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CRE Redevelopment Options and the Use of Mortgage Financing*

David Glancy[†] Robert Kurtzman[‡] Lara Loewenstein[§]

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Abstract

A significant share of commercial real estate (CRE) investment properties—about half by our estimates—are purchased without a mortgage. Using comprehensive microdata on transactions in the US CRE market, we analyze which types of properties are purchased without a mortgage, highlighting the important role of renovation or redevelopment options. We show that mortgage-financed properties are less likely to be subsequently redeveloped, and that owners anticipate these redevelopment frictions and avoid mortgage financing for properties with greater redevelopment options. These effects were even stronger during the COVID-19 pandemic, when uncertainty increased redevelopment option values.

Keywords: commercial real estate, cash buyers, redevelopment

JEL Classification: G21, G22, G23, R33

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[†]Federal Reserve Board of Governors, Division of Monetary Affairs, 20th Street and Constitution Ave. NW, Washington, D.C. 20551; email: david.p.glancy@frb.gov.

[‡]Federal Reserve Board of Governors, Division of Research and Statistics, 20th Street and Constitution Ave. NW, Washington, D.C. 20551; email: robert.j.kurtzman@frb.gov.

[§]Federal Reserve Bank of Cleveland, 1455 East 6th Street, Cleveland, OH 44114; email: lara.loewenstein@clev.frb.org.

1. INTRODUCTION

There is substantial evidence that collateral plays an important role in mitigating financial frictions (Hart and Moore, 1994). Real estate is especially well suited for use as collateral for loans, given it depreciates slowly (Rajan and Winton, 1995) and is relatively redeployable (Benmelech et al., 2005). Indeed, the commercial real estate (CRE) industry is generally known for operating with high leverage (Giacomini et al., 2017; Glancy et al., 2022). However, the use of collateral varies drastically across properties; about half of CRE transactions have no mortgages associated with them, well above the share of residential real estate (RRE) transactions without a mortgage (Han and Hong, 2020). CRE is also a less levered asset in aggregate, with CRE-secured debt estimated to be about 15 percent of the value of CRE assets (compared with 28 percent for RRE).[1]

Why do so many CRE investors purchase properties without a mortgage? The literature has broadly emphasized the desire to maintain financial flexibility as motivating unsecured borrowing (Benmelech et al., 2024). Another potential reason more specific to CRE is to maintain flexibility with regard to property operations and investment. Mortgage debt can inhibit investment for several reasons. Perhaps most importantly, loan contracts frequently prohibit borrowers from engaging in material alterations without the lender's consent and prohibit borrowers from taking out additional loans to cover the costs of alterations (Mann, 1997). Additionally, debt overhang considerations may discourage investors from engaging in costly investments whose benefits would partially accrue to debt holders (Correa et al., 2022; DeFusco et al., 2023), and debt service costs may introduce financial constraints that prevent property owners from undertaking profitable investments (Seltzer, 2021). Understanding investor renovation and redevelopment decisions is especially relevant today, as transitioning office properties to alternative uses could alleviate strains due to oversupply in that market (Gupta et al., 2023).

In this paper, we study how financing decisions affect redevelopment options using comprehensive

[1]Estimates are from 2023:Q3 data reported in the Financial Accounts of the United States. See Figure A1 in the appendix for time-series versions of these measures and for details on the data construction.

microdata on US CRE transactions. We provide theoretical and empirical evidence that an important motivation for leaving a property unencumbered is to maintain the value of the redevelopment option on the property. To guide our empirical analysis, we establish a simple theoretical framework where aging properties have the option to be redeveloped at a cost. Property owners choose whether to finance a property with a mortgage, trading off the benefit of secured financing against the higher cost of renovation that the mortgage creates. The model shows that older and less productive properties—that is, those that have low cash flow relative to a newly built property—have more valuable redevelopment options and are thus (1) more likely to be purchased for immediate redevelopment and (2) less likely to be mortgage financed.

Guided by our theoretical framework, we construct estimates of redevelopment option values for the properties in our sample. We show empirically that older, less productive properties are more likely to be purchased for redevelopment or renovation. The fitted values from this analysis—namely, the estimated probability of alteration—map directly into option values for properties that are not purchased for immediate redevelopment. These estimated redevelopment options, based on property age and quality, form the foundation of our analysis for how such options affect financing decisions.

Using our property-level estimates of redevelopment option values, we show that owners indeed strategically decide whether to use mortgage financing for property purchases with renovation options in mind. We identify this effect using an approach in the spirit of a difference-in-differences exercise: we estimate whether buyers use mortgage financing based on the estimated redevelopment option and the purchaser's experience in renovation or construction activity (reflecting a specific owner's competence at undertaking a renovation project). Buyers without development experience serve as a control for property-specific factors affecting the availability of debt (e.g., lenders being hesitant to lend against questionable collateral), and the inclusion of buyer fixed effects accounts for cross-borrower differences in financing needs or broad credit availability. Consequently, the effect we identify should capture the extent to which a borrower's desire to preserve the renovation option value affects financing decisions.

Finally, we present two pieces of additional evidence in favor of redevelopment options affecting financing choices. First, we show directly that when properties are not mortgage financed, they are more likely to be subsequently renovated or improved. Second, we show that we get similar findings when we use the COVID-19 pandemic as an alternative source of variation in redevelopment options. By virtue of producing significant uncertainty and inducing a flight to higher-quality properties, the pandemic plausibly increased the share of property values attributable to redevelopment options, particularly for office properties. Consistent with this idea, we show that buyers reduced their usage of mortgage financing for offices and for older or lower-quality properties during the pandemic.

The paper most closely related to our own is that of Loewenstein et al. (2021), who show that mortgaged properties are less likely to be redeployed to a new use. We add to this work in two ways. First, we demonstrate that the presence of mortgage debt not only inhibits redeployment across property types, but also affects smaller renovations and property improvements. Second, we analyze how frictions to renovation affect investors' ex-ante financing decisions.

In addition, we make contributions to three strands of the literature. First, we provide a broad summary of patterns regarding the characteristics of properties that are and are not mortgage financed. While there is much work analyzing "all cash" purchases in the residential real estate market (see, for example, Han and Hong (2020) and Reher and Valkanov (forthcoming)), there is significantly less work on this topic with regard to commercial properties. Conklin et al. (2018) also use transaction-level data to study buyers' decision to take out a mortgage; however, their sample is composed entirely of real estate investment trusts (REITs), which we show differ markedly from other buyers in terms of their usage of mortgage financing.[2] Consequently, we provide a more comprehensive overview of patterns with respect to mortgage usage across different types of

[2]REITs are about half as likely as other borrowers to purchase properties with mortgage debt. This difference could reflect a greater availability of other funding sources or the need for greater financial flexibility in light of REITs' limited ability to retain net income.

CRE-owning entities.

Second, we contribute to a broad literature on the benefits of collateral. The existing work demonstrates that pledging collateral (or higher-quality collateral) can reduce borrowing costs (Benmelech et al., 2022; Luck and Santos, 2023), alleviate credit rationing (Stiglitz and Weiss, 1981), mitigate information asymmetries (Boot et al., 1991), and increase borrowing capacity (Benmelech et al., 2005; Cerqueiro et al., 2016). Nonetheless, the usage of secured debt has been declining over time (Benmelech et al., 2024), arguably, in part, because of borrowers' desire to maintain flexibility in the usage of their assets. In the CRE literature, unencumbered CRE assets have been shown to provide property investors a source of liquidity via potential asset sales or future secured borrowing (Conklin et al., 2018; Campello et al., 2022; Demirci et al., 2023). However, unsecured lending generally comes with covenants that may limit overall debt capacity (Giambona et al., 2018; Riddiough and Steiner, 2020). We contribute to this literature by analyzing how secured financing affects operational flexibility for individual properties. We find that unsecured financing helps firms avoid restrictions from repositioning properties.[3]

Third, we contribute to the literature on CRE redevelopment. Munneke and Womack (2020) and Buchler et al. (2023) use information on the likelihood of redevelopment to estimate the value of redevelopment options. In a similar spirit, we use information on the likelihood of financing a purchase with a mortgage for properties with different redevelopment options to infer the extent to which secured financing hinders the value of the redevelopment option. Understanding these frictions to redevelopment are especially salient now, given that shifts in real estate markets prompted by the pandemic have likely dramatically changed the best use of space (Gupta et al., 2023).

The remainder of the paper proceeds as follows: in Section 2, we describe the data and provide descriptive statistics regarding which transactions are mortgage financed. In Section 3, we present a simple model of how redevelopment options affect financing decisions. In Section 4, we describe

[3] This result is also consistent with Mann (1997), who presents anecdotal evidence that concerns over the loss of operational flexibility can motivate unsecured borrowing, and the model of Rampini and Viswanathan (2020), which postulates a reduced-from cost of secured financing that counterbalances the greater debt capacity that comes from secured financing.

our empirical approach and primary findings. In Section 5, we conclude.

2. DATA AND DESCRIPTIVE ANALYSIS

2.1. Data

Our primary data source comes from MSCI Real Capital Analytics (RCA). The database provides information on property and loan characteristics for CRE transactions since 2001 for properties above $2.5 million in value. RCA sources information on mortgages from public records data, public filings, and industry contacts.

A few features make these data particularly well suited to the current study. First, RCA identifies the "true buyer" in the transaction, thus allowing us to know the actual entity acquiring a property rather than the subsidiary. This feature allows us to better analyze whether the acquiring company had experience engaging in renovation or redevelopment projects. Second, the data include a quality score (Q-Score), reflecting the price per square foot of a property relative to peer properties. A low Q-Score indicates a lower value relative to what could likely be achieved after renovation and thus is indicative that more of the value of the property comes from the redevelopment option.[4]

Third, the data link properties over time. Consequently, we can observe the characteristics of properties and loans that are associated with future renovation and redevelopment decisions. This information allows us to understand the property-level factors that influence the likelihood of redevelopment and study how the existence of property-level debt complicates that redevelopment.

We identify transactions that are not mortgage financed (colloquially referred to as "cash purchases") as those without any loan or lender information. This approach would misclassify some mortgaged purchases as cash transactions if RCA was not able to obtain any information on the mortgage loan or lender or if it was unable to provide that information in its data. However, we

[4]See Cvijanovic et al. (2022) for a more detailed description of RCA's Q-Score measure as well as a validation of RCA's coverage and identification of true buyers based on REIT disclosures.

believe that this source of misidentification is small for two reasons. First, mortgages are public records; so while information about some loan terms or property characteristics might be unavailable, whether there is a mortgage associated with a property should be reliably available. It is relevant to note that our analysis only requires information on whether a mortgage exists, not any specific loan terms. The public records should, in theory, be a comprehensive and complete record of all liens on real property. While a lender could make a mortgage loan without recording it in a public registry, doing so would significantly impair its ability to recoup any losses upon foreclosure because the lack of a public filing would mean that other parties or creditors would not have to respect the priority of the lender's lien.[5]

Second, we verify that the share of cash transactions is consistent with two other data sources. Appendix Figure A1 shows that the ratio of CRE debt to the current market value of CRE assets in the US averages about 17 percent. This current leverage ratio is about aligned with what would be expected given the cash shares estimated in this paper, combined with normal underwriting terms.[6] Additionally, Appendix Figure A2 shows that cash shares for institutional investors are similar in both RCA data and data from the National Council of Real Estate Investment Fiduciaries (NCREIF). As NCREIF provides more uniform reporting of property-level debt than RCA, this fact gives us confidence in RCA's coverage of loan and lender information.[7]

Our main sample is limited to non-portfolio purchase transactions from 2005 through 2022. We

[5]A related concern may be that not all public records are digitized and accessible, but given that we limit our sample to 2005 onward and that RCA transactions are at least $2.5 million in value and therefore largely located in metropolitan areas with digitized records, we do not think this is a major concern.

