CENTER FOR REAL ESTATE

Characteristics of Depreciation in Commercial and Multi-Family Property: An Investment Perspective

By:

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MIT Center for Real Estate

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Depreciation from an "Investment Perspective"…

"Depreciation" = "Long-term permanent decline in property value net of general inflation, associated with building age, caused by structure obsolescence *even after* expenditure on routine capital maintenance."

"Obsolescence" = "Physical", "Functional", or "Economic"…

"Investor Perspective" = "Fundamental impact of depreciation on investment performance"

- ➔ Economic (not accrual accounting) perspective
- ➔ Focused on cash flows & market values (not "book values")
- ➔ Compatible with IRR or HPR metrics of investment performance
- ➔ Decline relative to ***property value*** not just structure value (though attributable to structure obsolescence)
- ➔ Not same as tax policy perspective (though related).

Study features:

- ➔ Larger more comprehensive database: 73,229 obs 2001-13, sales > $2.5M, from RCA database of investment properties.
- ➔ Based on actual transaction prices not appraisals or assessments.
- ➔ NOI effect vs "cap rate creep" effect.
- ➔ Cause of differences across metros.

Why does depreciation matter?...

- Affects the capital return (hence total return) of CRE investment
- Real depreciation is ubiquitous in CRE investment property, and it is non-trivial (We find close to 150 bps/yr including land value ➔ ≈25% asset val).
- But it is often ignored in micro-level DCF valuation analysis of investment property:
  - Typical pro-forma automatically projects rental growth of "3%", vaguely basing that on inflation (even though actual inflation is probably less than 3%), not recognizing that real depreciation means that rents are likely to grow less than inflation. (The offset is the typical proforma applies a discount rate that is unrealistically higher than actual expected IRR.)
- And real deprecation has "characteristics." It varies across:
  - Metro markets (related to space mkt supply elasticity)
  - Types of properties
  - Age of the built structure on the property
  - Property market conditions
- So, depreciation is important for investors to understand…

Measure depreciation by "used asset vintage price" method:

Use hedonic regression model:

Ln(Price/SF) = f(Property Attributes, Transaction Info, Location Controls, Time Dummies)

- Property Attributes = PropertyType, LnSqft, Age, Age^2, cbd_fg
- Transaction Info = SellerType, resolveddistress_fg, cmbs_fg, leaseback_fg, excess_land_potential_fg
- Location Controls = RCA Metro Area dummy variables

In this specification Age & Age^2 coefficients capture essentially *cross-sectional* variation in price as a function of building age, i.e., age as of a given time (time of sale). E.g., How much less 30-yr-old Bldg A sells for compared to otherwise identical 20-yr-old Bldg B as of the same point in time. Hence:

"**real**" (net of inflation) depreciation.

Also note: this is depreciation **net** of routine capital expenditures on the properties (which are not controlled for).

Similar hedonic model of <u>cap rates</u>:

StandardizedCapRate = *f*(Hedonic Varbs, Time Dummies)

Hedonic varbs:

Age, Age^2,
LnSqft,
cbd_fg,
resolveddistress_fg,
cmbs_fg,
leaseback_fg,
excess_land_potential_fg,
SellerDummyVars
PropertyType, RCA Metro Dummies

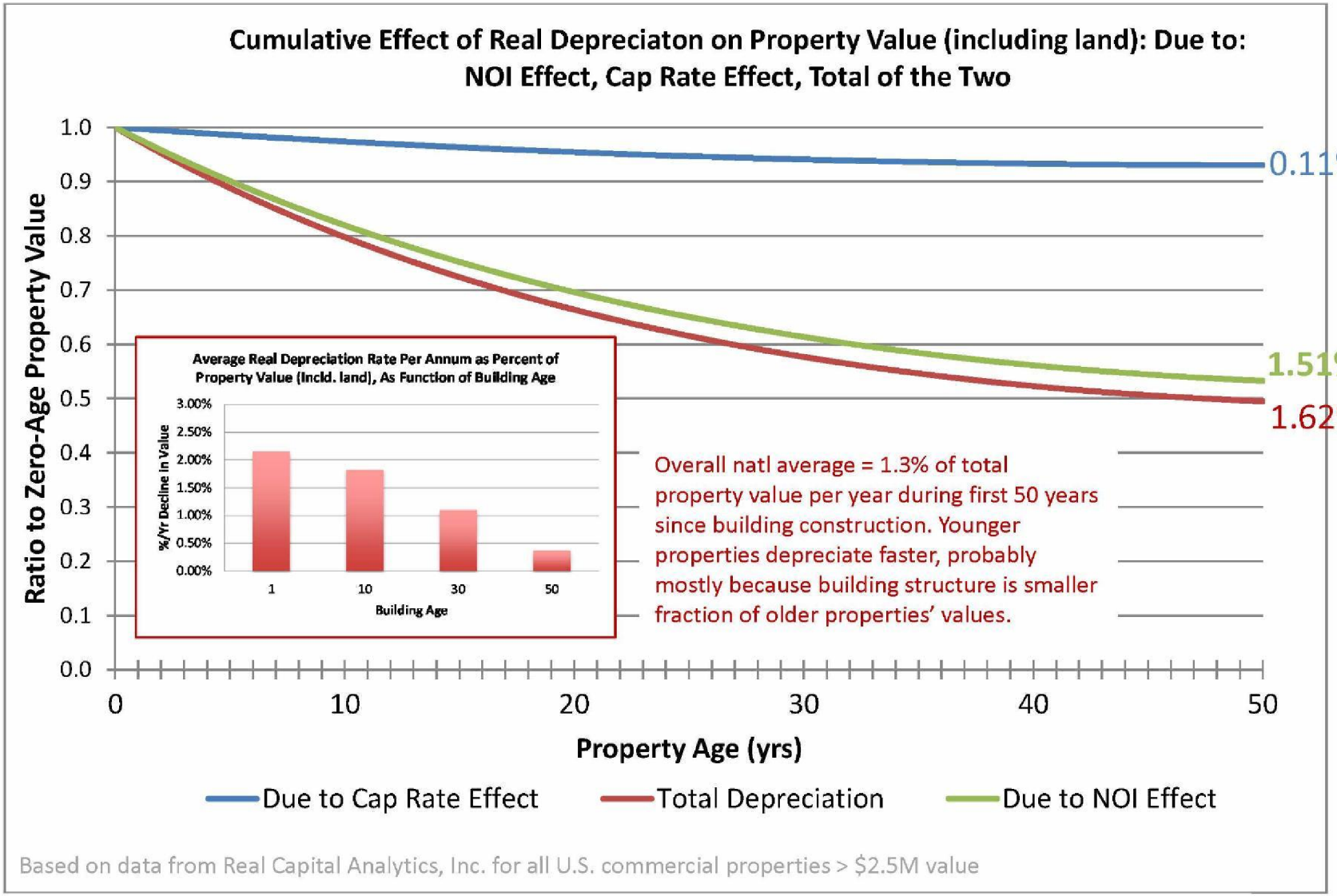
Where: StandardizedCapRate = CapRate – AvgCapRate(by Metro & Year)

In this specification Age & Age^2 coefficients capture essentially *<u>cross-sectional</u>* variation in cap rates as a function of building **age**. Systematic variation in cap rates across markets & across time are controlled for by the standardization.

