THE UNIVERSITY OF CHICAGO

FLEXIBLE RENT SETTING AND RENTAL INCOME

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE UNIVERSITY OF CHICAGO
BOOTH SCHOOL OF BUSINESS
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

BY
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CHICAGO, ILLINOIS
JUNE 2023

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ACKNOWLEDGMENTS

I thank Amir Sufi (Chair), Michael Weber, Anthony Lee Zhang, and Eric Zwick for their support and valuable advice. I also thank Mikhail Golosov, Scott Nelson, Pascal Noel, and Joseph Vavra for their helpful comments. Send correspondence to Seongjin Park, The University of Chicago Booth School of Business, 5807 South Woodlawn Avenue, Chicago, IL 60637; telephone: +1 (872) 804-8687. E-mail: spark160@chicagobooth.edu.

ABSTRACT

Using new high-frequency rent data for apartments in Chicago, this paper documents the origin of rent stickiness and its implications for income distribution in the rental housing market. This paper finds that neither Calvo nor Taylor's models fully explain rent-setting behaviors because apartments adjust rents in response to seasonal rental-housing demand and competition, showing they choose the timing and degree of rent changes. While menu costs also do not fully explain heterogeneous rent-setting behaviors across landlords, flexible rent settings of apartments owned by institutional, large, and experienced landlords suggest the lack of expertise in rent pricing leads to rent stickiness. The flexible apartments earned higher rental income than sticky apartments, and the rental income gap between flexible and sticky apartments widened during the COVID-19 pandemic, implying income or wealth shifts toward institutional landlords from mom-and-pop landlords when the rental housing market is volatile.

CHAPTER 1

INTRODUCTION

Rental housing is a large asset class in the US, the market value of which amounts to $12.3 trillion as of 2022.[1] On the basis that rental properties are an excellent investment in numerous advanced economies that has attracted institutional investors' capital since the Great Recession, academic interest in the rental housing market has grown recently (Chambers et al. [2021], Demers and Eisfeldt [2022], Giacoletti and Parsons [2022], Gurun et al. [2022], Jordá et al. [2019]). However, despite the popularity of investment in and burgeoning works on the rental housing market, the literature exhibits little understanding of properties' rent-setting behaviors, and how variation in rent affects vacancy and rental income.[2] Given that rent varies significantly throughout the business cycle, and rental income accounts for a substantial part of the total return on residential real estate, the lack of understanding is surprising (Eichholtz et al. [2021], Gupta et al. [2021]).

Using high-frequency asking-rent data for apartments in Chicago, this paper examines the determinant of rent-setting flexibility and how properties' flexibility to adjust rents explains their rent, vacancy, and rental income. The data comes from an apartment-rental agency in Chicago and traces daily asking rent for nearly all apartments listed through the Multiple Listing Service (MLS) and individual websites of professional management firms from May 2017 through June 2022. Because the period includes the COVID-19 pandemic that created significant economic shocks to the rental housing market (Gupta et al. [2021]), this paper exploits large rental-housing-market fluctuations during the pandemic and examines how properties differentially adjusted rents throughout the pandemic according to their ex-ante

1. Author's calculations using the Census data about the number of renter-occupied housing units and the average sales price of houses sold. The Census reports that there are 43 million rental units in the US, and houses are sold at $380,000 on average. Following Demers and Eisfeldt [2022], the calculations assume that the average rental houses are worth 25% less.

2. An important exception is work by Gupta et al. [2021] who, by exploring the changes in the working environment caused by the rise in working from home, explores geographical variation in rent during the COVID-19 pandemic in relation to the distances of properties from city centers.

rent-setting flexibility. It also studies how properties' vacancy and rental incomes evolved over the pandemic depending on their rent-setting flexibility.

To this end, this paper first measures properties' rent-setting flexibility by examining how frequently and substantially they changed rents prior to December 2019. The rent-setting-flexibility measures are inspired by the primary price-stickiness measures used in important research on price rigidity (Bils and Klenow [2004], Nakamura and Steinsson [2008], Golosov and Lucas [2007]), and gauge the frequency, volatility, and absolute size of rent changes for properties on the market.

This paper then documents properties flexible in the first listing tend to be flexible in the subsequent listings. It also documents properties flexible during the early period of a listing continue to be flexible during the later periods of the listing. As these findings imply rent-setting flexibility is associated with landlords' characteristics, this paper further tests whether landlords' expertise in the rental housing market and rent pricing affect rent-setting flexibility.

Toward this end, this paper first exploits a unique indicator variable in the data that separates properties owned and managed by professional management firms from properties owned by mom-and-pop landlords and shows that properties owned by professional management firms adjust rent more frequently and substantially than properties owned by mom-and-pop landlords. More specifically, this paper finds that management firms adjust rents 0.1 times a day more often than mom-and-pop landlords, and their rent adjustment was larger by 0.01%–0.05% than mom-and-pop landlords' rent adjustment even when they price similar properties located in the same zipcode.

On the other hand, as these results can be driven by the fact that professional management firms are substantially different from mom-and-pop landlords in many other dimensions than expertise, this paper restricts the sample to the properties owned by professional management firms and tests whether expertise matters among the professional management firms.

For this exercise, this paper collects additional information on the professional management firms and measures the firms' expertise in terms of their size, degree of asset diversification, and years of experience, assuming firms with greater expertise have more resources (e.g., larger budget, skilled personnel) and experience and tend to diversify their assets more geographically. Finally, this paper shows that a one-standard-deviation increase in the expertise measures is associated with a 0.05- to 0.18-standard-deviation increase in rent-setting flexibility and concludes that properties managed by firms with greater expertise adjust rent more flexibly.

Then, does the properties' rent-setting flexibility affect the real side of the economy, particularly properties' vacancy and rental income? When this paper examines rent and vacancy patterns across properties during the COVID-19 pandemic, it finds that properties' rent-setting behaviors are crucial to understanding their rent and vacancy development and, thus, rental income. More specifically, this paper finds that flexible properties earned higher rental income during the first year of the pandemic (i.e., rental-housing market downturn) because they experienced substantially lower vacancies by providing extensive rent discounts. Interestingly, they also earned higher rental income during the second year of the pandemic (i.e., rental-housing market boom) because they did not suffer from higher vacancies despite their aggressive rent increases.

Flexible properties' final rental income gains during the pandemic were sizeable, representing 20%-30% of average properties' monthly rent. However, the gains were much smaller during normal times, suggesting the value of flexible rent setting is greater when the rental housing market is volatile and the rental housing market volatility shifts wealth or income in the rental housing market toward expert institutional landlords from non-expert mom-and-pop landlords. That is, when this paper redefines the rent-setting flexibility using the data prior to December 2018 and computes the rental income gains from flexible rent settings in 2019, it finds that flexible properties' rental income gains in 2019 are at most half the gains during the pandemic.

The rent-setting flexibility and its implications for rent, vacancy, and rental income documented in this paper are not fully explained by workhorse models in macroeconomics, such as Calvo [1983], Taylor [1980], or menu cost models. The primary measures of rent-setting flexibility are computed when rental contracts end, and rents are floating, so they are less likely to be associated with staggered contracts or regular pricing schedules as suggested by Taylor [1980]. Further, the fact that the same landlords adjust rent more flexibly for properties located in a more competitive zipcode and the seasonality of rent-setting flexibility coincides with that of rental housing market demand implies that flexible rent settings are ways to maximize rental income, rejecting both Calvo [1983] and Taylor [1980]. Lastly, analyses showing that expert landlords adjust rent not less often than non-expert landlords and they adjust rent more substantially when they adjust rent reject a hypothesis that expert landlords have lower menu costs.

The findings of this paper pass several robustness tests. In particular, one of the robustness tests revisits the main analyses by exploring the Heckman selection model, because a central issue in the primary analyses is that rental contract terms are not purely random but instead are selected by tenants. Because this selection leads to missing values in key left-hand-side variables, this paper explores the Heckman selection model in which mean asking rent and zipcode fixed effects are used as explanatory variables in the selection equation. It thus addresses missing observations affected by geographical conditions and the relative rent level of a given property. The results show the coefficients of interest estimated by the Heckman selection model are all statistically significant, and their magnitudes are as large as the original ones.

Another robustness test addresses a concern that the primary analyses in this paper compute rent growth based not on contract rent but on asking rent. It also alleviates a concern that properties' promotional rent discounts are not included in the asking rent data.

More specifically, this paper uses actual contract rent data and shows that the last asking rent in each listing is close to contract rent. It then uses the last asking rent in each listing as a proxy for contract rent (i.e., estimated contract rent) and revisits primary analyses to show that the main results are robust to the use of the estimated contract rent. It lastly shows that the promotional rent discount is uncorrelated with rent-setting-flexibility measures, and thus, considering the promotional rent discount would not alter the main results.

This paper contributes primarily to three strands of literature. First, it contributes to the empirical literature on the rental housing market by investigating rent-setting patterns and their implications for rent, vacancy rates, and rental income. To the best of my knowledge, this paper is the first to explain property-level rent variation throughout the business cycle. It is also the first to explore the quantity (i.e., vacancy) and income (i.e., rental income) implications of rent-setting. Second, it contributes to the asset pricing literature because the results in this paper potentially explain why sticky-price firms are riskier than flexible-price firms (Weber [2015]). That is, sticky-price firms may be risky because they earn lower profits throughout the business cycle, as sticky properties earn a lower rental income due to their rigid rent settings. Third, this paper contributes to the empirical literature on macroeconomics because it documents an important determinant of rent stickiness: landlord expertise. As discussed below, this finding has crucial implications for monetary policy.

The results presented in this paper also have implications for policymakers. First, the findings on expert landlords' rent-setting flexibility and this flexibility's implications for vacancy and rental income can inform policy on institutional investment in residential housing markets.[3] Specifically, these findings suggest institutional landlords' profit-maximizing behaviors could lead to asymmetrical implications for public welfare, depending on market conditions. During a rental-housing-market bust, institutional landlords can improve both

3. A pilot program in 2017 operated by Fannie Mae and Freddie Mac is a good example of such a policy: under this program, Fannie Mae and Freddie Mac purchase and guarantee securitized loans issued by investors in single-family rentals to incentivize institutional investment.

their own welfare and that of their tenants by improving capital utilization in the economy through providing extensive rent discounts, consequently lowering vacancy rates. When the markets boom, however, they can earn higher rental income at the cost of tenant welfare, because the increase in rental-housing demand is substantial, meaning an institutional landlord can raise rents without incurring vacancies.

These results therefore also relate to policymakers' interest in rent control, which is in effect in six states (California, New York, New Jersey, Maryland, Oregon, and Minnesota) and the District of Columbia as of 2022. On top of the benefits of rent control for incumbent tenants (Diamond et al. [2019]), this paper further suggests rent control may effectively limit institutional or expert landlords' rent increases and thus increase public welfare, particularly when the rental housing market is booming.

Lastly, the results presented in this paper show landlord expertise is an important constraint on flexible rent setting, so they inform monetary policy. That is, because inexpert landlords account for a major share of landlords (i.e., 60% in the data) and their rent-setting behaviors are persistent, their rigid rent-setting behaviors are likely to work as a friction that slows down aggregate price response to monetary policy shocks. Thus, such behavior will likely work as a mechanism that amplifies monetary non-neutrality.

1.1 Related Literature and Contribution

This paper is related to literature in several areas. Most closely related are burgeoning works on the rents of residential real estate. Giacoletti and Parsons [2022] argue landlords' behavioral limitations lead them to use stale information when setting rents so that they tend to set higher rents for houses purchased during housing booms. Gurun et al. [2022] examine the consequences of institutional investment in the rental housing market, and provide evidence that institutional landlords leverage their market power to increase rent. Gupta et al. [2021] study the rental-housing markets during the COVID-19 pandemic and show working from home, which was a result of the pandemic, caused rents to decline in city centers. However, they claim this pattern will be reversed as working from home recedes and people return to city centers.

This paper contributes to this literature in two ways. First, by measuring properties' rent-setting flexibility before the COVID-19 pandemic and examining how ex-ante rent flexibility explains rent and vacancy dynamics during the pandemic, this paper identifies the determinants of property-level variation in rent and rental income. Second, using a relatively simple method (i.e., fixed effects), this paper investigates why rent flexibility arises and what prevents flexible rent-setting.

The results are closely related to the literature on residential real-estate returns. Demers and Eisfeldt [2022] are the first to consider total returns to single-family rental houses in the US, and shows the total returns on rentals amounted to 8.5% for the period 1986–2014. On the other hand, Chambers et al. [2021] investigate institutional real-estate portfolio data for several Oxbridge colleges and argue long-term annualized real return for residential real estate was as low as 2.3% for 1901–1983. Eichholtz et al. [2021] analyze rents and prices for 170,000 individual houses in Paris and Amsterdam and find annualized real total returns of 4% for both cities, which came entirely from rental yields. The findings presented in this paper further show vacancies can develop asymmetrically over the business cycle, suggesting residential rental real-estate returns can be affected by landlords' rent-setting behavior.

The results are also related to the literature on the implications of price rigidity for asset pricing. Using the firm-level stock return data merged with product prices, Weber [2015] identifies a 4% annual return premium for rigid firms, which he explains using differential exposure to systematic risks. Clara [2019] further explores high-frequency price and quantity data from Amazon and finds that firms facing more elastic demands are riskier and earn a 6.2% annual return premium. The findings presented in this paper suggest the risk premium can potentially be explained by rigid firms' cash-flow risk over the business cycle. In particular, this paper shows that when economic shocks hit, rigid rental-property management firms provide insufficient rent discounts and thus witness higher vacancy rates and lower profits. Rigid management firms also fail to earn higher profits during rental-market booms, because they raise rents only modestly.

Because this paper studies why rent-setting flexibility (i.e., price stickiness in the rental housing market) arises, it also builds on the literature on price rigidity. This paper is particularly related to the pioneering works of Calvo [1983] and Taylor [1980], who provide a micro-foundation for price rigidity. It also builds on the work of Gagnon [2009], who uses Banco de México's microdata and studies the comovement of price changes with inflation. He finds the magnitude rather than frequency of price changes is an important determinant of inflation when inflation is low, but both are crucial for inflation when inflation is high. This paper also relies on the insights of Alvarez et al. [2018], who study a similar issue in Argentina, which once experienced 200% monthly inflation. Using price quotes for the CPI of the Buenos Aires metropolitan area from 1988 to 1997, they analyze the impact of inflation on firms' price-setting behaviors and find the frequency of price changes strongly comoves with inflation only during periods of high inflation. By using high-frequency rent data for residential real estate, this paper overcomes some biases (Cavallo [2016]) caused by the low-frequency feature of the CPI or scanner datasets (e.g., Nielsen datasets). It further shows rent changes respond positively but asymmetrically to inflation and deflation. As price changes are measured for the same properties, these results are also free of the product renovation or substitution issues inherent in previous research.

The last strand of literature that is related to this paper works with price stickiness in relation to the rental housing market. Genesove [2003] is one of a few papers to examine rent stickiness in the rental housing market in the US, and documents a notable downward stickiness in yearly rent adjustment for 1974–1981. Shimizu et al. [2010], on the other hand, study the rental-housing markets in Japan and find rent stickiness in Japan is three times higher than in the US. Their analyses show inflation in Japan would have varied more during the 1980s housing bubble if the rental housing market in Japan had been as flexible as those in the US.

1.2 Outline

The rest of the paper proceeds as follows: Section 2 describes the primary data used in this paper. Section 3 introduces the research questions addressed in this paper and the main rent-setting-flexibility measures explored throughout. Section 4 explores the determinants of rent-setting flexibility, and Section 5 examines the implications of rent-setting flexibility for rent and vacancy. Section 6 discusses the determinants of rent-setting flexibility from the perspectives of workhorse macroeconomic models for price stickiness, and Section 7 presents several robustness tests. Lastly, Section 8 discusses future research and concludes.

CHAPTER 2

DATA

This section describes the data and key variables exploited in this paper.

2.1 Data Source and Representativeness of Chicago

The primary data used in this paper is daily asking rents for apartments in Chicago. The data spans from May 2017 to June 2022, and includes rent information on 91,262 apartments. As the data traces asking rents for properties that were on the market, an observation unit is an apartment unit times a day. In addition to rents, the data also contains information on properties' management firms, the number of bedrooms and bathrooms, and whether properties possessed amenities such as parking lots, washing mashings, and dryers.

I obtained the data from an anonymous apartment-rental agent in Chicago. According to the data provider, the data is more comprehensive than that collected from rental listing services such as Zillow and Apartments.com because the data was not only compiled using listings on Multiple Listing Services (MLS), but also collected directly from numerous professional management firms. The data also contains minimal errors because it was constructed for the data provider's own brokerage business, and filtered through an algorithm that sorts out fake listings.

The data is thus of good quality and represents the entire Chicago rental market well. To show the quality of the data, Panel (a) of Figure A.1 computes the rent index from the data and plots it along with the Zillow Observed Rent Index (ZORI). Panel (b) plots the year-over-year rent growth of both series. As illustrated, the rent index and growth computed based on the apartment listing data are close to ZORI, which was computed using asking rents for all housing types.

Importantly, the Chicago rental housing market could be representative of national markets. To illustrate this point, Panel (a) of Figure C.1 uses the ZORI and plots the distribution of pre-pandemic rent growth for the top 100 rental housing markets in the US. Panel (b) uses the same data but plots the distribution of rent growth from March 2021 to March 2022, which roughly corresponds to the troughs and peaks of the rental housing market during the pandemic. In both panels, Chicago is indicated by the vertical dotted line, which is located near the median of both distributions. Therefore, the figure implies Chicago is an average market in terms of rent variation, and studies on the Chicago rental-housing market have the potential to be applicable to national markets.

2.2 Key Variables and Summary Statistics

Table B.1 presents summary statistics for the key variables used in this paper. The primary measures of rent flexibility at the property level (i.e., frequency, volatility, and size) are defined in Section 3.1. Property-level rent growth early in the pandemic is defined as the annualized log difference between rent observed before March 2020 and rent observed between March 2020 and March 2021. Rent growth during later in the pandemic is defined using rent observed between March 2020 and March 2021 and rent observed after March 2021 until the end of the sample period. Mean rent growth during the early and later pandemic period is -3.5% and 0.7%, respectively. However, because properties were listed at relatively high rents later in the pandemic, rent growth during this period has a long right tail (i.e., the 95th percentile value of 29.2%) and a large standard deviation (i.e., 20.4%).

Vacancy status for the early pandemic period is an indicator variable equal to one for properties listed between March 2020 and March 2021 and left vacant until March 2021. Vacancy status for the later pandemic period is equal to one for properties listed between March 2021 and March 2022 and left vacant until March 2022. A lower vacancy rate during the later pandemic period suggests a rental-housing-market boom in the period.

The tract-level share of flexible properties is defined as the share of properties that changed rents while on the market prior to December 2019. The tract-level monthly rent index is computed based on Case and Shiller's weighted repeat-sales methods (Case and Shiller [1987]). The sample of tracts is restricted to tracts for which the rent index is reliably measured throughout the sample period.