[6]Typical at-origination LTV ratios for CRE loans are around 60 percent (see, for example, Glancy et al. 2022). After accounting for amortization and property appreciation, the average current LTV for outstanding loans—i.e., what is being measured in the Financial Accounts—would be around 50.6 percent (this calculation is based on 2 percent annual price appreciation, an average of a 10-year loan term, and 30-year average amortization schedules, and uniformly distributed origination dates, which would be broadly in line with the averages of these characteristics across loans as relayed in Glancy et al. (2022)). Given that investment properties and owner-occupied properties have cash shares of 43 percent and 70 percent, respectively (Figure 1), and about two-thirds of CRE properties are owner-occupied (Ghent et al., 2019), we would expect about 61 percent of the market to be cash financed. This would imply a current LTV of 50.6 percent $\times .39 \approx 20$ percent. If we overestimated the portion of the market that was cash-financed, we would expect this estimate to be below, rather than slightly above, the estimate based on aggregate US data.

[7]Additionally, the fact that cash purchases are most common for private buyers and least common for public ones is indicative that coverage is reliable. If misclassifications were common, we would expect to see higher estimated cash shares for private buyers since their funding is more opaque.

start the sample in 2005 because RCA expanded coverage that year. Estimated cash shares were higher before this expansion, raising the concern that loan information was less complete in those early years. We exclude portfolio transactions, as it is less feasible for the buyer to make financing based on the redevelopment potential of individual properties.

2.2. *Descriptive Statistics*

Figure 1 shows the share of purchase transactions (by number) without property-level debt (i.e., the cash share of purchases), split by buyer objective, buyer type, and property type. Regarding buyer objectives, cash purchases are most common for redevelopment projects, at 75 percent. Cash purchases are also on the higher end, at 59 percent, for purchases by intended occupiers, consistent with highly firm-specific assets being more likely to be owned than rented (Smith Jr. and Wakeman, 1985) and less suited for usage as collateral (Benmelech et al., 2005). Properties purchased for investment have cash shares around 46 percent, while cash shares for renovations are lower, at 31 percent.[8]

Regarding buyer type, cash purchases are highest for public buyers (e.g., REITs), at 79 percent, and lowest for private buyers, at 44 percent. Regarding property type, cash shares are highest for development sites, at 80 percent; lowest for apartment buildings, at 32 percent; and between 39 and 56 percent for nonresidential property types. These differences in cash purchase shares are reasonably stable over time, as is shown in Figure A3.

These differences provide some hints at motivations for deciding against using mortgage financing to fund purchases. First, differences in credit availability appear to affect capital structure decisions; public buyers, which likely have greater access to unsecured financing, are much less likely to use mortgage financing than private buyers. Additionally, mortgage usage is highest for apartment buildings, perhaps reflecting greater credit availability, given the involvement of

[8]These patterns are broadly similar when shares are weighted by property value (see Figure A4); on a weighted basis, cash purchases are around 70 percent of purchases for occupancy or redevelopment, compared with about 43 percent of purchases for investment. Figure A5 also includes the distribution of observations across the categories.

the government-sponsored enterprises in the secondary market. We will account for differences in credit availability along these dimensions in the empirical results by employing buyer and property-type fixed effects.

Second, the results are consistent with the hypothesis that buyers use cash financing to maintain operational flexibility to engage in redevelopment projects. Namely, cash usage is particularly high for redevelopment projects or development sites. In the next two sections, we will further develop and more formally test this hypothesis by analyzing differences in financing behavior based on properties' redevelopment options and buyers' redevelopment experience.

Table 1 provides some summary statistics for the full sample of property sales and for samples broken out by whether there is a mortgage associated with the transaction. Since we are interested in how financing decisions affect redevelopment *options* rather than how renovation and redevelopment projects are funded, this sample includes only purchase transactions for the sake of investment (as opposed to the other objectives listed at the top of Figure 1). The last column presents the difference in means for cash- and mortgage-financed purchases.

Unconditionally, properties that are cash financed have modestly higher Q-Scores, on average, but are 1 percentage point more likely to have a Q-Score in the bottom quartile ("Low Q-Score"= 1). Cash-financed properties are also more likely to be younger and to have lower average valuations but higher prices per square foot. Additionally, transactions with shorter average hold periods are more likely to be cash financed; this result is consistent with Demirci et al. (2023), who demonstrate that REITs are less likely to sell encumbered properties.

Regarding buyer characteristics, buyers with development experience, defined as buyers for which at least 25 percent of transactions are flagged as involving renovation, redevelopment, or construction, are more likely to purchase properties using all cash. Specifically, 11.2 percent of cash transactions are accounted for by developers, compared with only 10.7 percent of mortgaged transactions. The findings are similar when development experience is measured continuously; 16.5 percent of the average cash buyer's transactions involve some form of development, compared with 15.5 percent for mortgaged transactions. Cash-financed properties are also more likely to be materially improved (i.e., have an at least 20 percentage point increase in their Q-Score in the next transaction), consistent with a greater likelihood of renovation. Of course, these summary statistics are subject to composition effects, so we will require more formal analysis to understand these patterns better.

3. MODEL OF REDEVELOPMENT OPTIONS AND FINANCING DECISIONS

In this section, we present a simple model of how redevelopment options affect financing decisions. In the first subsection, we present a model where CRE investors optimally choose when to redevelop properties. The model establishes the framework we use for estimating cross-sectional differences in the value of redevelopment options. In the second subsection, we extend the model to include leverage and derive how frictions to redeveloping mortgaged properties affect option values and financing decisions.

3.1. Model

Suppose that a newly renovated property yields a net cash flow that we normalize to 1. Over time, this cash flow depreciates at rate δ. If property investors discount the future at rate r, then the value of a property after t years will satisfy the pricing equation:

$$rV(t) = e^{-\delta t} + V'(t). \tag{1}$$

Suppose that owners are able to renovate at cost c to return the property to the cash flow of a newly built one. In Appendix B, we show that equation (1) can thus be solved as

$$V(t) = \underbrace{\frac{e^{-\delta t}}{r+\delta}}_{\substack{\text{Value without} \\ \text{Renovation Option}}} \left(1 + \underbrace{\frac{\delta}{r} e^{-(r+\delta)(t^*(c)-t)}}_{\equiv \rho(t,c)}\right), \tag{2}$$

where $t^*(c)$ is the optimal time of renovation, which we show to be monotonically increasing in c.[9] This expression says that the increase in the value of the property due to the renovation option—defined in (2) as $\rho(t,c)$—is decreasing in the time until renovation (i.e., $t^*(c)-t$). Higher costs of renovation cause owners to wait longer to renovate and reduce the value of the option. We can thus derive the first hypothesis we test in the data.

Hypothesis 1. *Older and less productive (higher t) properties are more likely to be immediately redeveloped.*

This hypothesis follows directly from the fact that $\rho(t,c)$ is decreasing in the time until renovation. A purchaser i would acquire a property j for immediate redevelopment if $t^*_{i,j}-t_j<0$. If we assume t_j is observable and $t^*_{i,j}$ is distributed according to the cumulative distribution function F, then the probability that a purchase occurs for immediate redevelopment is $F(t_j)$. This probability is increasing in time since renovation (t_j) and decreasing in property productivity (since income relative to newly renovated properties, $e^{-\delta t_j}$, is a decreasing function of time).

In practice, t_j is typically not directly observed; so when we estimate the value of redevelopment options, we will instead estimate a probit based on a flexible function of a building's age (the time it has had to depreciate) and Q-Score (a direct measure of the property's relative productivity) to capture the renovation potential of a property. Specifically, we parameterize $t_j-t^*_{i,j}$, reflecting the value of the renovation option, as $t_j-t^*_{i,j}=X_j'\beta+\sigma\varepsilon_{i,j}$, where X_j is a set of variables measuring the property's age and quality, and $\varepsilon_{i,j}$ follows a standard normal distribution. We then estimate Pr(Renovation)$=\Phi(\frac{X_j'\beta}{\sigma})$, which provides a measure of the value of the renovation option.[10]

[9] $t^*(c)$ is defined implicitly by the value-matching condition that $V(t^*)=V(0)-c$.

[10] More formally, the value of the renovation option would be $\mathbb{E}(\rho \mid X_j)$, which is a monotonically increasing function of the fitted renovation probability. We work with the fitted probability that a property was purchased for renovation, since it is easier to interpret and does not require estimates of scale parameters (σ, r, δ).

3.2. *Model with Leverage*

We now introduce leverage following a trade-off theory approach, though we make some simplifying assumptions on the functional forms of the costs and benefits of debt for ease of exposition.

Assume the presence of a mortgage raises the cost of renovation such that the optimal renovation time increases from t^* to $t^* + \Delta$. Borrowers face a trade-off between this cost and a benefit to debt that is proportional to the renovation-option-free value of the property. Denoting this benefit by b, purchasers then use cash to finance a property if

$$V(t;t^*) > V(t;t^* + \Delta) + b\frac{e^{-\delta t}}{r+\delta}. \tag{3}$$

We can then derive our second hypothesis.

Hypothesis 2. *Investors use cash to purchase properties with greater redevelopment options.*

We can derive this hypothesis by combining equations (2) and (3) to show that buyers use cash if

$$b < \rho(t,c)\left(1 - e^{-(r+\delta)\Delta}\right). \tag{4}$$

This expression says that borrowers use cash if the benefit of secured financing, b, is smaller than the decline in the value of the renovation option, the expression on the right. The marginal effect of increasing the optimal renovation time, t^*, is greater when the renovation option is more valuable, i.e., when ρ is higher.