Results for the national all-property sample, 73,229 trans obs, Price & Caprate models together…

Real Depreciation in U.S. Commercial Properties

Mostly due to NOI decline (only slightly to cap rate creep)

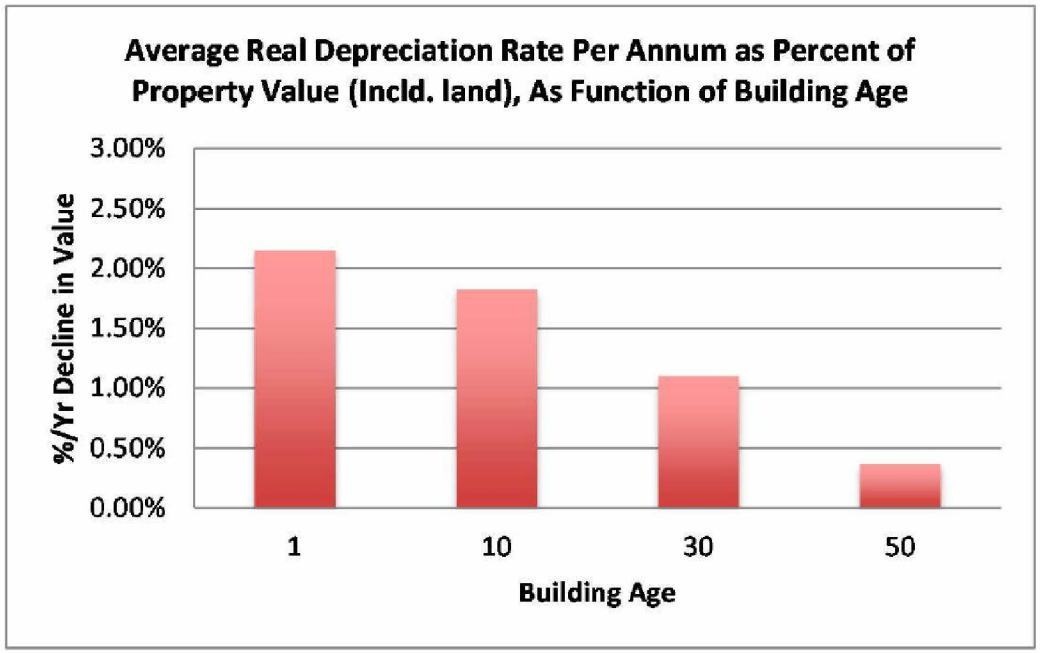


Based on data from Real Capital Analytics, Inc. for all U.S. commercial properties > $2.5M value

"NOI Effect" reflects some combination of lower rent, lower avg occupancy, or higher operating expenses.

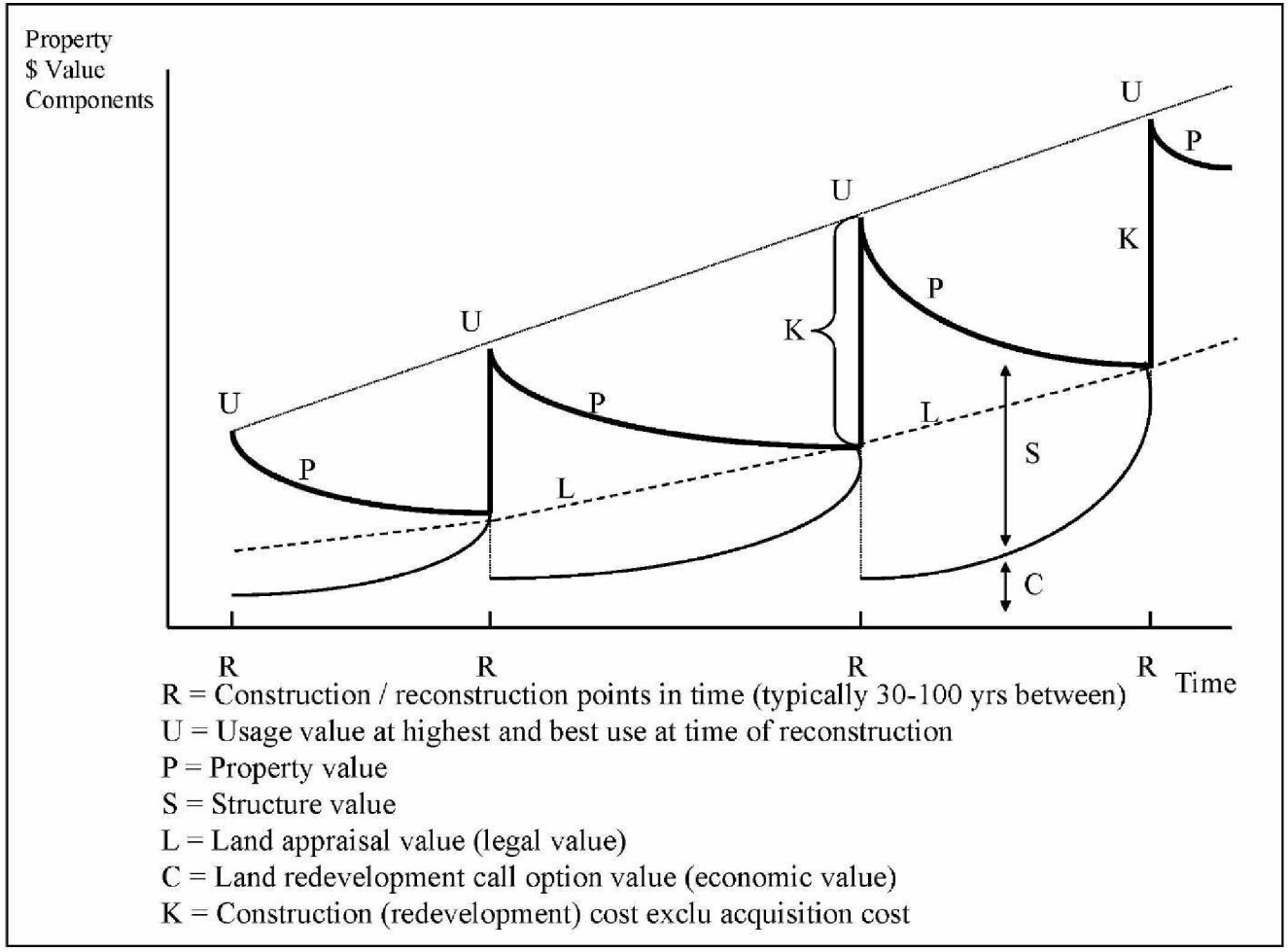
Magnitude of real deprecation:

- Overall average rate: 1.3% of total property value (inclu land) per year (based on median property age).
- E.g., if real deprec = 1.3% and inflation = 2.5% then observed nominal increase in same-property price is 2.5% - 1.3% = 1.2%/yr on avg.
- Faster deprec rate in properties with younger buildings, mostly due to decline of structure proportion of total property value (see next slides).
- Equates to approx 6%/yr of remaining structure value (excluding land) for median-age building (24 yrs old).
- This is in spite of capex. E.g., if capex averages 2% of property value/yr, then presumably without the capex the real depreciation would be at least 1.3%+2%=3.3% of prop val or about 16% of remaining structure value/yr.*



*At median building age structure is 20% of total property value depreciating at 6%/yr (of structure value). If capex is 2% of total property value, then it 10% of structure value, hence, sum of depreciation + capex as fraction of remaining structure value is: 6% + 10% = 16%.

Stylized depiction of property life cycle, value components over time: Value on a single land parcel in a place with increasing real location (usage) value, history spanning perhaps 200 years. Real depreciation drags property real value (P) down between redevelopments…



