose to either rent a unit at a building or make some outside option choice in the borough. We further specify the model in Section 2.1, such that a renter's indirect utility is a linear function of rent and building characteristics:

$$U_{ijbt} = \beta_0 + \beta_1 \cdot X_{jbt} + \alpha_{bt} \cdot \mathsf{r}_{jbt} + \delta_{jbt} + \epsilon_{ijbt}, \tag{13}$$

where δ is a building characteristic that is observed by the market but not in our dataset, $\alpha_{bt} = \alpha / \bar{y}_{bt}$ captures how rent affects utility and is parameterized as a single parameter divided by median borough income, and ϵ is the individual level idiosyncratic taste shifter (distributed Type-1 Extreme Value). Aggregating individual demands yields the logit market demand:

$$D_{jbt}(r, X, \delta) = \frac{\mathsf{e}^{\beta_0 + \beta_1 \cdot X_{jbt} + \alpha_{bt} \cdot \mathsf{r}_{jbt} + \delta_{jbt}}}{1 + \sum_{k \in \mathcal{J}_{bt}} \mathsf{e}^{\beta_0 + \beta_1 \cdot X_{kbt} + \alpha_{bt} \cdot \mathsf{r}_{kbt} + \delta_{kbt}}}. \tag{14}$$

We use the analytic inversion of Berry (1994) to arrive at our estimation equation:

$$\ln[\mathsf{s}_{jbt}] - \ln[\mathsf{s}_{0bt}] = \beta_0 + \beta_1 \cdot X_{jbt} + \alpha_{bt} \cdot \mathsf{r}_{jbt} + \delta_{jbt}, \tag{15}$$

where s_{0bt} is the market share of the borough's 'outside good' (i.e., not choosing a rental property). As in the log-log model, there is a potential correlation between the rent and the unobserved building characteristic, which leads us to instrument rent.

Controls For controls we use log distance to the nearest subway station, log average unit square feet, log years since a major renovation, an indicator for whether a building has an elevator, indicators for if the building is receiving various abatements. We also include tract-year fixed effects, ten-year age group fixed effects, and lot-size quartile fixed effects.

Instruments We use two approaches to identify the demand parameters. First, we use the characteristics of rival buildings, referred to as 'BLP instruments,' that shift the building markups. Second, we use variation tied to landlord costs by predicting building expenses and/or predicted land value from exogenous variables. Here we outline the identifying variation; for details on construction see Appendix E.

The identification based on rival characteristics posits that the degree that a landlord can markup rent is attenuated when renters have additional choices of similar buildings. Conditional on a building's own characteristics, the 'closeness' of rivals' characteristics should only affect rent through competition and not unobservables (to the econometrician) correlated with rent. We follow Bayer, McMillan, and Rueben (2004) and Davis et al. (2021) by reducing the set of BLP instruments to a single instrument.[26] The exclusion restriction holds if, when controlling for the characteristic of the building itself, the building's unobserved characteristic is orthogonal to the characteristics (and functions of the characteristics of) rivals: $\mathsf{E}[\delta_j \mid X_k] = 0 \; \forall \; j, k$. A major concern is that unobserved neighborhood characteristics are correlated with rivals' observable amenities. To deal with this concern, we follow the literature, omitting rivals from 1 kilometer around each building from the calculation of that building's instrument value. Still, the possibility of spatial auto-correlation patterns between observables and unobservables could pose an unknown threat to identification through long lags here and throughout this literature, which is the impetus for our second set of strategies.

The identification based on landlord costs posits that greater unit costs force the landlord to charge a higher rent. We proxy this economic cost concept using building reported expenses and land value assigned by the NYC DOF.[27] Our first instrument uses data on expenses. Of course, buildings' own expenses are in part endogenous to the amenities they provide, and in part exogenous. Buildings who employ doormen no doubt have higher expenses. Older buildings may both have distinct architectural amenities and higher costs

[26]Specifically, we regress rent on the BLP instruments alone, and then use that fitted value as an instrument for rent in the full estimation equation with the controls listed above.

[27]Expenses (and revenues) are reported annually by landlords to the NYC DOF for tax purposes, and the DOF uses city sales and income reports to generate land value measures.

because of aging infrastructure. To proxy for the exogenous dimension of expenses, we divide all buildings in our sample into 10-year age groups, calculating a leave-one-out average of expenses for each age group in each year:

$$Z_{jt}^{\text{Exp}} = \frac{\sum\limits_{k\in A_j} c_{kt}^{\text{Exp}} - c_{jt}^{\text{Exp}}}{N_{A_j,t} - 1}, \tag{16}$$

where A_j is the reference set of same age group buildings and $N_{A_j,t}$ is their count.

The leave-out average age group expenses varies by year for unobservable reasons. For example, in a particular year, a difficult winter may differentially increase heating costs for older buildings. We also directly control for age group, which means we do not use average expenses or amenities correlated with those expenses in identification. The exclusion restriction here is violated if time variation in unobserved age group amenities over the course of our nine-year sample is correlated with variation in leave-one-out expenses.

In a parallel strategy, we use leave-one-out averages land values of buildings group by lot area. Land valuation impact property taxes. While buildings in our sample are typically taxed on valuations derived from annual profits (reported income minus expenses) land values act as basis for an effective property tax floor.[28] We group parcels in each Neighborhood Tabulation Area (NTA) into deciles by lot size and calculate leave-one-out average land value per square foot for each decile (similar to Eq 16 but with a different cost concept and reference set). Controlling for the effect of decile directly, our variation exploits differential increases in land valuations for different deciles across our sample period. We group parcels by size because the fairly strong, nonlinear relationship between lot area and per-square-foot valuation varies over our sample time period. Changes in groups' land value per square foot can come from changes in assessor formulas, lumpiness in the comparable sales which feed into those formulas, or market forces which we assume to be orthogonal to the demand for rental units in our sample. The exclusion restriction requires that buildings' unobservable amenities are uncorrelated with changes in land valuation in of buildings with similar lot sizes in the NTA, after controlling for the direct effect of lot size (as well as tract).

[28]Appendix F discusses this feature of the tax code and shows how mass of buildings reporting low net income are assigned taxable values exactly equal to, but never below, land value.

6.2 Estimating Markups in the Presence of Supply-Side Restrictions

While our elasticity estimation is agnostic to the supply side of the market, to derive markups from estimated demand elasticities, we must account for how landowners set rents and quantities in our setting. As discussed in Section 2.3, a building's OPE is informative of its markup only for a subset of buildings. These are buildings that are redeveloped and not policy constrained. In practice, we isolate this group by finding the set of buildings which are less than ten-years old, not zoning constrained, and for which less than 10% of units are rent stabilized. While we do report median OPEs for the full sample, we stress and only interpret monopoly power using our results for unconstrained, new buildings.

We reiterate here that supply constraints like zoning constraints do not bias our estimates of demand parameters, and we use the full sample to estimate the demand parameters of our model, which requires only that the market for each building clears at the existing supply and price. Rent stabilization, which is present in our data, is distinct from rent control, which is not, and we take the view that rent stabilization does not affect long-run market clearing.

6.3 Elasticities and Markup Calculations

The logit-demand model uses equation 5, which in our empirical model is $\varepsilon_{jbt} = \alpha_{bt} \cdot \mathsf{r}_{jbt} \cdot (1 - \mathsf{s}_{jbt})$. We calculate the Lerner Index as: $\mathsf{L}_{jbt} = (-1/\varepsilon_{jbt})$. If landlords use a Bertrand price competition game to set rents, then the index is the proportion of rent due to markups: $\mathsf{L} = (\mathsf{r} - c)/\mathsf{r}$. We use Bertrand pricing only for interpretation but not estimation and, as stated above, only on the subset of policy-unconstrained plots.