We can therefore derive the conditions under which buyers immediately renovate, invest with cash financing, or invest with mortgage financing:

$$\text{Investment Strategy} = \begin{cases} \text{Immediately Renovate} & \text{if } t^*_{i,j} - t_j < 0 \\ \text{Invest with Cash Financing} & \text{if } 0 < t^*_{i,j} - t_j < \max\{\zeta, 0\} \\ \text{Invest with Mortgage Financing} & \text{if } t^*_{i,j} - t_j > \max\{\zeta, 0\}, \end{cases} \quad (5)$$

where $\zeta = \frac{1}{r+\delta} \ln\left(\frac{\delta(1-e^{-(r+\delta)\Delta})}{br}\right)$ is the threshold time to renovation below which buyers choose to use cash rather than mortgage financing based on equation (4).[11]

The decision whether to immediately renovate, invest with cash financing, or invest with mortgage financing could be estimated by ordered probit since those outcomes depend on the same latent variable, $t^* - t$, but with different thresholds (0 and ζ). However, such an estimation strategy would impose, rather than test for, the fact that cash purchases are used for properties with a greater renovation option. Consequently, when we test this proposition in the data in the next section, we instead use a probit model predicting whether a property is purchased for immediate development to estimate the likely value of the redevelopment option. We then test whether properties with a greater redevelopment option are more likely to be cash financed.

4. METHODOLOGY AND EMPIRICAL FINDINGS

In this section, we test the two hypotheses from the model and provide some additional analysis regarding the relationship between mortgage financing and redevelopment options. In the first subsection, we estimate the likelihood that a property is purchased for the purpose of redevelopment based on property age and quality. Guided by the framework in Section 3.1, we use these estimates to construct our measure of redevelopment potential. In the second subsection, we use this measure to demonstrate that investors disproportionately use cash purchases for properties with greater redevelopment potential. In the third subsection, we show directly that cash-financed properties

[11] If $\gamma < 0$, the cost of having secured debt is small enough that $V(t;t^*) < V(t;t^* + \Delta) + b\frac{e^{-\delta t}}{r+\delta}$ $\forall t^* > t$, meaning that all purchases are mortgage financed.

are more likely to be subsequently redeveloped or improved. In the fourth subsection, we study the increase in redevelopment option values during the COVID-19 pandemic.

4.1. Older or less productive properties are more likely to be redeveloped.

Our simple theoretical framework indicates that older or less productive properties are more likely to be redeveloped. At first blush, this hypothesis appears to be true in our data. In Figure 2, we present binned scatterplot (binscatter) regressions of an indicator of whether a property was purchased for redevelopment on property quality (Q-Score) in the left panel and building age in the right panel. We define redevelopment broadly to include both renovation and redevelopment. The binscatter regressions also control for the natural log of the acreage of the land parcel and include year, property-type, and buyer fixed effects. The plot by Q-Score also controls for building age and the plot by building age also controls for Q-Score.

The rate at which properties are purchased for redevelopment falls sharply in quality for properties in the lowest quintile and then levels off at higher Q-Scores (before jumping again for properties in the highest decile). Effects of age are more linear; the probability of redevelopment rises from about 2 percent for a 10-year-old property to about 8 percent for a 50-year-old property, and to over 10 percent for an 80-year-old property.

To more formally test how Q-Score and building age are related to redevelopment, we run the following regression:

$$\begin{aligned}\Pr(\text{Redevelopment or Renovation}_{i,j,t}) = f(\text{Building Age}_j) + g(\text{Q-Score}_j) \\ + \zeta_{p(j,t)} + \eta_t + \varepsilon_{i,j,t},\end{aligned} \tag{6}$$

where the dependent variable is an indicator for whether the buyer i's objective in purchasing a property is either renovation or redevelopment (as opposed to investment), $f(\text{Building Age}_j)$ is a function of building j's age in years, and $g(\text{Q-Score}_j)$ is a function of building j's Q-Score. We also include property-type fixed effects ($\zeta_{p(j,t)}$) and quarter fixed effects (η_t). We cluster the standard errors by buyer.

We predict the borrower's intent to alter properties (rather than actual alterations) for two reasons. First, since we are interested in how investors choose to finance property purchases, we want our measure of redevelopment potential to reflect the perceived potential at the time of purchase rather than whether the alteration actually occurs. Predictions of intended alteration better capture this concept. Second, the buyer objective is directly reported in the data, while actual alterations need to be imputed based on subsequent transactions.[12]

We use two separate specifications. First, we simply include building age and the Q-Score as independent variables. Second, we estimate linear splines for the independent variables of interest in order to capture the nonlinearities demonstrated in Figure 2. For building age, the knots of the spline are at 5, 25, 50, and 75 years old. For the Q-Score, we place knots at the 25th, 50th, and 75th percentiles.

We estimate equation (6) using two models: first, with OLS and, second, with a probit. The results are presented in Table 2. Columns (1) and (2) include the OLS results, with building age and Q-Score entering linearly in column (1) and with the linear splines in column (2). Columns (3) and (4) include parallel results using a probit model.

The signs of the coefficients are as expected. The coefficient on building age in column (1) indicates that, on average, a property that is one year older has a 0.14 percentage point higher likelihood of redevelopment or renovation, while a property with a Q-Score of 1 is almost 2 percentage points less likely to be purchased for redevelopment or renovation than one with a Q-Score of 0. The results for the linear spline in column (2) indicate that these effects vary across the building age and Q-Score distribution. Consistent with the findings from Figure 2, age fairly consistently increases the likelihood of intended redevelopment, with sizable effects starting at age 5 and continuing up until effects level off around 75. For Q-Score, higher quality reduces the likelihood of intended

[12] In Section 4.3, we show that cash-financed properties are more likely to be subsequently improved. Additionally, in unreported analysis, we confirm that the measures of intended alteration are indeed predictive of actual improvements and alterations.

redevelopment sharply in the first quartile but has modest effects at higher quartiles.

The coefficients for the probit model in columns (3) and (4) are harder to interpret in terms of magnitude but generally retain similar signs, significance levels, and relative magnitudes. As discussed in Section 3.1, we use the probit model to construct the fitted probability of redevelopment for properties purchased for investment. Specifically, we use the fitted probabilities from the specification in column (4) to produce a continuous measure of redevelopment potential that is a flexible function of a building's age and Q-Score. This metric will be our main measure of the value of the redevelopment option in the remaining analysis.

4.2. Properties with greater redevelopment options are less likely to be mortgage financed.

The summary statistics provide suggestive evidence for several potential reasons as to why buyers might forgo mortgage financing: high availability of unsecured funding (e.g., for REITs), avoiding transaction costs for projects with shorter investment horizons, and funding properties with a higher asset specificity (e.g., for owner-occupiers). Here, we focus on the role of investors maintaining their redevelopment option, as predicted in the theory.

The primary threat to identification is that one of these other motivations for cash purchases correlates with redevelopment option values, causing the analysis to incorrectly attribute the motivation for cash financing to borrowers trying to maintain redevelopment options. We address these threats to identification in two ways. First, in the spirit of Khwaja and Mian (2008), we exploit within-buyer variation to examine how buyers fund projects with high redevelopment options. Buyer fixed effects control for factors such as desired leverage or the availability of unsecured financing and increase confidence that the estimated effects are driven by the desirability of funding an individual property with cash as opposed to mortgage credit.

Second, we take a difference-in-differences-style approach and test how buyers with development experience respond to redevelopment options compared to buyers without it. If redevelopment options correlate with mortgage financing for reasons besides redevelopment options (for example, lenders being reluctant to finance obsolete properties), then this should affect buyers both with and without development experience. The difference in the effect of redevelopment potential on cash financing for developers relative to non-developers therefore plausibly reflects the additional motivation of borrowers to fund properties with cash (or unsecured financing) to preserve redevelopment options.[13]

Additionally, we supplement these strategies by controlling for other factors that could affect a buyer's decision to forgo mortgage financing. First, we add an indicator for whether the property was built in the last two years to control for differences in financing decisions during the lease-up stage of the development process. Second, we control for the size of the land to capture liquidity difficulties that could arise from funding larger purchases with cash. Third, we include an indicator for whether the property was resold within five years, since buyers might not take out a mortgage if their intended hold period is shorter than the length of a typical loan.

Namely, we estimate the following specification:

$$\begin{aligned}\text{Cash purchase}_{i,j,t} = \beta_1 \text{Developer}_i \times \text{Redevelopment Probability}_{j,t} \\ + \eta' X_{i,j,t} + \gamma_i + \zeta_{p(j,t)} + \eta_t + \varepsilon_{i,j,t},\end{aligned} \tag{7}$$

where Cash purchase$_{i,j,t}$ is an indicator for whether the purchase of property j by buyer i at time t was made without associated property-level debt. Developer$_i$ is an indicator for whether more than one-fourth of the buyer's transactions involve some type of development purpose (renovation, redevelopment, or construction). Redevelopment Probability$_{j,t}$ is the fitted probability that the property would be redeveloped as estimated in Section 4.1. The variable $X_{i,j,t}$ includes the aforementioned controls as well as the uninteracted property redevelopment probability. γ_i, $\zeta_{p(j,t)}$, and η_t are buyer, property-type, and quarter-of-transaction fixed effects, respectively. To account for our use of a generated regressor, the standard errors are estimated via bootstrap, clustered by

[13] We also consider specifications that include buyer-type fixed effects (instead of buyer fixed effects), which control for broad differences in the availability of credit to different buyer types without the same losses of observations and degrees of freedom that result when using buyer fixed effects.

buyer, with 1000 replications.[14]

Note that the sample differs from the analysis in Section 4.1. Here, we only include properties purchased for investment, rather than also having renovation and redevelopment projects in the sample. We do this because we are interested in how redevelopment options affect financing decisions, rather than how renovation and redevelopment projects are financed. If a buyer acquires a property for immediate renovation or redevelopment, they would take out a loan that explicitly allowed for such alterations. The focus here is on the degree to which buyers use cash financing for properties that are more likely to benefit from alterations in the future. This approach is consistent with the theoretical framework, which only specifies whether a purchase is mortgage financed for properties not purchased for immediate renovation. (In equation (5), financing options are specified only when $t^*_{i,j} > t_j$).

The estimates for the primary specification are presented in Table 3.[15] Columns (1) and (2) present estimates excluding the buyer or buyer-type fixed effects, with the interaction with the buyer's development experience added in the second column; columns (3) and (4) present the same specifications but include buyer-type fixed effects; and columns (5) and (6) again present the same specifications but include buyer fixed effects.

The estimates in column (1), which exclude the interaction terms, imply that a property with a 10 percentage point higher redevelopment probability is about 2.1 percentage points more likely to be cash financed. The sign on the indicator for buildings that have been recently built is also as expected: new buildings are about 11 percentage points more likely to be cash financed. We also find that larger parcels are less likely to be cash financed.

In column (2), we include the interaction of the redevelopment probability with the indicator for whether the buyer is a developer. The coefficient on the interaction term is positive and statistically

[14] Buyers are sampled with replacement, and redevelopment probabilities are reestimated for each sample.

[15] In this section, we use our estimated redevelopment probability created in Section 4.1. In Table A1, we run a similar specification using the two main components of redevelopment potential directly: the Q-Score and building age.

significant, as expected. It indicates that when developers buy a property, their financing decisions are over twice as sensitive to redevelopment options as those of non-developers; a 10 percentage point increase in redevelopment probability raises the use of cash purchases by 3.9 percentage points for developers, compared with 1.6 percentage points for non-developers.