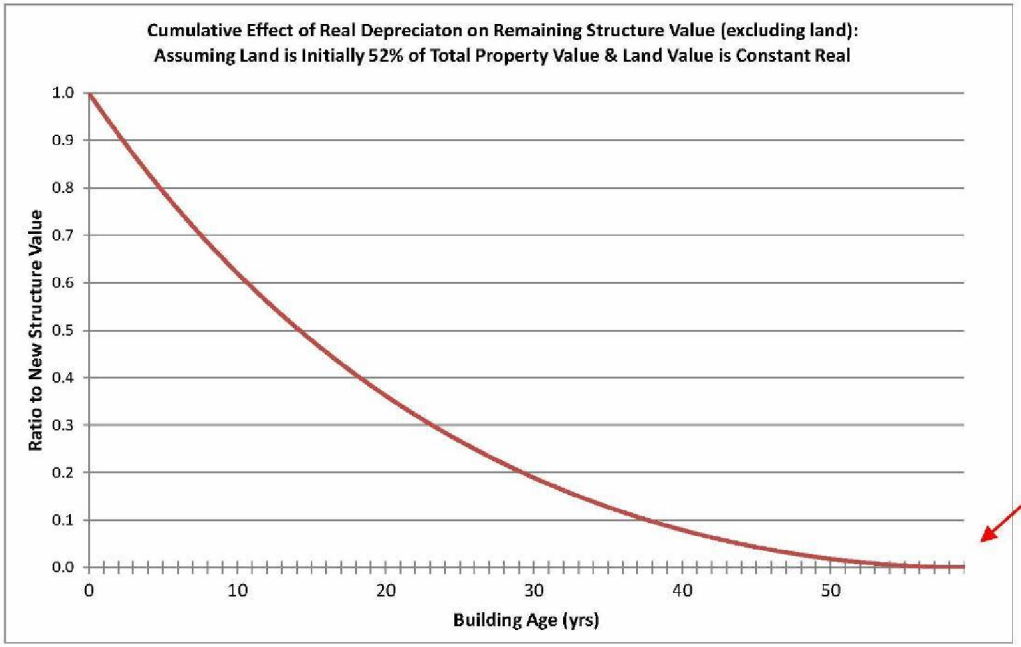
R = Construction / reconstruction points in time (typically 30-100 yrs between)
U = Usage value at highest and best use at time of reconstruction
P = Property value
S = Structure value
L = Land appraisal value (legal value)
C = Land redevelopment call option value (economic value)
K = Construction (redevelopment) cost exclu acquisition cost

Computing the implied average structure lifetime…

Empirically estimated hedonic price model (as fcn of bldg age):

$$\text{Ln}(P/SF) = -0.0219474(\text{Age}) + 0.0001843\ (\text{Age}^2)$$

This is a quadratic function of age. It has a minimum point (over Age). Beyond that minimum point there is no further property depreciation. Therefore, at that minimum point, the building structure is fully depreciated (assuming that it is only the structure that depreciates, not the land).



Find this minimum point using calculus (set derivative wrt Age equal to zero):

dLn(P/SF)/dAge = -0.0219474 + 2*0.0001843*Age = 0, ➔

Age at which no further depreciation = 0.0219474 / 0.0003686 = 60 yrs.

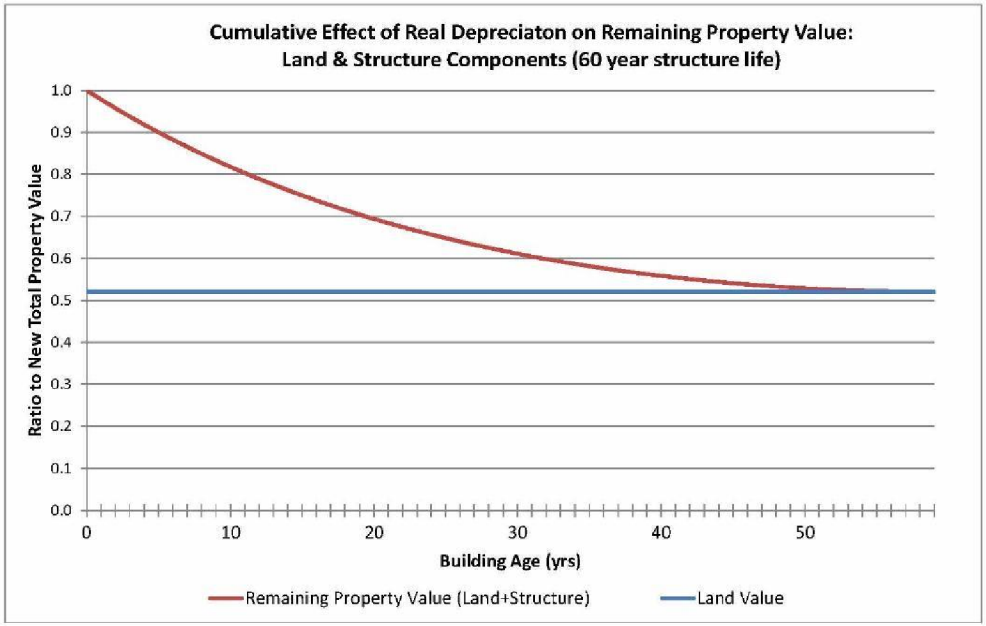
Computing the implied land value fraction at (re)development…

Age at which no further depreciation = 0.0219474 / 0.0003686 = 60 yrs.

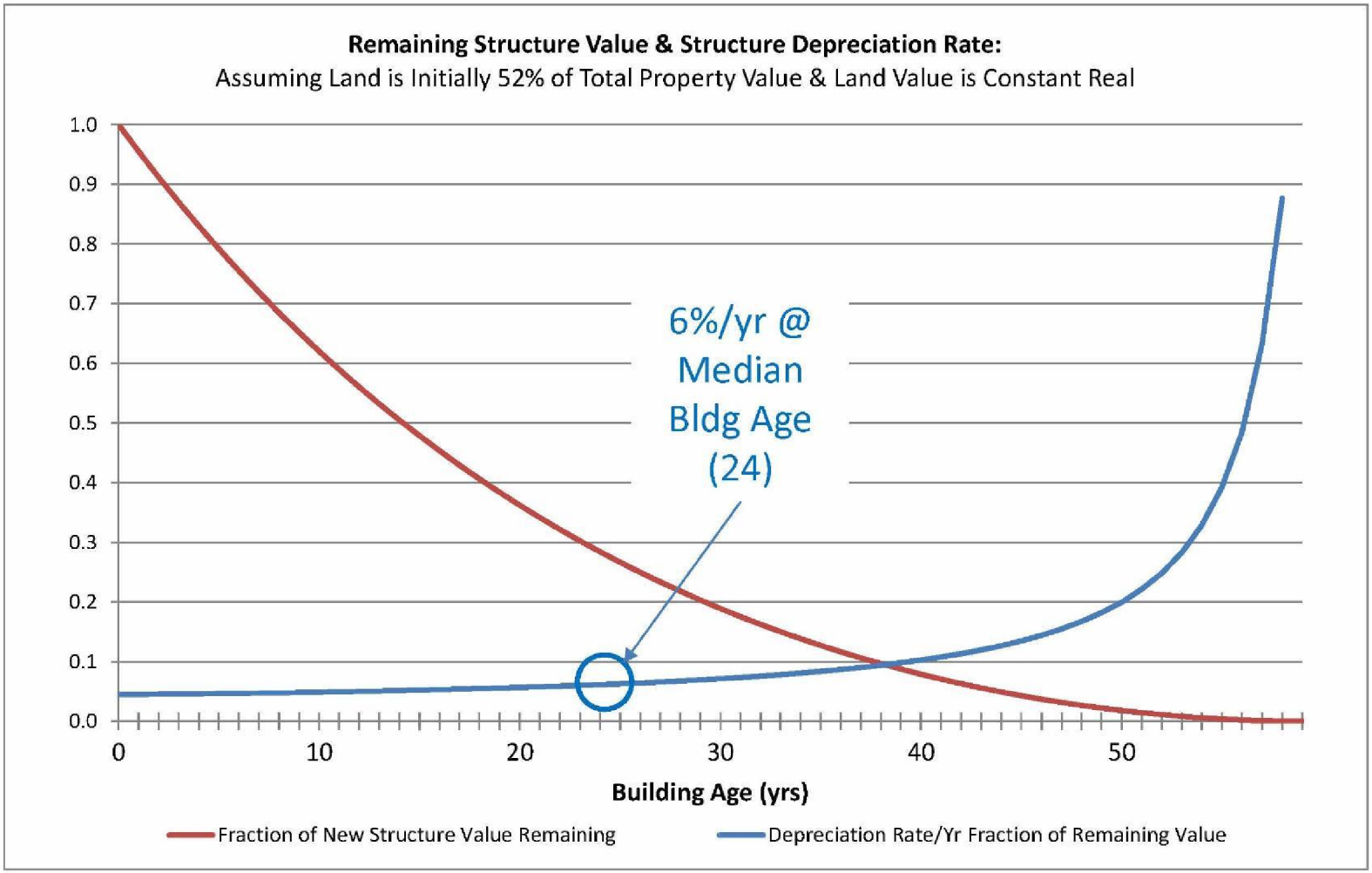
When the building is no longer depreciating it is worthless, hence, time for redevelopment. At that point, entire property value is land value. As a fraction of value of newly-built property value, this pure land value component found by plugging the building lifetime age (i.e., age when structure becomes worthless as indicated by no further depreciation) back into our hedonic price equation as a function of building age (exponentiate to get from logs to levels):

$$\mathbf{Exp(Ln(P/SF)) = Exp(-0.0219474(60) + 0.0001843\ (60^2)) = 0.52.}$$

Land value fraction is 52% of newly-built property value (structure is 48%).