Prior Literature Estimates Most housing demand literature estimates inelastic demand (Chen, Clapp, and Tirtiroglu, 2011; Albouy, Ehrlich, and Liu, 2016). This is an, "aggregate elasticity," the change in total housing consumed with a change in (aggregate) rents, rather than our targeted own-price elasticity, ε_j. To connect our setting to previous housing demand estimates, we calculate the aggregate elasticity which provides the responsiveness of renters to a 1% increase in rent for all 'inside' buildings (Berry and Jia, 2010; Conlon and Gortmaker, 2019):

$$\varepsilon_{bt}^{\text{Agg}} = \sum_{j \in \mathcal{J}_{bt}} \frac{D_{jbt}(\{\mathsf{r}_k + \Delta \mathsf{r}_k\}_{k \in \mathcal{J}_{bt}}) - D_{jbt}}{\Delta}\Bigg|_{\Delta = 1\%}. \tag{17}$$

Foreshadowing results, we will find both monopoly-consistent elasticities ε_j as well as literature-consistent inelastic aggregate elasticity ε^{Agg}.

7 Estimation Results

Table 3 presents our main empirical results. For the 2SLS results, we use three different just identified models and one overidentified model. Column (1) reports our OLS estimate of α, which is negative but small, and likely biased towards zero due to unobserved amenities. Column (2) reports the 2SLS estimates using BLP instruments. Here α is roughly -9, which corresponds to a median markup on the unconstrained sample of roughly one third. Our other three specifications, using our Expenses LOA (Column 3), Land Values LOA (Column 4), and, in an over-identified specification, the latter two combined (Column 5), are all very similar in magnitude, estimating α as roughly -15, and with a median markup on the relevant sample of between 20-25%. The slightly more conservative estimates are consistent with the possibility that the BLP instruments may suffer from some spatial auto-correlation. Overall, were units priced at the marginal cost reflective of the production and maintenance of buildings, we would expect rents to be about 70-80% of their current levels.

We report first stage effective F statistics (Olea and Pflueger, 2013), the Anderson-Rubin F statistic for rent, and weak IV robust confidence sets for rent (Finlay, Magnusson, and Schaffer, 2013). Of note is the weak F-stat in our Column (3) specification using just the expenses instrument. Nonetheless, our four IV specifications broadly agree that α is negative but bounded away from an extreme value which would imply no monopoly power.[29]

Since monopoly pricing is inconsistent with inelastic demand, observing whether buildings in our sample are elastic is a useful check. We find that (except for the OLS estimation) over 90% of all buildings have elastic demand that is compatible with monopoly pricing, and nearly all buildings are estimated to have elastic demand in our more conser-

[29] In Appendix G, we estimate a log-log regression to directly estimate a reduced-form OPE for additional support; we estimate $\varepsilon = -2.3$ (across all buildings) using our Cost IVs.

vative specifications.

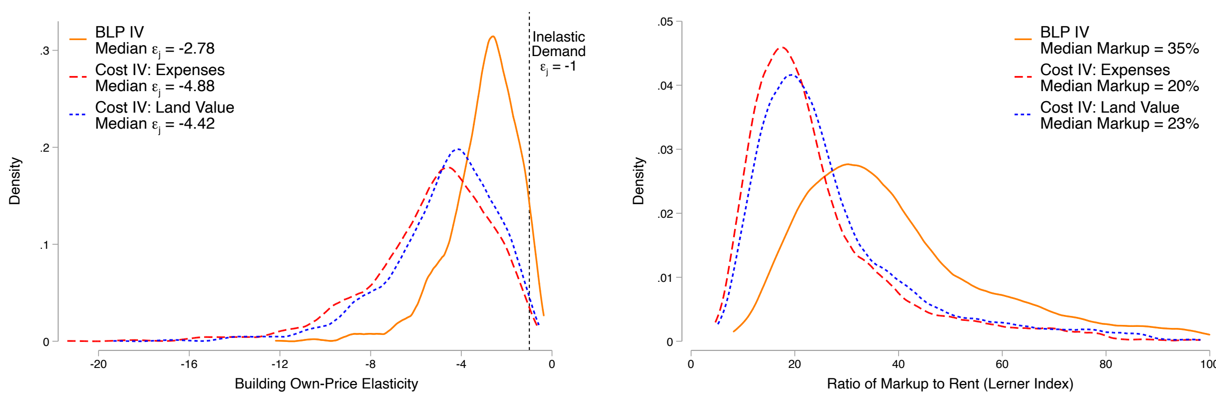
Figure 2 plots the full distribution of the own-price elasticities and Lerner Index for each of of our just-identified specifications. The figure highlights that the BLP IV estimates more inelastic OPEs (and subsequently larger markups) while the cost IVs find more elastic demand (and tend to agree with each other more).

Again, we note that our results differ from the literature on the elasticity of housing demand. Our elasticity of interest is conceptually different than that targeted by that literature, which seeks to measure the substitution between quantity of housing and consumption. In that literature, housing demand is typically found to be inelastic. When we estimate the aggregate elasticity in our data, which is more akin to the parameter estimated in the prior housing demand literature, we find similarly inelastic demand with an elasticity is between $(-0.80, -0.50)$. This estimate is slightly lower but quite similar to the consensus range in the prior literature: $(-0.70, -0.30)$ (Albouy, Ehrlich, and Liu, 2016). This may be due to a differences in setting (NYC rental markets) or in methodology as our outside good includes other housing choices in NYC rather than pure consumption.

Figure 2: Distribution of Results

(a) Own-Price Elasticity

(b) Markup as a Percent of Rent



Note: The figure plots the kernel density plot of own-price elasticities (Panel (a)) and markups / Lerner Index (Panel (b)) based on reults from Table 3. The solid orange line uses the BLP IVs (column 2), the long-dash red line uses the Cost IV using predicted expenses (column 3), and the short-dash blue line uses the Cost IV using predicted land values (column 4). The sample is all single-use residential buildings in the four boroughs with with four or more units, where unconstrained means all buildings that are not zoning constrained and where less than 50% of units are rent stabilized and where new buildings are 10 years old or less. The vertical line in Panel (a) indicates elasticities greater than -1, which would be incompatible with monopolistic pricing; these elasticities are excluded from Panel (b). The models and estimation are described in the text.

Table 3: Demand Estimation Results

	OLS (1)	IV:BLP (2)	IV: Cost Expenses (3)	IV: Cost Land Value (4)	IV: Cost Combined (5)
α	-0.27	-9.39	-16.46	-14.90	-14.98
	(0.04)	(2.13)	(7.37)	(2.73)	(2.63)
WIVR Conf. Set	–	$(-15.5, -6.3)$	$(-\infty, -8.6)$	$(-22.1, -10.7)$	$(-24.5, -9.8)$
First Stage Eff.F Stat	–	31.24	5.06	34.89	19.88
AR Stat for Rent	–	66.66	55.43	85.91	70.30
$\mathsf{Med}(\varepsilon_{jbt})$	-0.05	-1.90	-3.33	-3.02	-3.03
	(0.01)	(0.54)	(1.67)	(0.59)	(0.61)
$\mathsf{Med}(\varepsilon_{jbt}$ | Unconst., New)	-0.08	-2.78	-4.88	-4.42	-4.44
	(0.01)	(0.78)	(2.43)	(0.86)	(0.89)
Pct Elastic	0%	92%	99%	99%	99%
$\mathsf{Med}(\mathsf{L}_{jbt}$ | Unconst., New)	–	35%	20%	23%	23%
$\mathsf{Avg}(\varepsilon_{bt}^{\mathsf{Agg}})$	-0.01	-0.47	-0.82	-0.74	-0.75

Note: The table displays parameter estimates from Logit demand models. The own-price elasticity is ε, the Lerner index is $-1/\varepsilon$, and the aggregate price elasticity, ε^{Agg}, is based on Berry and Jia (2010). Buildings are 'unconstrained' if *not* rent stabilized and *not* zoning-constrained; buildings are considered new if less than 10 years old. We estimate the OLS model (1), three just-identified IV models using 'BLP instruments' (2), predicted expenses (3), and predicted land value (4), and finally an overidentified model using the two 'cost IVs' (5). All models include Census tract, ten-year age group, and lot size quartile fixed effects, along with controls for log distance to nearest subway station, average unit square-feet, an indicator for having an elevator, and indicators for having various NYC tax abatements. Standard errors are clustered by Census tract and the first stage F statistic and the Anderson-Rubin F statistic for the estimated coefficients are cluster robust as well. Weak IV Robust Confidence Sets (WIVR Conf. Set) calculated using `weakiv` by Finlay, Magnusson, and Schaffer (2013). Standard errors for the median elasticities are calculated using the parametric bootstrap; i.e., we draw 100 $\hat{\alpha}_r \sim \mathcal{N}(\hat{\alpha}, \mathtt{se}(\hat{\alpha}))$, compute median OPEs given each draw, and then calculate the standard deviation over the 100 draws.