The tract-level vacancy rate is estimated from the listing data used in this paper, because information about rental-housing vacancies does not exist. The current most sophisticated vacancy data is collected by the US Postal Service (USPS). However, it only contains the quarterly vacancy rate for the entire housing market and does not distinguish for-sale housing from rental housing. Therefore, analyses based on the USPS data could lead to erroneous conclusions about vacancies in the rental housing market, particularly during the COVID-19 pandemic, when the rental housing market developed distinctly from for-sale housing markets (Figure C.2).

To address this issue, this paper estimates the rental-housing vacancy rate by dividing the number of listings by the total number of properties ever listed. This method is reasonable as long as listed properties are consistently (soon-to-be) vacant and the number of ever-listed properties is close to the total number of rental properties. Figure C.3 tests these assumptions by plotting the estimated tract-level vacancy rate against the USPS vacancy rate during the pre-pandemic period and shows these two series are highly correlated. Thus, it shows the method is plausible.

2.3 Caveat

Before I proceed, I note some caveats regarding the analyses presented in this paper. First, because the analyses in this paper are based on data constructed from rental listings, the results are based on rental contracts with new tenants (i.e., extensive margin); for instance, vacancy patterns documented in this paper are generated by new rental contracts. Unfortunately, existing tenants' rental-contract renewals (i.e., intensive margin) are not public information and thus are not included in the data used in this paper. Second, as the data used in this paper does not discern why properties went off the market, this paper assumes properties that are off the market have been rented out. This assumption is based on the idea that a landlord's incentive to leave a property vacant is weak, and that it is unreasonable for landlords to give up on renting out their properties and take them off the market.

CHAPTER 3

QUESTIONS AND MEASURES

This section raises the key research questions addressed in this paper. It also introduces the three rent-setting flexibility measures that are examined throughout this paper.

3.1 Research Questions and Rent-Setting Flexibility Measures

Recent research on price rigidity and asset pricing demonstrates firms' pricing behaviors are associated with their profits and stock returns, because pricing patterns determine exposure to systematic risks (Weber [2015]). Inspired by this finding, this paper examines whether ex-ante flexible properties generate a better rental-income stream against economic shocks than rigid properties. Specifically, because the COVID-19 pandemic led to large rental-housing-market fluctuations (Figure A.1), this paper compares the rent and vacancy growth of flexible properties with those of rigid properties during the pandemic, and examines whether flexible properties produced higher rental income throughout the rental-housing-market boom and bust during the period.

This paper also examines the causes or determinants of rent-setting flexibility. More specifically, it investigates whether the rent-setting flexibility of a property is driven by purposeful pricing decisions or passively induced by a chance or regular pricing schedule, as described by Calvo [1983] or Taylor [1980]. It also explores whether a technical constraint or friction prevents flexible rent-setting.

To these ends, I now elaborate on the property-level rent-setting-flexibility measures. The primary rent-flexibility measures gauge how frequently and substantially landlords change property rents as follows:[1]

1. The fact that landlords change property rents more frequently and substantially does not necessarily mean that the properties are flexible in rent-setting; as landlords attempts to correct initial mispricings can induce more frequent and substantial rent changes, a test in Section 7 addresses this concern. As documented

Frequency: The number of rent adjustments per day while the property is on the market.

= Total number of rent adjustment ÷ Days on market.

Volatility: Standard-deviation-to-mean per day while the property is on the market.

= (Std. Dev. of asking rent ÷ Mean asking rent) × 100 ÷ Days on market.

Size: Range-to-mean per day while the property is on the market.

= (Range of asking rent ÷ Mean asking rent) × 100 ÷ Days on market.

These measures are based on previous research on price rigidity. For example, in their seminal study on the price rigidity of the lion's share of non-shelter items, Bils and Klenow [2004] and Nakamura and Steinsson [2008] examine the frequency of price changes as a primary measure of price adjustment. Two additional variables—the variability and absolute size of price changes—are credited to the studies of Kackmeister [2002] and Golosov and Lucas [2007], who analyze price stickiness over long-term periods and explore a menu-cost model to examine nominal rigidity's impact on monetary non-neutrality.

I have applied these measures to the study of the rental housing markets. As the rent of a given property cannot be observed once the property has been rented out, unlike consumer products, each property differs by the number of days on the market. I thus standardize the rent-flexibility measures by dividing them by the number of days on the market.[2] Further, I measure rent-setting flexibility based on properties' rent-adjustment behaviors before December 2019 in order to prevent the influence of the significant economic shocks of the COVID-19 pandemic. I also average the rent-flexibility measures across listings if properties are listed multiple times.

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in Section 7, the initial rent is uncorrelated with rent-change behaviors measured by the primary rent-flexibility measures, suggesting that the primary measures are not induced by mispricing and subsequent adjustment.

2. All else being equal, flexible properties may experience a shorter time on the market, boosting their rent-flexibility measures. Section 7 addresses this issue and explores alternative measures of rent flexibility that are free of it. As described in Section 7, the alternative method inevitably reduces the sample size. However, the results remain relevant despite the use of alternative measures.

Table B.2 presents the unconditional correlation between the measures, and shows the three measures of rent flexibility are not perfectly correlated with each other. Notably, the frequency measure is not strongly correlated with the other two measures. Thus, the three measures likely represent different aspects of rent flexibility, and each measure may work as a distinct explanatory variable statistically.

Before I proceed, note that I compute the rent-flexibility measures based on on-market rent-setting behavior for five reasons: First, the frequency of price adjustment, which is the primary measure of price changes in research on price rigidity (Bils and Klenow [2004], Nakamura and Steinsson [2008]), can only be observed when properties are on the market. Second, as Panel (a) of Figure C.4 shows, a considerable share of properties (i.e., 12%) is always on the market, so on-market rent-setting behaviors are crucial to understanding overall rent change.[3] Third, computing rent-flexibility measures using only one listing is possible by focusing on on-market rent-setting behavior. However, if we focus on contract rent adjustment, at least two listings are needed, because the computation of contract-rent change requires two data points, and each data point must be from separate listings. This exercise is inefficient and leads to serious data reduction because most properties in the data are listed at most twice (Panel (b) of Figure C.4)

Moreover, landlords adjust rents significantly while properties are on the market; thus, on-market rent adjustment is worth studying. To show this point, Figure C.5 divides properties into two groups—one that adjusts rents positively (Panel (a)) and the other that adjusts rents negatively (Panel (b))—and illustrates their indexed mean rent against the number of price adjustments. Since properties change rents five times on average and the standard deviation of the number of rent changes is thirteen, the figure traces rents up to the eighteenth rent change. The figure then shows that when landlords raise or discount rents, they do so by as much as 7%-8%.

3. Therefore, ZORI is also constructed based on on-market rent adjustment behaviors.

Therefore, on-market rent adjustment is crucial in determining final contract rents. Table C.1 restricts the sample to properties with more than two listings in the data, and examines the correlation between contract rent adjustment and on-market rent adjustment. Columns (1) and (2) explore all the listings, and columns (3) and (4) restrict the sample to listings that show up at least six months after the previous listing. Columns (5) and (6) further reduce the sample to listings whose previous contract term is a year. Odd-numbered columns have no fixed effects, but even-numbered columns have listing-month fixed effects constructed from the listing dates of the previous and following listings. The fixed effects minimize the seasonality of rent adjustment and ensure the comparison of rent-adjustment behaviors in the same period. The table then reports the coefficients of interest (i.e., the coefficients of the on-market rent adjustment) and shows they are highly significant and stable at 0.7 across the columns. Thus, they indicate a 1% increase in on-market rent adjustment is associated with 0.7% of the rent adjustment across the contract.

3.2 Heterogeneity and Persistency of Rent Flexibility

A notable characteristic of on-market rent adjustment is that its distribution is highly dispersed. To illustrate this point, Figure C.6 plots the histograms of property-level rent-flexibility measures and shows their distributions are strongly right-skewed. Figure C.7 further presents the tract-level heat map for the mean values of rent-flexibility measures and shows rent flexibility is highly heterogeneous across geography. The map implies properties in the top-quintile tracts are 20 times more flexible in rent-settings than properties in the bottom-quintile tracts.

More importantly, rent flexibility is persistent both within and across the listing, implying rent-setting flexibility is a property characteristic. To illustrate, Table B.3 computes the rent flexibilities of the same properties in different periods and compares the rent flexibility in the first period with rent flexibilities in the later periods. Specifically, Panel A of Table B.3

compares rent flexibility during the first listing and during the second and third listings, and shows rent flexibility is persistent across all listings. Panel B of Table B.3 compares rent flexibility for the first 30 days of a listing and for the following and the next 30 days, and examines the persistency of rent flexibility within each listing. As each listing differs by the listing date and the days on the market, the analysis in Panel A includes listing-month pair fixed effects constructed from each listing's first listing date. Analogously, Panel B includes listing-month fixed effects to compare rent-setting behaviors for the same period.

Table B.3 shows rent flexibility in the first period is significantly and positively correlated with rent flexibility in the later periods. The sizes of the estimated coefficients are also considerable: an incremental increase in rent flexibility in the first period is associated with a 0.2–0.7 increase in rent flexibilities in the later periods. Moreover, evidence of diminishing persistency over time is scant: the correlation with rent flexibility in the third period is not smaller than the correlation with rent flexibility in the second period.

CHAPTER 4

LANDLORDS' EXPERTISE AND RENT-SETTING FLEXIBILITY

The findings in the previous section show that flexible properties in the first listing (in the early period of listing) tend to be flexible in the following listings (in the latter period of listing), suggesting that rent-setting flexibility may be associated with landlords' characteristics. This section further shows that landlords with better expertise in pricing adjust rent more flexibly.

Toward this end, I use a unique feature of the data: I explore an indicator variable in the data that separates professionally managed properties from mom-and-pop properties. Further, I explore information on professional property management firms that I hand-collected based on the indicator variable.[1] I then begin the analyses by noting professional management firms set rents more flexibly than individual mom-and-pop landlords even in the same zipcode (Table B.4).

The right-hand-side variable of interest in Table B.4 is an indicator variable equal to one for the properties owned and managed by professional management firms. The left-hand-side variables are the rent-flexibility measures defined in section 3: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). To ensure the comparison of properties of the same type, the table controls for the mean asking rent for each property in all columns. It also includes the highest-floor-level decile fixed effects in all specifications. It explores zipcode fixed effects in columns (2), (4), and (6) to examine differential rent flexibility between the institutional and individual landlords within zipcodes. Listing-year-month fixed effects explored in all columns control for the seasonality of rent flexibility and ensure the comparison of rent-setting behaviors in

1. From this data-collection process, I found that 186 property-management firms own and manage 37,075 properties in Chicago.

the same period.

The table shows properties owned by professional management firms adjust rents more frequently and substantially than mom-and-pop landlords, even in the same zipcodes. The coefficients of interest are statistically significant at the 1% level and indicate that management firms change rents that are 0.1 times a day more than mom-and-pop landlords. The size of the rent adjustment amounts to 0.01%–0.05% a day as compared with the mean asking rent. These values are economically large given the mean and standard deviation of the rent-flexibility measures are 0.05 and 0.11 for the frequency measure, 0.04% and 0.06% for the volatility measure, and 0.07% and 0.12% for the size measure, respectively.

This finding suggests professional landlords, who potentially have better expertise than mom-and-pop landlords, are more flexible in their rent settings. Therefore, in Table B.5, I further restrict the sample to the properties owned by professional management firms and test whether firms with greater expertise adjust rents more flexibly.

In Table B.5, I measure the expertise of professional management firms in three different ways. The first is the size of the management firm, defined as the total rent of the properties each firm manages. This measure is based on the idea that larger firms have more resources (e.g., larger budget, skilled personnel) to deploy to catch up with markets (columns (1), (4), and (7)). The second measure considers the firm-level asset concentration based on the assumption that sophisticated firms are more likely to diversify their assets geographically (columns (2), (5), and (8)). The asset-concentration measure is constructed using a method for computing HHI; thus, a higher value indicates a firm's properties are concentrated in a smaller number of zipcodes.[2] Lastly, the table explores the ages of firms (columns (3), (6), and (9)) as the third measure of expertise, on the basis that more experienced firms likely have greater expertise.

The table shows the expertise measures of landlords are positively correlated with rent-

2. The firm-level asset concentration measure is defined as $HHI_b = \sum_z \left(\frac{\text{Total Rent}_{bz}}{\sum_z \text{Total Rent}_{bz}} \right)^2$ where b and z indicate a management firm and zipcode, respectively.

flexibility measures. As reported, the coefficients of the expertise measures are statistically significant in general, and their sizes are non-negligible: a one-standard-deviation increase in the expertise measure is associated with a 0.05- to 0.18-standard-deviation increase in rent-flexibility measures. Thus, I conclude the expertise of landlords is a crucial constraint on or determinant of flexible rent-setting.

CHAPTER 5

IMPLICATIONS OF RENT FLEXIBILITY FOR RENT AND VACANCY

This section shows ex-ante flexible properties earned higher rental income because they adjusted rents more substantially. Flexible properties experienced lower vacancies as their landlords provided aggressive rent discounts during the rental housing market downturn. However, they did not witness a meaningful increase in vacancies, although the landlords raised rents aggressively during the market boom. The value of flexible rent setting was greater during the COVID-19 pandemic when the rental housing market was volatile than in 2019, implying the market volatility shifts income or wealth from expert institutional landlords to non-expert mon-and-pop landlords.

5.1 Empirical Strategy

To examine how rent and vacancy evolved depending on properties' flexibility to adjust rents, this section employs two regression specifications. The first measures rent-setting flexibility at the property level, and investigates the implications of properties' ex-ante rent flexibility with regard to rent and vacancy growth:

$$y_i = \beta \cdot \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i. \tag{5.1}$$

In the specification, the left-hand-side variables are rent growth or log odds of vacancy status for property i during the first or second year of the pandemic (see section 2.2 for detailed definitions of the variables). The right-hand-side variables are property-level rent-flexibility measures defined in Section 3. As stated in Section 3, when this specification examines how the rent-setting flexibility is associated with rent and vacancy during the COVID-19 pandemic, it computes rent-flexibility measures using the data for properties listed prior to December 2019 to avoid a mechanical correlation between rent-adjustment patterns and rent growth.

Importantly, the specification includes the pair of year-month fixed effects α_t constructed from the first dates of the periods in which rent flexibility and growth were measured. As each property's rent flexibility and growth were measured in different periods and were affected by seasonal housing demand, the fixed effects address the seasonality of rent flexibility and ensure the comparison of rent growth for the same period. The specification also includes the rent ventile fixed effects α_r and zipcode fixed effects α_z in order to address the heterogeneity of tenants and their demands across property types and geography.

Although the property-level analyses can compare contemporary rent and vacancy growth across properties, they do not show how rent and vacancy evolved over time. Therefore, to trace rent and vacancy growth over time and compare these variables between the subperiods (e.g., the first year of the pandemic vs. the second year), this section further explores the tract-level difference-in-differences estimation as follows:

$$y_{ct} = \sum_{t \neq Mar2020 or Dec2020} \beta_t \cdot \mathit{Share\ of\ Flexible\ Properties}_c + \sum_t \gamma_t \cdot \mathit{Distance\ from\ City\ Center}_c + \sum_t \lambda_t \cdot \mathit{Mean\ Rent}_c + \alpha_c + \alpha_t + \varepsilon_{ct} \quad (5.2)$$

This specification uses a log rent index or vacancy rate for tract c and year-month t as the left-hand-side variables. As the right-hand-side variable, it uses standardized tract-level rent flexibility measured by the share of properties that changed rents while on the market before December 2019 (i.e., the share of flexible properties). α_c and α_t are the tract and year-month fixed effects. Further, since each tract likely served different types of tenants and experienced differential economic shocks during the COVID-19 pandemic, the specification includes two control variables: the distance from the city center and the mean rent. The former is the physical distance of each tract from the Chicago city center, and the latter is the mean asking rent of properties located in each tract. The distance from the city center addresses the change in the working environment associated with working from home during the pandemic, and the mean rent controls for neighborhood characteristics that serve different rental tenants (Gupta et al. [2021]). Therefore, those variables lead to plausible experimental settings wherein it is possible to observe the rent or vacancy growth in flexible tracts relative to rigid tracts throughout the pandemic.

5.2 Implications for Rent

I begin the analysis presented in this section by illustrating that throughout the COVID-19 pandemic, rent evolved differentially depending on landlords' ex-ante flexibility to adjust the rents of properties. I sorted properties based on their ex-ante rent-setting flexibility measured before December 2019, and selected two groups: properties whose rents did not change at all, and those that changed to above median rent-flexibility measures. I label these groups "sticky properties" and "flexible properties", respectively, and computed the Case-Shiller rent index for each after controlling for the square footage and zipcode of the properties. I then calculated the year-over-year growth of the rent indexes and demeaned the growth by the mean value of the growth during the pre-period (i.e., the period left of the vertical dotted line in the figure). I plot the results in Figure A.2.[1]

Figure A.2 illustrates that the rents of ex-ante flexible properties were adjusted more considerably over the entire period of the COVID-19 pandemic. From March 2020 to January 2021, when the rental housing market shrank, the landlords of flexible properties provided more discounts and dropped rents more aggressively. From January 2021 to January 2022, when the rental-housing market boomed, the landlords of flexible properties raised rents more actively, leading the market. The differences in rent adjustment between properties

1. Figure A.2 is based on the size measure. Appendix Figure C.8 further presents the rent indexes of the properties sorted by the frequency and volatility measures. As illustrated, the figure based on the frequency and volatility measures is qualitatively similar to Figure A.2.

were substantial, amounting to 4%–6%.

To formally confirm this finding, Table B.6 explores the following specification and examines the correlation between properties' ex-ante rent flexibility and rent growth during the COVID-19 pandemic.

$$\textit{Rent Growth}_i = \beta \cdot \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i \tag{5.3}$$

As the left-hand-side variables, the upper panel of the table uses properties' rent growth during the pandemic before March 2021, and the lower panel uses rent growth from March 2021 to the end of the sample period (refer to Section 2.2 for detailed definitions). As the right-hand-side variables, Columns (1) and (2), (3) and (4), and (5) and (6) use standardized frequency, volatility, and size rent-flexibility measures, respectively. Because rent flexibility and growth were measured in different periods, the table includes the pair of year-month fixed effects α_t in all columns. The table also explores rent ventile fixed effects α_r in all columns and zipcode fixed effects α_z in columns (2), (4), and (6) to control for the heterogeneity in tenant demand across property types and geography.

The table confirms the findings in Figure A.2 and shows ex-ante flexibility for adjusting rents predicts ex-post rent growth. During the rental housing market downturn in the early pandemic period, a one-standard-deviation increase in rent flexibility was associated with a 0.3%–1.5% point decrease in rent growth. During the market boom in the later pandemic period, it was associated with a 1.4%–2.7% point increase in rent growth. Considering the means (standard deviation) of rent growth during the early and later pandemic periods were −3.5% (11.5%) and 0.7% (20.4%), the effect of rent flexibility on rent growth was substantial and did not diminish throughout the pandemic.