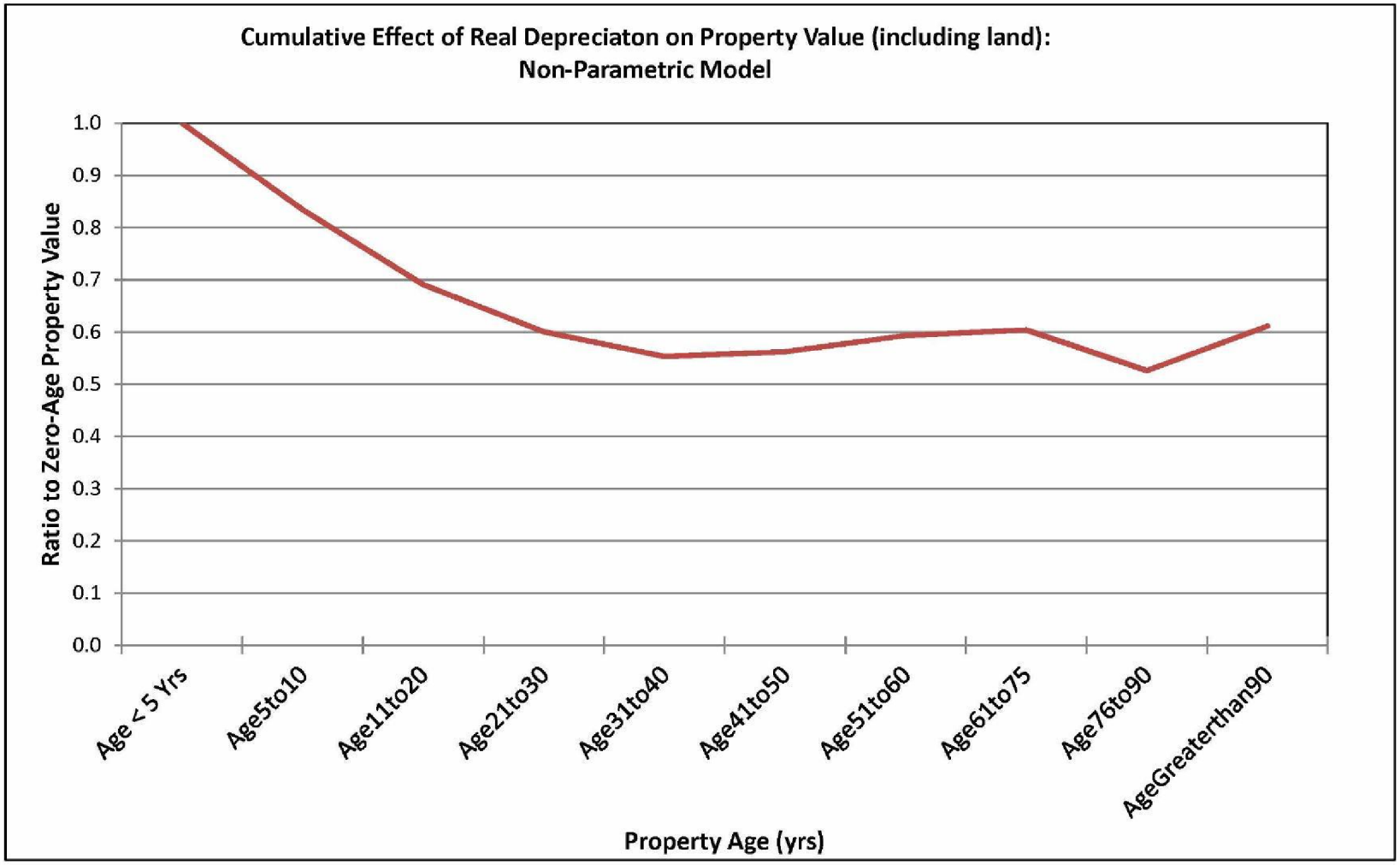


Fraction of Structure Value Remaining
&
Rate of Structure Depreciation/Yr…



The rate of structure depreciation as a fraction of structure value does not decrease with building age, it increases (ultimately becoming very great as the building nears the end of its lifetime and loses all its remaining value).

Non-parametric model also suggests depreciation peters out in the 40 to 90 year age range, with still about half of original property value remaining…



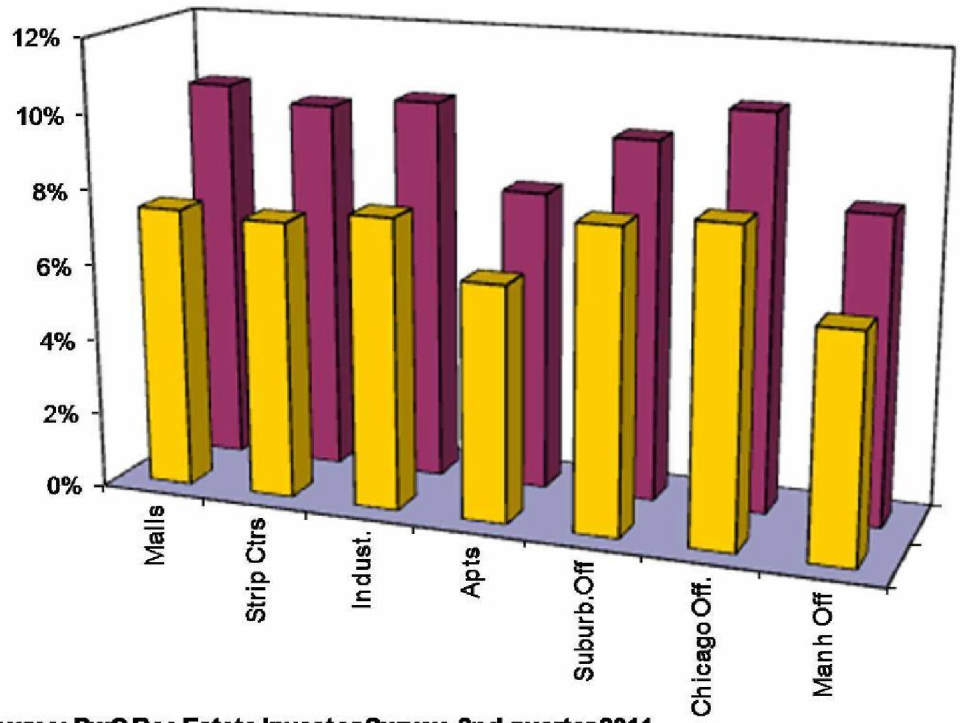
However, the building sales database is inherently "right censored":
Does not include the properties that were demolished already.
Further work (not reported here) will examine data on demolitions.

The finding about the **small role of cap rate creep** is a little surprising. Typical industry expectations are that "non-institutional" property sells at cap rates about 200 bps above "institutional" property. Supposing this reflects depreciation of a new "institutional" property to a fully "non-institutional" property over a 50-year period, then this implies a cap rate creep effect of about 50 bps/year:

((1/.10)/(1/.08))^(1/50)-1 = -.0045

Yet we find an average cap rate creep effect on value of only 11 bps/yr. This implies that the NOI source of real depreciation (rent – vacancy – oper expenses) accounts about 93% of property real depreciation, implying NOI of avg 50-yr-old bldg is 53% that of new bldg in real terms. If some of this is due to lower occupancy & higher oper exps, then this is consistent with non-instl rents approx 2/3 of otherwise equivalent instl rent.