Columns (3) and (4) repeat the same specifications but include buyer-type fixed effects to account for differences in access to alternative financing options across buyer types. The inclusion of these buyer-type fixed effects strengthens the relationship between redevelopment options and cash usage overall but does not materially affect the coefficient on the interaction term. REITs have high cash purchase shares despite tending to buy higher-quality properties, so not controlling for buyer type tends to weaken the estimates.[16]

We include buyer fixed effects in columns (5) and (6), which control for any buyer-specific access to or preference over various funding sources. The results are again broadly similar, with the coefficient on redevelopment probability increasing yet again but the interaction term remaining comparable to the other specifications with less granular fixed effects. Across the specifications, a 10 percentage point increase in redevelopment probability is found to raise the likelihood of cash financing by roughly 2 percent more for buyers with development experience compared with buyers without it.

Figure 3 presents similar estimates from binscatter regressions, thus allowing the relationship between cash purchases and redevelopment potential to be nonlinear. The regression is separately estimated for developers and non-developers, including the same fixed effects as in equation (7). The results confirm that developers are relatively more likely to use cash financing when purchasing properties with high redevelopment potential. The usage of cash financing is fairly similar across these types of buyers for properties with a redevelopment probability under 5 percent, but the difference increases (about linearly) for properties with greater redevelopment potential.

[16] In unreported results, we also run this specification excluding REITs. The results are quantitatively similar.

4.3. Cash financing and redevelopment outcomes

How well do financing decisions by developers relate to actual redevelopment activity? If developers use cash financing to ease frictions on subsequent renovations or redevelopment, we would expect cash purchases to be predictive of whether properties are actually altered after purchase. Answering this question is complicated by the fact that the RCA data report the purpose of the acquisition in terms of whether the buyer intends to renovate or redevelop a property but generally does not report whether the buyer eventually goes on to undertake such activities after buying.

To try to gain insight into such activities, we generate two proxies for whether properties are improved based on reporting in subsequent transactions (if available). First, we impute that a property is renovated if any of the following occur: the next transaction has a purpose listed as renovation, redevelopment, or construction; the next purchase updates the year built or year renovated field to indicate that rebuilding or renovation occurred since the previous transaction; or the property type changes to indicate the building was repurposed. Second, we impute improvements based on the change to the Q-Score, since property improvements would increase the value of the property for the next transaction. We flag a property as improved if the Q-Score rises by 0.2 between transactions. We then run regressions identical to those presented in Table 3 columns (2), (4), and (6) (i.e., the specifications with the interaction) but with indicators of renovation or improvement as the dependent variables and with a cash purchase indicator replacing the redevelopment probability variable. The estimates predicting these improvement variables are displayed in Table 4.

Overall, the results indicate that cash purchases by developers do predict future renovations and improvements. Columns (1) through (3) indicate that purchases by developers are almost 6 percent more likely to be renovated in the future and that cash purchases by developers are around an additional 2 percentage points more likely to be renovated. The coefficient on the interaction between the cash purchase and developer indicators stays fairly stable across specifications with buyer-type and buyer fixed effects.

Columns (4) through (6) indicate that cash purchases are, on average, between 3.0 and 4.2 percentage points more likely to be improved in the future. In the specifications without buyer fixed effects, cash purchases by developers are another 4 percentage points more likely to be improved in the future, but the effect goes away when buyer fixed effects are added. One explanation for this latter result is that the developer indicator is constructed based on a measure of the frequency with which the buyer is flagged as buying with the intention to renovate or redevelop; thus, the measure may struggle to capture the tendency to make improvements of the type that are not directly reported in the RCA data.

While this analysis provides suggestive evidence in favor of the hypothesis that mortgage financing impedes future alterations, a few important caveats are required. First, the proxies for whether alterations occur are imperfect. Most notably, significant enough redevelopment can cause the property identifier in RCA to change, restricting our ability to identify future redevelopment. We are thus less likely to observe redevelopment if the investor itself undertakes it (i.e., the situation we are principally studying) than if the investor sells to another party with the purpose of redevelopment. Second, given the previous evidence that investors use cash to purchase properties with redevelopment potential, we cannot interpret the coefficient on "Cash purchase" as entirely reflecting the effects of mortgage-related frictions. Instead, the estimates likely reflect a combination of both the direct effects of cash purchases and the previously studied selection effects.[17]

[17]The empirical strategy relies on age and quality affecting mortgage financing through their effect on redevelopment option values, so we do not want to explicitly control for age and quality in these regressions. However, when we add the controls for Q-Score and age to this specification, the coefficients on the cash indicator are largely unchanged and remain significant. This result indicates that the effects of cash financing do not entirely reflect the selection effects documented in the core of the paper. However, we are unclear on how to interpret this finding given the mechanical relationship between Q-Score and improvement.

4.4. *Redevelopment option values increased during the COVID-19 pandemic.*

The COVID-19 pandemic provides another source of variation in redevelopment options to study. The pandemic likely increased option values for a couple of reasons. First, it increased uncertainty, particularly for the CRE market; thus it likely increased option values. Indeed, in an extension to the model with stochastic cash flows (see Appendix B.2), we demonstrate that an increase in uncertainty (the volatility of the cash flow process) increases renovation options.[18]

Second, it prompted a shift in how space was used, increasing the need for some space to be redeployed or, at least, updated. These effects are particularly prominent for office properties, which—as of the time of this paper's distribution—are contending with rising vacancies, substantial uncertainty regarding the long-term demand for space, and the potential need for widespread redeployment to alternative property types. Given these factors, we would expect the pandemic to raise redevelopment option values and prompt an increase in the share of purchases made with cash.

Of course, identifying the causal effects of the COVID-19 pandemic on redevelopment option values and property financing decisions is complicated by the fact that lending standards also changed during the pandemic. Changes in lending standards could have (1) affected borrowers' access to mortgage financing and (2) increased the use of cash purchases for reasons that have nothing to do with redevelopment option values.

To plausibly identify the channel we are interested in, we again use a difference-in-differences specification where we compare properties with different redevelopment probabilities before and after the pandemic. If the pandemic did affect redevelopment option values, we would expect an increase in the use of cash financing for properties with greater redevelopment potential.

[18] That uncertainty increases option values is a well-known result (see, e.g., Dixit and Pindyck 1994).

We run the following regression:

$$\text{Cash purchase}_{i,j,t} = \beta_1 \text{COVID-19}_t \times \text{Redevelopment Probability}_{i,t} + \eta' X_{i,j,t} + \gamma_i + \zeta_{p(i,t)} + \eta_t + \varepsilon_{i,j,t}, \quad (8)$$

where COVID-19_t is equal to 1 starting in 2020 and continuing through the remainder of our sample. The redevelopment probability is the measure constructed in Section 4.1 and used to measure redevelopment options in the other results. We include buyer (γ_i), property-type ($\zeta_{p(j,t)}$), and year-quarter (η_t) fixed effects. Additionally, as in the previous subsections, we include a vector of controls that include CBSA fixed effects, an indicator for newly built properties, the natural log of the size of the land parcel, and an indicator for whether the property is sold within five years. Standard errors are bootstrapped as in the previous specifications and clustered by buyer.

Given the dramatic change in work-from-home policies during the pandemic, uncertainty increased for office properties in particular. Following the same logic as in the COVID-19 regressions, we run an additional regression specification where we replace the redevelopment probability with an indicator for office properties. If the redevelopment option value of office properties increased more during the pandemic relative to the redevelopment option of other properties, we would expect cash purchases of these properties to have also increased.

The results are presented in Table 5. Columns (1) through (3) include the specifications using the redevelopment probability, with each column adding different fixed effects. Columns (4) through (6) report results from parallel regressions but replace the redevelopment probability with an office indicator. The results in columns (1) through (3) indicate that the relationship between cash financing and redevelopment probability rose during the pandemic. Across specifications, a 10 percentage point increase in redevelopment probability is found to raise the likelihood of cash financing by roughly 2 percentage points more during COVID relative to before the pandemic. This effect is comparable in magnitude with the increase in cash financing for developers relative to non-developers found in Section 4.2.

Office properties were also more likely than other property types to be purchased with cash during the pandemic. In column (4), the results indicate that there is a roughly 4 percent greater increase in cash purchases for office properties during the pandemic relative to other property types. The estimate is similar when including buyer-type fixed effects in column (5) but falls to under 2 percent when including buyer fixed effects.

5. CONCLUSION

Our results indicate that CRE investors consider a property's redevelopment potential when deciding how to finance a purchase. Mortgages on CRE properties often require the owner to relinquish some control over property management to the lender and can therefore create additional frictions to redevelopment.

We provide evidence that buyers strategically decide whether to take out mortgages with these frictions in mind. Using within-borrower variation to account for differences in financing availability, we show that properties with greater redevelopment potential are more likely to be cash financed, particularly when the buyer has experience in undertaking renovation and redevelopment projects. These effects grew in magnitude during the pandemic, consistent with COVID-19 increasing the importance of renovation and redevelopment options. Office properties, in particular, had a strong rise in the usage of cash financing during the pandemic. These findings can help explain the significant number of CRE properties that are purchased without mortgage financing.