8 Conclusion

While previous housing and urban literatures have considered the scope for monopoly power, we believe we are the first to quantify its importance in urban rental markets, finding that its scope appears economically significant and policy relevant. We find that a 10% increase in Census tract level ownership concentration correlates to a 1% increase in building rents, and that in NYC rental markets markups account for at least a fifth of rents.

Second, we explore the link between monopoly pricing and urban policies, specifically redevelopment incentives and zoning constraints, along with the effects of ownership concentration. We show how monopoly landownership affects not only the quantity supplied at a given point in time but also causes redevelopment failure by limiting future urban housing growth. We discuss a welfare improving policy that is implementable without requiring any structural estimates. Additionally, we show the theoretical links between ownership concentration and zoning constraints on the markups for a given building and its rivals.

Lastly, we caution that an important aspect of the residential real estate market beyond the scope of this paper is the decision of landowners to enter and exit the market. We have highlighted the existence of monopoly pricing power and the complex interaction between that and urban policies. However, monopoly profits from renting, and thus urban policies affecting those profits, impact entry and exit decisions. Policies which impact those markups will likely impact the size of the rental market.

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Online Appendix of
Is the Rent Too High? Landownership and Monopoly Power

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A Propositions

A.1 Proposition 1

We can rewrite the redevelopment cost as the sum of redevelopment to the existing size $q_{a,0}$ and the sum of marginal development costs from $q_{a,0}$ to $q^*_{a,1}$:

$$C^{\mathsf{d}}_a(q^*_{a,1}) = C^{\mathsf{d}}_a(q_{a,0}) + \int_{q_{a,0}}^{q^*_{a,1}} c^{\mathsf{d}}_a(q)dq \tag{18}$$

and likewise, the leasing cost $C^{\mathsf{f}}_a(q^*_{a,1})$ as

$$C^{\mathsf{f}}_a(q^*_{a,1}) = C^{\mathsf{f}}_a(q_{a,0}) + \int_{q_{a,0}}^{q^*_{a,1}} c^{\mathsf{f}}_a(q))dq \tag{19}$$

Rewriting (7), redevelopment occurs iff

$$[r_a(q_{a,0}) - r_a(q^*_{a,1})] \cdot q^*_{a,0} < \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq - C^{\mathsf{f}}_a(q_{a,0}) \tag{20}$$

However, the redevelopment is socially optimal when

$$\int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq - C^{\mathsf{f}}_a(q_{a,0}) + \int_{q_{a,0}}^{q^*_{a,1}} D_a(q) - r_a(q^*_{a,1})dq > 0 \tag{21}$$

Now construct a new demand $D^1_a(q)$ takes the form

$$D^1_a(q) = s + D_a(q) \tag{22}$$

and note that $\dfrac{\partial \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq}{\partial s} > 0$, as $\dfrac{\partial q^*_{a,1}}{\partial s} > 0$ and $r_a(q^*_{a,1})q > c^{\mathsf{f}}_a(q) + c^{\mathsf{d}}_a(q)$.

Now, choose subsidy$_a$ such that $\int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq = C^{\mathsf{f}}_a(q_{a,0})$ and note that Equation (21) is satisfied while Equation (20) is not.

A.2 Proposition 2

We consider welfare changes in the presence of a subsidy of size $C^{\mathsf{d}}_a(q_{a,0})$ under the restriction that rents are reduced such that $subsidy \leq (r(q_{a,0}) - r) \cdot q_{a,0}$.

Let $q_{a,sub}$ be the quantity chosen conditional on policy uptake. Let $q_{a,comp}$ be the "competitive" quantity such that

$$c^{\mathsf{d}}_a q_{a,comp} + c^{\mathsf{f}}_a q_{a,comp} = P(q_{a,comp}).$$

And further let $z_a = c^{\mathsf{d}}_a q^*_{a,1} + c^{\mathsf{f}}_a q^*_{a,1})$ be the marginal cost at the optimal quantity $q^*_{a,1}$.

We consider four cases.

Case 1: $r \geq r(q^*_{a,1})$ When r is set above $r(q^*_{a,1})$, conditional on redevelopment developers set $q = q^*_{a,1}$. If redevelopment occurs with the subsidy, then the requirement $r(q^*_{a,1}) < r$ is therefore fulfilled. Furthermore, the subsidy is weakly welfare improving.

To see this, first note that for redevelopment failure to occur in the presence of a subsidy subsidy_a, a necessary condition is

$$[r_a(q_{a,0}) - r_a(q^*_{a,1})] \cdot q^*_{a,0} + C^{\mathsf{f}}_a(q_{a,0}) + s > \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq$$

When the subsidy is set at

$$\text{subsidy}_a = C^{\mathsf{f}}_a(q_{a,0})$$

redevelopment failure implies

$$[r_a(q_{a,0}) - r_a(q^*_{a,1})] \cdot q^*_{a,0} > \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq$$

However, recall $q^*_{a,1}$ is the monopoly-chosen optimal point and by definition profit maximizing for the landowner-developer. This always precludes the above condition. The proposed subsidy subsidy_a is therefore large enough to preclude redevelopment failure.

However, with this subsidy alone, we are not guaranteed that all subsidized redevelopment is socially optimal. Redevelopment is socially optimal when

$$C^{\mathsf{f}}_a(q_{a,0}) \leq \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq + \int_{q_{a,0}}^{q^*_{a,1}} D_a(q) - r_a(q^*_{a,1})dq$$

That is, when the costs associated with reconstructing existing structures is weakly smalelr than the combined increase in consumer and producer surplus. A sufficient condition for this is if costs are less than increases in producer surplus:

$$C^{\mathsf{f}}_a(q_{a,0}) \leq \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq.$$

The requirement for uptake of the subsidy is that the total change in rent is greater than the subsidy, which implies

$$\text{subsidy}_a = C^{\mathsf{f}}_a(q_{a,0}) \leq [r_a(q_{a,0}) - r_a(q^*_{a,1})] \cdot q^*_{a,0}$$

We further know, because $q^*_{a,1}$ is the monopoly-optimal redevelopment quantity, that redevelopment only occurs with the subsidy when

$$[r_a(q_{a,0}) - r_a(q^*_{a,1})] \cdot q^*_{a,0} \leq \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq.$$

The imposed requirement therefore ensures that

$$C^{\mathsf{f}}_a(q_{a,0}) \leq \int_{q_{a,0}}^{q^*_{a,1}} r_a(q^*_{a,1})q - c^{\mathsf{f}}_a(q) - c^{\mathsf{d}}_a(q)dq$$

which is a sufficient condition to ensure redevelopment is socially optimal.

Because all redevelopment is to $q^*_{a,1}$ and as such is socially optimal, any uptake is welfare improving in this case.

Case 2: $P_a((q_{a,comp}) \geq r_a < r(q^*_{a,1})$ In this case, if the subsidy is taken, then $q_{a,subsidy}$ is chosen such that $r(q_{a,subsidy}) = r_a$, as this is

Case 3: $z_a < r_a \geq P_a((q_{a,comp})$

Case 4: $r_a < z_a$

A.3 Proposition 4

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Recall that $D_a = \frac{e^{F(a,y-r(a),y)/\sigma_\epsilon}}{\sum\limits_{a' \in \mathcal{A}} \{e^{F(a',y-r(a'),y)/\sigma_\epsilon}\}} \cdot M$ from the main text using logit demand. Here, we switch to indexing buildings using j rather than a. To make notation easier, let $\alpha = \frac{\partial F(a,y-r,y)}{\partial r} < 0$ be the (negative) marginal utility of consumption, and set $\sigma_\epsilon = 1$.