Exh.11-8b: Investor Cap Rate Expectations for Various Property Types*



***Source: PwC Rea Estate Investor Survey, 2nd quarter 2011**

	Malls	Strip Ctrs	Indust.	Apts	Suburb.Off	Chicago Off.	Manh Off
Institutional	7.50%	7.40%	7.76%	6.29%	8.04%	8.33%	6.00%
Non-institutional	10.29%	9.90%	10.18%	7.99%	9.58%	10.50%	8.13%

Source: © Exh.11-8b (p.251) Geltner-Miller "Commercial Real Estate Analysis & Investments" 3e, OnCourse Learning (2014)

Cap Rate Life Cycle:

- The fact that the property depreciation rate decreases with building age reflects the fact that land does not depreciate, only the structure, and as the structure depreciates it becomes a smaller fraction of the total property value.

- This would make the nominal appreciation (value growth) rate increase with building age (starting from an ever-lowering level due to depreciation).

- Since the cap rate essentially equals discount rate minus growth rate ($y = r - g$), depreciation could make the cap rate actually decline with building age. But we don't see this (quite), because…

- As the building ages, depreciation makes the structure value component of the property value a smaller fraction, the land value fraction increases, and…

- Land value is more risky than structure value. Land is a call option (on the next structure, strike price = construction cost). Land is a residual value. Most of the longitudinal volatility in property value is volatility in land value (construction costs don't have much volatility). Thus…

- The discount rate (opportunity cost of capital) for computing property present value, which must include a risk premium ($r = rf + RP$), increases with building age.

Why Cap Rate Creep Is So Small:

- Cap rate creep (higher cap rate as building ages) is so small for the reason noted on the previous slide. Cap rate might not even increase at all with building age, as the property depreciation rate decreases with building age, meaning that nominal value growth increases with building age.

- Cap rate creep only *seems* small because it is less than what is typically conventionally assumed in appraisal and underwriting at the individual deal level. Going-out cap rates are typically assumed to be 50 bps higher than going-in cap rates *ceteris paribus* (apart from market cycle and property-specific vintage lease considerations) in a 10-year DCF analysis. The rate of cap rate creep we find equates to:

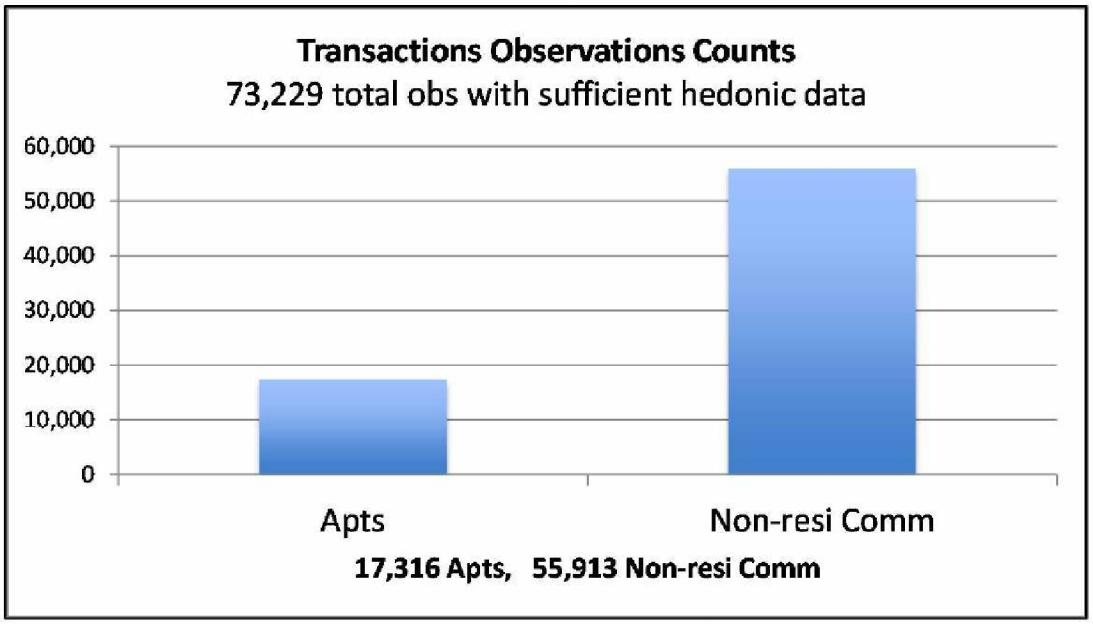
- Going-out cap rate only 7 bps above going-in cap rate if the going-in rate is 6%, or going-out cap rate only 11 bps above going-in if going-in is 10%, in a 10-yr DCF.

- So, the appraisers' and underwriters' conventional assumption of 50 bps differential is wrong (by our evidence, for typical RCA property, typical U.S. CRE property > $2.5M).

- Appraisers & underwriters typically ignore (at least partially) the magnitude of real depreciation in the property NOI growth rate they project. Thus, overstating NOI growth in the DCF analysis. Thus,…

- In order to get correct current discounted PV for the property (which they generally do), appraisers & underwriters MUST do some combination of discount at unrealistically high opportunity cost of captital, &/or apply a going-out cap rate that is unrealistically high. Apparently they do some of both.

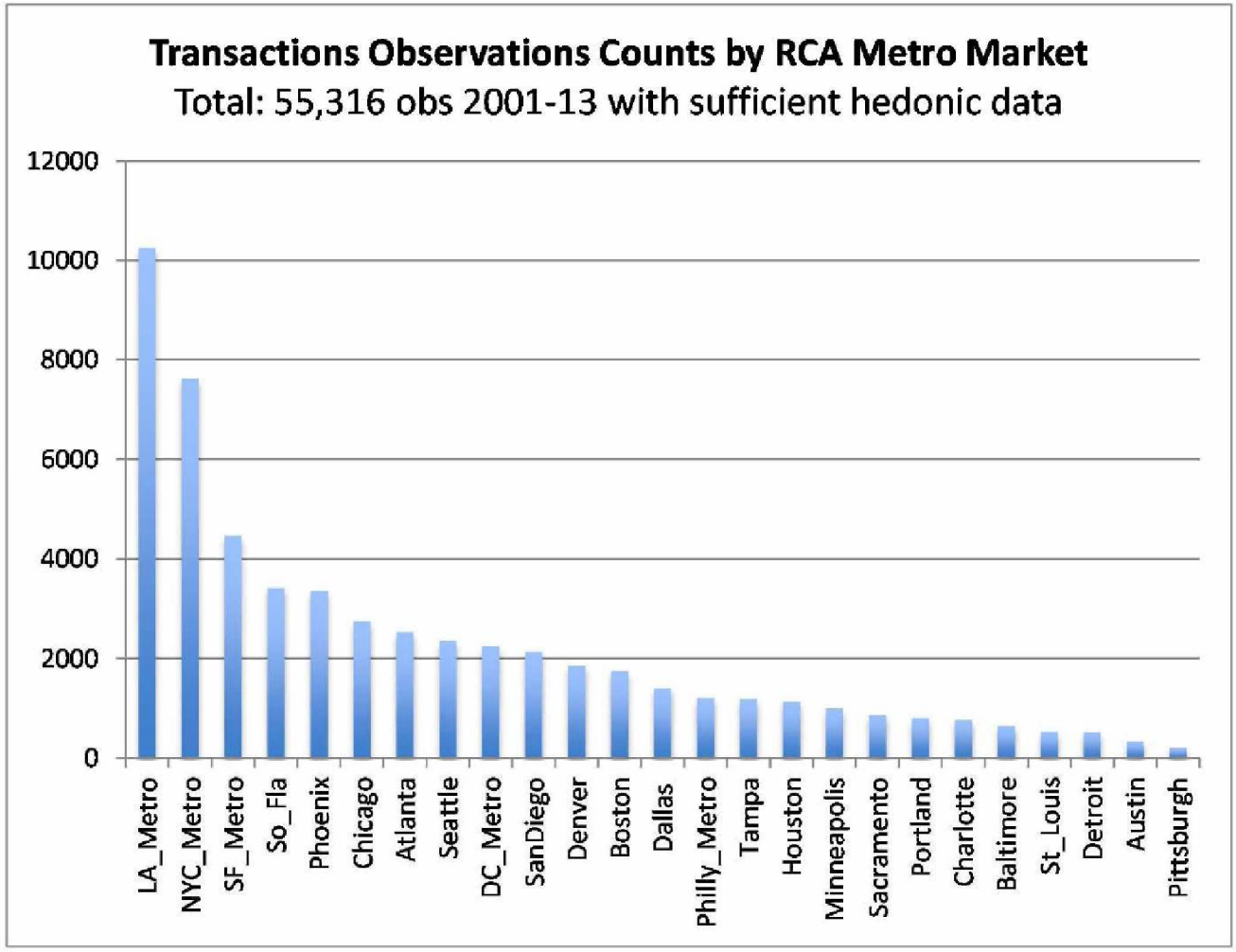
RCA database obs with previously-noted hedonic variables and sales between 2001 & 1Q2013: More Comm than Apts, and Apts avg almost 10 yrs older than Comm…