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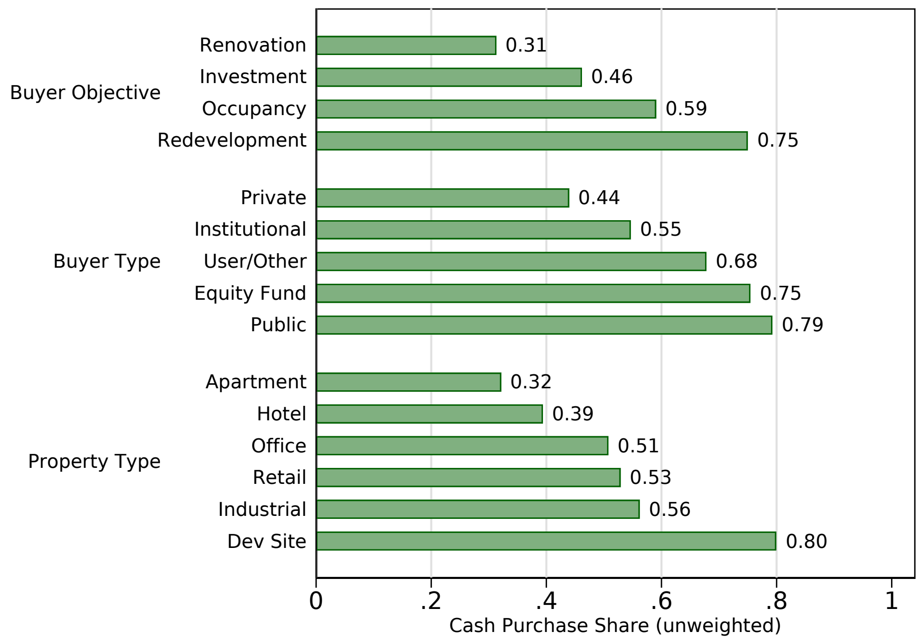
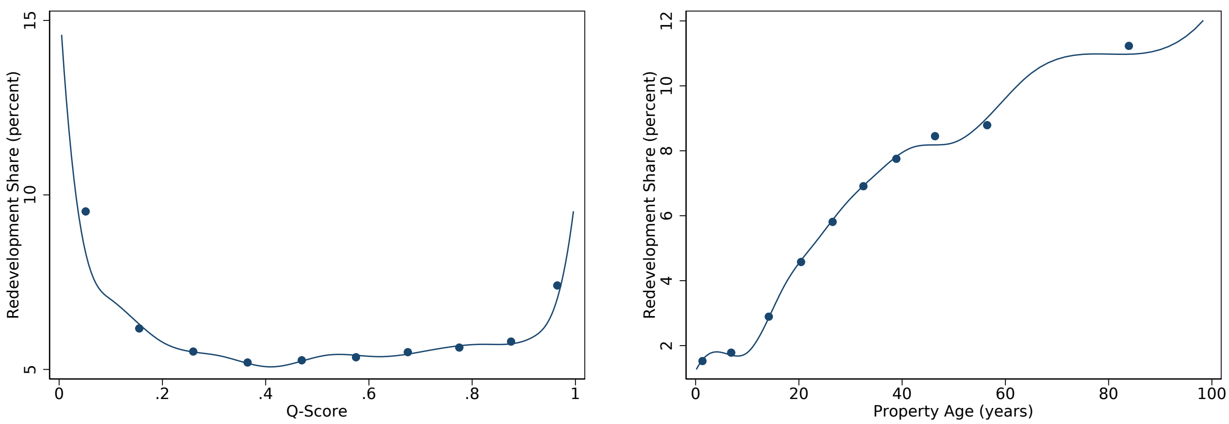
Figure 1: Cash Purchase Shares



Note: This is the share of CRE purchases that are cash financed (i.e., financed without mortgages) by buyer objective (top), buyer type (middle), and property type (bottom). Condo conversions are excluded as they are specific to multi-family properties. Shares are unweighted; equivalent value-weighted statistics are shown in Figure A4.
Source: Authors' calculations using MSCI RCA data.

Figure 2: Redevelopment by Q-Score and Age

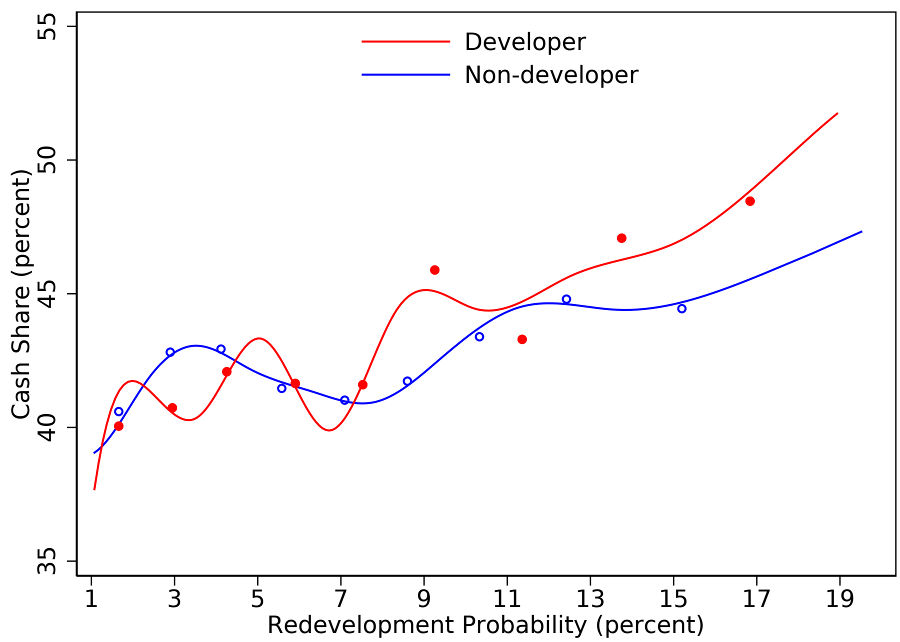


(a) By Property Quality

(b) By Age

Note: The plots are produced using the Stata command "binsreg" (Cattaneo et al., 2019). Each binscatter regression includes year-quarter and property-type fixed effects. Additionally, the property-quality plot controls for age, and the age plot controls for property quality. A higher Q-Score indicates a higher-quality property relative to a peer group. The dependent variable is an indicator for whether the property was purchased for renovation or redevelopment. The dots reflect estimated redevelopment shares by decile of the independent variable of interest, while the lines plot semi-linear regression estimates with a cubic B-spline.
Source: Authors' calculations using MSCI RCA data.

Figure 3: Cash Purchases by Redevelopment Potential



Note: The plots are produced using the Stata command "binsreg" (Cattaneo et al., 2019). Each binscatter regression includes year-quarter, property-type, and buyer fixed effects. The dots reflect estimated cash purchase shares by decile of renovation probability, while the lines plot semi-linear regression estimates with a cubic B-spline. Estimates for developers are in red, and those for non-developers are in blue.
Source: Authors' calculations using MSCI RCA data.

Table 1: Summary Statistics

	Full Sample (1)	Cash Purchases (2)	Mortgage Purchases (3)	Difference (4)
Q-Score	0.51	0.52	0.50	0.02**
	(0.30)	(0.31)	(0.29)	(0.00)
Low Q-Score	0.26	0.26	0.26	0.01**
	(0.44)	(0.44)	(0.44)	(0.00)
Age	34.94	33.47	36.12	-2.65**
	(27.07)	(26.98)	(27.08)	(0.10)
Sold Within 5 Years	0.17	0.17	0.18	-0.01**
	(0.38)	(0.37)	(0.38)	(0.00)
Holding Period	4.98	4.75	5.15	-0.40**
	(3.54)	(3.66)	(3.44)	(0.02)
Value (millions)	14.59	13.48	15.54	-2.07**
	(47.50)	(43.70)	(50.51)	(0.16)
Price per Sq. Ft.	231.40	235.75	227.58	8.16**
	(235.89)	(251.68)	(221.00)	(0.85)
Redevelopment Probability (%)	9.01	9.17	8.89	0.28**
	(6.02)	(6.34)	(5.77)	(0.02)
Buyer Development Share (%)	15.95	16.50	15.48	1.01**
	(14.06)	(14.27)	(13.86)	(0.05)
Developer (%)	10.92	11.23	10.67	0.56**
	(31.20)	(31.57)	(30.87)	(0.11)
Imminent Improvement (%)	15.18	18.39	13.17	5.21**
	(35.88)	(38.74)	(33.82)	(0.28)

Note: Columns (1), (2), and (3) present the mean and standard deviation (in parentheses) of various property or transaction characteristics for the full sample of property investments, cash purchases, and mortgage purchases, respectively. Column (4) presents the difference in means, and standard error of the difference, for cash purchases as compared with mortgage purchases. The full sample is limited to non-portfolio purchase transactions in 2005 or later where the buyer has indicated that their objective is investment. "Low Q-Score" is an indicator for a Q-Score in the bottom quartile of the distribution. "Developer" is defined as a buyer with a development share above 25 percent. "Redevelopment Probability" is the fitted value predicting the probability that a property is purchased for renovation or redevelopment (see Section 4.1). Imminent Improvement is an indicator for whether the Q-score increases by at least 20 percentage points at the time of the next transaction (see Section 4.3). $^{+}$, *, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using MSCI RCA data.

Table 2: Predictors of Redevelopment or Renovation

	Purchased for Redevelopment or Renovation (in percentage points)			
	OLS		Probit	
	(1)	(2)	(3)	(4)
Building Age (years)	0.14**		0.01**	
	(0.01)		(0.00)	
Q-Score	-1.87**		-0.25**	
	(0.45)		(0.02)	
Age 0–5		0.05		-0.04**
		(0.05)		(0.01)
Age 5–25		0.35**		0.04**
		(0.01)		(0.00)
Age 25–50		0.17**		0.01**
		(0.02)		(0.00)
Age 50–75		0.12**		0.01**
		(0.03)		(0.00)
Age 75–100		0.00		-0.00
		(0.03)		(0.00)
Q-Score: Quartile 1		-30.99**		-2.37**
		(2.00)		(0.10)
Q-Score: Quartile 2		4.40**		0.36**
		(1.04)		(0.08)
Q-Score: Quartile 3		3.85**		0.19*
		(1.00)		(0.08)
Q-Score: Quartile 4		13.63**		0.88**
		(1.55)		(0.10)
R_a^2	0.040	0.045		
Observations	249,145	239,857	249,145	239,853
$\bar{Y}$	8.49	8.22	8.49	8.23
sd(Y)	27.87	27.47	27.87	27.47
Property Type FE	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓

Note: The sample is limited to refinance and sales transactions where the buyer's objective is investment, redevelopment, or renovation. The dependent variable is an indicator of whether the buyer's objective is redevelopment or renovation, multiplied by 100. Columns (2) and (4) fit a linear spline in age and Q-Score, and the coefficient estimates reflect slopes within a particular age or Q-Score bin. $\bar{Y}$ and sd(Y) report the mean and standard deviation of the dependent variable in each regression sample, respectively. Standards errors, in parentheses, are clustered by buyer. $^{+}$,*, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using MSCI RCA data.

Table 3: Cash Purchases and Redevelopment Options

	Cash Indicator (in percentage points)					
	(1)	(2)	(3)	(4)	(5)	(6)
Redevelopment Probability	21.30**	15.68**	36.97**	31.66**	48.73**	44.52**
	(5.45)	(5.42)	(4.59)	(5.15)	(4.33)	(4.23)
Redevelopment Probability× Developer		22.33**		20.41**		19.07*
		(8.27)		(7.21)		(7.61)
Developer		-1.44		-1.05		
		(1.30)		(1.05)		
Age<2	10.88**	10.83**	8.53**	8.48**	5.20**	5.18**
	(0.97)	(0.98)	(0.99)	(0.99)	(0.71)	(0.71)
ln(Land Area in Acres)	-1.18**	-1.19**	-1.76**	-1.76**	-1.86**	-1.86**
	(0.17)	(0.17)	(0.13)	(0.13)	(0.11)	(0.12)
Sold Within 5 Years	-2.02**	-2.01**	-1.28*	-1.28*	0.95$^+$	0.95*
	(0.63)	(0.63)	(0.55)	(0.56)	(0.48)	(0.47)
R_a^2	0.102	0.102	0.143	0.144	0.329	0.330
Observations	127,307	127,307	125,103	125,103	116,977	116,977
$\bar{Y}$	42.14	42.14	41.72	41.72	42.1	42.1
sd(Y)	49.38	49.38	49.31	49.31	49.37	49.37
Property Type FE	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
CBSA FE	✓	✓	✓	✓	✓	✓
Buyer Type FE	-	-	✓	✓	-	-
Buyer FE	-	-	-	-	✓	✓

Note: The sample is limited to purchase transactions in 2005 or later where the buyer has indicated that their intention is investment. The dependent variable is an indicator for whether the property is cash financed, scaled by 100 so estimates can be interpreted in percentage points. The redevelopment probability is calculated as described in Section 4.1. $\bar{Y}$ and sd(Y) report the mean and standard deviation, respectively, of the dependent variable in each regression sample. Standard errors, in parentheses, are bootstrapped using 1000 replications, clustered by buyer. $^+$, *, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using the MSCI RCA data.

