# On the value of information signals by peer investors: Evidence from commercial real estate redevelopment

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# Research question

How do local **information externalities** affect investment decisions via **real options**?

Specifically:

- How do local investment decisions made by commercial real estate investors influence the likelihood of subsequent 'buy-to-redevelop' investment strategies in the same area?
- To what extent do these peer investment decisions capitalize into the the transaction price of a property via **real option value**?

# Setting

- We use data on **commercial real estate** transactions between institutional investors in the US from 2000 to 2018 (provided by Real Capital Analytics).
- We focus on the **intention to redevelop** at the moment of the transaction $\longrightarrow$ **intrinsic option value**.
- We consider two main information externalities
  - **Capital intensity gap**: ratio of FAR of nearby recently built buildings to the transacted building.
  - **Type of economic activity mismatch**: share of nearby recently built buildings that have a different economic activity (residential, retail, industrial, or offices).

# Redevelopment option value

Figure: Source: https://www.businessinsider.com

# Approach

- **Theoretical framework** (not for today!) ▸ Model
  - Formalizes key determinants leading investors to exercise a real option.
  - Provides identification strategy (endogeneity issues).
  - Allows to interpret empirical estimates.
- **Empirics**
  - Estimation of relationship between the likelihood of investing for redevelopment and local information externalities (Probit model).
  - Estimation of the intrinsic option value of redevelopment in a causal way (3-step procedure, information externalities as instruments).

# Key findings

- Information externalities strongly affect 'buy-to-redevelop' investment strategies:
  - A one standard deviation increase in capital intensity gap (capital depreciation) increases such likelihood, on average, by 29% (11%) in relative terms.
  - A mismatch between the type of economic activity also increases the propensity to purchase the property for immediate redevelopment, although to a lower extent.
- These information externalities spur redevelopments if they are geographically close.
- In contrast, more distant signals act as a deterrent.
- Intrinsic value of redevelopment up to 30 percent of property transaction price.
  - *Ceteris paribus*: NOI, age, FAR, etc.

# Empirical approach

$$\ln P_{it} = c + \beta_1 D_{it}^{Red} + \theta_2 X_{it} + \epsilon_{it}$$

- Omitted variable and sample selection should not be a problem, but **reverse causality** may well be present! Why?
  - Investors might be more reluctant to redevelop more pricey properties $\longrightarrow$ higher financial exposure
  - Lenders might also be more reluctant $\longrightarrow$ more likely to i) reject the mortgage application, and/or ii) charge higher rates.

$\longrightarrow$ We need an instrument!

# Measures of economic obsolescence

Instruments:

- $\frac{S^{*R}_{it}}{S_{it_0}}$: ratio between Floor to Area Ratios of recently built nearby properties and the one of $i$.
- $H^{*}_{it}$: share of recently built nearby properties that have a different type of economic activity than $i$.

Remarks:

- Developers build to HBU to maximize their profit $\rightarrow$ use information on nearby (10 closest) *new* buildings.
- The instruments' relevance hinges on the extent to which investors consider the investment decisions of other investors as useful information externalities.

# Three-step estimation strategy

We use the following three-step estimation strategy. First, we estimate the following Probit model:

$$D_{it}^{Red} = \Phi\left(\alpha_1 \frac{S_{it}^{*R}}{S_{it_0}} + \alpha_2 H_{it}^{*} + \theta_1 X_{it}\right), \tag{1}$$

where $X_{it}$ contains hedonic characteristics, market potential, and buyer/seller characteristics as controls. $\rightarrow$ We obtain fitted values $\hat{D}_{it}^{Red}$.

Next, we estimate the following 2SLS instrumenting $D_{it}^{Red}$ with $\hat{D}_{it}^{Red}$:

$$\ln P_{it} = c + \beta_1 D_{it}^{Red} + \theta_2 X_{it} + \epsilon_{it} \tag{2}$$

# Data

- Georeferenced transactions of US commercial properties (residential, retail, office, industrial) provided by Real Capital Analytics Inc. (RCA) from 2000 to 2018.
- Focuses on institutional investors.
- Features commercial property characteristics such as transaction price ($P_{it}$), NOI, size of land, FAR ($S_{it}$), year of sale, property type, location, and construction year.
- Contains information on the intent of purchase, i.e., whether purchased for redevelopment ($D_i^{Red}$).
- Hedonic characteristics, market potential, buyer/seller.