Binding zoning restrictions, by reducing quantities at a plot k, increase rents at that plot. The rest of Proposition 4 will follow as long as plots, as competing products, are strategic complements in pricing decisions.

Definition A.1. Strategic Complements: If the cross derivative of a given player's own payoff function with respect to her action and that a rival's action is positive, then the actions are strategic complements.

In our Bertrand oligopoly setting, rents are strategic complements if

$$\frac{\partial^2 \pi_j}{\partial r_j \partial r_k} = \frac{\partial \left[\partial D_j / \partial r_j\right]}{\partial r_k} \cdot (r_j - C_j(D_j)) + \frac{\partial D_j}{\partial r_j} \cdot \left(-\frac{\partial C_j}{\partial D_j}\frac{\partial D_j}{\partial r_k}\right) + \frac{\partial D_j}{\partial r_k} \geq 0. \tag{23}$$

Denote the derivative of marginal cost as $\frac{\partial C_j}{\partial D_j} := c_j$. When we apply Logit demand functions, this becomes:

$$\frac{\partial^2 \pi_j}{\partial r_j \partial r_k} = -\alpha^2 D_j D_k (1 - 2D_j)(r_j - C_j) - c_j \alpha D_j (1 - D_j) - \alpha D_j D_k \tag{24}$$

$$= \underbrace{-\alpha D_j D_k}_{>0} \left[\underbrace{\frac{D_j}{(1 - Dj)}}_{>0} + \underbrace{(-c_j \alpha D_j (1 - D_j))}_{>0 \text{ if } c_j > 0} \right]. \tag{25}$$

Note, we use the equilibrium relationship that $(r_j - C_j) = -r_j / \varepsilon_j$.

Thus, generally the strategic nature of pricing decisions is ambiguous. A sufficient condition for strategic complements in the logit case is that $c_j \geq 0 \forall j$. This is true with constant marginal costs or diseconomies of scale for the building. With decreasing marginal costs, the strategic complementary of pricing decisions is ambiguous and may vary between pairs of buildings.

If marginal cost is constant, then the rent increase could only be due to an increase in monopoly markups. With variable marginal cost, this the degree that the markup changes is ambiguous. Decreasing marginal costs would push the landowner to expand quantity supplied and travel further down the demand curve, which may lead to a smaller markup per unit but greater profit (and lower rent). On the other hand, increasing marginal costs attenuate the landowner's desire to expand keeping the landowner in a steeper part of the demand curve but with greater marginal costs eating into the markup.

If long as marginal cost is 'locally constant' in equilibrium (i.e., its change is 'small enough'), then we can say buildings are strategic complements in the logit case. Given strategic complements of price strategies, an increase in zoning constrained building k's rent will increase demand for unzoned building j, and increases the price at j accordingly.

A.4 Proposition 3

First, we prove that when an landlord's parcel ownership concentration increases, the landlord increases the prices at all properties. We apply the framework of Nocke and Schutz (2018b) and Nocke and Schutz (2018a) to calculate the price effect by utilizing the ι-markup of the landlord. The authors use a nested-logit model, but we simplify the result removing the nesting structure.[30]

We wish to show that in the logit case with non-decreasing marginal cost, $\frac{\partial r_j}{\partial s_f} > 0, \ \forall\ j \in f$, which proves the proposition. Below, we show this in the two product for intuition and then in the general case with arbitrary number of products.

Oligopolist Pricing Equation First, we show that landowner f chooses a common markup (Nocke and Schutz, 2018a,b). Let each landlord solves the following joint-profit equation:

$$\max_{\{r_j\}_{j\in f}} \sum_{j\in f} r_j D_j - C_j(D_j). \tag{26}$$

Following the insight from Nocke and Schutz (2018b), the first order for each property satisfies:

$$\left(r_j - \frac{\partial C_j}{\partial D_j}\right) = \frac{-1}{\alpha} + \pi_f = \frac{-1}{\alpha(1-s_f)}. \tag{27}$$

[30]These results also remove individual heterogeneity in renter preferences in order to take advantage of the IIA property.

We can rearrange 27 to solve for rent:

$$r_j = \frac{\partial C_j}{\partial D_j} - \frac{1}{\alpha(1-s_f)} > 0, \tag{28}$$

where marginal cost is positive to yield an upward sloping supply curve. Denote marginal cost as $\frac{\partial C_j}{\partial D_j} = c_j$. We will assume that its derivative is positive: $\tilde{c}_j := \frac{\partial c_\ell}{\partial D_\ell} \geq 0, \ \forall \ell \in J$.[31]

Two Product Case Recall again that under logit demand:

$$\frac{\partial D_j}{\partial r_j} = \alpha D_j(1-D_j) < 0 \tag{29}$$

$$\frac{\partial D_k}{\partial r_j} = -\alpha D_j D_k > 0 \tag{30}$$

Now, we differentiate with respect to the landlord's total market share:

$$r_j = \frac{-1}{\alpha(1-s_f)} + c_j(D_j) \tag{31}$$

$$\implies \frac{\partial r_j}{\partial s_f} = \frac{-1}{\alpha(1-s_f)^2} + \frac{\partial c_j}{\partial D_j}\left(\frac{\partial D_j}{\partial r_j}\frac{\partial r_j}{\partial s_f} + \frac{\partial D_j}{\partial r_j}\frac{\partial r_k}{\partial s_f}\right) \tag{32}$$

and by symmetry:

$$\frac{\partial r_j}{\partial s_f} = \frac{\frac{-1}{\alpha(1-s_f)^2} + \frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_k}\left[\frac{\frac{-1}{\alpha(1-s_f)^2} + \frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_j}\frac{\partial r_j}{\partial s_f}}{\left(1-\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_k}\right)}\right]}{\left(1-\frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_j}\right)} \tag{33}$$

$$= \frac{-1}{\alpha(1-s_f)^2}\left[\frac{1-\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_k} + \frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_k}}{\left(1-\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_k}\right)\left(1-\frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_j}\right) - \left(\frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_k}\right)\left(\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_j}\right)}\right]. \tag{34}$$

Finally, we impose the logit model to get:

$$\frac{-1}{\alpha(1-s_f)^2}\left[\frac{1-\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_k} + \frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_k}}{1-\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_k} - \frac{\partial c_j}{\partial D_j}\frac{\partial D_j}{\partial r_j} - \frac{\partial c_j}{\partial D_j}\frac{\partial c_k}{\partial D_k}\frac{\partial D_k}{\partial r_j}\alpha(1-s_f)}\right] > 0. \tag{35}$$

[31] A micro-foundation is that the residential space production function is concave in inputs which implies that the cost function in convex in quantity; hence, marginal cost is non-decreasing in quantity.

A.5 General Product Case

Note that we have the following:

$$[r_i] = [\Gamma(s_f) \cdot 1_f] + [c_i(D_i)] \tag{36}$$

$$\mathsf{D}_{s_f} r = [\Gamma'(s_f) \cdot 1_f] + \mathsf{D}_D c \cdot \mathsf{D}_r D \cdot \mathsf{D}_{s_f} r \tag{37}$$

$$\implies \mathsf{D}_{s_f} r \cdot [\mathbb{I} - \mathsf{D}_D c \cdot \mathsf{D}_r D] = [\Gamma'(s_f) \cdot 1_f] \tag{38}$$

$$\implies \mathsf{D}_{s_f} r = [\mathbb{I} - \mathsf{D}_D c \cdot \mathsf{D}_r D]^{-1} \cdot [\Gamma'(s_f) \cdot 1_f] \tag{39}$$

A.5.1 Definitions and Lemmas

Definition A.2. Strictly (Row) Diagonally Dominant : for every row, i, the element along the diagonal, a_{ii}, is greater in magnitude than the sum of the magnitudes of each non-diagonal element in the row $a_{i,j},\ j \neq i$. That is, $|a_{i,i}| > \sum_{j \neq i} |a_{i,j}|$.