Table 4: Cash Purchases as a Predictor of Improvement or Renovation

	Renovation Indicator (in percentage points)			Improvement Indicator		
	(1)	(2)	(3)	(4)	(5)	(6)
Cash Purchase	-1.01**	-1.12**	-0.85*	3.04**	3.80**	4.17**
	(0.32)	(0.33)	(0.38)	(0.49)	(0.51)	(0.55)
Cash Purchase × Developer	1.91*	2.17**	2.03*	4.08**	3.80**	-0.47
	(0.78)	(0.78)	(0.94)	(1.12)	(1.13)	(1.39)
Developer	5.61**	5.56**		4.41**	4.42**	
	(0.54)	(0.54)		(0.70)	(0.70)	
ln(Land Area in Acres)	1.48**	1.41**	0.86**	-0.62**	-0.43**	-0.36*
	(0.10)	(0.10)	(0.11)	(0.13)	(0.13)	(0.15)
Age<2	-6.29**	-6.33**	-5.13**	-6.73**	-6.37**	-2.66**
	(0.51)	(0.52)	(0.63)	(0.68)	(0.69)	(0.79)
Sold Within 5 Years	2.20**	1.92**	1.24**	0.37	0.48	0.76
	(0.31)	(0.30)	(0.35)	(0.46)	(0.46)	(0.49)
R^2_a	0.036	0.037	0.090	0.037	0.040	0.150
Observations	86,119	85,322	76,156	43,274	42,963	36,153
$\bar{Y}$	14.79	14.81	14.93	14.99	15.02	14.54
sd(Y)	35.5	35.52	35.64	35.7	35.72	35.25
Property Type FE	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
CBSA FE	✓	✓	✓	✓	✓	✓
Buyer Type FE	-	✓	-	-	✓	-
Buyer FE	-	-	✓	-	-	✓

Note: The redevelopment probability is calculated as described in Section 4.1. $\bar{Y}$ and sd(Y) report the mean and standard deviation, respectively, of the dependent variable in each regression sample. Standard errors, in parentheses, are clustered by buyer. $^{+}$, *, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using MSCI RCA data.

Table 5: Cash Purchases during the COVID-19 Pandemic

	Cash Indicator (in percentage points)					
	(1)	(2)	(3)	(4)	(5)	(6)
Redevelopment Probability	18.30**	33.82**	46.38**			
	(5.26)	(2.98)	(4.41)			
Redevelopment Probability × COVID-19	24.99*	26.92**	19.26*			
	(10.39)	(6.76)	(9.12)			
Office × COVID-19				4.37**	4.01**	2.19
				(1.21)	(1.18)	(1.45)
Age<2	11.01**	8.66**	5.29**	9.49**	6.42**	3.25**
	(1.00)	(0.63)	(0.72)	(1.00)	(1.03)	(0.69)
ln(Land Area in Acres)	-1.19**	-1.76**	-1.86**	-1.05**	-1.64**	-1.86**
	(0.17)	(0.09)	(0.11)	(0.16)	(0.12)	(0.11)
Sold Within 5 Years	-2.02**	-1.29**	0.94^{+}	-0.68	-0.19	2.06**
	(0.65)	(0.34)	(0.48)	(0.54)	(0.50)	(0.42)
R^2_a	0.102	0.144	0.330	0.090	0.131	0.309
Observations	127,307	125,103	116,977	154,637	151,521	143,406
$\bar{Y}$	42.14	41.72	42.1	43.09	42.5	43.07
sd(Y)	49.38	49.31	49.37	49.52	49.43	49.52
Property Type FE	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
CBSA FE	✓	✓	✓	✓	✓	✓
Buyer Type FE	-	✓	-	-	✓	-
Buyer FE	-	-	✓	-	-	✓

Notes: The COVID-19 indicator is set equal to 1 for transactions in 2020:Q1 or later. The redevelopment probability is calculated as described in Section 4.1. $\bar{Y}$ and sd(Y) report the mean and standard deviation, respectively, of the dependent variable in each regression sample. Standard errors, in parentheses, are bootstrapped using 1000 replications, clustered by buyer. $^{+}$, *, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using MSCI RCA data.

A. DATA APPENDIX

A.1. Further Details on Appendix Exhibits Referenced in Main Text

Figure A1 shows aggregate leverage in the CRE and RRE markets. The leverage ratios reflect the average loan-to-value (LTV) ratios for properties that are mortgage financed, as well as the share of properties that have a mortgage. Given that real estate is marked to market in the Financial Accounts while debt is kept at book value, price appreciation over time decreases leverage relative to at-origination LTV ratios, also contributing to low aggregate leverage.

A.2. Alternative Measures of Redevelopment Potential

In Table A1, we run regressions similar to those outlined in equation (7) but using different measures of redevelopment potential. Specifically, we replace the redevelopment probability with an indicator for whether the Q-Score is in the bottom quartile and an indicator for whether the property is over 25 years of age.

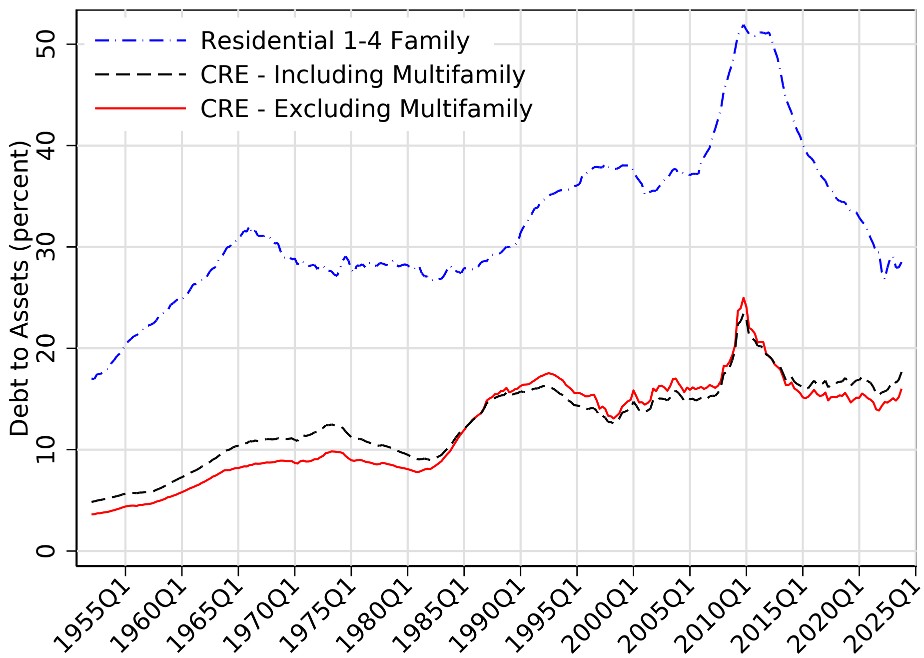
Columns (1) through (3) include estimates excluding the buyer or buyer-type fixed effects, layering in the interaction terms related to redevelopment potential one at a time; columns (4) through (6) present the same specifications but include buyer-type fixed effects; and the last three columns again present the same specifications but include buyer fixed effects.

The findings are qualitatively similar to those shown in Table 3, in which information on age and quality was combined into a single measure of renovation potential. Lower-quality properties are more likely to be cash financed. Properties with low Q-Scores are predicted as having a roughly 4 percentage point higher cash share in specifications without buyer controls (column 1), rising to about a 6 percentage point effect in specifications with buyer type or buyer fixed effects (columns 4 and 7). In contrast to the main results, older properties are predicted as having lower cash purchase shares after controlling for property quality; however, the effect goes away when buyer fixed effects are added, indicating that the results are driven by buyer-specific omitted variables.

The results looking at differences across buyers with and without development experience are more uniformly consistent with the primary results. Developers are more likely to use cash financing than other buyers, but only when the property has at least one of the characteristics indicating that it has redevelopment potential (advanced age or low Q-Scores). Focusing on the results in column (9)—the specification where both property characteristics are interacted with the developer indicator and buyer fixed effects are included—we find that having a low Q-Score raises the likelihood of cash financing by about 5.8 percentage points for non-developers and 8.5 percentage points for developers. As a bit under half of investment properties are cash financed, these results imply that low Q-Score properties are over 10 percent more likely to be purchased with cash overall, and over 15 percent more likely to be bought by buyers with development experience. Advanced age increases the likelihood of using cash financing by about 2 percentage points for developers while having little effect on other buyers. Differences between developers and non-developers tended to be slightly stronger in the other specifications without buyer fixed effects (columns 3 and 6).

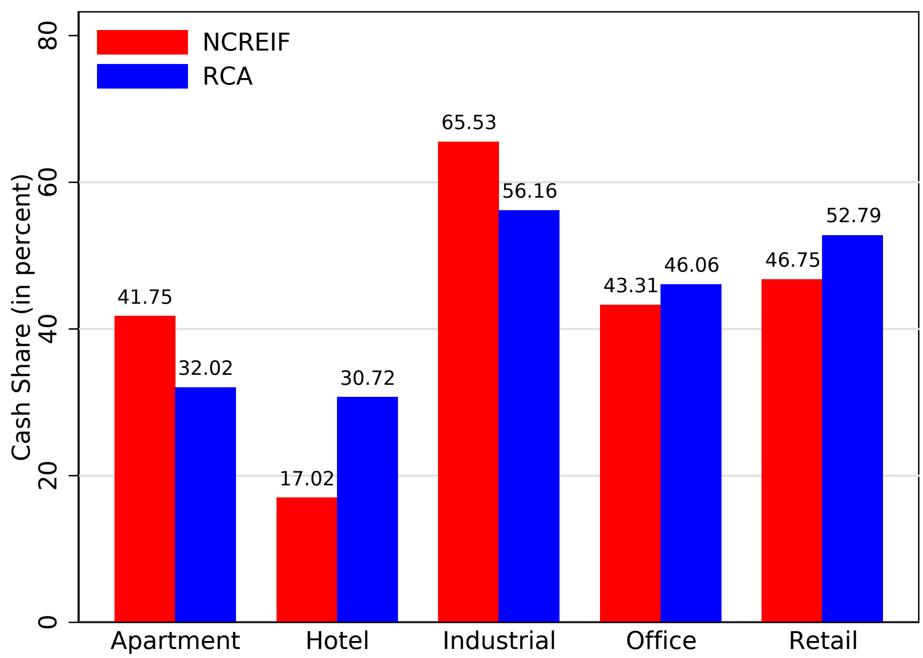
Similar results are shown in Figure A6, which presents binscatter regression estimates of the relationship between cash financing and Q-Score or age, by the buyer's development experience.

