

Redevelopment Option Value for Commercial Real Estate

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The paper in a nutshell

Research questions:

- What are the determinants leading institutional investors to redevelop commercial real estate properties?
 - Physical depreciation (PD)
 - Economic (and functional) obsolescence (EO)
- What is the *intrinsic* market value that investors attach to redevelopment?

The paper in a nutshell

Approach:

- Theoretical framework (skip for time reasons)
 - formalizes key determinants of redevelopment
 - provides identification strategy (endogeneity issues)
 - allows to interpret empirical estimates
- Empirics (today's goal)
 - Estimation of relationship between probability of purchase for redevelopment and measures of PD + EO (Probit model)
 - Estimation of the intrinsic option value of redevelopment by 2SLS (we instrument with measures of EO)

The paper in a nutshell

Key findings:

- Physical and economic obsolescence are two concurrent factors leading investors to redevelop a property.
 - A one SD increase in our measure of EO increases the probability of redevelopment by about 1 percentage point
 - A one SD increase in PD (building age) increases the probability of redevelopment by about 6 percentage point
- Intrinsic value of redevelopment about 22 percent of property transaction price
 - *Ceteris paribus*: NOI, age, FAR, etc.
 - We isolate the intrinsic option value due to EO

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 (y_{it}), size of land (L_{it}), 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})

Measures of economic obsolescence

Model provides us with three measures for EO (besides PD) affecting redevelopment potential r^{Pot} :

- $\frac{y_{it}^{*R}}{y_{is}}$: highest best use NOI to current NOI
- $\frac{S_{it}^{*R}}{S_{it0}}$: highest best use capital intensity to current capital intensity
- HBU Property type index H_{it}^* : share of HBU property type that match with the current property type

Highest and best use (HBU) quantities y_{it}^{*R} and S_{it}^{*R} and property type are **unobserved** → need to define proxies!

Assumption: developers build to HBU to maximize their profit
→ use information on nearby (10 closest) *new* buildings

Descriptive statistics of our constructed proxies

	Mean	SD	10%	90%
<i>Redevelopment properties (2,494 obs.)</i>				
NOI proxy ($\frac{y^*}{S}$)	4.660	7.238	1.254	9.342
FAR proxy ($\frac{y^*}{S}$)	3.121	4.555	0.616	6.466
HBU property type instrument (H)	0.273	0.249	0.000	0.600
<i>Non-redevelopment properties (43,238 obs.)</i>				
NOI proxy ($\frac{y^*}{S}$)	4.199	6.745	1.267	7.771
FAR proxy ($\frac{y^*}{S}$)	1.909	2.239	0.626	3.622
HBU property type instrument (H)	0.359	0.259	0.000	0.700

Determinants of redevelopment

We do not observe the redevelopment potential \rightarrow observe the intention to redevelop dummy D_i^{Red}

In a first step, we estimate the following Probit model

$$D_{it}^{Red} = \Phi \left(r_i^{Pot} \left(\frac{y_{it}^{*R}}{y_{is}}, \frac{S_{it}^{*R}}{S_{it0}}, H_{it}^*, Age \right) + \theta X_{it} + v_{it} \right), \quad (1)$$

where

- r_i^{Pot} is the redevelopment potential \rightarrow approximated with a linear function of its (observed) arguments
- X_{it} are controls and v is a stochastic error term

Intrinsic option value

In a second step, we estimate the following equation by 2SLS

$$\ln \left(\frac{P_{it}}{L_{it}} \right) = c + \beta_1 D_{it}^{Red} + \beta_2 f(Age) + \beta_3 X_{it} + \epsilon_{it}, \quad (2)$$

where the first stage is given by (1).

Why instrument D_{it}^{Red} ? Reverse causality might be an issue...for example due to borrowing constraints.

The parameter β_1 is 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 ($t^* > t$).