Definition A.3. `Z`-matrix : a matrix whose off-diagonal entries are less than or equal to zero.

Definition A.4. `M`-matrix : a `Z`-matrix where every real eigenvalue of A is positive.

Lemma 1. *If A is a `Z`-matrix that is strictly diagonally dominant, then A is an `M`-matrix by* Gershgorin Circle Theorem.

Lemma 2. *If A is an `M`-matrix with positive diagonals and negative off diagonals, then $B = A^{-1}$ is monotone positive; i.e., $b_{ij} > 0,\ \forall\ i, j$; proof in Fan 1958.*

A.5.2 General Case Proof

We need to show that the lemma holds and that the vector $B \cdot \Gamma'(s)$ is a monotone positive vector. Let $[\mathbb{I} - \mathsf{D}_D c \cdot \mathsf{D}_r D] = A$.

First, see that A is (a) a Z-matrix that is (b) Strictly (Row) Diagonally Dominant :

(a) for each row, using logit demand, we have

$$a_{i,i} = 1 - \tilde{c}_i \alpha D_i (1 - D_i) > 0 \tag{40}$$

$$a_{i,j} = \tilde{c}_i \alpha D_i D_j < 0 \tag{41}$$

(b) plug into definition of (row) diagonally dominant

$$\implies 1 + \tilde{c}_i |\alpha| D_i (1 - D_i) > \sum_{j \in f \setminus i} \tilde{c}_i |\alpha| D_i D_j = \tilde{c}_i |\alpha| D_i \sum_{j \in f \setminus i} D_j \tag{42}$$

$$\implies 1 + \tilde{c}_i |\alpha| D_i > \tilde{c}_i |\alpha| D_i \cdot s_f . \tag{43}$$

Thus A satisfies lemma 2, so B is a monotone positive matrix.
Second, $\Gamma'(s_f) = \frac{\mathsf{d}}{\mathsf{d}s_f} \frac{-1}{\alpha(1-s_f)} = \frac{-1}{\alpha(1-s_f)^2} > 0$.
Thus as $B \cdot \Gamma'(s_f)$ is a series of multiplication and addition of positive numbers, so $\mathsf{D}_{s_f} r$ must be a monotone positive vector.

B Detailed Construction of Samples

Here, we discuss the exact steps in sample construction. Recall, the samples we use in the paper are as following:

- HHI: 2008-2015 NYC: Ownership Matched and Unconstrained
- Demand: 2007-2015 NYC: Residential, Unconstrained, New Unconstrained.

B.1 HHI: 2008-2015 NYC

We begin with all buildings in NYC, and then drop buildings based on:

1. missing location information, plots that are under construction, vacant, or are parks;
2. residential area is zero, there are zero residential units, or market values equal zero;
3. plots where the building is not classified as a private rental building (i.e., we drop owner occupied single family residences, condominium and cooperative buildings, 100% publicly owned buildings, any remaining commercially classified buildings, buildings designated as land-marks);
4. missing building characteristic information;
5. building has less than four units.

Next, we link this sample to the MDRC files that link reported building owners to shareholders using the BBL building identifiers. We then test if the reported building owner name matched the MDRC owner name (the owning entity, not shareholders) using a fuzzy string matching algorithm. This results in a match rate of roughly 80% for each year.[32] We drop buildings that do not match.[33] See Appendix C for more details on the matching process.

Using this matched group, we then calculate HHI and leave-out HHI measures. Finally, we drop buildings that are mixed use, as we cannot separately identify commercial vs residential income sources. This forms the sample in Table 2 Panel A. For Table 2 Panel B, we drop buildings that have over 50% of units rent stabilized and/or are zoning constrained.

[32]We drop the entire year 2007 due to excessively high proportion of non-matches, over 40%.

[33]We believe matching failures happen primarily for two reasons. First, there does not seem to be oversight of the ownership registrations so misspellings are common – we correct as best we can using our fuzzy match. Second, the MDRC is a snap-shot that does not save information across years or transactions, so it is possible that a building owner changes and it is not recorded when we have access to the files.

B.2 Demand: 2007-2008 NYC

We begin with all buildings in NYC, and then drop buildings based on:

1. missing location information, plots that are under construction, vacant, or are parks;
2. residential area is zero, there are zero residential units, or market values equal zero;
3. plots where the building is not classified as a private rental building (i.e., we drop owner occupied single family residences, condominium and cooperative buildings, 100% publicly owned buildings, any remaining commercially classified buildings, buildings designated as land-marks);
4. missing building characteristic information;
5. building has less than four units.

To arrive at the residential sample, we drop buildings where there is positive commercial building area or commercial units. Again, we drop mixed use buildings because we cannot separate commercial and residential income sources. This is not the same as treating these buildings as 'outside goods' for the model. Utility parameters are identified under the assumption that the parameters do not depend on whether the building has commercial space.[34]

This set of buildings constitutes the estimation sample on which we estimate the model in Table 3. We arrive at the Unconstrained & New sample by dropping buildings that have over 50% of units rent stabilized, are zoning constrained, and/or are older than ten years old.

[34]Unreported monte carlo tests show that under the assumptions of the model, parameters remain unbiased. At worst, we believe the model is less efficiently estimated due to smaller samples.

C HHI and Ownership Matching

Here we describe how we match buildings to owner groups. This procedure is necessary because a large portion of reported rental building owners are a corporate entity that is itself owned a holding company.[35] Thus the reported ownership structure underestimates the degree of common ownership. The NYC Department of Housing Preservation and Development (HPD) requires that building owners register each building with multiple dwellings (or inhabited by non-family members) and compiles this registration list to create the Multiple Dwelling Registry and Contacts (MDRC). Importantly, the MDRC assigns a unique ID to each building-owner pair and for each owner lists the names of the main shareholders of the corporate owner or partnership. Building owners must re-register annually so the list updates annually. Thus we have a list of buildings with their corporate owner names and shareholder names.[36]

However, we face two data challenges in matching buildings to owners using the MDRC. First, we only have MDRC lists for three years: 2012, 2015, and 2020. Second, the MDRC does not link buildings by common owners. We deal with each in turn.

To create a building owner panel, we append the three MDRC annual files together and 'back-fill' the ownership from MDRC information for missing years. That is, if we observe a building-owner pair for year 2020, then we assume the owner is the same from 2020, 2019, 2018, and so on.[37] We then merge this with our DOF/PLUTO building year panel of rental buildings. Finally, we use a text matching procedure to ensure that the reported building corporate owner matches the MDRC corporate owner name.[38] Table A1 reports the match rate for the main four boroughs by year used in the rent sample.

To find all buildings that have common shareholders, we again perform a text matching procedure. We perform this procedure for each tract-year pair in the four main boroughs of NYC for three sets of shareholder names. The first is matching the primary shareholder, the second is matching the primary and secondary shareholders, and the third is matching across all shareholders. Using only the first shareholder name is the most conservative

[35] We speak loosely with the terms 'corporate entity' and 'holding company'; some building owners are literally a corporation while others are limited liability companies, sole proprietorship, partnerships, or cooperatives.

[36] We arrange the shareholder names based on frequency. For example, if name A is associated with 5 buildings and name B with 4 buildings, then for any set of buildings with both names $\{A, B\}$ we designate name A as the primary name.

[37] We find that the 2015 file matches better to years 2016 and 2017 than back-filling the 2020 file, so we extend the 2015 file two years as well as back fill 2014 and 2013.

[38] We use the Stata command `matchit` with a threshold of 0.5.