Figure A1: Debt to Assets in the Financial Accounts: Commercial and Residential Real Estate



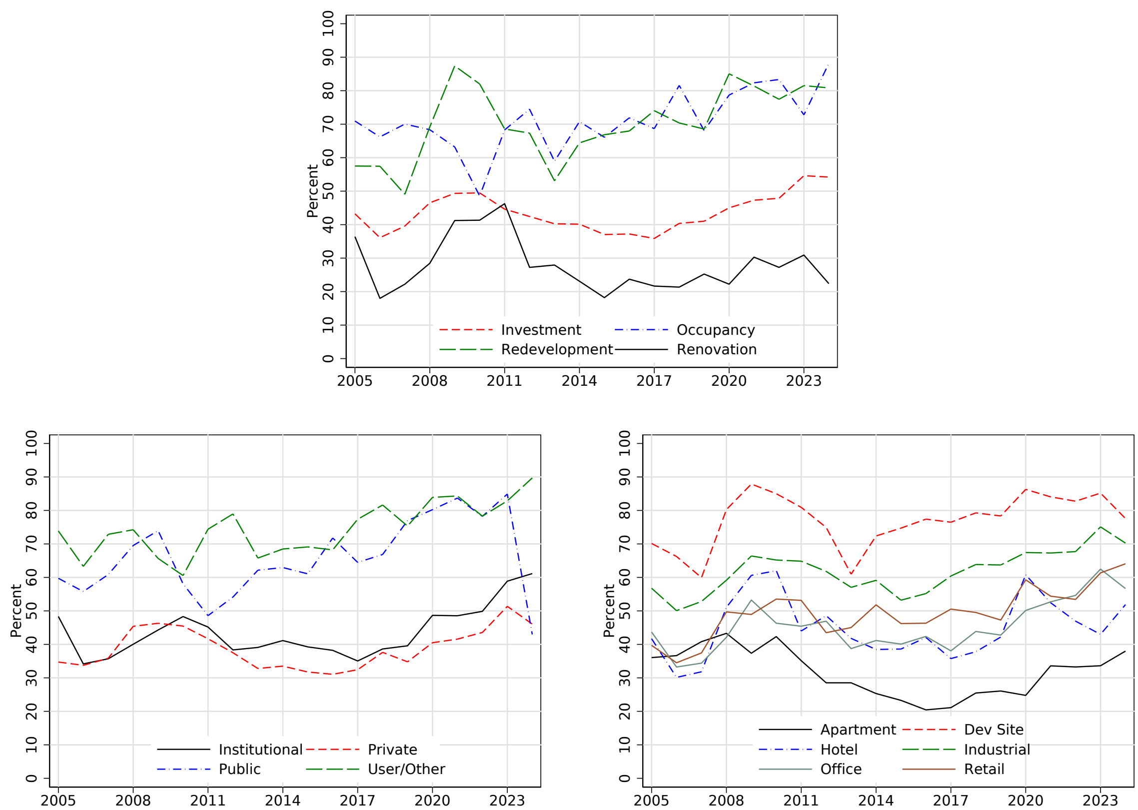
Note: The figure plots time series of commercial real estate (CRE) and residential real estate (RRE) debt to assets. CRE debt is measured as "all sectors; commercial mortgages; asset" in Table L.220 (series FL893065505.Q). RRE debt is measured as "all sectors; one-to-four-family residential mortgages; asset" in Table L.214 (series FL893065105.Q). We follow Ghent et al. (2019)'s definition of CRE and RRE assets. CRE assets are measured as the sum of "nonfinancial noncorporate business; nonresidential real estate at market value" and "nonfinancial corporate business; real estate at market value" in Tables B.103 and B.104, respectively (series FL115035035.Q and FL105035005.Q, respectively). RRE assets are measured as "households and nonprofit organizations; real estate at market value" in Table B.101 (series FL155035005.Q). When we include all multifamily mortgages in our CRE debt measure (series FL893065405.Q), we also include in the denominator "nonfinancial noncorporate business; residential real estate at market value" (series FL115035023.Q).
Source: Authors' calculations using the Federal Reserve Board, Statistical Release Z.1, "Financial Accounts of the United States."

Figure A2: Comparison of Cash Purchase Shares between RCA and NCREIF



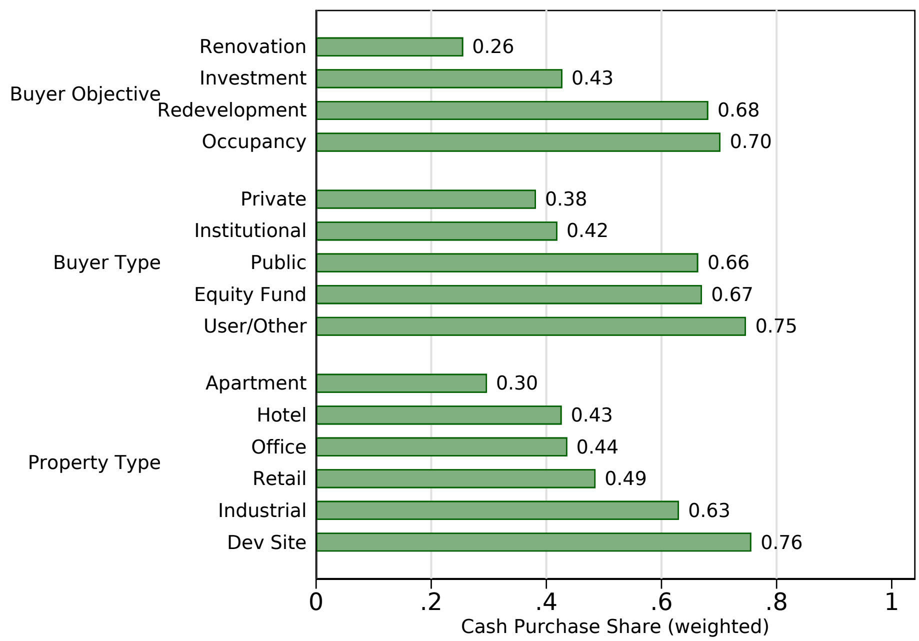
Note: Both the RCA sample and the NCREIF sample are limited to sales transactions by institutional buyers between 2005 and 2020.
Source: Authors' calculations using transaction-level data from NCREIF and MSCI RCA.

Figure A3: Time Trends by Buyer Objective, Buyer Type, and Property Type



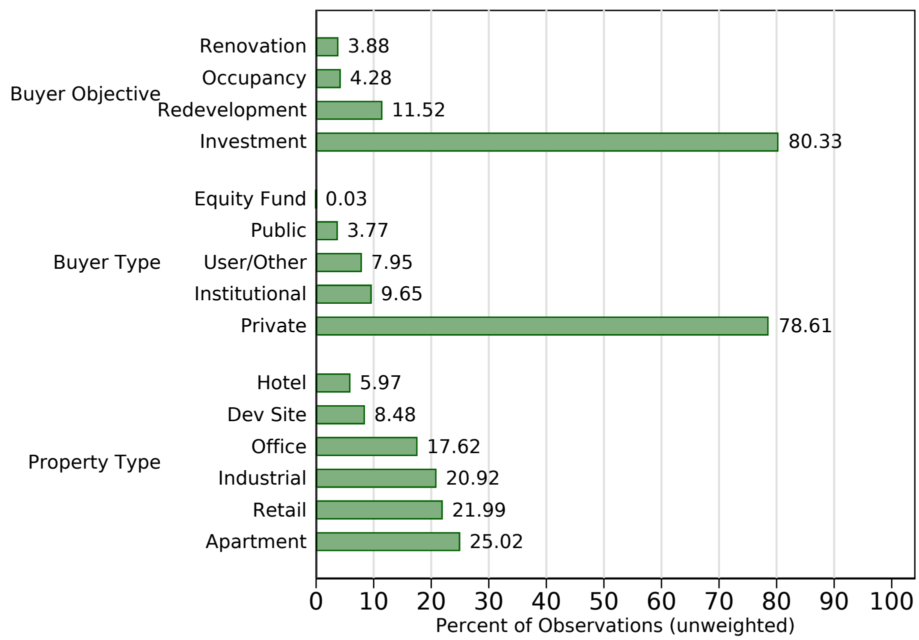
Note: The figure plots the share of CRE purchases over time that are cash financed by buyer objective (top), buyer type (bottom left), and property type (bottom right). Shares are weighted by the property value. The sample is limited to non-portfolio sales transactions.
Source: Authors' calculations using MSCI RCA data.

Figure A4: Cash Purchase Shares (weighted)



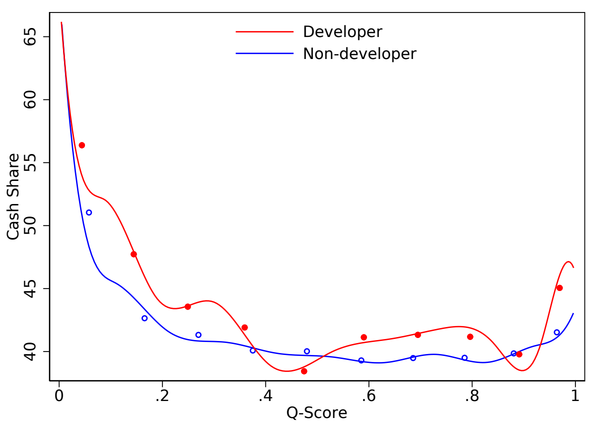
Note: The figure plots the share of CRE purchases that are cash financed (i.e., not financed by a mortgage) by buyer objective (top), buyer type (middle), and property type (bottom). Shares are weighted by the property value. Condo conversions are excluded as they are specific to multifamily properties.
Source: Authors' calculations using MSCI RCA data.

Figure A5: Category Shares (unweighted)

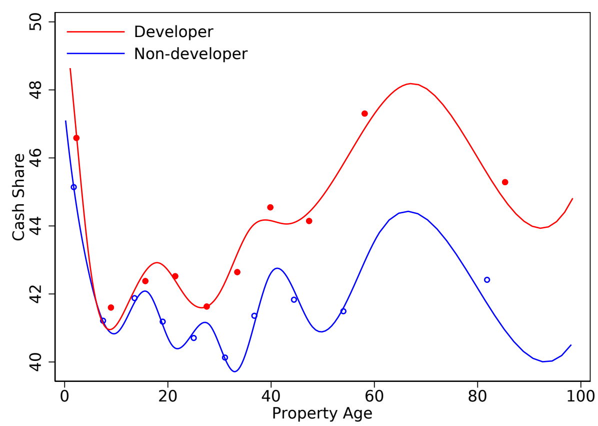


Note: The figure plots the share of observations across categories of buyer objective (top), buyer type (middle), and property type (bottom). Condo conversions are excluded as they are specific to multifamily properties.
Source: Authors' calculations using MSCI RCA data.