Probit model: Determinants of redevelopment

Dep. var: redevelopment dummy	(1)	(2)	(3)
$\ln \frac{y^*}{y}$ (NOI instrument)	0.123*** (0.015)		0.036* (0.021)
$\ln \frac{S^*}{S}$ (FAR instrument)		0.160*** (0.017)	0.132*** (0.024)
H (HBU property type instrument)		-0.727*** (0.045)	-0.722*** (0.045)
Age	0.028*** (0.002)	0.025*** (0.002)	0.025*** (0.002)
Age ²	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
ln NOI	0.393*** (0.019)	0.285*** (0.020)	0.310*** (0.025)
ln FAR	-0.304*** (0.022)	-0.133*** (0.026)	-0.160*** (0.031)
Constant	-3.983*** (0.165)	-3.335*** (0.165)	-3.416*** (0.172)
Time fe	Yes	Yes	Yes
Metro fe	Yes	Yes	Yes
Proper type fe	Yes	Yes	Yes
Observations	45,732	45,732	45,732
AIC	17,173	16,889	16,888

Redevelopment option value model

Dep. var.: log-price	(1) OLS	(2) IV (i)	(3) IV (ii)	(4) IV (iii)
Redevelopment	-0.067*** (0.014)	0.491*** (0.089)	0.223*** (0.067)	0.279*** (0.067)
Age	-0.010*** (0.000)	-0.013*** (0.000)	-0.012*** (0.000)	-0.012*** (0.000)
Age ²	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
In NOI	0.797*** (0.006)	0.768*** (0.006)	0.782*** (0.006)	0.779*** (0.006)
In FAR	0.278*** (0.007)	0.305*** (0.008)	0.292*** (0.007)	0.295*** (0.007)
Constant	2.782*** (0.024)	2.875*** (0.026)	2.830*** (0.025)	2.839*** (0.025)
Time fe	Yes	Yes	Yes	Yes
Metro fe	Yes	Yes	Yes	Yes
Proper type fe	Yes	Yes	Yes	Yes
Observations	45,732	45,732	45,732	45,732
Kleibergen-Paap F	-	463.48	662.43	667.32

Conclusion

- Physical depreciation *and* economic obsolescence significantly increase the probability of redevelopment → concurrent factors determining redevelopment
 - Provide new evidence on the investments decision process by institutional investors (comparative equity valuation)
- Intrinsic value of redevelopment significantly positive → positive capitalization of economic obsolescence in the redevelopment option value
- Evidence of 'development spillovers' → new investments attract re-development → urban renewal and growth → insights to policy makers where to expect/ stimulate re-development

Thank you for your attention!

Motivation

Urban economic models usually assume that real estate assets are perfectly malleable (supply clears demand)

- evaluate the long-run consequences of a variety of policies
- investigate how cities form and evolve in the long-run

However, relatively little is known about the willingness of real estate investors to exert the right to reconfigure existing tangible capital investments.

- surprising given the sheer size of the commercial real estate markets (about 17 trillion USD in 2018)

Literature

Real options:

- Merton (1973); Black and Scholes (1973); Brennan and Schwartz (1985); Titman (1985); Williams (1991); Quigg (1993); Grovenstein et al. (2011).

Redevelopment option value theory:

- Brueckner (1980); Wheaton (1982); Geltner et al. (2014).

Estimation of redevelopment option value:

- Rosenthal and Helsley (1994); Munneke (1996); Clapp and Salavei (2010); Clapp et al. (2012a); Clapp et al. (2012b); McMillen and OSullivan (2013); Munneke and Womack (2018).

Descriptive statistics

	Mean	SD	10%	90%
<i>Redevelopment properties (2,494 obs.)</i>				
Sales price	389.875	823.417	14.928	981.260
NOI	24.038	45.162	1.574	69.196
Age	47.561	26.812	18.000	91.000
Floor area ratio (FAR)	1.232	1.795	0.215	3.232
Property types	Residential 33.20%	Industrial 23.70%	Office 21.69%	Retail 21.41%
<i>Non-redevelopment properties (43,238 obs.)</i>				
Sales price	215.857	515.385	15.097	504.724
NOI	11.898	27.069	1.174	27.432
Age	38.319	23.369	16.000	79.000
Floor area ratio (FAR)	0.923	1.354	0.217	2.351
Property types	Residential 52.41%	Industrial 13.95%	Office 17.34%	Retail 16.30%

Theoretical framework

Investors decide the optimal time to redevelop *and* capital intensity \rightarrow the price P_{it} of property i built in t_0 at time t is

$$P_{it} = P_{it}^N r^{Pot} \left(\frac{y_{it}^{*R}}{y_{is}}, \frac{S_{it}^{*R}}{S_{it_0}}, t - t_0 \right),$$

- P_{it}^N is the price if the property is never redeveloped. Depends on NOI (y_{is}), land (L_i), capital to land ratio ($\frac{C_{it_0}}{L_i}$), building age ($t - t_0$) + expectations, risk free rate
- r^{Pot} is the **redevelopment potential** (≥ 1).