Table A1: Match Rate Across Boroughs

	BK	BX	MN	QN
2008	0.79	0.82	0.81	0.80
2009	0.80	0.83	0.83	0.81
2010	0.83	0.86	0.86	0.84
2011	0.83	0.87	0.87	0.84
2012	0.84	0.89	0.87	0.85
2013	0.85	0.88	0.87	0.85
2014	0.84	0.89	0.87	0.84
2015	0.84	0.88	0.87	0.84

Note: 2008-2015 NYC residential buildings with 4+ units. Data from DOF, PLUTO, MDRC files. Match rate between reported owner from PLUTO & FAR and MDRC owner name.

measure of common ownership and is the one with the least expected errors.[39] For any building that does not match to the MDRC, we use the reported ownername (usually a corporate entity) and require an exact string match within the tract-year.[40]

To get a sense of the scale of the issue. For Manhattan rental buildings, we find that the average number of distinct owner groups ('landlords') in a tract-year are 48.6 using the reported ownership structure and 34.8 using the MDRC matched ownership structure. For the same set of buildings, we find that within a census tract the average landlord owns 3 buildings when we use the reported ownership structure and 4.3 buildings when we use the MDRC matched ownership structure Table A2 reports these values by year for Manhattan and the other three major boroughs.

[39]We again use the Stata command `matchit` but increase the match threshold to 0.55 for primary name matching and to 0.6 for the multi-name matching. As the length of a string increases, the fuzzy text matching procedure is more likely to find false-positive matches.

[40]We use an exact matching because our fuzzy string matching procedure cannot tell the difference between corporate names of the form 555 Street LLC and 554 Street LLC.

Table A2: Difference Between Reported and MDRCC Common Ownership

	Manhattan				Brooklyn, Bronx, Queens			
	Distinct Owners		Avg Bld per Owner		Distinct Owners		Avg Bld per Owner	
	MDRC	Reported	MDRC	Reported	MDRC	Reported	MDRC	Reported
2008	34.2	46.9	4.3	3.0	20.9	24.4	2.5	2.1
2009	34.6	47.8	4.3	3.1	21.1	24.7	2.5	2.1
2010	34.8	48.1	4.2	3.1	21.3	25	2.5	2.1
2011	35.0	48.5	4.3	3.0	21.5	25.2	2.5	2.1
2012	35.3	49.2	4.3	3.0	21.6	25.4	2.5	2.1
2013	35.3	49.4	4.4	3.0	21.8	25.6	2.5	2.1
2014	34.7	49.4	4.3	3.0	21.6	25.7	2.5	2.1
2015	34.8	49.4	4.2	3	21.6	25.7	2.5	2.1

Note: 2008-2015 NYC residential buildings with 4+ units. Data from DOF, PLUTO, MDRC files. Comparison between reported owners in PLUTO & FAR versus MDRC files. Owners matched within tract-years.

D Detailed Construction of Average Building Rent

Recovering building average unit rents is a key feature of this analysis that relies on three facts. First, by law, the DOF assesses rental buildings based on their income generation. For single-use, residential rental buildings, this corresponds to the rent paid to landlords. For mixed-use rental buildings, we cannot separate the source of income between commercial and residental tenants. This leads to our sample restriction of single-use buildings in our estimations.

Second, we use the web-scraped NPV data. We believe the NPV data is high quality because it is based on communications with owners who have a financial stake in ensuring the information is correct. However, because we rely on a third party's efforts in web-scraping, we must deal with the fact that the third party did not collect information on all buildings. Primarily, the web-scraped data does not include any building with 4 or 5 units and is randomly missing others.

To remedy this, we rely on the third fact. The DOF uses building income data in its assessment process to derive "market value" which is then used for property taxes. Specifically, the DOF calculates market value using the following formula:

$$\text{MarketValue}_j = \text{GIM}_j \cdot \text{Avg}\left(\text{Annual Rent}\right)_j \cdot \text{units}_j, \tag{44}$$

where the Gross Income Multiplier (GIM) is determined by the DOF based on the building's market value per square foot and its location.

Since we observe market value for all buildings in the FAR dataset, we can use the buildings that overlap the NPV data to backout the the function $\text{GIM}_j = \text{G}(\frac{MV_j}{SQFT_j}, \text{Units} \geq 10, \text{borough}, \text{year})$. We estimate the GIM function via the following:

1. For the matched set, divide market value by income to recover GIM_j;
2. Calculate market value by square feet (mvsqft);
3. By borough and year, calculate the 50-point quantiles of mvsqft;
4. By borough, year, and large building status (units ≥ 10), find the average GIM_j – Avg(GIM | B,Y,U>10);
5. For the set of buildings that are not in the matched set, calculate $\frac{MV_j}{\text{Avg(GIM|B,Y,U>10)}} = \hat{Y}_j$.

We use the reported value Y_j for the matched buildings and $\hat{Y}_j$ for the unmatched buildings.

D.1 Additional Information

The income data is ultimately sourced from the Real Property Income and Expense (RPIE) statements that all income generating property owners are required to file annually and face financial penalties for not filing. Nevertheless, not all property owners will file this report. If an owner does not file, the DOF has the right to assign a market value based on its best judgement. In addition, the DOF documentation says that they will adjust report amounts that seem extreme; e.g., a building reporting high costs and no income in an area where other buildings are report incomes above costs. Without access to the RPIE statements, it is not possible to determine which properties have been adjusted.

The DOF Assessment Guidelines show how Income and Market Value relate to each other and how one can be directly inferred using the other. In the table below, we describe the DOF mapping that goes from observed income to market value: $G\colon Y \times SqFt \to M$.

D.1.1 Robustness of Calculations

We can check the robustness of our calculations by using an auxilary dataset by the DOF, the Condo/Coop Comparable Rental Income data. By law, condominium buildings must be valued for tax purposes as-if they were rental buildings. To accomplish this, the DOF matches condominiums with rental properties and calculates and expected, market value and income of the condominiums. They publish these comparisons and include the rental building income and market value used in the comparisons. Thus, we are able to check our

Table A3: Example Mapping of Market Value to Income

y	GIM_{Low}	GIM_{High}	m	Y_j
$[y_1, y_2]$	$\frac{m_1}{y_1}$	$\frac{m_2}{y_2}$	$[m_1, m_2]$	$= MV_j \cdot \frac{y_2}{m_2}$
$[y_2, y_3]$	-	$\frac{m_3}{y_3}$	$[m_2, m_3]$	$= MV_j \cdot \frac{y_3}{m_3}$
$[y_3, y_4]$	-	$\frac{m_4}{y_4}$	$[m_3, m_4]$	$= MV_j \cdot \frac{y_4}{m_4}$

Note: This table provides a simplified example of the Gross Income Multiplier (GIM) method used by the NY DOF that we utilize to infer building income from observed building market value. For 80% of our multi-year sample, we observe both market value and income, which we use to estimate the GIM for the remaining properties, as described in the main text.

results for the matched buildings. Our values are nearly identical except for inconsistent rounding behavior on the part of the NYC DOF, typically in the owner's favor.[41]

[41]For Manhattan, we are able to check against 1,883 rental buildings, and we find 83 buildings where the absolute difference between our assigned GIM and the empirical ratio of market value to income is greater than 0.1; this represents an error rate around 4% of buildings. Again, these errors are due to inconsistent behavior by the NYC DOF.

E Instrument Construction

We use two sets of instruments for this analysis. Intuitively we can think of market rent having two parts:

$$\text{Rent} = \text{Marginal Cost} + \text{Markup}. \tag{45}$$

Our first set uses variation in competition from similar buildings to shift the markup, parameterized using 'BLP instruments' (Berry, Levinsohn, and Pakes, 1995). Our second set uses variation in the landlord's cost to provide space, parameterized as leave-out-averages (LOA) of expense and land values.