AGE Means & Medians in the Samples:			
	Sample N	Mean	Median
Natl-AllProp	73229	29	24
Natl-Apts	17316	37	33
Natl-Comm	55913	27	22
Caprate subs	21910	24	20
Bubble	23885	30	24
Non-Bubble	49344	29	24

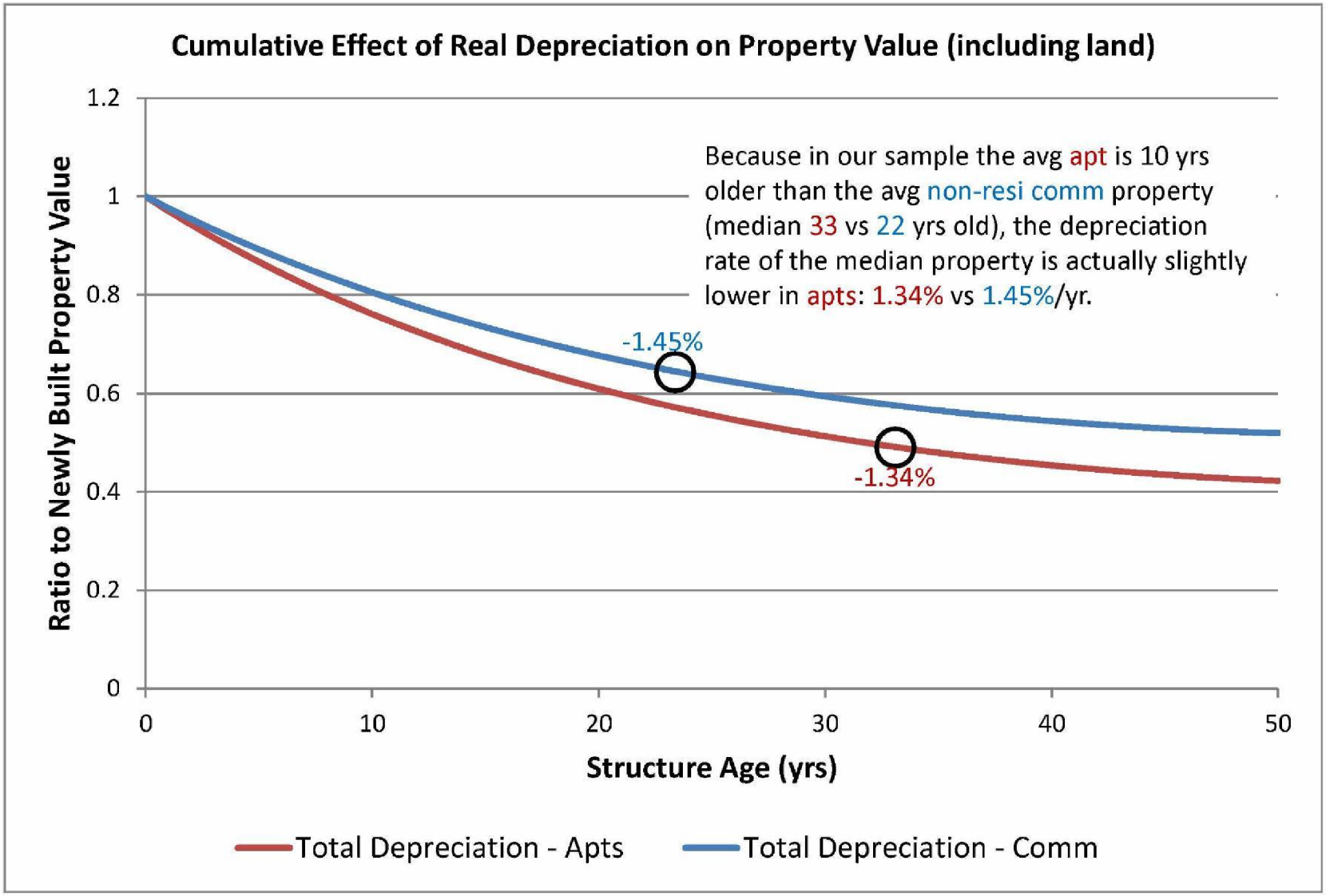
Note: we have filtered out the few obs with property age > 100 yrs, to avoid "historical structure" effects.

RCA database obs with previously-noted hedonic variables AND located in top-25 RCA metros (by obs), sales between 2001 & 1Q2013:



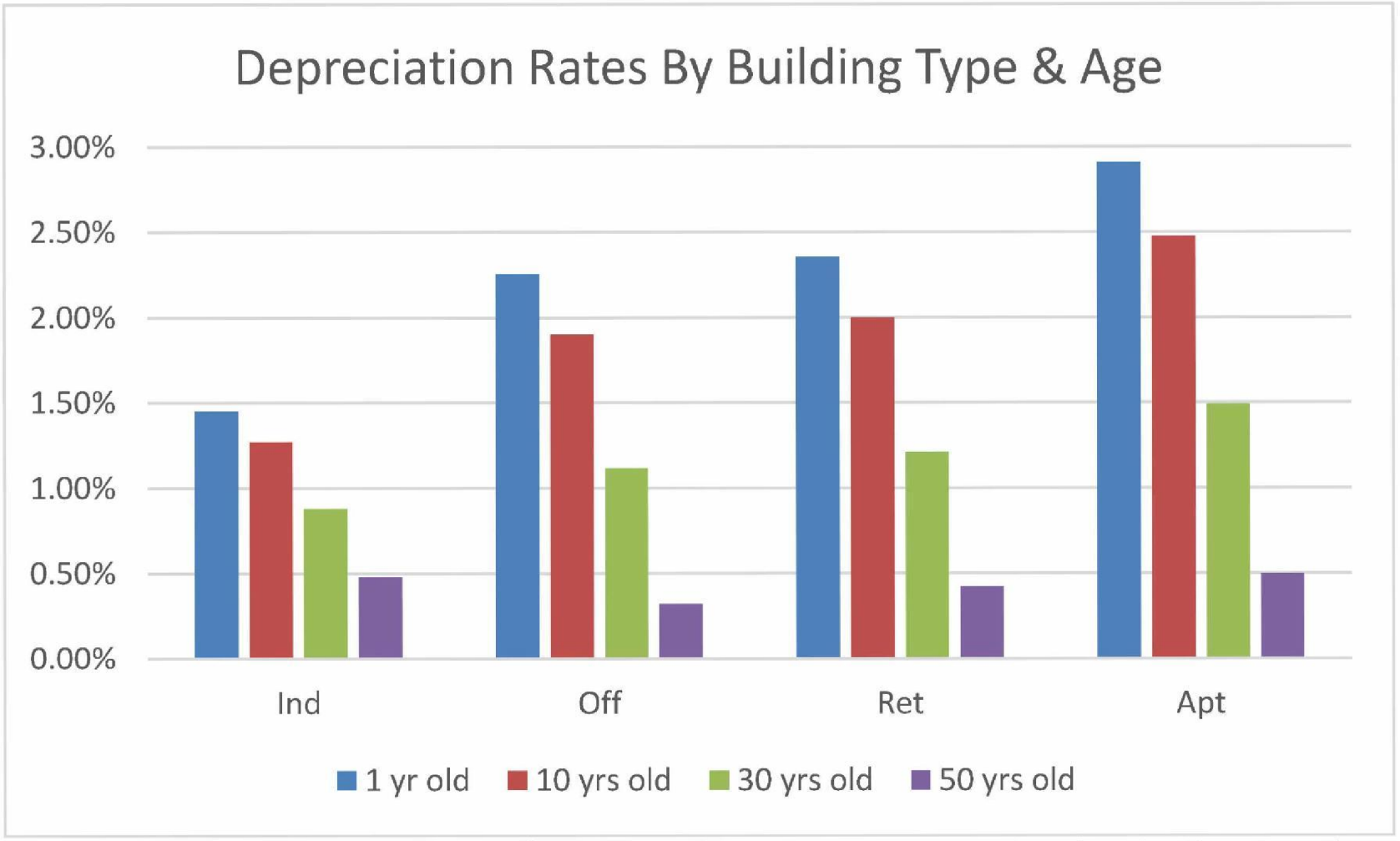
Max is LA_Metro with 10,246 obs; Min is Pittsburgh with 208 obs.