How, then, did rent evolve relative to the pre-pandemic period? What about the rent growth during the later pandemic period relative to the early pandemic period? To answer these questions, I estimate the following tract-level difference-in-differences specification:

$$ln(Rent\ Index)_{ct} = \sum_{t \neq Mar2020 or Dec2020} \beta_t \cdot Share\ of\ Flexible\ Properties_c$$
$$+ \sum_t \gamma_t \cdot Distance\ from\ City\ Center_c + \sum_t \lambda_t \cdot Mean\ Rent_c + \alpha_c + \alpha_t + \varepsilon_{ct} \quad (5.4)$$

where the left-hand-side variable is the log of rent index for tract c and year-month t. The right-hand side variable of interest is the share of flexible properties defined as the standardized tract-level share of properties that adjusted rents prior to December 2019.

Figure A.3 plots the estimated coefficients β_t and shows rent was substantially adjusted during the pandemic in a tract with more flexible properties. Specifically, it shows a tract with one-standard-deviation more flexible properties witnessed a 1% faster rent decrease than a tract with less flexible properties in the early pandemic period. The figure also shows a tract with more flexible properties experienced a 2% faster rent growth than a tract with less flexible properties in the later pandemic period. The magnitude of the rent growth was considerable because the mean tract-level rent growth was −2.7% (8.9%) in the early (later) pandemic period.

5.3 Implications for Vacancy

Vacancy in the rental-housing market is important because it represents the slack in the rental housing market and is directly related to landlord profit. Interestingly, the rental-housing vacancy rate in Figure A.4 shows that it is negatively correlated with rent growth. The correlation was weak prior to the COVID-19 pandemic (i.e., the period left of the vertical dotted line), but during the pandemic, the vacancy rate soared while rent dropped significantly. It also plummeted as rent soared.

Additional analyses show vacancy rate grew differentially according to properties' ex-ante flexibility to adjust rents, but overall rent growth in the rental housing market was important for the vacancy growth. To illustrate this point, Figure A.5 uses the Kaplan-Meier method to estimate the probability of vacancy for two property types that differ by the ex-ante flexibility to adjust rents. The dotted blue line represents the vacancy probability for the properties whose rents were not adjusted prior to December 2019, and the solid red line indicates the vacancy probability for properties above the median rent-flexibility measure. Panel (a) of the figure estimates the vacancy probability based on the data from March 2020 to March 2021, when the rental market shrank, and Panel (b) uses the data from March 2021 to March 2022, when the rental market boomed.[2]

The figure shows ex-ante flexible properties experienced a lower vacancy rate when overall rent decreased, because flexible properties provided rent discounts more aggressively than rigid properties during the period. However, the figure also shows the ex-ante flexible properties experienced a similar vacancy level to rigid properties during the rental-housing market boom, although those properties raised rents more extensively than rigid properties.

Table B.7 confirms these findings more formally by estimating the marginal effect of rent-setting flexibility on vacancy probability. It uses a logit model (Equation (5.1)), where the right-hand-side variables are rent-flexibility measures computed before December 2019: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). The left-hand-side variable in the upper panel is a log odds created from an indicator variable for the vacant properties listed between March 2020 and March 2021 (i.e., the early pandemic period). The left-hand-side variable in the lower panel is a log odds created from an indicator variable for the vacant properties listed between March 2021 and March 2022 (i.e., the later pandemic period). As above, all columns include the pair of year-month fixed effects constructed from the first dates of the listing period and

2. Figure A.5 is based on the size measure of rent flexibility. Appendix Figure C.9 further presents the vacancy probability for the properties sorted by frequency and volatility measures. As illustrated, the figure based on the frequency and volatility measures is qualitatively similar to Figure A.5

the period for which rent flexibility was computed. Further, the table includes rent ventile (all columns) and zipcode fixed effects (columns (2), (4), and (6)).

The table shows the marginal effects in the upper panel are all statistically significant, and their signs are negative. Therefore, the results indicate flexible properties experienced lower vacancies when landlords lowered their rents during the first year of the pandemic. On the other hand, the coefficients of interest in the lower panel are statistically indistinguishable from zero in general. Thus, they suggest flexible properties did not witness higher vacancies, although their landlords aggressively raised rents during the second year of the pandemic. Qualitatively, the negative coefficients of interest in the upper panel imply flexible properties earned higher rental income during the early period of the pandemic because they were rented out sooner after being listed. The positive coefficients in the lower panel suggest flexible properties earned higher rental income during the later period of the pandemic because their rents were raised aggressively.

To examine the quantitative implications of flexible rent-setting, the table computes the rental-income gains from flexible rent-setting in the middle of each panel. The basic idea of the computation is to compare the rental-income loss (gain) from a rent discount (increase) with the rental-income gain (loss) from lower (higher) vacancy rates. To this end, the analysis assumed the amount of time a property is to be rented follows an exponential distribution, and computed the hazard rate accordingly. It also assumed a typical rental contract lasts for 12 months. Lastly, it used values from the survival function in Figure A.5 to estimate rigid properties' vacancy probability based on the median days on the market, and used flexible properties' rent discount/increase in Table B.6 and vacancy rate in Table B.7 (see Appendix C.3 for the detailed computation).

The final results of the computation show flexible properties—which are one standard deviation more flexible than properties that never changed rent—earned \$−88-\$455 (\$380-\$655) more rental income during the first (second) year of the pandemic than rigid properties.

The positive gains during the first year prove flexible properties' lower vacancy rates compensated for their rental-income losses due to rent discounts. The positive gains during the second year show flexible properties' rental-income gains from extensive rent increases were more significant than their losses due to higher vacancies. These values are sizeable, representing 20%–30% of the median monthly rent.[3]

Results from a tract-level, difference-in-differences estimation support these findings. Figure A.6 uses the tract-level vacancy rate as the left-hand-side variable and estimates the following specification to trace the relative vacancy rate in flexible tracts compared to rigid tracts:

$$\begin{aligned} \textit{Vacancy Rate}_{ct} = & \sum_{t \neq Mar2020 or Dec2020} \beta_t \cdot \textit{Share of Flexible Properties}_c \\ & + \sum_t \gamma_t \cdot \textit{Distance from City Center}_c + \sum_t \lambda_t \cdot \textit{Mean Rent}_c + \alpha_c + \alpha_t + \varepsilon_{ct} \end{aligned} \tag{5.5}$$

where c and t indicate the census tract and year-month, respectively.

As the figure shows, the vacancy rate dropped more significantly in flexible tracts relative to rigid tracts during the early pandemic when overall rent decreased (Panel (a)). The vacancy rate, however, did not notably increase during the later pandemic when flexible tracts raised rents aggressively (Panel (b)). Therefore, this figure implies tracts with more flexible properties experienced a relative change in the vacancy rate (i.e., a decrease in vacancy rate) only when flexible properties provided extensive rent discounts; they did not witness a relative increase in the vacancy rate when properties raised rents.

Taken together, the results in this section are consistent with Weber's (2015) findings that flexible firms command negative return premiums because they are less exposed to systematic shocks. Flexible firms in his paper are analogous to flexible properties in the rental housing market, and this paper shows flexible properties' rental-income streams provide

3. The median rent during the first (second) year of the pandemic was $1,875 ($1,995).

better insurance against large economic shocks, in this case, those caused by the COVID-19 pandemic. Moreover, the findings presented in this paper show flexible properties have better rental-income prospects even during rental-housing-market booms.

If rent-setting flexibility leads to higher rental income, however, why do all landlords not adjust rent flexibly to maximize their rental income? Is it because rent-setting is not a purposeful decision on the part of a landlord, but a passive result induced by a regular pricing schedule or cost changes? Otherwise, do any technical constraints or frictional factors prevent flexible, optimal rent-setting? Based on the results presented in this section, the following section attempts to answer these questions.

5.4 Implications in Normal Times

The analyses above have examined the implications of rent flexibility for rent and vacancy during the COVID-19 pandemic because the pandemic caused sizeable economic shocks that economic theorists may care about. This section extends the analyses by examining whether the main findings in this paper are valid in normal times. It also compares the rental income gains from flexible rent settings during the pandemic with the rental income gains or losses during normal times

To this end, Tables B.8 and B.9 define rent-flexibility measures based on properties' on-market rent adjustment prior to December 2018, and explore the implications of rent flexibility for rent and vacancy growth in 2019. To ascertain how rent-setting flexibility affects rent and vacancy growth asymmetrically depending on rental-market conditions, the upper and lower panels of the tables explore rent flexibility's implications separately for the cold and hot seasons of 2019.

The cold and hot seasons are defined according to the average monthly rent growth illustrated in Figure A.7. Months with negative (positive) rent growth are defined as the cold (hot) season, but July and August are excluded from the analyses because they are likely to be intermediate periods between the cold and hot seasons. Accordingly, the upper panel of Table B.8 defines rent growth in the cold season as the annualized log difference between rents observed between January and June 2019 and rents between September and December 2019. The lower panel of the table defines rent growth in the hot season as the annualized log difference between rents observed before January 2019 and rents observed between January and June 2019. In the upper panel of Table B.9, vacancy status is indicated for properties listed between September and December 2019, and in the lower panel, vacancy status is marked for properties listed between March and June 2019.[4]

As reported in Tables B.8 and B.9, the implications of rent flexibility for rent and vacancy in 2019 generally mirrored those during the COVID-19 pandemic. Specifically, the upper panels of Tables B.8 and B.9 indicate landlords of ex-ante flexible properties lowered rent during the cold season and consequently experienced lower vacancy. The lower panels, on the other hand, show that flexible properties raised rents during the hot season. Although these rent increases led to increases in vacancies, the increases in vacancies were compensated by rent increases and brought higher rental income to flexible properties.

More importantly, the results show that the rental income gains from flexible rent settings in 2019 are much smaller than those during the pandemic. Therefore, these results imply that the value of a flexible rent setting is more prominent when rental housing markets are volatile. Combined with the finding that expert landlords adjust rent more flexibly than non-expert landlords, they suggest that income or wealth in the rental housing market shifts toward institutional landlords from mom-and-pop landlords during the rental housing market turmoil.

4. The analyses in Table B.9 exclude properties listed in January and February because, unlike rent growth, vacancy status cannot be annualized, and thus, the length of the period in which the marginal effects of rent flexibility on vacancy is estimated should be matched.

CHAPTER 6

DISCUSSION

This section discusses the determinants of rent-setting flexibility from the perspectives of workhorse macroeconomic models for price stickiness.

6.1 Expert Landlords' Menu Cost

An extensive macroeconomic literature on price stickiness often assumes that a small menu cost occurs when price setters change their product prices and shows that those small menu costs are responsible for the price setters' price-changing patterns and profitability. Therefore, it is important from the theoretical standpoint to examine whether the main results in Table B.5, B.6, and B.7 are driven by landlords' menu costs, not landlords' expertise.

As it is challenging to measure landlords' menu costs explicitly, I exploit the implications of the menu cost models: when shocks arrive, firms with higher menu costs adjust their product prices less often, but they change prices more extensively when they do. In other words, I test in Table B.10 whether larger, more asset-diversifying, or more experienced landlords have lower menu costs by examining how they changed rent during the COVID-19 pandemic. If they changed rent less often but changed it more significantly when they did, expert landlords' flexible rent settings and the higher rental income would likely have been induced by their lower menu costs.

Table B.10 restricts the sample to the rent data of the properties managed by professional management firms and examines expert landlords' price-setting behaviors during the COVID-19 pandemic. As a left-hand-side variable, it uses the amount of time it takes to change the price (Columns (1) through (3)), and the percentage rent changes (Columns (4) through (6)). As the right-hand-side variable, Columns (1) and (4) use the size of landlords defined as the total rent of each firm's properties. Columns (2) and (5) use the firm-level asset concentration measure, and Columns (3) and (6) use the ages of firms. If expert landlords have lower menu costs, it will take less time for them to adjust rent, so coefficients of interest will be negative in Columns (1) and (3) (positive in Column (2)). Further, if they changed rent less extensively when they adjusted rent, the coefficient of interest will be negative in Columns (4) and (6) (positive in Column (5)).

However, Table B.10 shows expert landlords did not change rent less often when shocks arrived in the rental housing markets (Columns (1) through (3)). Further, expert landlords changed rent more significantly when they adjusted rent. Therefore, these results suggest that the landlords' expertise measures are not a proxy of landlords' menu cost, and it is not the menu costs that drive the main results in the previous sections.

6.2 Seasonality in Rent settings, Calvo (1983) and Talyor (1980).

In the US, considerable seasonality exists in price setting of consumer items or wages, and literature on price stickiness typically associates these seasonalities with regular pricing schedules and product-development cycles, which are orthogonal to a firm's desire to change its prices (Nakamura and Steinsson [2008], Grigsby et al. [2021]). However, seasonality in rent-setting flexibility implies landlords adjust rents purposefully according to demand in rental-housing markets.

To illustrate this point, Figure A.7 presents the mean value of rent-setting-flexibility measures along with the mean number of listed and rented-out apartments for each month. The figure restricts the sample to the listings until December 2019 to avoid influence from outliers during the COVID-19 pandemic. Panel (a) of the figure shows the frequency, volatility, and size of rent-setting-flexibility measures using dotted blue, dotted red, and solid red lines, respectively. Panel (b) shows the number of listed and rented-out apartments using a dashed blue line and a solid red line, respectively. Both panels use a dotted grey line to show average monthly rent growth. To examine relative variation, all values, except for rent growth, are indexed as 1 in January.

As Panel (a) shows, rent flexibility is highly seasonal: rents are 10%-40% more flexibly adjusted in the third quarter than in the first quarter. Interestingly, Panel (b) shows the months in which landlords adjust rents most flexibly are months in which rental-housing demand starts to wane (i.e., July to October). It also shows the month in which landlords adjust rents least flexibly coincides with when rental-housing demand peaks (i.e., May).

Importantly, unlike seasonality in consumer and producer prices or wages, seasonality in rent-setting flexibility is less likely induced by staggered contracts or regular pricing schedules, as in the model of Taylor [1980], because rent flexibility is measured based on on-market rent-setting patterns; that is, rental agreements have already ended, and rents are floating.[1] Further, it is unlikely to be caused by product renovation or product-development cycles, as is the case for the seasonality of the price of apparel (Nakamura and Steinsson [2010]), because rent-setting flexibility is measured for constant properties. There is also little evidence that rent-adjustment costs vary throughout the year.[2]

Therefore, seasonality in rent-setting flexibility is likely induced by landlords' responses to changes in demand. It may also be related to the thick-market effects of rental-housing markets, by which the willingness of tenants to pay decreases during the "cold season" (Ngai and Tenreyro [2014]). That is, it is likely that landlords adjust rents during the cold season to maximize profit, responding to declining demand and consequent sluggish rent growth.

1. As Grigsby et al. [2021] argue, Calvo [1983] predicts that the probability of price changes is stable across the season. Therefore, the seasonality in rent flexibility also rejects Calvo's (1983) prediction.

2. To ascertain that rent-adjustment costs do not vary throughout the year, Figure C.10 examines the variation in property characteristics throughout the year by plotting the mean number of bedrooms and square footage of the listed apartments for each month. The figure shows that property characteristics rarely vary across the year, and if anything that variation in property characteristics does not coincide with the patterns of rent-flexibility variation.

6.3 Competition and Rent-Setting Flexibility

Additional evidence suggests landlords adjust rent more flexibly in competitive areas, further implying landlords choose the timing and degree of rent changes. More specifically, analyses in Table B.11 explore the firm fixed effects and show geographical competition is a vital determinant of rent flexibility. Table B.11 constructs a zipcode-level HHI by computing the zipcode-level market share of landlords based on the total rent of properties they manage. It then regresses rent-flexibility measures on the HHI: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). The table explores management-firm fixed effects in columns (2), (4), and (6) to examine how the same landlord adjusts rent differentially across geographies depending on the competition in the area. It also uses the mean asking rent as a control variable in all columns.

The results in columns (1), (3), and (5) show properties in more competitive zipcodes adjust rents more flexibly. More importantly, the results in columns (2), (4), and (6) show that when landlords own multiple properties across a zipcode they adjust rents more flexibly for the properties located in the more competitive zipcodes. In all columns, the coefficients of interest are statistically significant at the 1%–5% level, and their sizes are economically large: a one-standard-deviation increase in competition is associated with a 0.1- to 0.5-standard-deviation increase in rent flexibility. The results hence show rent flexibility is a way to compete with competitors and attract potential tenants.

Interestingly, although rental properties are non-tradable, rent flexibility is not affected by geographical conditions. Table C.2 tests this hypothesis by examining the correlation between rent flexibility and selected geographical characteristics: zipcode-level income, house prices, number of establishments, and relative share of rental properties. All of the variables in the table are standardized to facilitate comparison across the analyses. An initial hypothesis with regard to the analyses in the table is that rent is differentially set in different areas based on housing conditions and business activities, which affect demand. For example, rents may change more slowly in areas with more active businesses, because such areas may witness a higher demand for rental housing.

However, Table C.2 shows none of the selected geographical characteristics explain rent flexibility. Notably, when the table explores the management-firm fixed effects, it finds property management firms do not differentially adjust rents across geography depending on the selected geographical conditions (columns (2), (4), (6), and (8)): the coefficients of interest are statistically indistinguishable from zero, and their sizes are also close to zero. Therefore, the results presented in this table further support the idea that rent flexibility arises as a result of proactive rent-setting as part of landlords' efforts to compete with others.

CHAPTER 7

ROBUSTNESS

This section revisits the analyses presented above to check the robustness of the results.

7.1 Initial Rent Setting and Adjustment

As the first step of the robustness test, this section addresses a concern that flexible rent-setting is merely induced by initial mispricing and subsequent adjustment. If this is the case, rent-flexibility measures will represent an inability to set rents, and landlords who initially set higher rents when listing will adjust rents more while their properties are on the market.

To ameliorate this concern, Table C.3 examines the correlation of the rent-flexibility measures with the initial rent of each listing. It uses properties' initial rents as the right-hand-side variable and rent-flexibility measures as the left-hand-side variables: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). All the variables are standardized to facilitate comparison across the columns. Further, columns (2), (4), and (6) examine the correlation with fixed effects included. Building fixed effects obtained from the street addresses of properties and listing-year-month fixed effects constructed from the first date of each listing are included in these columns.

The table shows none of the coefficients on the initial rent are statistically significant. The sizes of the coefficients are also close to zero, indicating rent-flexibility measures vary only marginally despite a one-standard-deviation increase in initial rent. Therefore, I conclude the flexibility measures are not a mere product of high initial rent-setting; in other words, they are not caused by mispricing and adjustment.

7.2 Property Qualities

Unlike previous studies on price stickiness that used the price data for components of CPI or PPI, this paper measures price stickiness on the constant, unswitched products—this paper measures rent-setting flexibility for a given property—and its implications for rent and vacancy for the same property. However, this exercise still does not fully guarantee that the quality of properties remains stable after the rent-setting setting flexibility is measured, because properties can experience renovation or maintenance later that would significantly alter the features of the properties. Therefore, this section addresses the concern that the change in the quality of properties by renovation or maintenance possibly induces the rent and vacancy patterns documented above.

More specifically, I address the concern in Table C.4 by using building permit data and examining whether the rent-setting flexibility measures are systematically correlated with renovation or maintenance costs during the COVID-19 pandemic. If this is the case, the main findings in this paper could have been driven not by landlords' rent-setting flexibility but by the change in property qualities. For example, the lower (higher) rent growth of flexible properties during the early (later) period of the pandemic resulted from poor maintenance or the absence of renovation.