E.1 BLP Instruments

We combine two approaches for this approach. First, we use the 'differentiation' based instruments advocated in Gandhi and Houde (2018); Conlon and Gortmaker (2020), with a spatial radius, as in Bayer, McMillan, and Rueben (2004); Bayer, Ferreira, and McMillan (2007). These instruments are meant to be *an* approximation to the optimal instruments in the sense of Amemiya (1977) and Chamberlain (1987).[42]

Digression The 'true' optimal instruments are based on the partial derivative of the structural error term:

$$Z^{\mathsf{opt}} = \mathsf{Var}(\delta_j)^{-1} \cdot \mathsf{E}\left[\frac{\partial \delta_j}{\partial \beta} \quad \frac{\partial \delta_j}{\partial \alpha} \middle| Z\right]. \tag{46}$$

This has exactly as many moments as parameters, so is exactly identified. To calculate this object, one must take a stand on the conditional distribution of the structural error, solve the Bertrand pricing problem, back out model-implied structural errors, and then calculate the derivatives. Because we do not accurately observe prices for mixed-use buildings, which is roughly half of the choice set, we cannot credibly solve the Bertrand pricing problem.[43] □

Still faced with the issue of many possibly weak instruments, we second follow the

[42]More formally, they are a finite-order basis-function approximation to the optimal instruments.

[43]In addition, with rent control and zoning constraints, we would need to solve a constrained Bertrand pricing problem, which is considerably more difficult.

approach in Bayer, McMillan, and Rueben (2004); Bayer, Ferreira, and McMillan (2007); Davis et al. (2021) in reducing the dimension of instruments. Our approach is the natural application of these authors in the context of Berry (1994) (i.e., no random coefficients). We simply regress log rent on the BLP IVs, attain the fitted value, exponentiate it (to go from log to level and ensure positive rent values), and then divide by the average borough income.

E.2 Cost Instruments

For our cost instruments, we use variation in the landlord's cost of providing space. We have information on two sources of cost information.

First, we have reported building expenses. These are reported as part of the information (along with income) collected by the NYC DOF for tax purposes.[44] Second, we have assessed land value of the parcel. This value is calculated outside of the NYC DOF by independent assessors based on sales around the city and their own statistical procedures and non-public information. In Appendix F, we show that land value acts as an implicit tax floor (before abatements) for a building.

However, we cannot guarantee that both expenses and land values are not also correlated with unobserved building quality. Thus, we want to create exogenous (to a given building's unobserved quality) measures of these variables.

We use a 'leave-out-average' approach by calculating the average of all buildings with a similar profile but without the given building. For the expenses LOA, we calculate average unit expenses (expenses divided by units) and then use buildings that are in the same 10-year age bin across the city in the same year for the LOA.[45]

For each year,

1. Create $\bar{e}_j$ = $\text{Expenses}_j/\text{Units}_j$
2. Create 10-year age bins
3. By age bins, calculate the sum of $\bar{e}$ ($\Sigma\bar{e}$)
4. By age bins, calculate the count of each age bin (N_{age})
5. Create IV(Expenses) = $\frac{\Sigma\bar{e}-\bar{e}_j}{N_{\text{age}}-1}$

---

[44]Specifically, building tax rates are applied to net-revenue of buildings.

[45]Unfortunately, we cannot narrow the geographic scope of this approximation due to data limitations.

For land value LOA, we calculate land value per square foot and then use all buildings in the same pacel area decile in the same Neighborhood Tabulation Area (NTA) and year for the LOA.[46]

For each year *and* NTA,

1. Create ℓ_j = $\mathsf{Land\ Value}_j/\mathsf{Parcel\ SQFT}_j$
2. Create $\mathsf{Parcel\ SQFT}_j$ decile bins
3. By area bins, calculate the sum of ℓ ($\Sigma\ell$)
4. By area bins, calculate the count of each area bin (N_{area})
5. Create $\mathsf{IV}(\mathsf{LandVal}) = \frac{\Sigma\ell-\ell_j}{N_{\mathsf{area}}-1}$

---

[46]NTAs are collections of Census tracts that NYC officials use to describe the city's geography.

F Relationship Between Land Values and Tax Assessments

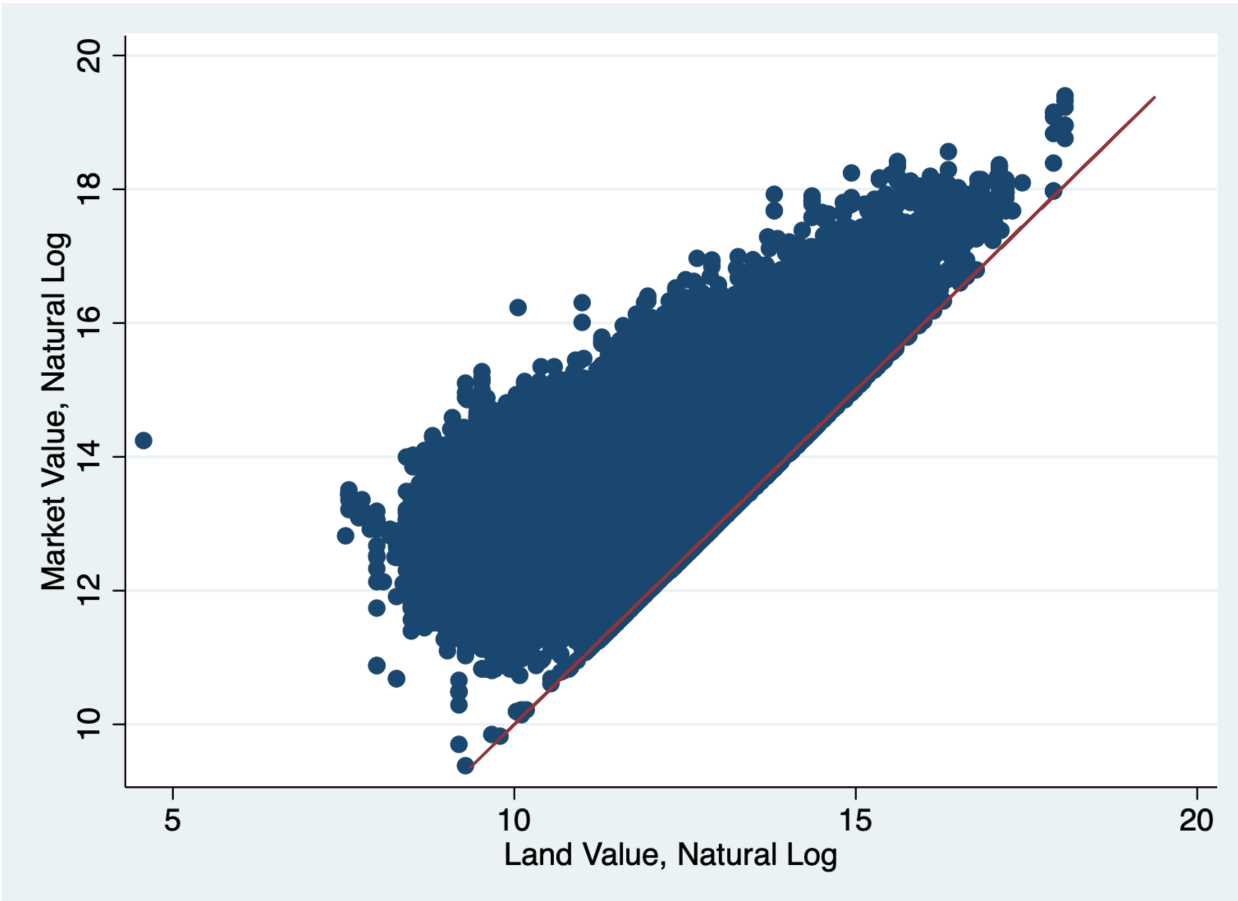
Our land value based cost instrument leverages the fact that land values directly impact rents through tax assessments.

According to Publications from the New York City Department of Finance, tax bills for Class 2 properties – which include the properties in our sample – are derived from market values which are themselves calculated based on a statistical model using income and expenses reported to the department on Real Property Income and Expense statements.[47]

However, the Department also uses other valuations in place of income-derived values when predicted income and expenses do not adequately reflect real market values. While the department does not release its statistical model, land values, which are produced by each Borough's Assessor from nearby vacant land sales, are used in place of market values when the income approach generates low values for building capitalized rent. Figure A.1 plots the market and land values for the buildings in our sample along with the 45-degree line. Despite the overall dispersion, no market values fall below land values, indicating the land values serves as an alternative minimum value for income-based market values. When land values are high for reasons other than capitalized rent, land values act as a tax shifter.