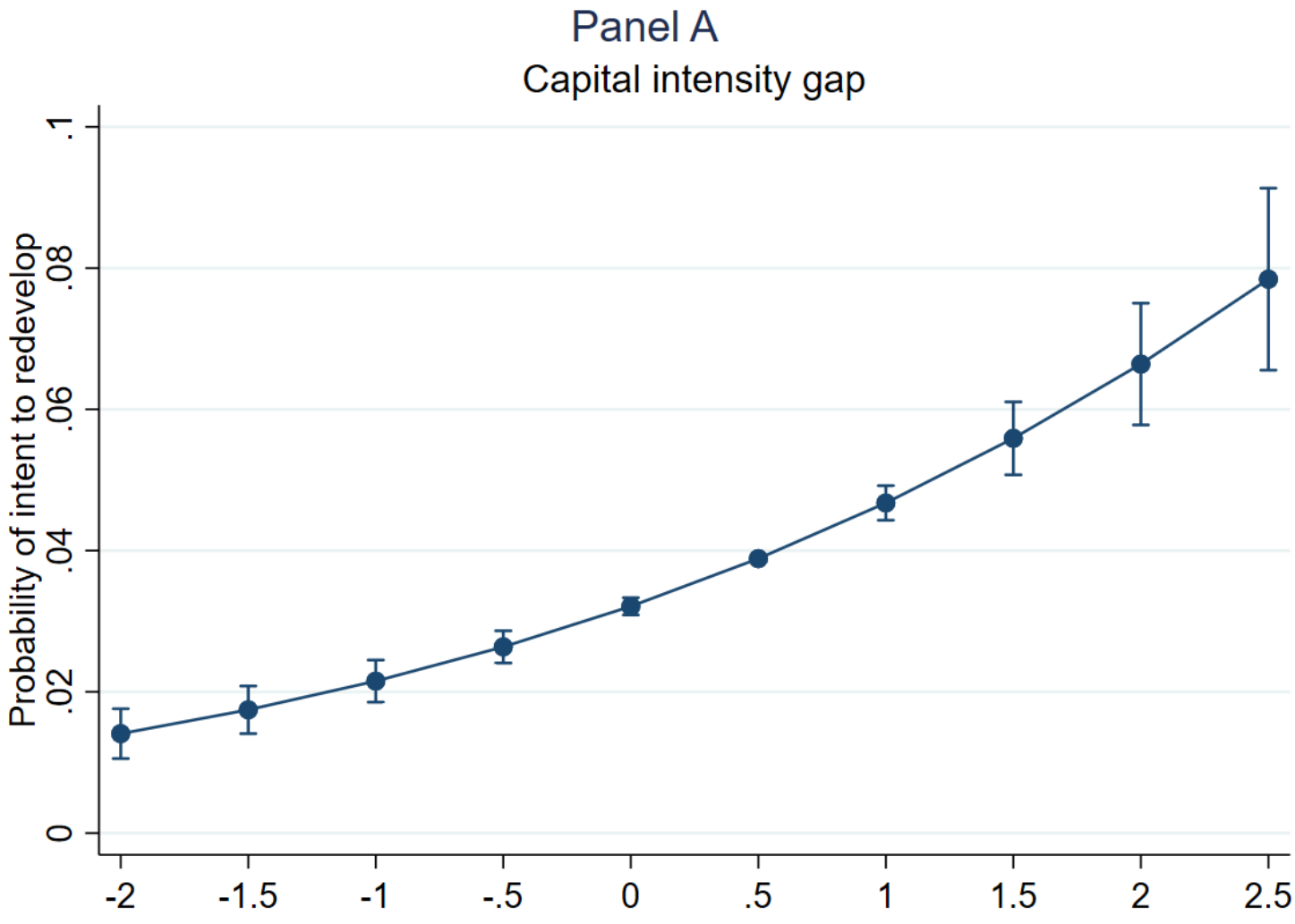
Characteristics

# Probit model

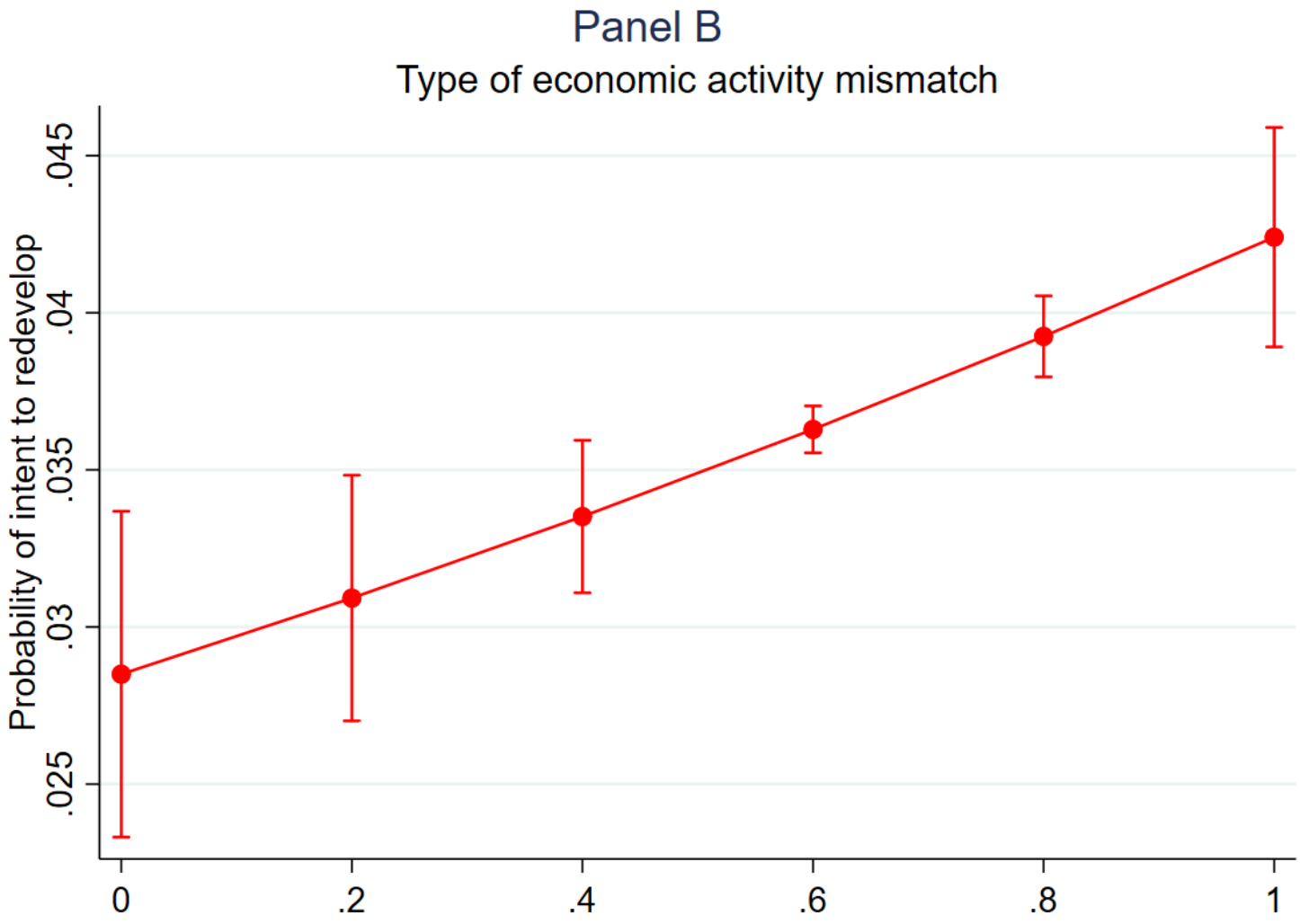
| Panel A - Dependent variable: Redevelopment dummy ($D^{Red}$) | | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Capital intensity gap | 0.273*** | 0.210*** | 0.205*** |
| | (0.025) | (0.024) | (0.025) |
| Economic type mism. | 0.284*** | 0.247*** | 0.214*** |
| | (0.066) | (0.072) | (0.072) |
| Age | 0.113*** | 0.098*** | 0.095*** |
| | (0.010) | (0.009) | (0.009) |
| ln NOI | 0.041* | 0.036 | 0.029 |
| | (0.022) | (0.024) | (0.023) |
| ln FAR | 0.338*** | 0.268*** | 0.255** |
| | (0.099) | (0.100) | (0.101) |
| ln Land | 0.254*** | 0.350*** | 0.320*** |
| | (0.097) | (0.097) | (0.098) |
| Year FE | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes |
| Hedonic char. | Yes | Yes | Yes |
| Market potential | No | Yes | Yes |
| Buyer/seller char. | No | No | Yes |
| Observations | 83,610 | 83,610 | 83,610 |
| AIC | 23,195 | 22,862 | 22,094 |