As the building permit is given at the building level, I average the rent-setting flexibility at the building level and report the correlation between the building-level rent-setting flexibility and renovation costs. In Table C.4, the left-hand-side variable in Columns (1) through (3) is the total cost for renovation or maintenance since March 2020 and the left-hand-side variable in Columns (4) through (6) is the total cost only for a full renovation. The right-hand-side variables in Columns (1) and (4), (2) and (5), and (3) and (6) are frequency, volatility, and size measures of rent-setting flexibility.

As reported, the table shows that the renovation or maintenance costs during the COVID-19 pandemic are not significantly correlated with the rent-setting flexibility measures. Moreover, the correlation coefficients are close to zero, implying that the rent-setting behaviors are an unmeaningful predictor for subsequent renovation or maintenance. Therefore, this table shows that the change in property quality does not drive the primary results in this paper.

7.3 Sample-Selection Bias

A central issue in the analyses presented in Table B.3 and Table B.6 is that rental contract terms are not random, and instead are selected by tenants, so the left-hand-side variables for some observations are missing. To address this concern, this section explores the following Heckman selection model and corrects biases induced by geographical conditions or a relative rent level of a given property within the geography:

$$\begin{aligned} &\textit{Selection Equation: } \delta \cdot \textit{Rent}_i + \alpha_z + \nu_{iz} > 0 \\ &\textit{Main Equation: } y_i = \beta \cdot \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_c + \varepsilon_i. \end{aligned} \tag{7.1}$$

In the model, i indicates the property, and $Rent_i$, α_z, and α_c represent the property-level mean asking rent, zipcode fixed effects, and census-tract fixed effects, respectively. The selection equation implies the left-hand-side variable in the regression equation is less likely to be observed if the asking rent is lower within a zipcode because it would induce longer contract terms.

Table C.5 revisits Table B.3 and shows the estimation of the Heckman selection models results in quantitatively similar coefficients to the original ones. In both panels in the table, the coefficients of interest are all statistically significant at the 1% level. Their magnitudes are also close to those of the original ones.

Table C.6 revisits Table B.6 and also shows similar results. Despite the full-sample estimation addressing the sample selection, the coefficients of interest in Table C.6 are quantitatively and statistically close to the initial results in Table B.6. Thus, the estimation of the Heckman selection model suggests the main results are not likely to have been induced by the sample selection.

7.4 Alternative Measures of Rent Flexibility

A potential concern about the rent-setting-flexibility measures explored throughout this paper is that the denominator of the measures—days on the market—may be endogenous to rent flexibility itself. That is, more flexible properties could experience a shorter time on the market and thus be assigned larger flexibility measures than they should be.

To address this concern, I restricted the sample to the properties on the market more than 30 days. I then measured rent-setting flexibility based on rent-adjustment behaviors for the first 30 days each property was on the market. I revisited the main analyses using the alternative measures of rent flexibility, and report the results in Tables C.7 and C.8.

Interestingly, the results presented in Tables C.7 and C.8 are similar to the original results in Tables B.6 and B.7. The coefficients of interest are as statistically significant as the original results, and their sizes are also about the same. The profit gains from flexible rent settings computed and presented in the middle of Table C.8 are also quantitatively and qualitatively similar to the original results in Table B.7. Therefore, I conclude the main results are not significantly affected by the endogeneity issue in the primary rent-flexibility measures and remain intact, even after redesigning the main rent-flexibility measures.

7.5 Contract Rent vs. Asking Rent

An additional concern about the primary analyses in Table B.6 is that they compute rent growth based not on contract rent but on asking rent. The use of asking rent can potentially be problematic because if no one leases properties at the asking rents used in Table B.6, the differential rent growth documented in the table merely shows properties' differential rent offers, not the rent changes that matters for landlords' profits and tenants' welfare.

Properties' promotional rent discounts not being included in asking rents also raises concerns. In practice, landlords often provide promotional rent discounts by deducting several months' rent from the total rent. Because such rent discounts are unlikely to be included in listing information, they can cause biases in the primary analyses if they are systematically correlated with landlords' flexibility to adjust rents.

Therefore, this section estimates contract rents from listing data and revisits Table B.6 based on rent growth computed from the estimated contract rents. In particular, this section utilizes the last asking rent in each listing as a proxy for contract rent, because the last asking rent—rent asked right before properties are taken off the market—is likely to be used as a reference rent for contract rent.

Figure C.11 and Table C.9 use rental-contract data from the data provider and show this method is reasonable. More specifically, Panel (a) of Figure C.11 plots estimated contract rents against nominal contract rents, which do not include properties' promotional rent discounts. Panel (b) considers promotional rent discounts and compares estimated contract rents with effective contract rents, which subtract rent discounts from nominal contract rents. Both panels plot the identity line (i.e., $y = x$) as a base line. Table C.9 computes the percentage rent discount by dividing the rent discount by the nominal contract rent, and shows how correlated the percentage rent discount is with rent-setting flexibility measures.

As shown in Figure C.11, contract rent estimated from the last asking rent in each listing is highly correlated with nominal and effective contract rent. Furthermore, Table C.9 shows that although effective contract rents tend to be lower than estimated contract rents (Panel (b) of Figure C.11), the promotional rent discount is uncorrelated with rent-setting-flexibility measures. Thus, the table shows rent discounts are unlikely to cause biases in analyses that determine the correlation between rent-setting flexibility and rent growth.

Based on these findings, Table C.10 uses the last asking rent for each listing to compute contract-rent growth. It then examines whether properties' flexibility to adjust rent predicts contract-rent adjustments during the COVID-19 pandemic. It shows ex-ante flexible properties adjusted contract rents more considerably during the entire period of the pandemic.[1] Given that the mean and standard deviation of contract-rent growth are -2.7% and 8.4% (4.3% and 9.4%), respectively, during the first (second) year of the pandemic, the table shows the degree of flexible properties' contract-rent adjustment is as substantial as the original results in Table B.6.

1. Although I obtained the contract rent data from the data provider, I cannot use the data directly for the primary analyses in Table B.6 because the sample is small, meaning that few properties repeatedly show up in the data. Thus, it was not feasible to compute rent changes from the contract rent data.

CHAPTER 8

CONCLUSION

Using asking-rent data for apartments in Chicago, this paper examines the implications of landlords' rent-setting flexibility for properties' rent, vacancy, and rental income. To this end, this paper first measures properties' rent-setting flexibility by examining how frequently and substantially they changed rents prior to December 2019 and shows that landlords' expertise determines their rent-setting flexibility. More specifically, this paper documents that properties owned by professional management firms adjust rent more frequently and substantially than properties owned by mom-and-pop landlords, and among the professional management firms, larger, more asset-diversifying, and experienced firms adjust rent more flexibly even though their properties are located in the same zipcode.

The rent-setting flexibility was crucial for rental income over the rental housing market cycle. Particularly, flexible properties earned higher rental income during the rental housing market downturn because they experienced substantially lower vacancies by providing extensive rent discounts. They also earned higher rental income during the rental housing market boom because they did not suffer from higher vacancies despite their aggressive rent increases. However, the gains were much smaller during normal times (i.e., 2019) than during the pandemic, suggesting the value of flexible rent setting is greater when the rental housing market is volatile, and the rental housing market volatility shifts wealth or income in the rental housing market toward expert institutional landlords from non-expert mom-and-pop landlords.

The findings in this paper have policy implications. In particular, they suggest policies to incentivize institutional investment in residential real estate should be considered with rent controls because expert landlords are likely to profit at the expense of tenants' welfare during rental-housing-market booms (i.e., they can raise rents without sacrificing vacancies). Further, the findings regarding the determinants of rent-setting flexibility inform monetary policy because the determinant—landlords' expertise—may work as a friction that slows down aggregate price response to monetary policy, amplifying the effect of the policy on the real economy.

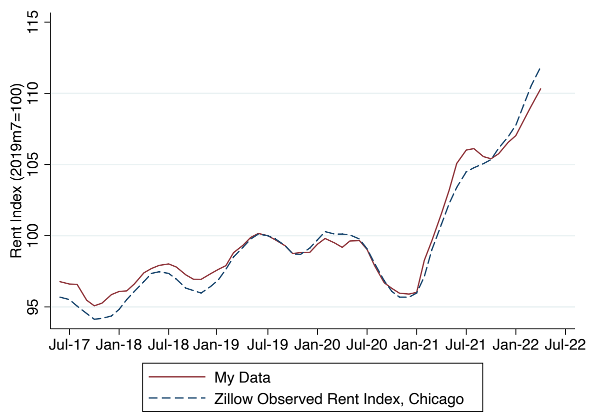
Lastly, this paper suggests a number of directions for future research. One is analyzing the financial or behavioral constraints that may hamper landlords in flexible rent-setting. This paper shows the differences in terms of rent-setting between institutional and mom-and-pop landlords, and between institutional landlords with different levels of expertise. However, it does not comment on the underlying financial or behavioral constraints that induce such differences. Therefore, a natural extension of this paper would be to examine the underlying factors associated with the rigid rent-setting behaviors of small or inexpert landlords.

Another research project could trace a given landlord's rent-setting behaviors over time. Although this paper provides cross-sectional evidence about the rent-setting of different landlords, additional research could examine how a given landlord's rent-adjusting behaviors evolve as the landlord obtains more experience or expertise. Institutional mergers similar to the one explored in Gurun et al. [2022] may provide useful experimental settings for such studies.

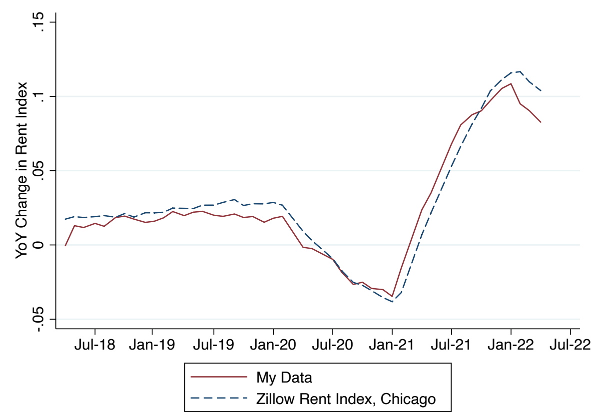
APPENDIX A

FIGURE

Figure A.1: Rent Index Created from the Listing Data and Its Year-over-Year Growth



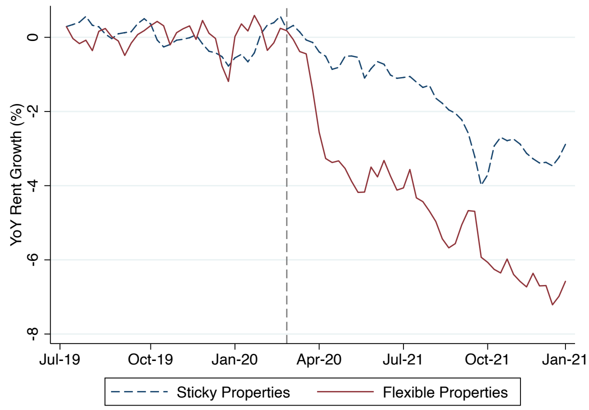
(a) Rent Index



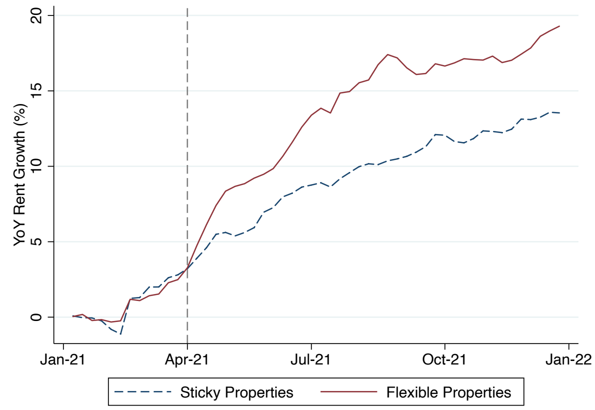
(b) Year-over-Year Rent Growth

Notes: This figure computes the Case-Shiller rent index from the listing data for apartments in Chicago (Case and Shiller [1987]). Panel (a) plots the raw Case-Shiller rent index (solid red line) along with the Zillow Observed Rent Index (dashed blue line). Panel (b) computes the year-over-year growth of both rent indexes.

Figure A.2: Year-over-Year Rent Growth by Ex-Ante Rent Flexibility



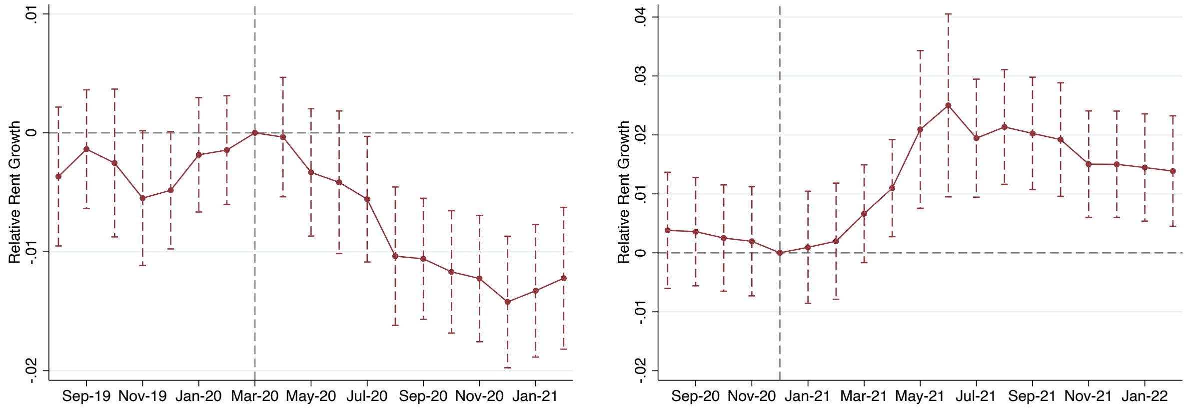
(a) During Early Period of the Pandemic



(b) During Later Period of the Pandemic

Notes: This figure plots the year-over-year rent growth from the Case-Shiller rent indexes for the two property groups: sticky (dashed blue line) and flexible (solid red line) properties. Sticky properties are defined as properties that never changed rents while on the market before December 2019. Flexible properties are those above the median value of the size rent-flexibility measure computed before December 2019. The rent indexes control for the SQFT and zipcode of the properties. The year-over-year rent growth is demeaned by the mean of the pre-period (i.e., the period left to the vertical dotted line in the figure).

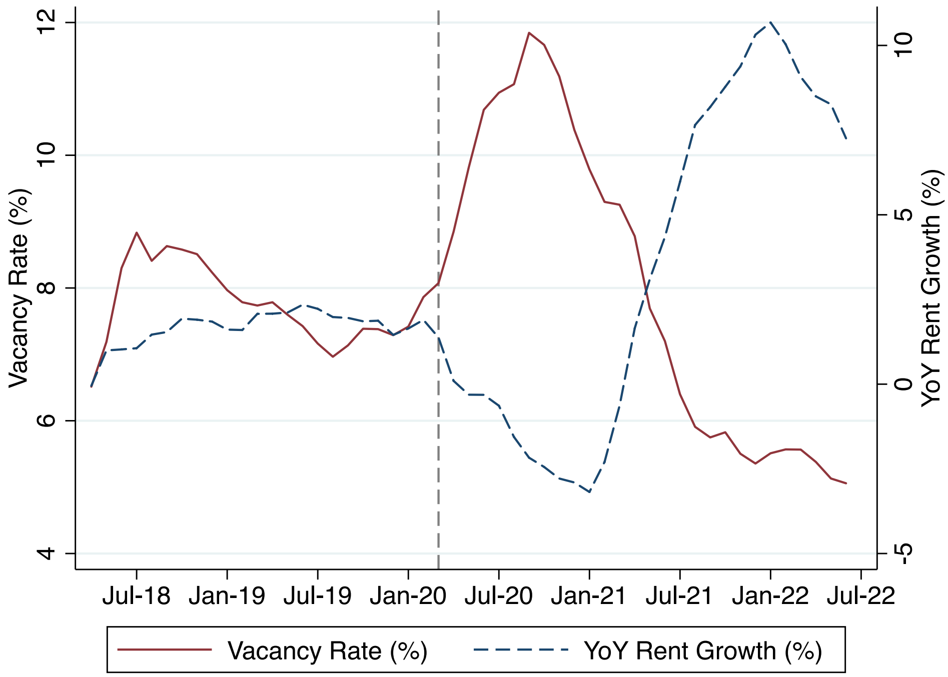
Figure A.3: Tract-Level Difference-in-Differences Estimation, Rent Growth



(a) During Early Period of the Pandemic (b) During Later Period of the Pandemic

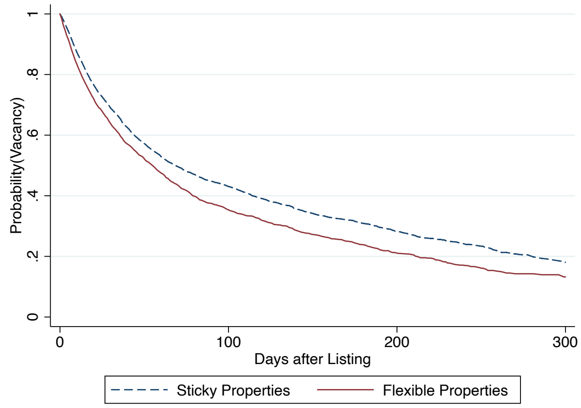
Notes: This figure estimates β_t from the following specification and plots them with 95% confidence intervals: $ln(Rent\ Index)_{ct} = \sum_{t \neq Mar2020 or Dec2020} \beta_t \cdot Share\ of\ Flexible\ Properties_c + \sum_t \gamma_t \cdot Distance\ from\ City\ Center_c + \sum_t \lambda_t \cdot Mean\ Rent_c + \alpha_c + \alpha_t + \varepsilon_{ct}$ where the left-hand-side variable is the log of the Case-Shiller rent index for tract c and year-month t. The share of flexible properties on the right-hand side is the tract-level share of properties that ever adjusted rents before December 2019. The distance from the city center is the physical distance of each tract from the Chicago city center, and the average rent is the mean asking rent of properties located in each tract. α_c and α_t are the tract and year-month fixed effects, and all the right-hand-side variables are standardized to facilitate interpretation. Confidence intervals are computed based on the heteroskedasticity-robust standard errors.

Figure A.4: Vacancy Rate and Year-over-Year Rent Growth

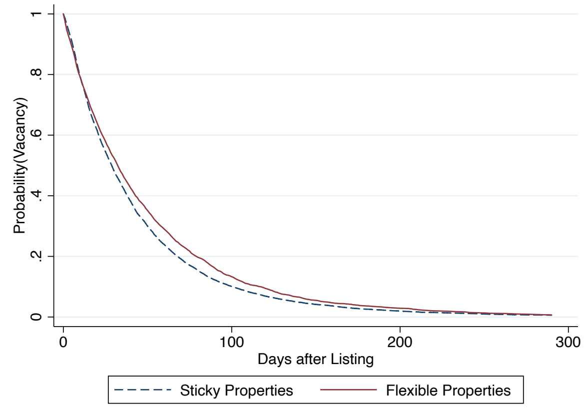


Notes: This figure plots Chicago's vacancy rate (solid red line) along with year-over-year rent growth (dotted blue line). The figure computes the vacancy rate by dividing the number of listings at a given time by the total number of properties ever listed. The dotted grey line indicates the outbreak of the COVID-19 pandemic (i.e., March 2020).