In the aggregate, apt & non-resi commercial depreciation is very similar (controlling for age, slightly more in apts, avg 1.7%/yr vs 1.3%/yr)



Based on data from Real Capital Analytics, Inc. for all U.S. commercial properties > $2.5M value

Until buildings are very old, apartment properties depreciate slightly faster, industrial slightly slower, office & retail in between. Properties with younger buildings always depreciate faster (smaller land value fraction).



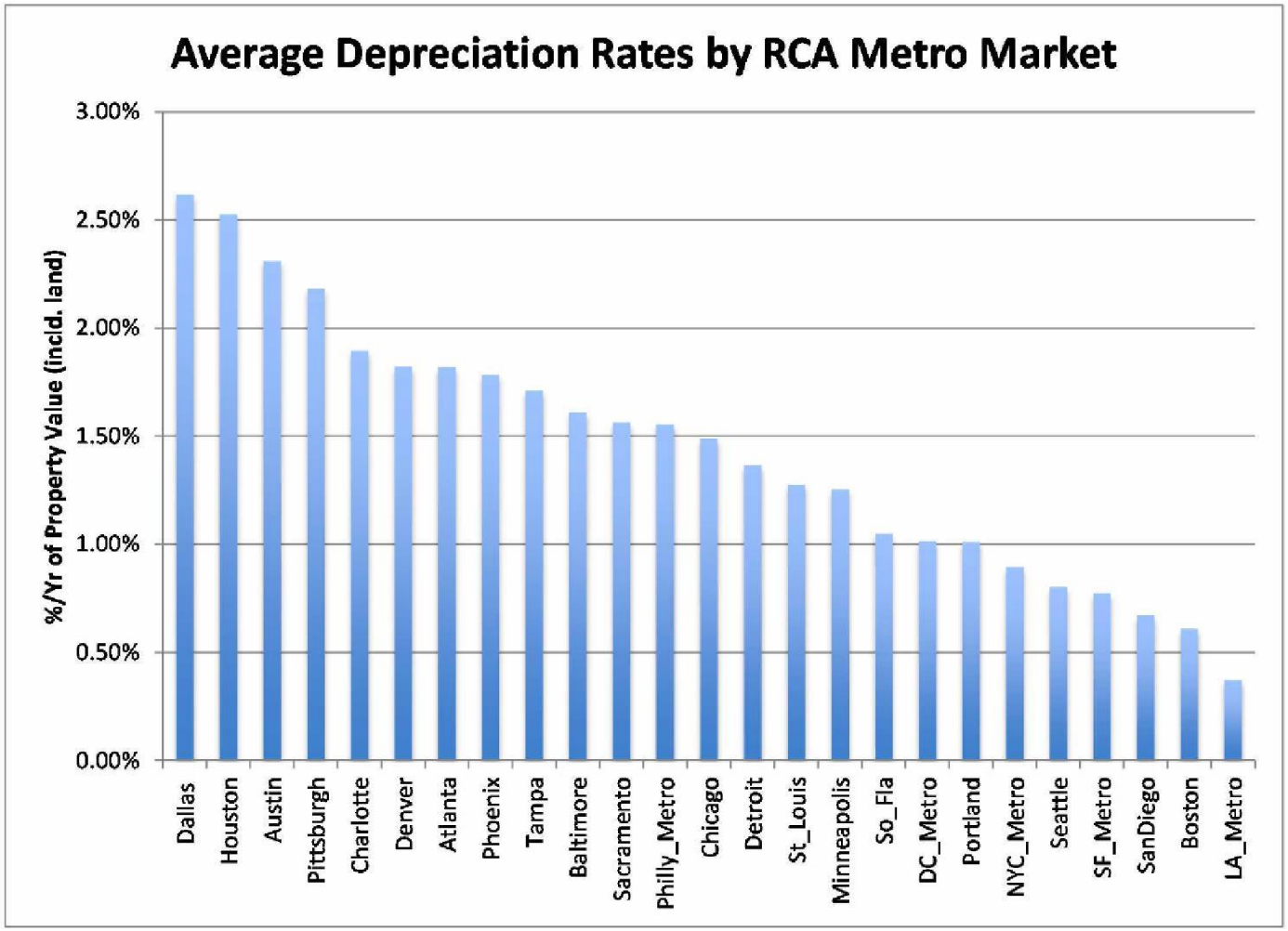
Depreciation per year as fraction of total property value (including land)

Based on data from Real Capital Analytics, Inc. for all U.S. commercial properties > $2.5M value

Estimated depreciation rates as a function of building age, by RCA Metro Mkt, sorted from highest to lowest depreciation rates…

Real Depreciation Rates Per Annum:					
	Building Age (Yrs):				
Metro Market:	**1**	**10**	**30**	**50**	Average
Dallas	4.84%	3.94%	1.89%	-0.20%	2.62%
Houston	3.38%	3.03%	2.25%	1.46%	2.53%
Austin	3.50%	3.01%	1.92%	0.81%	2.31%
Pittsburgh	3.37%	2.88%	1.79%	0.69%	2.18%
Charlotte	2.79%	2.42%	1.60%	0.77%	1.90%
Denver	2.96%	2.49%	1.45%	0.39%	1.82%
Atlanta	3.22%	2.65%	1.36%	0.05%	1.82%
Phoenix	3.23%	2.64%	1.31%	-0.04%	1.79%
Tampa	2.78%	2.34%	1.36%	0.36%	1.71%
Baltimore	2.36%	2.05%	1.36%	0.67%	1.61%
Sacramento	2.35%	2.03%	1.30%	0.57%	1.56%
Philly_Metro	2.35%	2.02%	1.29%	0.56%	1.56%
Chicago	2.16%	1.89%	1.27%	0.64%	1.49%
Detroit	2.19%	1.85%	1.09%	0.33%	1.37%
St_Louis	1.96%	1.68%	1.05%	0.42%	1.28%
Minneapolis	1.66%	1.49%	1.12%	0.74%	1.25%
So_Fla	2.26%	1.76%	0.65%	-0.47%	1.05%
DC_Metro	1.55%	1.33%	0.84%	0.34%	1.01%
Portland	1.39%	1.23%	0.89%	0.54%	1.01%
NYC_Metro	1.42%	1.20%	0.72%	0.23%	0.89%
Seattle	1.25%	1.07%	0.65%	0.24%	0.80%
SF_Metro	1.15%	0.99%	0.65%	0.30%	0.77%
SanDiego	1.30%	1.04%	0.46%	-0.13%	0.67%
Boston	0.80%	0.72%	0.54%	0.37%	0.61%
LA_Metro	0.67%	0.55%	0.28%	0.01%	0.37%
Average	**2.28%**	**1.93%**	**1.16%**	**0.39%**	**1.44%**
All estimated rates are statistically significant					