▸ Average marginal effects

# Capital intensity gap



# Type of economic activity mismatch



# Redevelopment option value model

| Panel A: 2nd stage – Dependent variable: log-price | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | OLS | | IV | |
| Redevelopment | -0.005 | 0.507*** | 0.374** | 0.308*** |
| | (0.025) | (0.176) | (0.160) | (0.115) |
| Age | -0.002 | -0.008*** | -0.008*** | -0.007*** |
| | (0.002) | (0.003) | (0.003) | (0.002) |
| Log-NOI | 0.167*** | 0.164*** | 0.132*** | 0.133*** |
| | (0.009) | (0.009) | (0.007) | (0.007) |
| Log-FAR | 0.086** | 0.079* | 0.080** | 0.093** |
| | (0.044) | (0.044) | (0.038) | (0.037) |
| Log-land area | 0.065 | 0.056 | 0.069* | 0.087** |
| | (0.042) | (0.042) | (0.038) | (0.037) |
| Kleibergen-Paap F | - | 316.37 | 418.05 | 301.23 |

# Redevelopment option value model

| Panel B: 1st stage – Dependent variable: Redevelopment dummy | | | | |
|---|---|---|---|---|
| Redevelopment pot. | | 1.101*** | 1.215*** | 1.171*** |
| | | (0.062) | (0.059) | (0.067) |
| Year FE | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes |
| Hedonic char. | Yes | Yes | Yes | Yes |
| Market potential | No | No | Yes | Yes |
| Buyer/seller char. | No | No | No | Yes |
| Observations | 83,610 | 83,610 | 83,610 | 83,610 |

We also conducted several Robustness checks and City-level ROV.

# Conclusion

- Capital intensity gap and type of economic activity mismatch significantly increase the probability of redevelopment.
  → Concurrent factors determining redevelopment.
  - Provide new evidence on the effect of information externalities on investment decisions.
- Intrinsic value of redevelopment significantly positive.
  → Positive capitalization of information externalities via real options.
  - Reverse causality matters!
- Evidence of 'investment spillovers' → new investments attract redevelopment → urban renewal and growth → insights to policy makers where to expect/stimulate redevelopment.

# Theoretical framework

We build on the work of Capozza and Li (1994) and Clapp and Salavei (2010). A bit of notation

- $P_{it}$ denote the value of commercial property $i$ at time $t$ that was built in $t_0$
- The property generates a periodic net operating income $y_{is}c_{is}$ in $s \geq t$, where $y_{is}$ and $c_{is}$ denote the net operating income per unit of building capacity and the total building capacity
- $c_{is} = AL_i^{\alpha}C_{is}^{1-\alpha}$, where $0 < \alpha < 1$ denotes the land output elasticity, and $A$ the total factor productivity. $S_{it_0} = C_{it_0}/L_i$ is the capital to land ratio $\longrightarrow$ measure of **capital intensity**.

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# Theoretical framework

- The land component of the building capacity is time-invariant, whereas the capital-investment component depreciates at a constant rate $\rho$
- Let $r$ denote the risk-adjusted rate, $g$ the expected income growth rate (Gordon Growth Model setting)

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# Empirical approach

It can be shown that

$$\begin{aligned}\ln P_{it} = c + \ln(y_{is}) + (1-\alpha)\ln(S_{it_0}) \\ -(1-\alpha)\rho(t-t_0) + \ln L_i \\ + \ln\left(r^{Pot}\left(\frac{y_{it}^{*R}}{y_{it}}, \frac{S_{it}^{*R}}{S_{it_0}}, t-t_0\right)\right) + \epsilon_{it},\end{aligned} \tag{3}$$

where the redevelopment potential $r^{Pot}$ is an increasing function of:

- $\frac{y_{it}^{*R}}{y_{is}}$: HBU income to current income ratio
- $\frac{S_{it}^{*R}}{S_{it_0}}$: HBU capital intensity to current one ratio
- $t - t_0$ building age

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# Empirical approach

We do not observe the redevelopment potential $r^{Pot}$
$\longrightarrow$ But we do observe $D_i^{Red}$! We can thus estimate

$$\begin{aligned} \ln P_{it} = c + \ln(y_{is}) + (1-\alpha)\ln(S_{it_0}) \\ -(1-\alpha)\rho(t-t_0) + \ln L_i + \beta_1 D_i^{Red} + \epsilon_{it}, \end{aligned} \tag{4}$$

Issues:

- How do we interpret $\beta_1$, i.e., the intrinsic option value?
- What about endogeneity issues?

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# Empirical approach

Let's discuss these two issues:

- The parameter $\beta_1$ can be interpreted as the *relative* intrinsic option value

$$\beta_1 = E\left(\ln\left(\frac{r_{it}^{Pot}}{r_{it^*}^{Pot}}\right)\right),$$

  i.e., value to redevelop now $(t)$ vs. in the future $(t^* > t)$.

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# Data

Other variables that we use as controls:

- **Hedonic characteristics**: type of commercial building (residential, industrial, office, or retail), a quality index based on the building's physical characteristics, and the number of real estate units in the building.
- **Market potential**: we control for i) a building walk-score index measuring the degree of access to the building without relying on the car or public transportation, ii) a street retail dummy indicating whether street retail in the building is possible, iii) a dummy indicating whether the building is subsidized, and iv) a dummy indicating whether the building is located in an opportunity zone.

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# Data

Other variables that we use as controls:

- **Buyer/seller characteristics**: i) The buyer/seller type of capitalization, ii) the geographic scope of the buyer/seller (local, national, continental, and global), iii) whether the buyer is foreign (dummy), iv) the type of deal between buyer and seller (appraised, approximate, confirmed, private, street talk), v) and whether the owner of building resolved a situation of distress (dummy).

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# Descriptive statistics

| | Mean | SD | 10% | 90% |
|---|---|---|---|---|
| *Panel A: Redevelopment properties (3,133 obs.)* | | | | |
| Price (1000 USD) | 21,196 | 49,548 | 2,826 | 44,170 |
| Age (Years) | 53 | 29 | 18 | 96 |
| NOI (USD/m2) | 217 | 401 | 53 | 392 |
| FAR | 1.953 | 3.243 | 0.224 | 5.094 |
| Land (m2) | 21,519 | 54,095 | 523 | 55,078 |
| Capital int. gap | 2.551 | 2.229 | 0.547 | 5.829 |
| Econ. type mism. | 0.705 | 0.251 | 0.300 | 1.000 |
| Property types | Residential 15.13% | Industrial 19.69% | Office 35.17% | Retail 30.00% |

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# Descriptive statistics

| *Panel B: Non-redevelopment properties (80,477 obs.)* | | | | |
|---|---|---|---|---|
| Price (1000 USD) | 15,679 | 47,269 | 2,550 | 32,695 |
| Age (Years) | 37 | 28 | 6 | 85 |
| NOI (USD/m2) | 152 | 159 | 47 | 282 |
| FAR | 1.210 | 2.122 | 0.212 | 3.231 |
| Land (m2) | 19,832 | 35,525 | 707 | 52,609 |
| Capital int. gap | 1.715 | 1.546 | 0.515 | 3.461 |
| Econ. type mism. | 0.641 | 0.274 | 0.200 | 1.000 |
| Property types | Residential | Industrial | Office | Retail |
| | 38.95% | 17.33% | 21.15% | 22.57% |

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# Average marginal effects

| Panel B - Average Marginal Effects | | | |
|---|---|---|---|
| Capital intensity gap | 0.020*** | 0.015*** | 0.014*** |
| | (0.002) | (0.002) | (0.002) |
| Economic type mism. | 0.020*** | 0.018*** | 0.015*** |
| | (0.005) | (0.005) | (0.005) |