Figure A.5: Probability of Vacancy



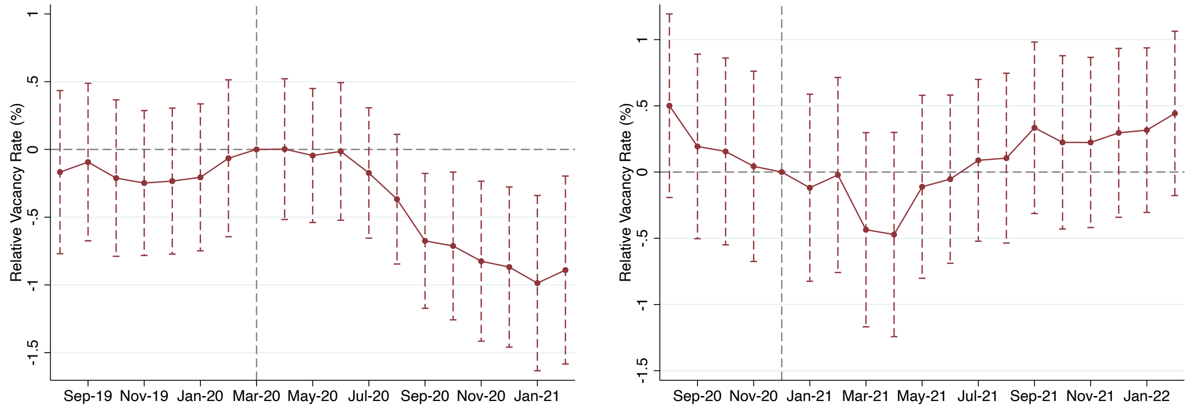
(a) During the First Year of the Pandemic



(b) During the Second Year of the Pandemic

Notes: This figure uses the Kaplan-Meier methods to estimate the vacancy probability for sticky (dashed blue line) and flexible (solid red line) properties during the first (Panel (a)) and second (Panel (b)) years of the COVID-19 pandemic. The figure defines sticky properties as properties that never changed the on-market rents before December 2019. It defines flexible properties as properties above the median of the size rent-flexibility measures. The first year of the pandemic spans from March 2020 to March 2021, and the second year spans from March 2021 to March 2022. Properties are assumed to be rented out if they are off the market.

Figure A.6: Tract-Level Difference-in-Differences Estimation, Vacancy Rate

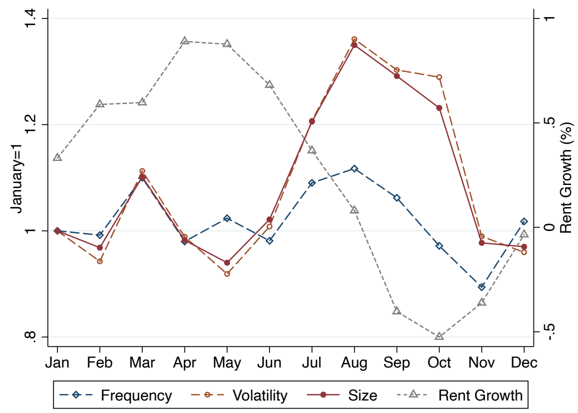


(a) During Early Period of the Pandemic

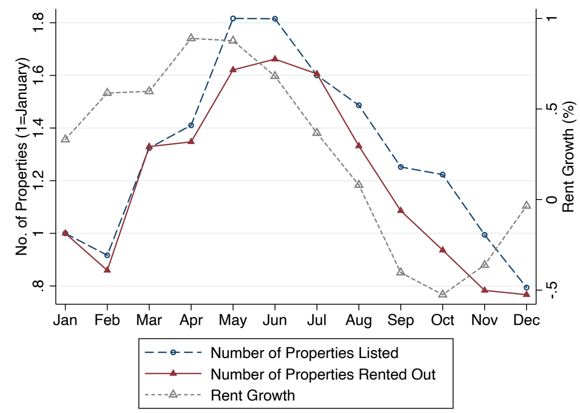
(b) During Later Period of the Pandemic

Notes: This figure estimates β_t from the following specification and plots them with 95% confidence intervals: $Vacancy\ Rate_{ct} = \sum_{t \neq Mar2020 or Dec2020} \beta_t \cdot Share\ of\ Flexible\ Properties_c + \sum_t \gamma_t \cdot Distance\ from\ City\ Center_c + \sum_t \lambda_t \cdot Mean\ Rent_c + \alpha_c + \alpha_t + \varepsilon_{ct}$ where the left-hand-side variable is the vacancy rate for tract c and year-month t. The share of flexible properties on the right-hand side is the tract-level share of properties that ever adjusted rents before December 2019. The distance from the city center is the physical distance of each tract from the Chicago city center, and the average rent is the mean asking rent of properties located in each tract. α_c and α_t are the tract and year-month fixed effects, and all the right-hand-side variables are standardized to facilitate interpretation. Confidence intervals are computed based on the heteroskedasticity-robust standard errors.

Figure A.7: Seasonality of Rent Flexibility



(a) Rent Flexibility



(b) Rental Transactions

Notes: Panel (a) of this figure uses the sample of properties listed from July 2017 to Dec 2019 and plots the mean value of rent-flexibility measures for each month. Rent flexibility measures are defined in Section 3, and larger values of them indicate more flexible rent adjustment. The dotted blue, dotted red, and solid red lines indicate the frequency, volatility, and size measures of rent flexibility, respectively. Panel (b) uses the same data and presents the mean number of listed (dashed blue line) and rented-out (solid red line) properties for each month. In both panels, the dotted grey line represents the mean rent growth. All variables but rent growth are indexed as 1 in January.

APPENDIX B

TABLE

Table B.1: Summary Statistics

	N	Mean	SD	P25	P50	P75	P95
Property-Level Variables							
Frequency Rent Flexibility Measure	74,217	0.052	0.108	0.000	0.000	0.034	0.333
Volatility Rent Flexibility Measure	74,217	0.035	0.063	0.000	0.000	0.047	0.160
Size Rent Flexibility Measure	74,217	0.072	0.126	0.000	0.000	0.100	0.330
Rent Growth (%), Early Pandemic	15,359	-3.540	11.560	-6.653	0.000	1.425	8.590
Rent Growth (%), Later Pandemic	9,642	0.731	20.476	-2.890	0.000	7.509	29.217
Vacancy Status, Early Pandemic	13,453	0.410	0.492	0.000	0.000	1.000	1.000
Vacancy Status, Later Pandemic	13,321	0.146	0.353	0.000	0.000	0.000	1.000
Tract-Level Variables							
Share of Flexible Properties	333	40.443	12.426	33.043	39.683	47.076	61.404
ln(Rent Index)	10,311	0.028	0.083	-0.012	0.023	0.064	0.158
Vacancy Rate (%)	10,416	9.246	6.545	5.190	8.021	11.867	19.915
Other Variables							
Zipcode-Level HHI	58	0.771	0.314	0.535	0.982	1.000	1.000
Firm Size (in million dollars)	24,627	3.570	2.977	1.165	2.714	4.415	9.632
Firm Asset Concentration Measure	24,627	0.391	0.280	0.185	0.289	0.518	1.000
Firm Experience (in years)	23,413	42.7	28.5	27	34	57	129

Notes: This table reports summary statistics for key variables in this paper. Primary measures of rent flexibility at the property level (i.e., frequency, volatility, and size rent flexibility measures) are defined in Section 3. Property-level rent growth during the early pandemic is defined as the annualized log difference between rent observed before March 2020 and rent observed between March 2020 and Feb 2021. Rent growth during the later pandemic is defined using rent observed between March 2020 and Feb 2021 and rent witnessed after Feb 2021 until the end of the sample period. Vacancy status for the early pandemic period is an indicator variable taking one for properties listed between March 2020 and March 2021 and left vacant until March 2021. Vacancy status for the later pandemic period takes one for properties first listed between March 2021 and March 2022 and still listed until March 2022. Fleixble properties are defined as the properties that ever changed rent while on the market. The tract-level share of flexible properties is computed based on the properties' on-market rent adjusting behaviors before December 2019. The tract-level monthly rent index is computed based on Case and Shiller's weighted repeat sales methods (Case and Shiller [1987]). The vacancy rate is defined as the number of listed properties divided by the number of all properties ever listed. The zipcode-level HHI represents the degree of competition in each zipcode and is defined as $HHI_z = \sum_b \left(\frac{\text{Total Rent}_{bz}}{\sum_b \text{Total Rent}_{bz}} \right)^2$ where b and z indicate a management firm and zipcode, respectively. Firm size is the total rent of properties a firm manages. The firm-level asset concentration measure represents the degree of firm's asset concentration and is defined as $\sum_z \left(\frac{\text{Total Rent}_{bz}}{\sum_z \text{Total Rent}_{bz}} \right)^2$ where b and z indicate a management firm and zipcode, respectively. Firm experience is defined as a firm age.

Table B.2: Correlation between the Rent Flexibility Measures

	Frequency Measure	Volatility Measure	Size Measure
Frequency Measure	1.0000		
Volatility Measure	0.3854	1.0000	
Size Measure	0.5698	0.9458	1.0000

Notes: This table reports the unconditional correlation between the rent flexibility measures defined in Section 3.

Table B.3: Persistency of Rent Flexibility

Panel A.	Dep. Var: Rent Flexibility during the N'th Listing					
	Frequency		Volatility		Size	
	N=2	N=3	N=2	N=3	N=2	N=3
	(1)	(2)	(3)	(4)	(5)	(6)
Rent Flexibility during the First Listing	0.6311***	0.5723***	0.1891***	0.1934***	0.3279***	0.3348***
	(0.0299)	(0.0477)	(0.0234)	(0.0482)	(0.0359)	(0.0570)
Listing Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.2762	0.1918	0.0356	0.0187	0.0731	0.0380
# Obs	18,765	3,375	18,765	3,375	18,765	3,375

Panel B.	Dep. Var: Rent Flexibility for N Days					
	Frequency		Volatility		Size	
	31-60 Days	61-90 Days	31-60 Days	61-90 Days	31-60 Days	61-90 Days
	(1)	(2)	(3)	(4)	(5)	(6)
Rent Flexibility during the First 30 Days	0.7605***	0.6806***	0.2439***	0.2469***	0.4141***	0.4284***
	(0.0116)	(0.0220)	(0.0261)	(0.0325)	(0.0247)	(0.0349)
Listing Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.6182	0.4573	0.09839	0.07181	0.2209	0.1885
# Obs	8,617	6,606	8,617	6,606	8,617	6,606

Notes: This table examines the persistency of rent-setting flexibility across (Panel A) and within (Panel B) the listing. Panel A computes rent flexibilities during the first, second, and third listings and compares rent flexibility during the first listing to rent flexibilities during the second and third listings. All columns in Panel A include listing-month pair fixed effects constructed from each listing's first listing date. Panel B computes rent-flexibility measures for the first, following, and next 30 days and examines the correlation of the former with the next two. All columns in Panel B include listing-month fixed effects. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.4: Institutional Ownership and Rent Flexibility

	Dep. Var: Rent Flexibility Measure$_i$					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
I(Owned by Management Firms)$_i$	0.0998***	0.0955***	0.0149***	0.0139***	0.0555***	0.0525***
	(0.0110)	(0.0108)	(0.0033)	(0.0034)	(0.0096)	(0.0098)
Rent$_i$, Standardized	-0.0080**	-0.0085***	-0.0011	-0.0020**	-0.0035	-0.0050**
	(0.0037)	(0.0027)	(0.0014)	(0.0009)	(0.0040)	(0.0025)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Listing Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Highest-floor-level Decile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.2526	0.2897	0.02377	0.03851	0.06666	0.09302
# Obs	70,155	70,155	70,155	70,155	70,155	70,155

Notes: This table compares institutional landlords' rent-setting flexibility with mom-and-pop landlords' rent-setting flexibility. The left-hand-side variables are rent-flexibility measures defined in section 3: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). The right-hand-side variable of interest is an indicator variable that takes one for properties owned and managed by professional management firms. All columns control for the mean asking rent for each property and include the highest-floor-level decile fixed effects. They also exploit listing year-month fixed effects. Columns (2), (4), and (6) include zipcode fixed effects. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.5: Landlord's Expertise and Rent Flexibility

	Dep. Var: Rent Flexibility Measure$_i$, Standardized								
	Frequency			Volatility			Size		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Firm Size$_b$, Standardized	0.0516			0.0463***			0.0644***		
	(0.0391)			(0.0121)			(0.0181)		
Asset Concentration$_b$, Standardized		-0.1865***			-0.0748**			-0.1137***	
		(0.0666)			(0.0288)			(0.0388)	
Experience$_b$, Standardized			0.1540			0.1042*			0.1316*
			(0.1092)			(0.0514)			(0.0717)
Rent$_i$, Standardized	-0.1347***	-0.1151**	-0.1308***	-0.0583**	-0.0446**	-0.0537**	-0.0698**	-0.0503*	-0.0620**
	(0.0453)	(0.0437)	(0.0424)	(0.0241)	(0.0217)	(0.0216)	(0.0290)	(0.0261)	(0.0257)
Listing Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zipcode FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.1283	0.1431	0.1230	0.04591	0.04289	0.03958	0.07493	0.07180	0.06321
# Obs	24,627	24,627	23,412	24,627	24,627	23,412	24,627	24,627	23,412

Notes: This table tests a hypothesis that expert landlords adjust rents more flexibly. It measures a firm size by the total rent of properties a firm manages. It defines asset concentration using the Herfindahl–Hirschman index (HHI): $HHI_b = \sum_z \left(\frac{\text{Total Rent}_{bz}}{\sum_z \text{Total Rent}_{bz}} \right)^2$ where b and z indicate a management firm and zipcode, respectively. The asset concentration measure shows the degree to which a firm concentrates its asset across the zipcode (i.e., the higher HHI is, the more concentrated the firm's properties are in a small number of zipcodes). The table defines firm's experience as a firm age. All columns exploit zipcode and listing year-month fixed effects. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.6: Implication of Rent Flexibility for Rent Growth

Panel A.	Dep. Var: Rent Growth (%) during the Pandemic before March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	-1.4866***	-1.0466***	-0.5190***	-0.3088**	-0.9001***	-0.5721***
Standardized	(0.2342)	(0.2521)	(0.1897)	(0.1440)	(0.2231)	(0.1842)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.05724	0.07585	0.03865	0.06773	0.04269	0.06937
# Obs	15,359	15,359	15,359	15,359	15,359	15,359
Panel B.	Dep. Var: Rent Growth (%) during the Pandemic after March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	2.7596***	2.5710***	1.6507***	1.4614***	2.3240***	2.0933***
Standardized	(0.4222)	(0.4988)	(0.3140)	(0.3205)	(0.3148)	(0.3435)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.1083	0.1185	0.09075	0.1050	0.09708	0.1100
# Obs	9,642	9,642	9,642	9,642	9,642	9,642

Notes: This table estimates the following specification to examine the implication of ex-ante rent flexibility on rent growth during the COVID-19 pandemic: $\textit{Rent Growth}_i = \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i$ As the left-hand-side variables, Panel A uses the properties' rent growth during the pandemic before March 2021, defined as the annualized log difference between rent observed before March 2020 and rent observed between March 2020 and Feb 2021. Panel B uses the rent growth from March 2021 to the end of the sample period, defined as the annualized log difference between rent observed between March 2020 and Feb 2021 and rent witnessed after Feb 2021 until the end of the sample period. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures before December 2019. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the first dates of the period in which rent flexibility and growth are computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.7: Implication of Rent Flexibility for Vacancy

Panel A.	Sample: Properties listed between Mar 2020 and Mar 2021 Dep. Var: Dummy variable$_i$ indicating vacancy until Mar 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility,	-0.0143***	-0.0230***	-0.0326***	-0.0305***	-0.0307***	-0.0326***
Standardized	(0.0050)	(0.0056)	(0.0037)	(0.0035)	(0.0040)	(0.0038)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	-95.7	62.0	406.0	421.9	291.8	394.1
Psuedo R^2	0.2769	0.3093	0.2796	0.3101	0.2796	0.3110
# Obs	13,453	13,453	13,453	13,453	13,453	13,453
Panel B.	Sample: Properties listed between Mar 2021 and Mar 2022 Dep. Var: Dummy variable$_i$ indicating vacancy until Mar 2022					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility,	0.0111***	0.0080**	0.0030	0.0010	0.0075**	0.0044
Standardized	(0.0031)	(0.0035)	(0.0030)	(0.0028)	(0.0036)	(0.0034)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	572.1	552.1	371.6	342.0	496.9	466.8
Psuedo R^2	0.3675	0.3790	0.3648	0.3778	0.3656	0.3781
# Obs	13,321	13,321	13,321	13,321	13,321	13,321

Notes: This table estimates the logit model to examine the implication of ex-ante rent flexibility for vacancy during the COVID-19 pandemic. As the left-hand-side variables, Panel A uses a log odds constructed from an indicator variable for the vacant properties listed between March 2020 and March 2021. Panel B uses a log odds constructed from an indicator variable for the vacant properties listed between March 2021 and March 2022. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures before December 2019 to avoid mechanical correlation. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the listing date and the first dates of the period in which rent flexibility is computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.8: Implication of Rent Flexibility for Rent Growth in 2019

Panel A.	Dep. Var: Rent Growth (%) during the Cold Season in 2019					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	-0.4801	-0.4606	-1.1254	-0.9620	-1.4503	-1.1974
Standardized	(0.7980)	(0.6882)	(0.8149)	(0.7307)	(1.0278)	(0.8733)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.0291	0.0558	0.0308	0.0569	0.0333	0.0582
# Obs	1,009	1,009	1,009	1,009	1,009	1,009
Panel B.	Dep. Var: Rent Growth (%) during the Hot Season in 2019					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	0.4117**	0.4995**	0.9173***	0.8663***	1.0394***	0.9942***
Standardized	(0.2021)	(0.2115)	(0.2059)	(0.2721)	(0.1641)	(0.2430)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.0946	0.1037	0.0967	0.1051	0.0980	0.1062
# Obs	9,072	9,072	9,072	9,072	9,072	9,072

Notes: This table estimates the following specification to examine the implication of ex-ante rent flexibility for rent growth in 2019: $\textit{Rent Growth}_i = \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i$ As the left-hand-side variables, Panel A uses the properties' rent growth during the cold season in 2019, defined as the annualized log difference between rent observed between Jan 2019 and Aug 2019 and rent witnessed between Aug 2019 and Feb 2020. Panel B uses the rent growth during the hot season in 2019, defined as the annualized log difference between rent observed before Jan 2019 and rent observed between Jan 2019 and Aug 2019. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, computed before Dec 2018. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the first dates of the period in which rent flexibility and growth are computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.9: Implication of Rent Flexibility for Vacancy in 2019