Figure A6: Cash Purchase Shares by Development Experience



(a) By Property Quality



(b) By Age

Note: The figures are produced using the Stata command "binsreg" (Cattaneo et al., 2019). Each binscatter regression includes year, property-type, and buyer fixed effects. The dots reflect estimated cash purchase shares by decile of Q-Score (left) or age (right), while the lines plot semi-linear regression estimates with a cubic B-spline. The estimates for developers are in red, and those for non-developers are in blue.
Source: Authors' calculations using MSCI RCA data.

Table A1: Cash Purchases and Redevelopment Options

	Cash Indicator (in percentage points)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Low Q-Score	3.84**	2.82**	2.95**	5.39**	4.40**	4.54**	6.29**	5.71**	5.77**
	(0.46)	(0.53)	(0.52)	(0.43)	(0.51)	(0.50)	(0.57)	(0.65)	(0.64)
Age>25	-3.57**	-3.56**	-4.09**	-2.15**	-2.15**	-2.71**	0.25	0.26	-0.14
	(0.49)	(0.48)	(0.56)	(0.44)	(0.44)	(0.52)	(0.46)	(0.46)	(0.52)
Low Q-Score × Developer		4.97**	4.50**		4.75**	4.27**		2.95**	2.69**
		(1.09)	(1.07)		(0.95)	(0.95)		(1.03)	(1.03)
Age> 25× Developer			2.63*			2.71**			1.98*
			(1.05)			(0.94)			(0.89)
Developer		-0.35	-1.79		-0.03	-1.50			
		(1.07)	(1.34)		(0.77)	(1.01)			
Age<2	8.88**	8.84**	8.80**	6.85**	6.82**	6.78**	4.27**	4.25**	4.24**
	(0.96)	(0.96)	(0.96)	(1.01)	(1.01)	(1.01)	(0.73)	(0.73)	(0.72)
ln(Land Area in Acres)	-1.50**	-1.51**	-1.51**	-2.12**	-2.13**	-2.13**	-2.13**	-2.14**	-2.14**
	(0.16)	(0.16)	(0.16)	(0.13)	(0.13)	(0.13)	(0.12)	(0.12)	(0.12)
Sold Within 5 Years	-2.19**	-2.20**	-2.19**	-1.56**	-1.58**	-1.56**	0.69	0.69	0.70
	(0.61)	(0.61)	(0.61)	(0.54)	(0.54)	(0.54)	(0.46)	(0.46)	(0.46)
R^2_a	0.101	0.102	0.102	0.142	0.142	0.143	0.327	0.327	0.327
Observations	132,077	132,077	132,077	129,753	129,753	129,753	121,762	121,762	121,762
$\bar{Y}$	41.97	41.97	41.97	41.55	41.55	41.55	41.9	41.9	41.9
sd(Y)	49.35	49.35	49.35	49.28	49.28	49.28	49.34	49.34	49.34
Property Type FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
CBSA FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Buyer Type FE	-	-	-	✓	✓	✓	-	-	-
Buyer FE	-	-	-	-	-	-	✓	✓	✓

Note: The sample is limited to purchase transactions in 2005 or later where the buyer has indicated that their intention is investment. $\bar{Y}$ and sd(Y) report the mean and standard deviation, respectively, of the dependent variable in each regression sample. Standard errors, in parentheses, are clustered by buyer. $^{+}$, *, and ** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively.
Source: Authors' calculations using MSCI RCA data.

B. THEORY APPENDIX

In this section of the appendix, we provide further details on the solution to the model described in Section 3. First, we derive the value function shown in Equation (2) and characterize the solution for the optimal renovation time. Second, we present an extension that adds stochastic fluctuations in property incomes.

B.1. Derivations

Equation (1) has the solution:

$$V(t) = \frac{e^{-\delta t}}{r+\delta} + Ae^{rt}, \tag{9}$$

where A is a constant determined by the boundary condition and optimality condition:

$$V(t^*) = V(0) - c,$$
$$V'(t^*) = 0.$$

The first condition is the value-matching condition that the value of the property at the time of renovation is the value of a newly renovated property net of construction costs. The second condition is the smooth-pasting condition required for t^* to be optimal.

We can use the smooth-pasting condition to solve for A as a function of t^*. Differentiating (9) with respect to t, evaluating at t^*, and setting the equation to 0, we can obtain the following:

$$A(r+\delta) = \frac{\delta}{r} e^{-(r+\delta)t^*}.$$

Substituting A into (9) gives us the expression in equation (2):

$$V(t) = \frac{e^{-\delta t}}{r+\delta}\left(1 + \underbrace{\frac{\delta}{r}e^{-(r+\delta)(t^*(c)-t)}}_{\equiv\rho}\right). \tag{10}$$

The optimal renovation threshold, t^*, is defined implicitly by the value-matching condition that $V(t^*) = V(0) - c$. Evaluating (2) at t^* and 0, we can simplify this expression to

$$e^{-\delta t^*}\frac{1}{r} - \frac{1}{r+\delta} - \frac{\delta}{r(r+\delta)}e^{-(r+\delta)t^*} + c \quad = \quad 0.$$

Applying the implicit function theorem thus implies

$$\frac{\partial t^*}{\partial c} = \left(\frac{\delta}{r}e^{-\delta t^*}(1 - e^{-rt^*})\right)^{-1} > 0.$$

This expression demonstrates that t^* increases monotonically in the cost of renovation. To summarize how renovation costs affect property values, when c is zero, $t^* = 0$, and property values are $\frac{1}{r}$. Higher renovation costs then cause renovations to occur later (higher t^*) and property values to decline, reflecting a smaller value of the renovation option (since $\frac{\partial\rho}{\partial t^*} < 0$). In the limit, t^* goes to ∞ as c goes to ∞, and the value of the renovation option goes to 0.

B.2. Extension with Stochastic Cash Flows

In the baseline model, the only changes in income come from depreciation. Under this assumption, income (and hence property values) are a deterministic function of time since renovation. This setup is useful for motivating the primary analysis, as redevelopment option values are a simple function of time. Consequently, the model is closely related to the empirical work that measures redevelopment option values in part by age. However, having a deterministic income flow means that we miss an important component of the option value: the ability to adjust actions following the resolution of uncertainty.

In this section, we present an extension of the model with stochastic income flows. We show that the primary insight from the baseline model holds: redevelopment option values rise as incomes decline toward the redevelopment threshold (which is now defined by an income cutoff rather than time). The extension also allows us to generate an additional prediction: greater income uncertainty increases redevelopment option values and induces some investors to switch to cash financing.

Suppose that property income, denoted X, follows a geometric Brownian motion process:

$$\frac{dX_t}{X_t} = -\delta dt + \sigma dZ_t.$$

Denoting the renegotiation threshold X^*, property values in the continuation region $X \in (X^*, \infty)$ satisfy:

$$rV(X) = X - \delta V'(X)X + \frac{1}{2}\sigma^2 X^2 V''(X), \tag{11}$$

which has the solution:

$$V(X) = \frac{X}{r+\delta} + AX^{-\gamma},$$

where $\gamma = -\left(\delta + .5\sigma^2 - \sqrt{(.5\sigma^2+\delta)^2 + 2\sigma^2 r}\right)/\sigma^2 > 0.$[19]

The rest of the derivation proceeds as before but noting that $V(\cdot)$ is a function of income rather than time. X^* and A satisfy the value-matching and smooth-pasting conditions:

$$V(X^*) = V(1) - c,$$
$$V'(X^*) = 0.$$

Using the smooth-pasting condition to solve for $A(X^*)$ and substituting back into $V(X)$ gives the

[19] $-\gamma$ is the negative root of the quadratic $.5\sigma^2 Z^2 - (.5\sigma^2 + \delta)Z - r = 0$. The general solution to equation (11) also has a term related to the positive root, but we can omit it as the constant of integration is 0.

value function at the optimal X^*:

$$V(X) = \frac{X}{r+\delta}\left(1 + \underbrace{\frac{1}{\gamma}\left(\frac{X^*}{X}\right)^{\gamma+1}}_{\equiv\rho}\right), \tag{12}$$

where X^* is defined implicitly by the value-matching condition. To characterize X^*, we can simplify to:

$$(X^*)^{\gamma+1} - (1+\gamma)X^* + \gamma(1 - c(r+\delta)) = 0. \tag{13}$$

We then apply the implicit function theorem to show that:

$$\begin{aligned} \frac{\partial X^*}{\partial c} &= -\frac{\gamma(r+\delta)}{(1+\gamma)(1-(X^*)^{\gamma})} < 0 \\ \frac{\partial X^*}{\partial \gamma} &= -\frac{\ln(X^*)(X^*)^{\gamma+1} - X^* + 1 - c(r+\delta)}{(1+\gamma)((X^*)^{\gamma} - 1)} \\ &= \frac{X^*}{1+\gamma}\left(\frac{1}{\gamma} - \frac{\ln(X^*)}{1-(X^*)^{-\gamma}}\right) < 0. \end{aligned} \tag{14}$$

The third line comes from substituting (13) back into the second line to remove the term $c(r+\delta)$.[20]

These equations show that owners wait longer to renovate when (1) renovation costs are higher, and (2) cash flows are more variable. The logic behind (1) is the same as in the baseline model: when costs are higher, a greater increase in cash flows is needed to justify renovation. The effect in (2) reflects a greater return to renovation being needed to offset the loss of the option value of delaying an irreversible investment (Dixit and Pindyck, 1994).

We can also use these expressions to characterize the value of the renovation option, ρ. First, it is immediately obvious from (12) that renovation options (i.e., ρ) are more valuable for properties with lower cash flows.

[20]The inequality in the third line uses the characteristic of natural logarithms that $\ln(x) = \lim_{\alpha\to 0}\frac{X^{\alpha}-1}{\alpha}$ and the fact that the right expression is increasing in α.

Second, we can see that renovation options are more valuable when uncertainty is higher. Differentiating equation (12) with respect to σ shows that:

$$\begin{aligned} \frac{\partial \rho}{\partial \sigma} &= \rho \gamma_\sigma \left(\frac{-1}{\gamma} + \ln\left(\frac{X^*}{X}\right) + (1+\gamma)\frac{X^*_\gamma}{X} \right) \\ &= \underbrace{\rho \gamma_\sigma}_{(-)} \left(\underbrace{\ln\left(\frac{X^*}{X}\right)}_{(-)} + \underbrace{\frac{\ln(X^*)}{(X^*)^{-\gamma} - 1}}_{(-)} \right) > 0, \end{aligned} \tag{15}$$

where

$$\gamma_\sigma \equiv \frac{\partial \gamma}{\partial \sigma} = \frac{2\left(.5\sigma^2 + \delta - \sqrt{(.5\sigma^2+\delta)^2 + 2r\sigma^2}\right)}{\sigma^3} < 0.$$

Note that the last line comes from substituting in the expression for X_γ from (14).