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# Robustness checks

| Robustness – Dependent variable: log-price | | | |
|---|---|---|---|
| (1) County-level time trends | 0.365*** | (2) Non-linear depreciation | 0.253** |
| | (0.116) | | (0.118) |
| Kleibergen-Paap F | 349.42 | Kleibergen-Paap F | 364.85 |
| (3) Impact of imputation 1 | 0.261** | (4) Impact of imputation 2 | 0.357*** |
| | (0.115) | | (0.123) |
| Kleibergen-Paap F | 260.32 | Kleibergen-Paap F | 307.14 |
| (5) Market segmentation | 0.295*** | (6) Positive externalities | 0.266** |
| | (0.112) | | (0.116) |
| Kleibergen-Paap F | 370.98 | Kleibergen-Paap F | 352.86 |
| (7) Classic 2SLS | 0.317 | | |
| | (0.418) | | |
| Kleibergen-Paap F | 17.39 | | |

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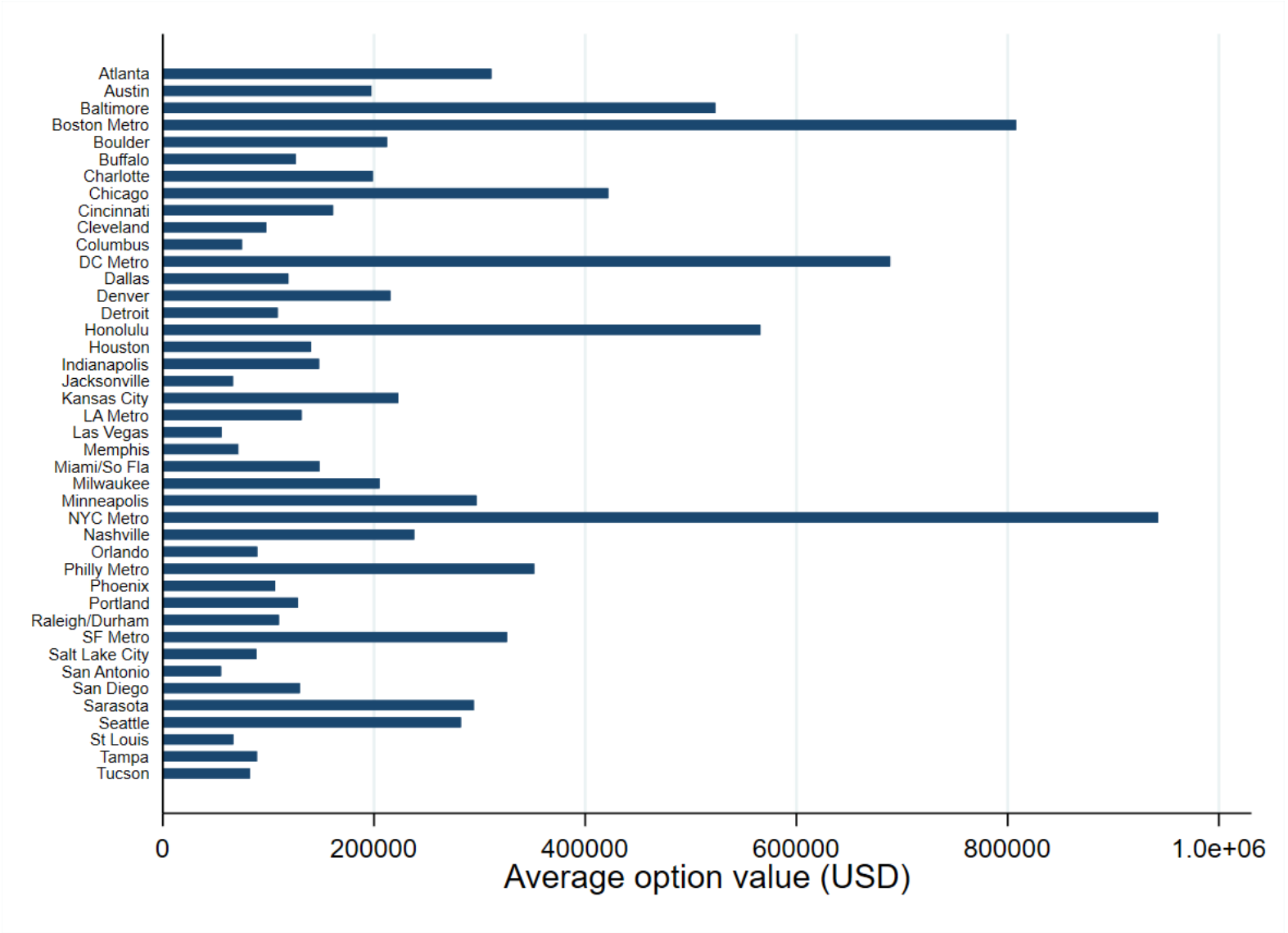
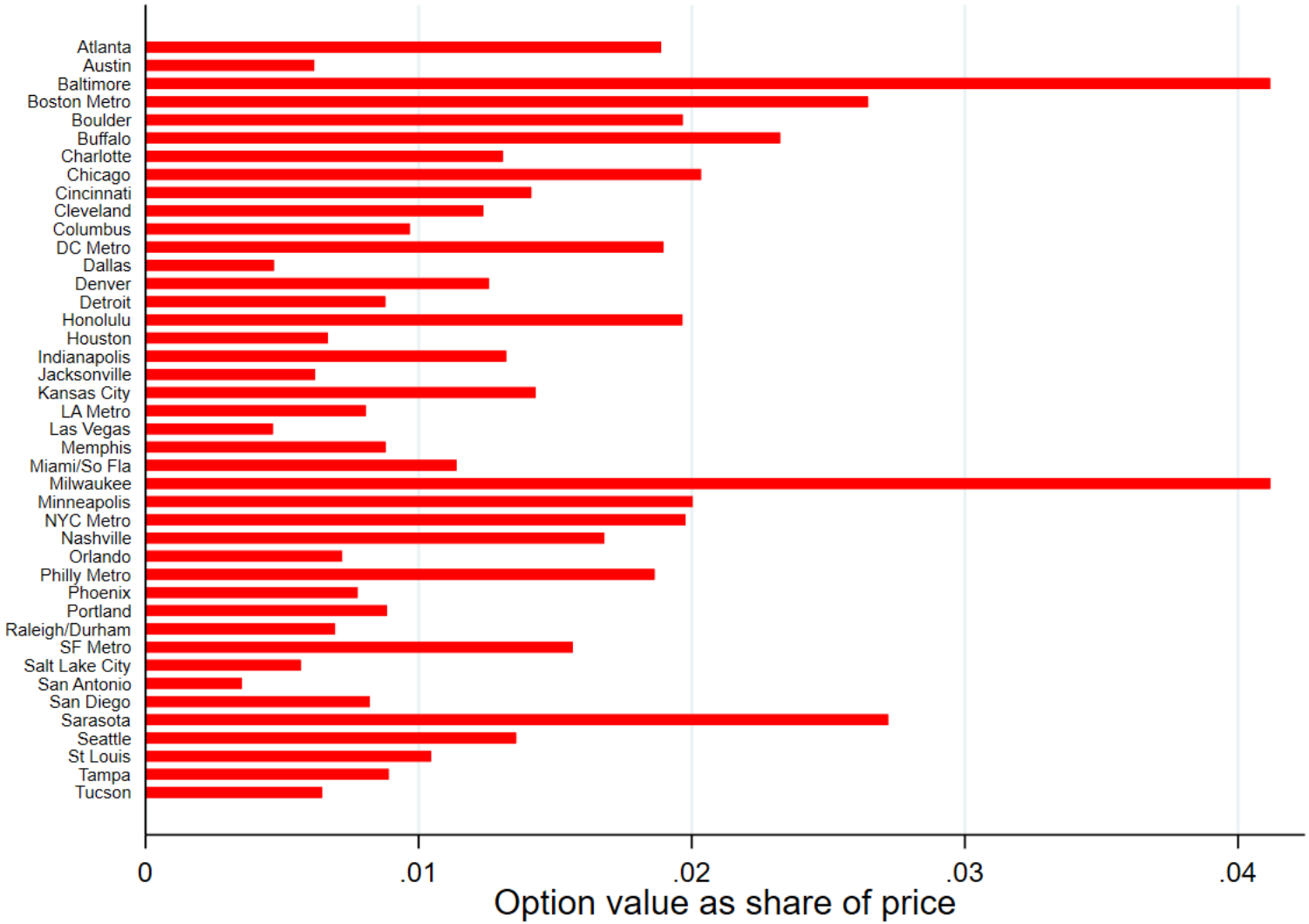
# Heterogeneous option value - USD



# Heterogeneous option value - % of price



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