Panel A.	Sample: Properties listed between Aug 2019 and Dec 2019					
	Dep. Var: Dummy variable$_i$ indicating vacancy					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility,	-0.0100	-0.0418	-0.0237***	-0.0219***	-0.0215***	-0.0187***
Standardized	(0.0078)	(0.0075)	(0.0074)	(0.0077)	(0.0063)	(0.0065)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	28.4	6.9	59.5	74.3	-44.0	-21.7
Psuedo R^2	0.1621	0.1743	0.1634	0.1755	0.1633	0.1752
# Obs	3,422	3,422	3,422	3,422	3,422	3,422
Panel B.	Sample: Properties listed between Jan 2019 and May 2019					
	Dep. Var: Dummy variable$_i$ indicating vacancy until					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility,	0.0214***	0.0218***	0.0080	0.0054	0.0191**	0.0156**
Standardized	(0.0423)	(0.0380)	(0.0439)	(0.0405)	(0.0496)	(0.0452)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	-72.3	-53.9	156.2	205.7	96.7	118.6
Psuedo R^2	0.2295	0.2536	0.2268	0.2511	0.2281	0.2520
# Obs	5,746	5,746	5,746	5,746	5,746	5,746

Notes: This table estimates the logit model to examine the implication of ex-ante rent flexibility for vacancy in 2019. As the left-hand-side variables, Panel A uses an indicator variable for the vacant properties among the properties listed between August 2019 and December 2019. Panel B uses an indicator variable for the vacant properties among the properties listed between January 2019 and May 2019. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures before December 2018 to avoid mechanical correlation. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the listing date and the first dates of the period in which rent flexibility is computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.10: Test of Menu Cost Model

Dep. Var	Time to Adjust Rent			Rent Adjustment		
	(1)	(2)	(3)	(4)	(5)	(6)
Firm Size$_b$, Std	0.0534			0.1227***		
	(0.1086)			(0.0353)		
Asset Concentration$_b$, Std		0.3243			-0.2602***	
		(0.2339)			(0.0642)	
Experience$_b$, Std			-0.5223			0.2071**
			(0.4091)			(0.0959)
Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Rent Decile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Zipcode FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.01734	0.01762	0.01792	0.04578	0.04304	0.03958
# Obs	215,499	215,499	215,499	215,499	215,499	215,499

Notes: This table examines if the measures of landlords' expertise are proxies of landlords' menu costs. The restricts the sample to the rent data during the COVID-19 pandemic for the properties managed by professional management firms. As a left-hand-side variable, it uses the amount of time it takes to change the price (Columns (1) through (3)), and the percentage rent changes (Columns (4) through (6)). As the right-hand-side variable, Columns (1) and (4) use the size of landlords defined as the total rent of each firm's properties. Columns (2) and (5) use the firm-level asset concentration measure, and Columns (3) and (6) use the ages of firms. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table B.11: Competition and Rent Flexibility

	Dep. Var: Rent Flexibility Measure, Standardized					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
HHI_z, Standardized	-0.4491***	-0.2780**	-0.2152***	-0.1241**	-0.3014***	-0.1752**
	(0.1227)	(0.1208)	(0.0463)	(0.0457)	(0.0640)	(0.0722)
Rent_i, Standardized	-0.1194*	-0.0703**	-0.0305	-0.0690***	-0.0347	-0.0744***
	(0.0691)	(0.0317)	(0.0253)	(0.0214)	(0.0306)	(0.0261)
Managemenet Firm FEs	No	Yes	No	Yes	No	Yes
Listing Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.05982	0.2862	0.02132	0.09558	0.03430	0.1457
# Obs	24,627	24,627	24,627	24,627	24,627	24,627

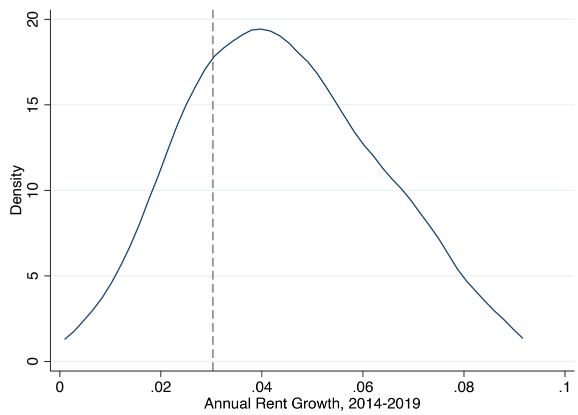
Notes: This table explores the correlation between rent flexibility and competition in the area. The left-hand-side variables are flexibility measures defined in section 3: frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). The right-hand-side variables include the Herfindahl–Hirschman index (HHI) constructed from the zipcode-level market share of management firms computed based on the total rent of properties they manage: $HHI_z = \sum_b \left(\frac{\text{Total Rent}_{bz}}{\sum_b \text{Total Rent}_{bz}}\right)^2$ where b and z indicate a management firm and zipcode, respectively. Higher HHI indicates a higher market concentration at the zipcode. Listing year-month fixed effects are exploited in all columns. Management firm fixed effects are included in columns (2), (4), and (6). The mean asking rent is used as a control variable in all columns. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

APPENDIX C

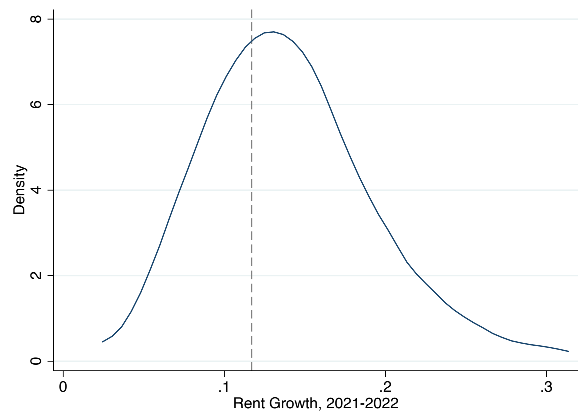
SUPPORTING ANALYSIS

C.1 Figure

Figure C.1: Representativeness of Chicago Rental-Housing Market.



(a) Pre-Pandemic Rent Growth



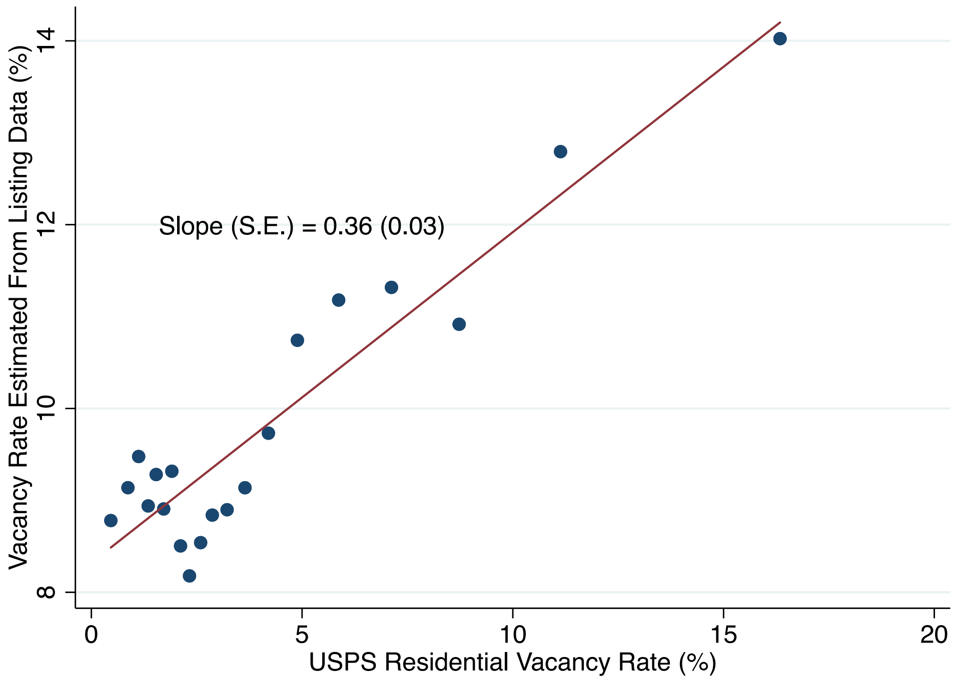
(b) Post-Pandemic Rent Growth

Notes: This figure uses the Zillow Observed Rent Index (ZORI) and plots the distribution of rent growth for the top 100 rent-housing markets in the US. Panel (a) plots the distribution of pre-pandemic rent growth from 2014 to 2019. Panel (b) plots the distribution of rent growth from March 2021 to March 2022, which roughly correspond to the trough and peak of rental-housing markets during the pandemic. In both panels, the vertical dotted line indicates Chicago.

Figure C.2: Zillow House Price and Observed Rent Index

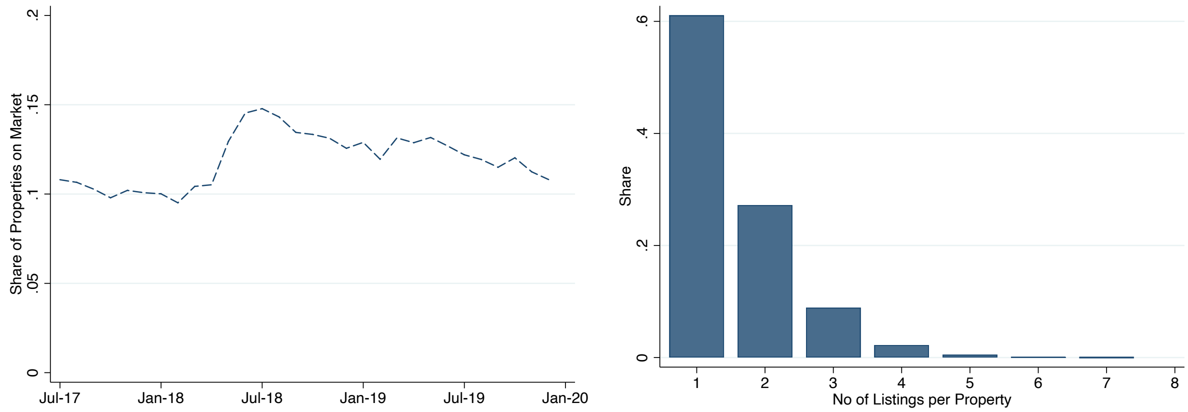
Notes: This figure presents the year-over-year house price and rent growth computed from the Zillow house price index (solid red line) and Zillow Observed Rent Index (dashed blue line) around the COVID-19 pandemic.

Figure C.3: Vacancy Rate Estimated from the Listing Data vs USPS Vacancy Rate



Notes: This figure plots the vacancy rate estimated from the listing data against the USPS residential vacancy rate. The estimated vacancy rate is defined as the number of listings in a given quarter divided by the number of properties ever listed. Both vacancy rates are at the tract level.

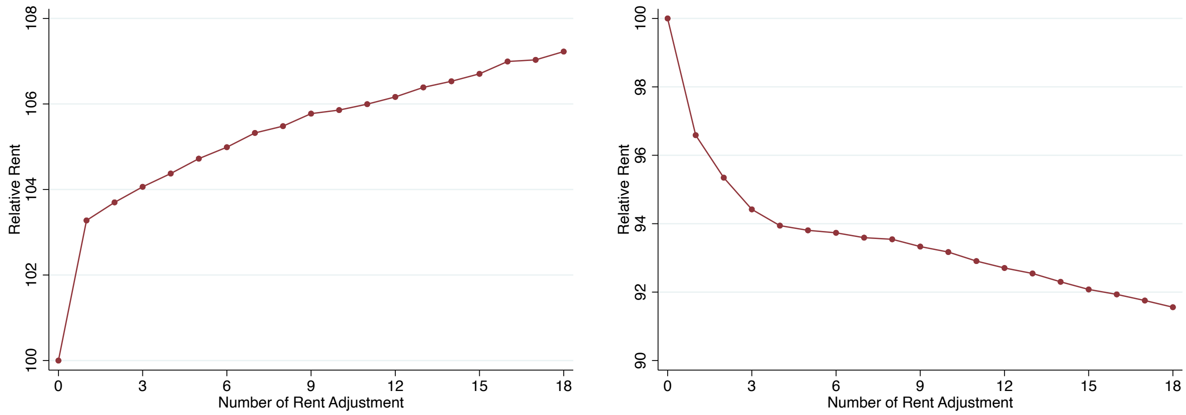
Figure C.4: Share of Properties on the Market and the Number of Listings per Property



(a) Share of Properties on the Market (b) Number of Listings per Property

Notes: Panel (a) of this figure computes the share of properties on the market for each month and plots it from July 2020 to December 2019. Panel (b) plots the distribution of the number of listings per property in the data exploited in this paper.

Figure C.5: Typical Rent Adjustment

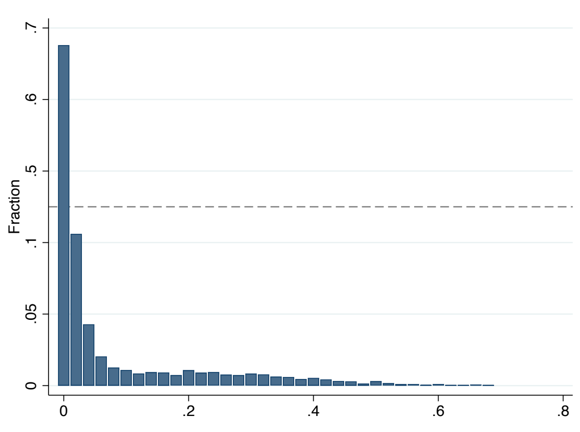


(a) Upward Adjustment

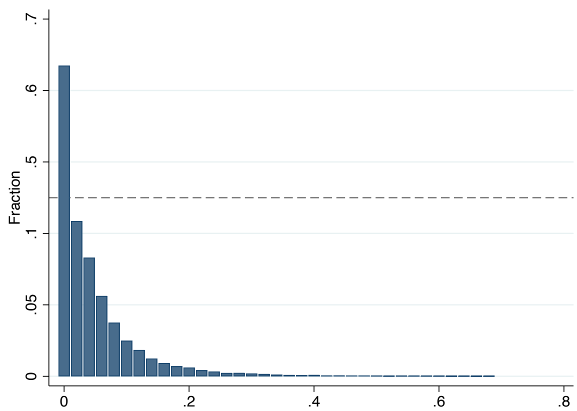
(b) Downward Adjustment

Notes: This figure divides properties into two groups, one that adjusts rents positively (Panel (a)) and the other that adjusts rents negatively (Panel (b)) while they are on the market, and illustrates the indexed mean rent against the number of price adjustments.

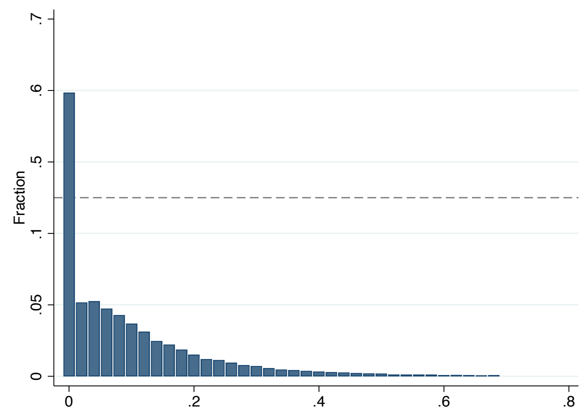
Figure C.6: Heterogeneity of On-Market Rent Adjustment across Property



(a) Frequency Measure



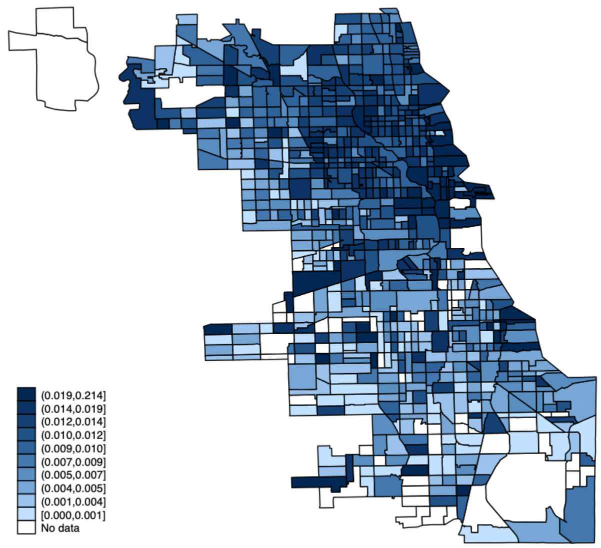
(b) Volatility Measure



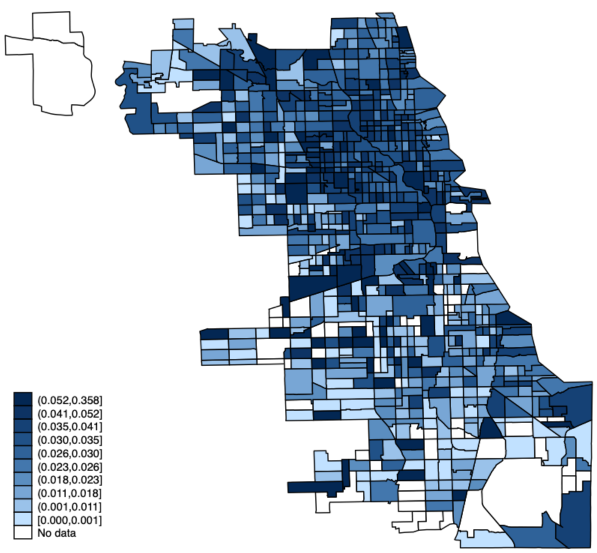
(c) Size Measure

Notes: This figure presents the distribution of rent flexibility measures defined in Section 3: frequency measures (Panel (a)), volatility measure (Panel (b)), and size measure (Panel (c)). Due to disproportional incidents near zero on the x-axis, histograms include a scale break between 0.1 and 0.5 on the y-axis and indicate it as a dotted grey line.