[47]See the following brochure:
https://www1.nyc.gov/assets/finance/downloads/pdf/brochures/class_2_guide.pdf.

Figure A.1: Land Value as Tax Floor



Note: The figure plots the log of market value (y-axis) and the log of land value (x-axis) for buildings in our estimation samples (i.e., single-use residential buildings with income and other non-missing variables). The red line is the $45°$ line fro the origin. Market value is calculated by the NYC DOF as a function of building income–see Appendix D for details–and serves as the taxable value used for property tax of income-generating properties. Land value is calculated by the NYC DOF based on sales across the city and a non-public statistical procedure. This plot shows that, because property taxes are based on market value, land value provides an implicit tax floor (before abatements) for a given building.

G Additional Estimation Results

G.1 Additional HHI Estimation Results

In this section, we probe robustness to our results in Section 5 using two alternative specifications. First, we replace the leave-one-out HHI variable $HHI_{f(j),g,t}$, which calculates for each building, the concentration index at the tract level excluding the building's landowner's own buildings, with the tract-level variable $HHI_{g,t}$, which more simply calculates the total tract-level concentration. Results are largely similar to our main specification, although the point estimates are slightly attenuated.

Table A4: The Relationship Between Aggregate Ownership Concentration and Prices

	(1)	(2)	(3)	(4)	(5)	(6)
			$\ln[\text{Average } r_{j,g,t}]$			
			Panel (A): Manhattan			
$\ln[\text{HHI}_{g,t}]$	-0.012	0.161	0.075	0.009	0.162	0.075
	(0.032)	(0.080)	(0.076)	(0.038)	(0.076)	(0.076)
$\ln[s^{f(j)}_{g,t}]$				-0.028	0.002	-0.013
				(0.026)	(0.025)	(0.027)
Year FEs	Y	Y	Y	Y	Y	Y
Tract FEs	N	Y	N	N	Y	N
Building FEs	N	N	Y	N	N	Y
Observations	2,519	2,504	2,393	2,519	2,504	2,393
R^2	0.29	0.63	0.75	0.29	0.63	0.75
			Panel (B): Bronx, Brooklyn, Manhattan, Queens			
$\ln[\text{HHI}_{g,t}]$	0.053	0.092	0.076	0.047	0.094	0.079
	(0.016)	(0.076)	(0.039)	(0.019)	(0.076)	(0.039)
$\ln[s^{f(j)}_{g,t}]$				0.007	-0.005	-0.038
				(0.014)	(0.013)	(0.014)
Borough-year FEs	Y	N	N	Y	N	N
Tract and year FEs	N	Y	N	N	Y	N
Building and year FEs	N	N	Y	N	N	Y
Observations	13,669	13,592	12,758	13,669	13,592	12,758
R^2	0.4	0.64	0.77	0.40	0.64	0.77

Note: The table replicates the results of Table 2 using tract-level HHI measures $HHI_{g,t}$, instead of the leave-one-out HHI, $HHI_{f(j),g,t}$. Otherwise, controls and specifications match Table 2. Standard errors clustered two ways by Census tract and year.

Second, we explore an alternative specification where price-per-square-foot rather than total rent is the building-level outcome variable. Accordingly, in this specification, total square feet is no longer a control. Results are broadly slimiar to our main specification.

G.2 Additional Demand Estimation Results

Table A6 presents direct estimates of the building-level own price elasticity (OPE) and, for completeness, first stage regression information. We find that the Cost IVs increase prices

Table A5: The Relationship Between Ownership Concentration and Price per Square Foot

	(1)	(2)	(3)	(4)	(5)	(6)
	$\ln[(\text{Building } r_{j,g,t})/(\text{Building Square Feet})]$					
	Panel (A): Manhattan					
$\ln[\text{HHI}_{f(j),g,t}]$	-0.049	0.210	0.130	-0.012	0.206	0.158
	(0.038)	(0.097)	(0.094)	(0.050)	(0.094)	(0.098)
$\ln[s_{g,t}^{f(j)}]$				-0.046	-0.006	-0.015
				(0.033)	(0.025)	(0.037)
Year FEs	Y	Y	Y	Y	Y	Y
Tract FEs	N	Y	N	N	Y	N
Building FEs	N	N	Y	N	N	Y
Observations	2,517	2,502	2,392	2,517	2,502	2,392
R^2	0.27	0.65	0.74	0.28	0.65	0.75
	Panel (B): Bronx, Brooklyn, Manhattan, Queens					
$\ln[\text{HHI}_{f(j),g,t}]$	0.035	0.163	0.139	0.036	0.164	0.133
	(0.023)	(0.072)	(0.050)	(0.023)	(0.069)	(0.050)
$\ln[s_{g,t}^{f(j)}]$				-0.002	0.001	-0.035
				(0.017)	(0.014)	(0.018)
Borough-year FEs	Y	N	N	Y	N	N
Tract and year FEs	N	Y	N	N	Y	N
Building and year FEs	N	N	Y	N	N	Y
Observations	13,646	13,572	12,738	13,646	13,572	12,738
R^2	0.28	0.59	0.72	0.28	0.59	0.73

Note: The table replicates the results of Table 2 using rent per square foot as the dependent variable and omitting the total square foot variable as a control. Otherwise, controls and specifications match Table 2. Standard errors clustered two ways by Census tract and year.

in the first stage and lead to negative IV estimates of the OPE, which are between -2.4 and -2.2. We note two things about these estimates.

First, they are slightly lower in magnitude from our main estimates. For example, the median elasticity across all buildings for the land-value based cost IV is -3.0 while the estimate here is -2.2.[48] We hesitate to interpret this difference other than each approach is implicitly targetting a different parameters though they appear similar.

[48]The average across all buildings higher at -3.3.

Second, unlike the model based estimates, these pool across buildings for the OPE estimate. Our theoretical discussion makes clear that this elasticity *cannot* be used to measure monopoly power in the city and many buildings are likely price or quantity constrained. However, the estimates do provide evidence that building level OPEs are negative and elastic in the city. This highlights the conceptual difference between our work and those of prior housing demand studies (Gyourko and Voith, 2000; Albouy, Ehrlich, and Liu, 2016).

Additionally, we omit the BLP IV column present in Table 3 because, unlike in the logit-demand results, we find that first stage and IV estimates are both positive. Since the BLP IV measures the effect of competition demand (literally the number of similar buildings), we should expect a negative first stage and positive reduced-form coefficient to get a negative IV estimate of the elasticity. While we acknowledge this is an important caveat to the BLP IVs, we hesitate to interpret it and instead choose to emphasize the cost based IVs.

Table A6: Additional Demand Estimation Results

	OLS (1)	IV: Cost Expenses (2)	IV: Cost Land Value (3)
		First Stage Equation	
β^{FS}	–	0.02	0.03
	–	(0.00)	(0.00)
Wald F Stat	–	76.9	477.7
First Stage Eff.F Stat	–	23.1	51.1
AR Stat for Log Rent	–	64.4	27.1
		Structural Equation	
ε	-0.04	-2.37	-2.23
	(0.01)	(0.53)	(0.54)

Note: The table displays parameter estimates from log-log demand models. We estimate the OLS model (1) and two just-identified IV models using predicted expenses (2) and predicted land value (4); for each, we estimate the 'first stage' regression and the 'structural equation' regression. All models include Census tract, ten-year age group, and lot size quartile fixed effects, along with controls for log distance to nearest subway station, average unit square-feet, an indicator for having an elevator, and indicators for having various NYC tax abatements. Standard errors are clustered by Census tract and the first stage F statistics and the Anderson-Rubin F statistic for the estimated coefficients are cluster robust as well.