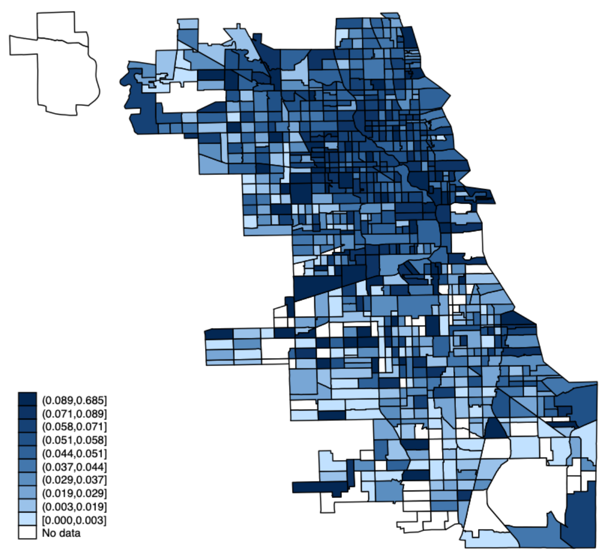
Figure C.7: Heterogeneity of On-Market Rent Adjustment across Geography



(a) Frequency Measure



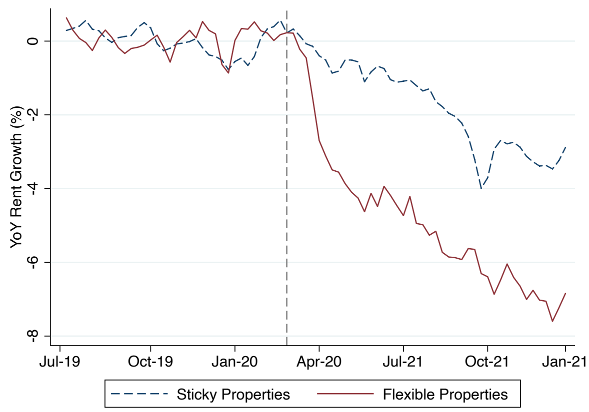
(b) Volatility Measure



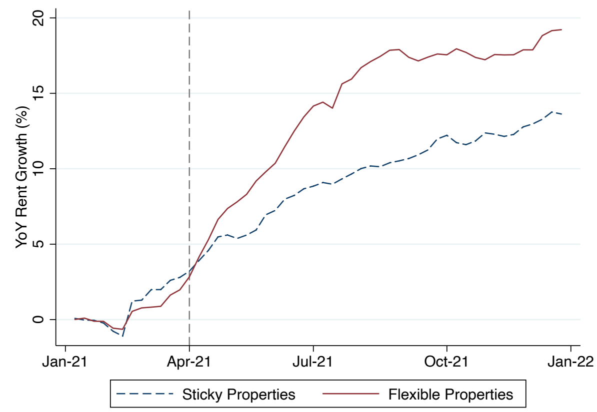
(c) Size Measure

Notes: This figure presents tract-level maps of Chicago for the mean value of rent flexibility measures defined in Section 3: frequency measures (Panel (a)), volatility measure (Panel (b)), and size measure (Panel (c)).

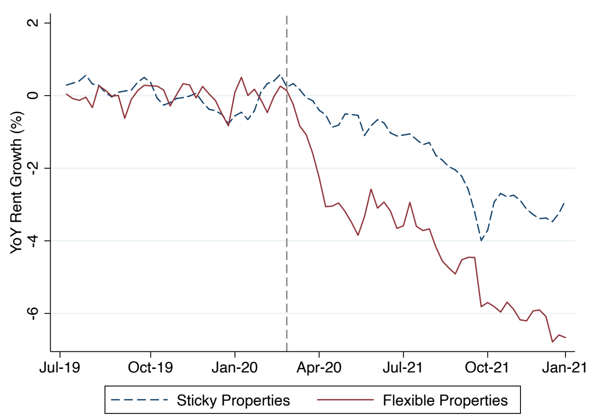
Figure C.8: Year-over-Year Rent Growth by Ex-Ante Rent Flexibility, Robustness



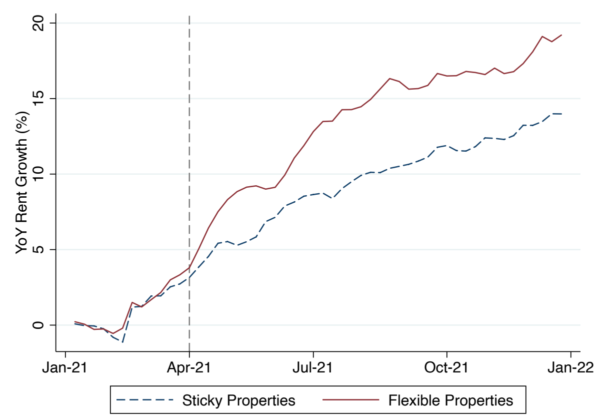
(a) Frequency Measure, Early Period



(b) Frequency Measure, Later Period



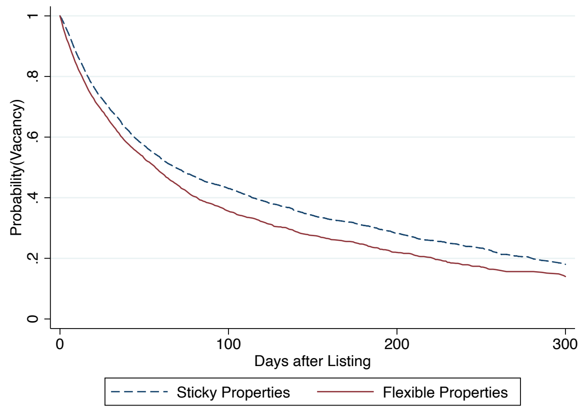
(c) Volatility Measure, Early Period



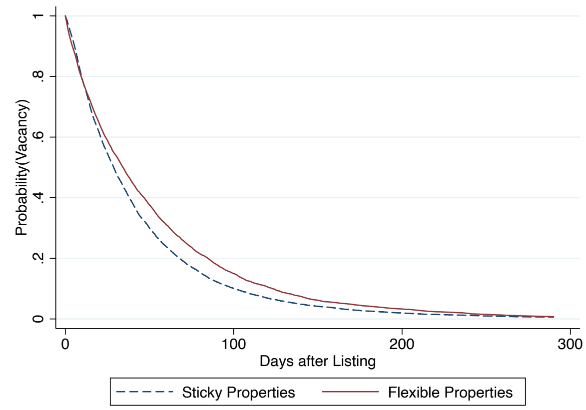
(d) Volatility Measure, Later Period

Notes: This figure plots the year-over-year rent growth from the Case-Shiller rent indexes for the two property groups: sticky (dashed blue line) and flexible (solid red line) properties. Sticky properties are defined as properties that never changed rents while on the market before December 2019. Flexible properties are those above the median value of the frequency (Panel (a) and (b)) and volatility (Panel (c) and (d)) rent-flexibility measure computed before December 2019. The rent indexes control for the SQFT and zipcode of the properties. The year-over-year rent growth is demeaned by the mean of the pre-period (i.e., the period left to the vertical dotted line in the figure).

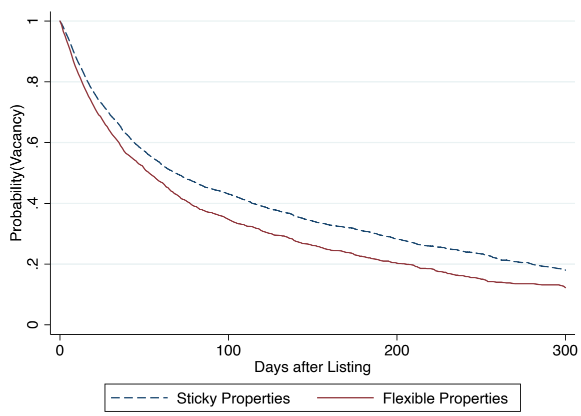
Figure C.9: Vacancy Status by Ex-Ante Rent Flexibility, Robustness



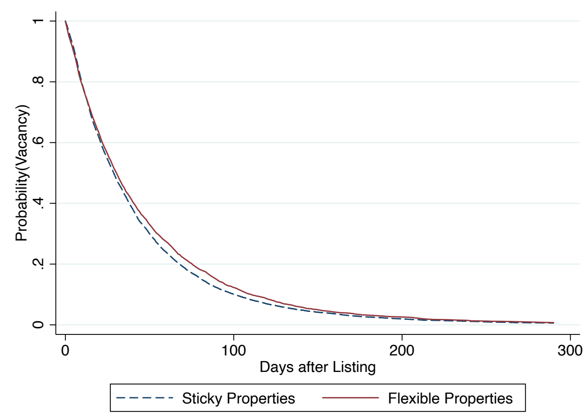
(a) Frequency Measure, Early Period



(b) Frequency Measure, Later Period



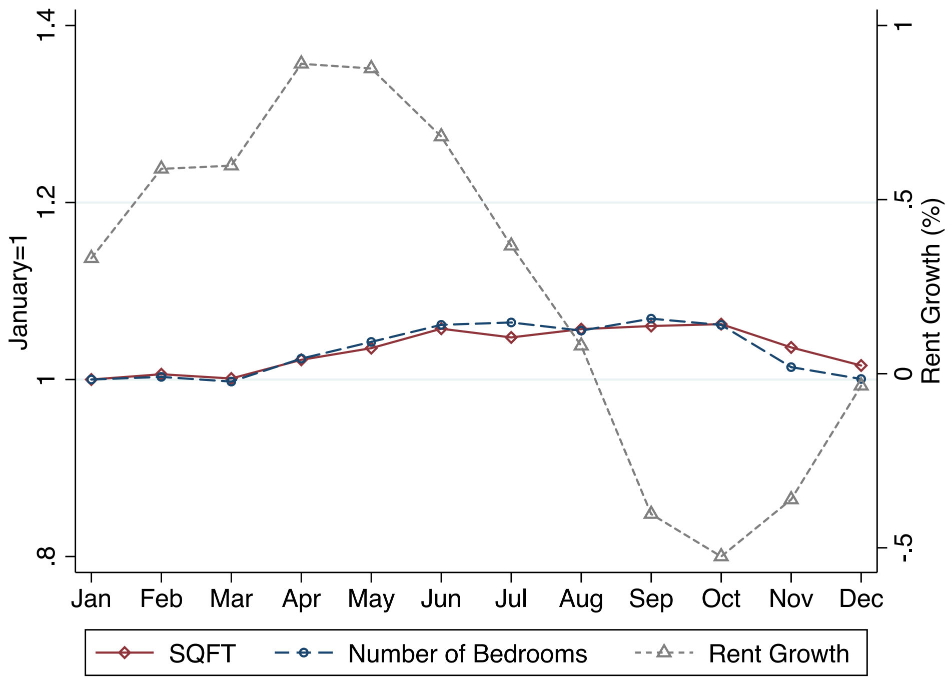
(c) Volatility Measure, Early Period



(d) Volatility Measure, Later Period

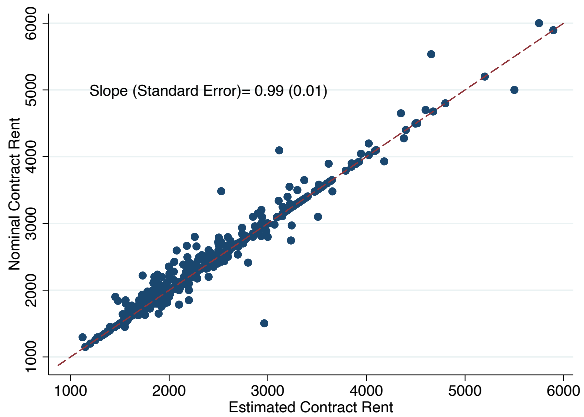
Notes: This figure uses the Kaplan-Meier methods to estimate the vacancy probability for sticky (dashed blue line) and flexible (solid red line) properties during the first (Panel (a)) and second (Panel (b)) years of the COVID-19 pandemic. The figure defines sticky properties as properties that never changed the on-market rents before December 2019. It defines flexible properties as properties above the median of the frequency (Panel (a) and (b)) and volatility (Panel (c) and (d)) rent-flexibility measures. The first year of the pandemic spans from March 2020 to March 2021, and the second year spans from March 2021 to March 2022. Properties are assumed to be rented out if they are off the market.

Figure C.10: Seasonality in Property Characteristics

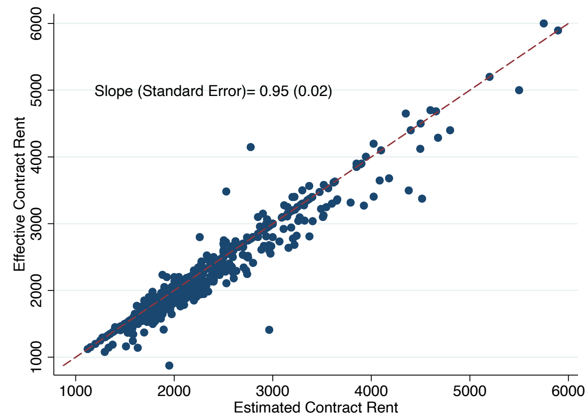


Notes: This figure plots the listed properties' mean SQFT (solid red) and number of bedrooms (dotted blue) for each month. Dotted grey line indicates the mean rent growth for each moth. All variables, except for the rent growth, are indexes as 1 in January.

Figure C.11: Actual Contract Rent vs Estimated Contract Rent



(a) Nominal Contract Rent



(b) Effective Contract Rent

Notes: This figure uses rental transaction data obtained from the data provider and compares actual contract rents to estimated contract rents. As actual contract rents, Panel (a) uses nominal contract rents, which do not include a promotional rent discount. Panel (b) uses effective contract rents, which subtract the promotional rent discounts from the nominal contract rents. Both panels indicate the identity line (i.e., $y = x$) as a dotted red line. Estimated contract rent is the last asking rent in each listing.

C.2 Table

Table C.1: Correlation between On-Market and Contract Rent Adjustment

	Dep. Var: Contract Rent Adjustment (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
On-Market Rent Adjustment (%)	0.7242***	0.7178***	0.7154***	0.7125***	0.7339***	0.7244***
	(0.0223)	(0.0235)	(0.0307)	(0.0317)	(0.0570)	(0.0604)
Constant	2.4469***		3.3320***		2.8352***	
	(0.0635)		(0.0802)		(0.1382)	
Term of the Previous Contract	All	All	$\geq$ 6 Months	$\geq$ 6 Months	1 Year	1 Year
Listing Month Pair FEs		Yes		Yes		Yes
Adjusted R^2	0.2651	0.2860	0.2759	0.2842	0.3841	0.3902
# Obs	23,768	23,768	16,066	16,066	5,272	5,272

Notes: This table restricts the sample to properties whose listings show up more than twice in the data and examines the correlation between contract rent adjustment and on-market rent adjustment. Columns (1) and (2) explore all the listings, and (3) and (4) restrict the sample to listings that show up at least six months after the previous listing. Columns (5) and (6) further reduce the sample to listings whose previous contract term is a year. Odd-numbered columns exploit no fixed effects, but even-numbered columns exploit listing month fixed effects constructed from the listing dates of the previous and following listings. Standard errors reported in parentheses are heteroskedasticity-robust standard errors. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively

Table C.2: Geographic Characteristics and Rent Flexibility

Indep. Variable:	$Income_z$		$House\ Price_z$		No. of $Establishment_z$		Homeownership $Rate_z$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var: Frequency $Measure_i$	-0.0383*	-0.0140	-0.0864	0.0422	-0.0040	0.0030	0.0402	0.0396
	(0.0201)	(0.0186)	(0.1116)	(0.0850)	(0.0473)	(0.0335)	(0.1768)	(0.1184)
Dep. Var: Volatility $Measure_i$	-0.0046	-0.0024	0.0281	0.0243	0.0270	0.0079	0.0640	0.0108
	(0.0072)	(0.0064)	(0.0448)	(0.0277)	(0.0197)	(0.0125)	(0.0724)	(0.0485)
Dep. Var: Size $Measure_i$	-0.0088	-0.0031	0.0267	0.0369	0.0348	0.0140	0.0868	0.0152
	(0.0111)	(0.0096)	(0.0647)	(0.0418)	(0.0275)	(0.0182)	(0.1009)	(0.0719)
Management Firm FEs	No	Yes	No	Yes	No	Yes	No	Yes
Listing Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	24,627	24,627	24,627	24,627	24,627	24,627	24,627	24,627

Notes: This table examines the correlation of rent flexibility measures with geographic characteristics. The left-hand-side variables are the flexibility measures defined in section 3: frequency measure in the first row, volatility measure in the second row, and size measure in the third row. The right-hand-side variables include zipcode-level income in 2018 obtained from the IRS, Zillow house price in June 2018, the total number of establishments in 2018 obtained from zipcode business pattern data, and the homeownership rate collected from the 2010 Census. All variables are standardized to facilitate comparison across the analysis. All columns exploit listing year-month fixed effects. columns (2), (4), (6), and (8) include management firm fixed effects. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.3: Correlation between Initial Rents and Rent Flexibility

	Dep. Var: Measures of Rent Flexibility$_i$, Standardized					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Initial Rent$_i$, Standardized	-0.0113	0.0022	0.0057	0.0058	0.0088	0.0100
	(0.0412)	(0.0084)	(0.0193)	(0.0083)	(0.0319)	(0.0077)
Building FEs	No	Yes	No	Yes	No	Yes
Listing Year-Month FEs	No	Yes	No	Yes	No	Yes
Adjusted R^2	0.0001	0.5727	0.0000	0.1028	0.0000	0.2097
# Obs	86,162	86,162	86,162	86,162	86,162	86,162

Notes: This table examines the correlation of the rent flexibility measures with the initial rent of each listing. The right-hand-side variable is the initial rent, and the left-hand-side variables are the flexibility measures defined in section 3:frequency measure in columns (1) and (2), volatility measure in columns (3) and (4), and size measure in columns (5) and (6). All the variables are standardized to facilitate comparison across the columns. Columns (1), (3), and (5) exploits no fixed effects, but columns (2), (4), and (6) include building fixed effects obtained from the street addresses of properties. Columns (2), (4), and (6) also include listing year-month fixed effects constructed from the first date of each listing. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.4: Correlation between Renovation Costs and Rent Flexibility

	Dep. Var: Total Cost for Renovation after March 2020 (in Million)					
	Frequency	Volatility	Size	Frequency	Volatility	Size
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	0.0004	0.0003	0.0006	0.0003	0.0001	0.0002
Standardized	(0.0007)	(0.0006)	(0.0007)	(0.0003)	(0.0003)	(0.0003)
Sample	All Permits	All Permits	All Permits	Renovation	Renovation	Renovation
Listing Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Zipcode FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.06863	0.06861	0.06865	0.02047	0.02042	0.02044
# Obs	15,285	15,285	15,285	15,285	15,285	15,285

Notes: This table examines the correlation of the rent flexibility measures with renovation costs during the COVID-19 pandemic. As the building permit is given at the building level, this table averages the rent-setting flexibility at the building level and report the correlation at the building level. The left-hand-side variable in Columns (1) through (3) is the total cost for renovation or maintenance since March 2020 and the left-hand-side variable in Columns (4) through (6) is the total cost only for a full renovation since March 2020. The right-hand-side variables in Columns (1) and (4), (2) and (5), and (3) and (6) are frequency, volatility, and size measures of rent-setting flexibility. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.5: Persistency of Rent Flexibility, Heckman Selection Correction

Panel A.	Dep. Var: Rent Flexibility during the N'th Listing					
	Frequency		Volatility		Size	
	N=2	N=3	N=2	N=3	N=2	N=3
	(1)	(2)	(3)	(4)	(5)	(6)
Rent Flexibility during the First Listing	0.5684***	0.5005***	0.1776***	0.1808***	0.2996***	0.3013***
	(0.0082)	(0.0210)	(0.0105)	(0.0339)	(0.0103)	(0.0310)
Listing Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	74,132	74,132	74,132	74,132	74,132	74,132
Panel B.	Dep. Var: Rent Flexibility for N Days					
	Frequency		Volatility		Size	
	31-60 Days	61-90 Days	31-60 Days	61-90 Days	31-60 Days	61-90 Days
	(1)	(2)	(3)	(4)	(5)	(6)
Rent Flexibility during the First 30 Days	0.7596***	0.6793***	0.2427***	0.2434***	0.4127***	0.4244***
	(0.0066)	(0.0094)	(0.0088)	(0.0115)	(0.0088)	(0.0113)
Listing Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	17,839	17,839	17,839	17,839	17,839	17,839

Notes: This table revisits Table B.3 and examines the persistency of rent flexibility across (Panel A) and within (Panel B) the listing by estimating Heckman's selection model with the selection equation: $Rent_i + \alpha_z + \nu_{iz} > 0$ where i indicates the property, $Rent_i$ and α_z represent the mean asking rent and zipcode fixed effects, respectively. Panel A computes rent flexibilities during the first, second, and third listings and compares rent flexibility during the first listing to rent flexibilities during the second and third listings. All columns in Panel A include listing-month pair fixed effects constructed from each listing's first listing date. Panel B computes rent-flexibility measures for the first, following, and next 30 days and examines the correlation of the former with the next two. All columns in Panel B include listing-month fixed effects. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.6: Implication of Rent Flexibility for Rent Growth, Heckman Selection Correction

Panel A.	Dep. Var: Rent Growth$_i$ (%) during the Pandemic before March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	-1.5023***	-1.1740***	-0.5453***	-0.2765***	-0.9214***	-0.5641***
Standardized	(0.0814)	(0.0965)	(0.0969)	(0.1027)	(0.0928)	(0.1016)
Tract FEs	No	Yes	No	Yes	No	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	74,132	72,061	74,132	72,061	74,132	72,061
Panel B.	Dep. Var: Rent Growth$_i$ (%) during the Pandemic after March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility,	1.9736***	1.7145***	1.1443***	0.8393***	1.5968***	1.2497***
Standardized	(0.1505)	(0.1800)	(0.1887)	(0.2070)	(0.1788)	(0.2005)
Tract FEs	No	Yes	No	Yes	No	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
# Obs	74,132	72,866	74,132	72,866	74,132	72,866

Notes: This table revisits Table B.6 and examine the implication of ex-ante rent flexibility for rent growth during the COVID-19 pandemic by estimating Heckman's selection model with the selection equation: $Rent_i + \alpha_z + \nu_{iz} > 0$ where i indicates the property, $Rent_i$ and α_z represent the mean asking rent and zipcode fixed effects, respectively. As the left-hand-side variables, Panel A uses the properties' rent growth during the pandemic before March 2021, defined as the annualized log difference between rent observed before March 2020 and rent observed between March 2020 and Feb 2021. Panel B uses the rent growth from March 2021 to the end of the sample period, defined as the annualized log difference between rent observed between March 2020 and Feb 2021 and rent witnessed after Feb 2021 until the end of the sample period. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures before December 2019. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the first dates of the period in which rent flexibility and growth are computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.7: Implication of Rent Flexibility for Rent Growth, Alternative Measures

Panel A.	Dep. Var: Rent Growth (%) during the Pandemic before March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility for the First 30 Days, Standardized	-1.3999***	-0.9497***	-0.5559**	-0.4303*	-0.9616***	-0.6815**
	(0.2607)	(0.2796)	(0.2453)	(0.2388)	(0.2704)	(0.2676)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2 0.04586	0.06533	0.03243	0.06014	0.03654	0.06195	
# Obs	8,902	8,902	8,902	8,902	8,902	8,902
Panel B.	Dep. Var: Rent Growth (%) during the Pandemic after March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility for the First 30 Days, Standardized	2.7675***	2.5006***	1.1416***	0.9679***	1.8568***	1.5908***
	(0.3259)	(0.3732)	(0.3621)	(0.3547)	(0.2876)	(0.3111)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.1039	0.1166	0.08435	0.1021	0.08935	0.1057
# Obs	5,694	5,694	5,694	5,694	5,694	5,694

Notes: This table estimates the following specification to examine the implication of ex-ante rent flexibility for rent growth during the COVID-19 pandemic: $\textit{Rent Growth}_i = \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i$ As the left-hand-side variables, Panel A uses the properties' rent growth during the pandemic before March 2021, defined as the annualized log difference between rent observed before March 2020 and rent observed between March 2020 and Feb 2021. Panel B uses the rent growth from March 2021 to the end of the sample period, defined as the annualized log difference between rent observed between March 2020 and Feb 2021 and rent witnessed after Feb 2021 until the end of the sample period. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures. The table computes the flexibility measures based on rent-adjustment behaviors for the first 30 days of listings. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the first dates of the period in which rent flexibility and growth are computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.8: Implication of Rent Flexibility for Vacancy, Alternative Measures

Panel A.	Sample: Properties listed between Mar 2020 and Mar 2021 Dep. Var: Dummy variable$_i$ indicating vacancy until Mar 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility for the First 30 Days, Standardized	-0.0126*	-0.0188***	-0.0190***	-0.0136**	-0.0188***	-0.0171***
	(0.0074)	(0.0068)	(0.0060)	(0.0061)	(0.0059)	(0.0060)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	-103.8	97.1	188.8	130.6	94.4	130.4
Psuedo R^2	0.2790	0.3145	0.2796	0.3136	0.2797	0.3141
# Obs	6,304	6,304	6,304	6,304	6,304	6,304
Panel B.	Sample: Properties listed between Mar 2021 and Mar 2022 Dep. Var: Dummy variable$_i$ indicating vacancy until Mar 2022					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect from Ex-Ante Rent Flexibility for the First 30 Days, Standardized	0.0100**	0.0069	-0.0052	-0.0058	-0.0008	-0.0030
	(0.0049)	(0.0056)	(0.0041)	(0.0039)	(0.0047)	(0.0047)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Profit Gain from Flexible Rent Setting (in dollar)	582.9	544.0	313.5	276.5	450.8	404.1
Psuedo R^2	0.3378	0.3549	0.3370	0.3547	0.3368	0.3545
# Obs	4,596	4,596	4,596	4,596	4,596	4,596

Notes: This table estimates the logit model to examine the implication of ex-ante rent flexibility for vacancy during the COVID-19 pandemic. As the left-hand-side variables, Panel A uses a log odds constructed from an indicator variable for the vacant properties listed between March 2020 and March 2021. Panel B uses a log odds constructed from an indicator variable for the vacant properties listed between March 2021 and March 2022. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures based on rent-adjustment behaviors for the first 30 days of listings. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the listing date and the first dates of the period in which rent flexibility is computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.9: Promotional Rent Discount and Rent-Setting Flexibility

	Dep. Var: Percentage Rent Discount$_i$ (%)					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-Ante Rent Flexibility, Standardized	-0.0343 (0.1299)	-0.0971 (0.1502)	0.0071 (0.1215)	-0.0586 (0.1082)	0.0352 (0.1178)	-0.0276 (0.0956)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Year-Month FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.2911	0.3046	0.2910	0.3044	0.2911	0.3043
# Obs	1,029	1,029	1,029	1,029	1,029	1,029

Notes: This table estimates the following specification to examine the correlation between promotional rent discounts and ex-ante rent-setting flexibility: $\textit{Percentage Rent Discount}_i = \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i$ As the left-hand-side variables, all columns use the percentage rent discounts defined as promotional rent discount divided by nominal contract rent. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures, respectively. The table computes the flexibility measures before December 2019. All columns include the year-month fixed effects α_t constructed from the contract dates. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

Table C.10: Implication of Rent Flexibility on Rent Growth Using Estimated Contract Rent

Panel A.	Dep. Var: Rent Growth (%) during the Pandemic before March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-ante Rent Flexibility,	-1.3464***	-0.8116***	-0.2437**	-0.0507	-0.5819***	-0.2436**
Standardized	(0.1108)	(0.1061)	(0.1204)	(0.1009)	(0.1399)	(0.1164)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.2185	0.2602	0.1881	0.2507	0.1924	0.2516
# Obs	7,362	7,362	7,362	7,362	7,362	7,362
Panel B.	Dep. Var: Rent Growth (%) during the Pandemic after March 2021					
	Frequency		Volatility		Size	
	(1)	(2)	(3)	(4)	(5)	(6)
Ex-ante Rent Flexibility,	1.5597***	1.1597***	0.8529***	0.6369***	1.2146***	0.9013***
Standardized	(0.1689)	(0.1985)	(0.1780)	(0.1794)	(0.1909)	(0.1846)
Zipcode FEs	No	Yes	No	Yes	No	Yes
Rent Ventile FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.1320	0.1531	0.1057	0.1413	0.1148	0.1459
# Obs	3,738	3,738	3,738	3,738	3,738	3,738

Notes: This table estimates the following specification to examine the implication of ex-ante rent flexibility for rent growth during the COVID-19 pandemic: $\textit{Rent Growth}_i = \textit{Ex-Ante Rent Flexibility}_i + \alpha_t + \alpha_r + \alpha_z + \varepsilon_i$ As the left-hand-side variables, Panel A uses the properties' rent growth during the pandemic before March 2021, defined as the annualized log difference between the estimated contract rent observed before March 2020 and the estimated contract rent observed between March 2020 and Feb 2021. Panel B uses the rent growth from March 2021 to the end of the sample period, defined as the annualized log difference between the estimated contract rent observed between March 2020 and Feb 2021 and the estimated contract rent witnessed after Feb 2021 until the end of the sample period. The estimated contract rent is defined as the last asking rent in each listing. As the right-hand-side variables, columns (1) and (2), (3) and (4), and (5) and (6) use frequency, volatility, and size rent-flexibility measures. The table computes the flexibility measures based on rent-adjustment behaviors for the first 30 days of listings. All columns include rent ventile α_r and the pair of year-month fixed effects α_t constructed from the first dates of the period in which rent flexibility and growth are computed. Columns (2), (4) and (6) include zipcode fixed effects α_z. Standard errors reported in parentheses are clustered at the zipcode level. *, **, and *** indicate statistical significance at 10, 5, and 1 percent levels, respectively.

C.3 Profit Gain/Loss from Flexible Rent Settings

Assuming that the days to be rented t follows an exponential distribution, its C.D.F and the hazard rate can be written as

$$F(t) = 1 - e^{-\lambda t} \Leftrightarrow \lambda = -\frac{1}{t} \cdot ln(1 - F(t)).$$

Then, the implied expected days on the market is

$$\frac{1}{\lambda}.$$

Based on the estimated probability of being rented, 0.42 (0.50), by the median days on the market, 47 (29) days, during the early (later) period of the pandemic (Figure A.5), this means that the implied days on the market for the sticky properties are

$$\frac{1}{\lambda_{sticky,early}} = \frac{1}{-\frac{1}{47} \cdot ln(1 - 0.42)} = 88 \ days$$

and

$$\frac{1}{\lambda_{sticky,later}} = \frac{1}{-\frac{1}{29} \cdot ln(1 - 0.50)} = 42 \ days$$

for the early and later period of the pandemic, respectively.

On the other hand, for the average property whose monthly rent is R, profit loss from rent discount D (%) for a typical 12-month rental contract is

$$R \cdot \left(1 - \frac{D}{100}\right) \cdot 12 \tag{C.1}$$

and profit gain from shortened days on the market for the flexible rent setting is

$$R \cdot \left(\frac{12}{365}\right) \cdot \left(\frac{1}{\lambda_{sticky}} - \frac{1}{\lambda_{flexible}}\right). \tag{C.2}$$

Finally, using the median rent for the early (later) period of the pandemic, \$1,875 (\$1,995), the estimated rent discount or increase for flexible properties in Table B.6, and the estimated difference in vacancy rate for flexible properties in Table B.7, profit loss from the rent discount (C.1) and profit gain from the shortened days on the market (C.2) can be computed. Then, the profit gain or loss is determined by the difference between (C.1) and (C.2).

REFERENCES

Marcus T. Allen, Ronald C. Rutherford, and Thomas A. Thomson. "residential asking rents and time on the market". *Journal of Real Estate Finance and Economics*, 38:351–365, 2007.

Fernando Alvarez, Martin Beraja, Martín Gonzalez-Rozada, and Pablo Andrés Neumeyer. "from hyperinflation to stable prices: Argentina's evidence on menu cost models". *Quarterly Journal of Economics*, 134(1):451–505, 2018.

Eric T. Anderson and Duncan I. Simester. "price stickiness and customer antagonism". *Quarterly Journal of Economics*, 125(2):729–765, 2010.

Susan Athey, Kyle Bagwell, and Chris Sanchirico. "collusion and price rigidity". *Review of Economic Studies*, 71:317–349, 2004.

Patrick Augustin, Linxiao F. Cong, Alexandre Corhay, and Michael Weber. "price rigidities and credit risk". *Working Paper*, 2021.

David Autor, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen. "the fall of the labor share and the rise of superstar firms". *Quarterly Journal of Economics*, 135(2):645–709, 2020.

Simcha Barkai. "declining labor and capital structure". *Journal of Finance*, 75(5):2421–2463, 2020.

Kyle Barron, Edward Kung, and Davide Proserpio. "the effect of home-sharing on house prices and rents: Evidence from airbnb". *Marketing Science*, 40(1):23–47, 2021.

Robert B. Barsky, Christopher L. House, and Miles S. Kimball. "sticky-price models and durable goods". *American Economic Review*, 97(3):984–998, 2007.

Mark Bils and Peter J. Klenow. "some evidence on the importance of sticky prices". *Journal of Political Economy*, 112(5):947–985, 2004.

Guillermo A. Calvo. "staggered prices in a utility-maximizing framework". *Journal of Monetary Economics*, 12(3):383–398, 1983.

Andrew S. Caplin and Daniel F. Spulber. "menu cost and the neutrality of money". *Quaterly Journal of Economics*, 102(4):703–726, 1987.

Carlos Carvalho. "heterogeneity in price stickiness and the real effects of monetary shocks". *Frontiers of Macroeconomics*, 2(1):1–56, 2006.

Karl Case and Robert Shiller. "prices of single-family homes since 1970: New indexes for four cities". *New England Economic Review*, pages 45–56, 1987.

Alberto Cavallo. "scraped data and sticky prices". *Review of Economics and Statistics*, 2016.

Alberto Cavallo. “are online and office prices similar? evidence from large multi-channel retailers.”. *American Economic Review*, 107(1):283–303, 2017.

Edward Chamberlin. “the theory of monopolistic competition”. *Harvard University Press*, 1933.

David Chambers, Christophe Spaenjers, and Eva Steiner. “the rate of return on real estate: Long-run micro-level evidence”. *Review of Financial Studies*, 34:3572–3607, 2021.

Nuno Clara. “demand elasticities, nominal rigidities and asset prices”. *Working Paper*, 2019.

John B. Clark and John M. Clark. “the control of trusts”. *Palala Press*, 1902.

Francesco D’Acunto, Ryan Liu, and Michael Weber. “flexible prices and leverage”. *Journal of Financial Economics*, 129(1):46–68, 2018.

Jan De Leocker, Jan Eechout, and Gabriel Unger. “the rise of market power and the macroeconomic implications”. *Quarterly Journal of Economics*, 135(2):561–644, 2020.

Andrew Demers and Andrea L. Eisfeldt. “total returns to single-family rentals”. *Real Estate Economics*, 50(1):7–32, 2022.

Rebecca Diamond, Tim McQuade, and Franklin Qian. “the effects of rent control expansion on tenants, landlords, and inequality: Evidence from san francisco ”. *American Economic Review*, 199(9):3365–3394, 2019.

Itamar Drechsler, Alexi Savov, and Philipp Schnabl. “the deposit channel of monetary policy”. *Quarterly Journal of Economics*, 132(4):1819–1876, 2017.

Piet Eichholtz, Matthijs Korevaar, Thies Lindenthal, and Ronan Tallec. “the total return and risk to residential real estate”. *Review of Financial Studies*, pages 3608–3646, 2021.

Etienne Gagnon. “price setting during low and high inflation: Evidence from mexico”. *Quarterly Journal of Economics*, 124(3):1221–1263, 2009.

David Genesove. “the nominal rigidity of apartment rents”. *Review of Economics and Statistics*, 85(4):844–853, 2003.

Marco Giacoletti and Christopher A. Parsons. “peak-bust rental spread”. *Journal of Financial Economics*, 143(1):504–526, 2022.

Mikhail Golosov and Robert E. Lucas. “menu costs and pillips curves”. *Journal of Political Economy*, 115(2):171–199, 2007.

Joao Gomes, Urban Jermann, and Lukas Schmid. “sticky leverage”. *American Economic Review*, 106(12):3800–3828, 2016.

Yuriy Gorodnichenko and Michael Weber. “are sticky prices costly? evidence from the stock market”. *American Economic Review*, 106(1):165–199, 2016.

John Grigsby, Erik Hurst, and Ahu Yildirmaz. “aggregage nominal wage adjustments: New evidence from administrative payroll data”. *American Economic Review*, 111(2):427–471, 2021.

Arpit Gupta, Vrinda Mittal, Jonas Peeters, and Stijin Van Nieuwerburgh. “flattening the curve: Pandemic-induced revaluation of urban real estate”. *Journal of Financial Economics*, pages 1–43, 2021.

Umit G. Gurun, Jiabin Wu, Steven Chong Xiao, and Serena Wenjing Xiao. “do wall street landlords undermine renter’ welfare?”. *Review of Financial Studies*, pages 1–52, 2022.

Óascar Jordá, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, and Taylor M. Alan. “the rate of return on everything, 1870-2015”. *Quarterly Journal of Economics*, 134(3): 1225–1298, 2019.

Alan K. Kackmeister. “has retail price behavior changed since 1889? evidence from microdata”. *Working Paper*, 2002.

Daniel Levy, Mark Bergen, Shantanu Dutta, and Robert Venable. “the magnitude of menu costs: Direct evidence from large us supermarket chains”. *Quarterly Journal of Economics*, 112(3):791–825, 1997.

Edward Mason. “price and production policies of large-scale enterprise”. *American Economic Review*, 29(1):61–74, 1939.

Raven Molloy, Charles Nathanson, and Andrew Paciorek. “housing supply and affordability: Evidence from rents, housing consumption and housing location”. *Journal of Urban Economics*, 129:1–21, 2022.

Emi Nakamura and Jón Steinsson. “five facts about prices: A reevaluation of menu cost models”. *The Quarterly Journal of Economics*, 123(4):1415–1464, 2008.

Emi Nakamura and Jón Steinsson. “monetary non-neutrality in a multisector menu cost model”. *Quarterly Journal of Economics*, 125(3):961–1013, 2010.

David Neumark and Steven A. Sharpe. “market structure and the nature of price rigidity: Evidence from the market for consumer deposits”. *Quarterly Journal of Economics*, 107 (2):657–680, 1992.

L. Rachel Ngai and Silvana Tenreyro. “hot and cold seasons in the housing market”. *American Economic Review*, 104(12):3991–4026, 2014.

Giovanni Olivei and Silvana Tenreyro. “the timing of monetary policy shocks”. *American Economic Review*, 97(3):636–663, 2007.

Jolio J. Rotemberg. “monopolistic price adjustment and aggregate output”. *Review of Economic Studies*, 49(4):517–531, 1982.

Chihiro Shimizu, Kiyohiko G. Nishimura, and Tsutomu Watanabe. “residential rents and price rigidity: Micro structure and macro consequence”. *Journal of the Japanse and International Economies*, 24(2):282–299, 2010.

John B. Taylor. “aggregate dynamics and staggered contracts”. *Journal of Political Economy*, 88(1):1–23, 1980.

Michael Weber. “nominal rigidities and asset pricing”. *Journal of Political Economy,*, Revise and Resubmit, 2015.