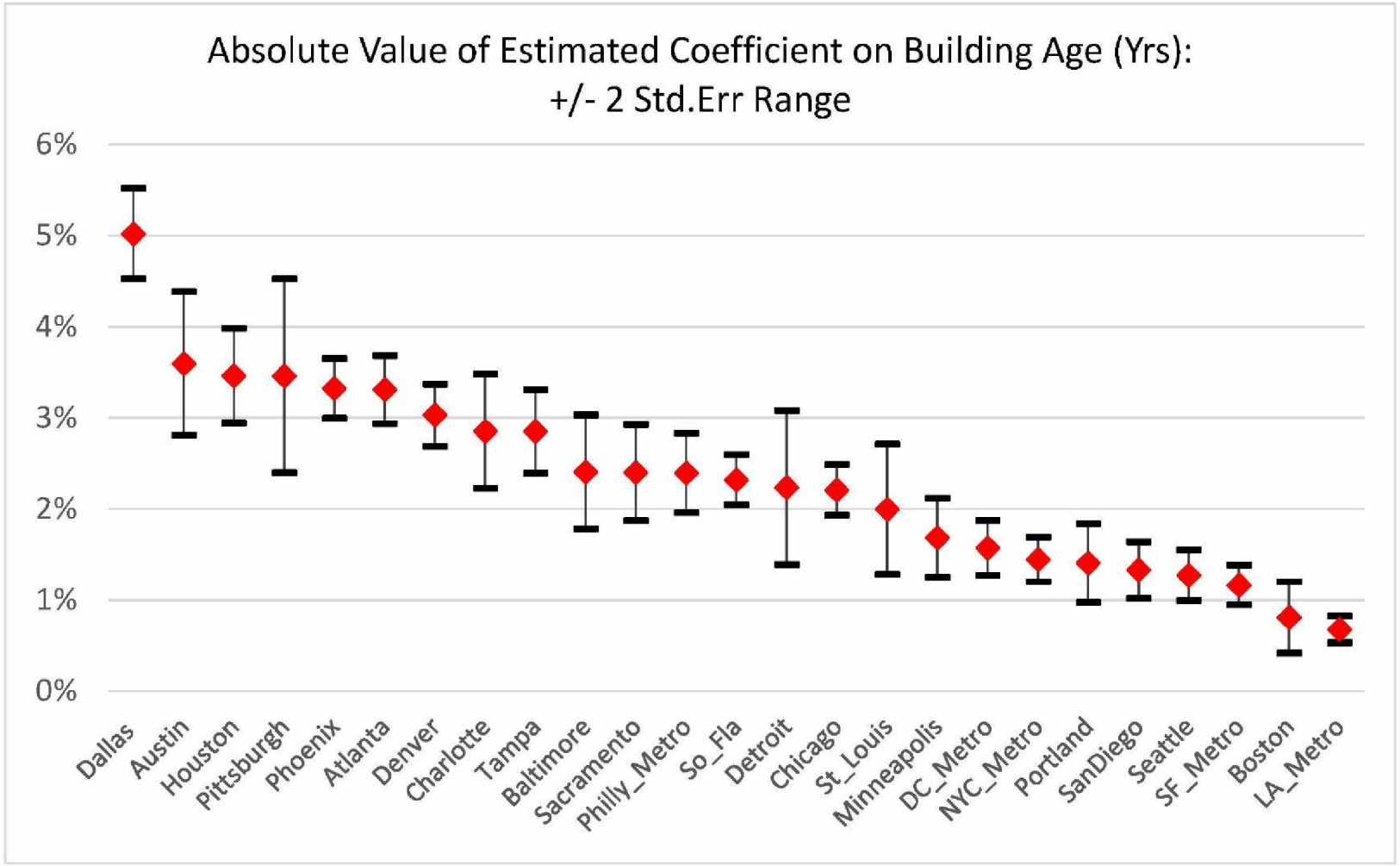
Depreciation varies strongly by metro area:



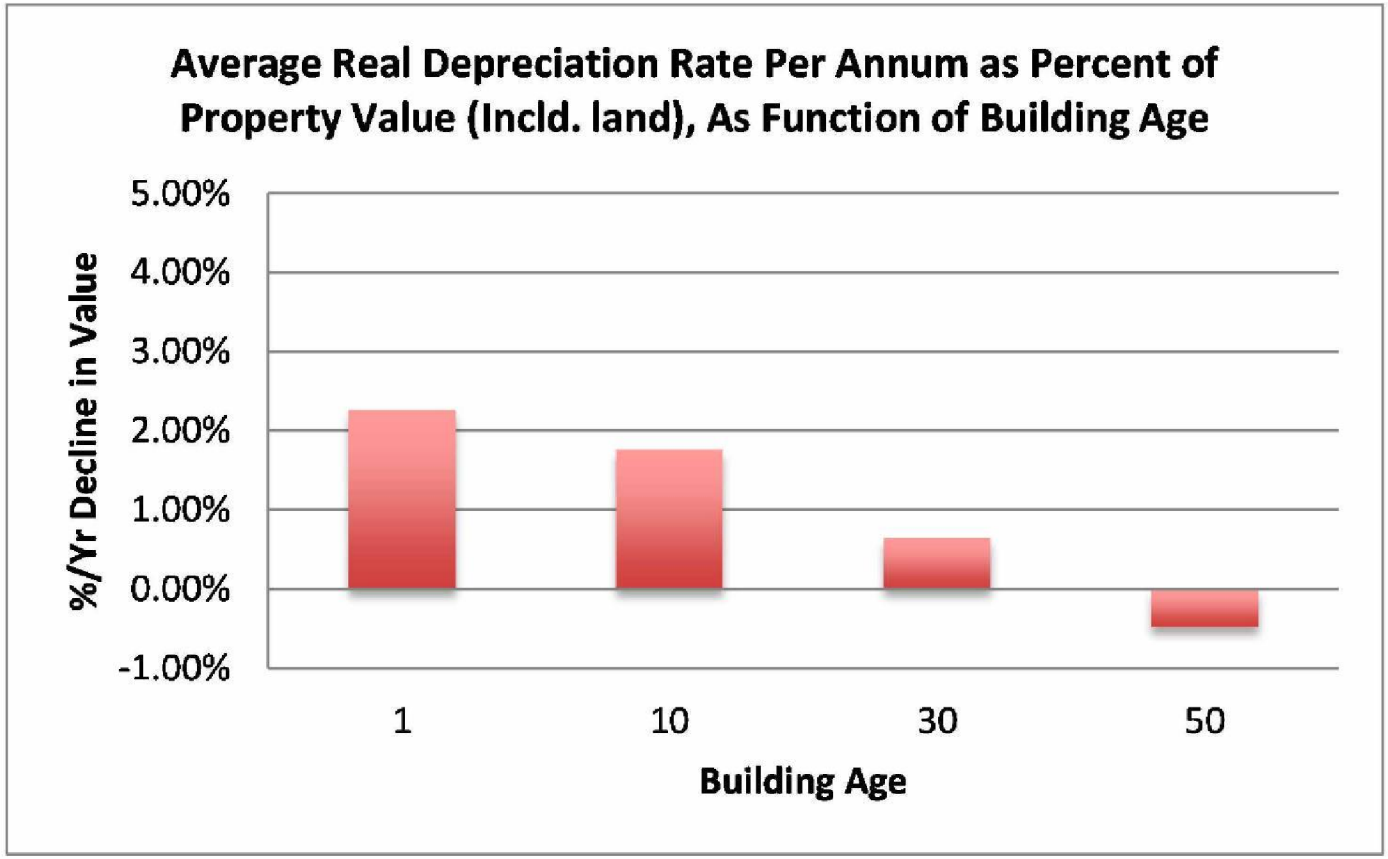
Bigger more land-constrained cities show less depreciation…

These are the (abs val of the) estimated coefficients on the Age variable by Metro, where bldg age is measured in years, +/- 2 Std.Errs:

(Note: The Age^2 coefficient, not shown here, makes the depreciation rate/yr a function of bldg age, not indicated here.)

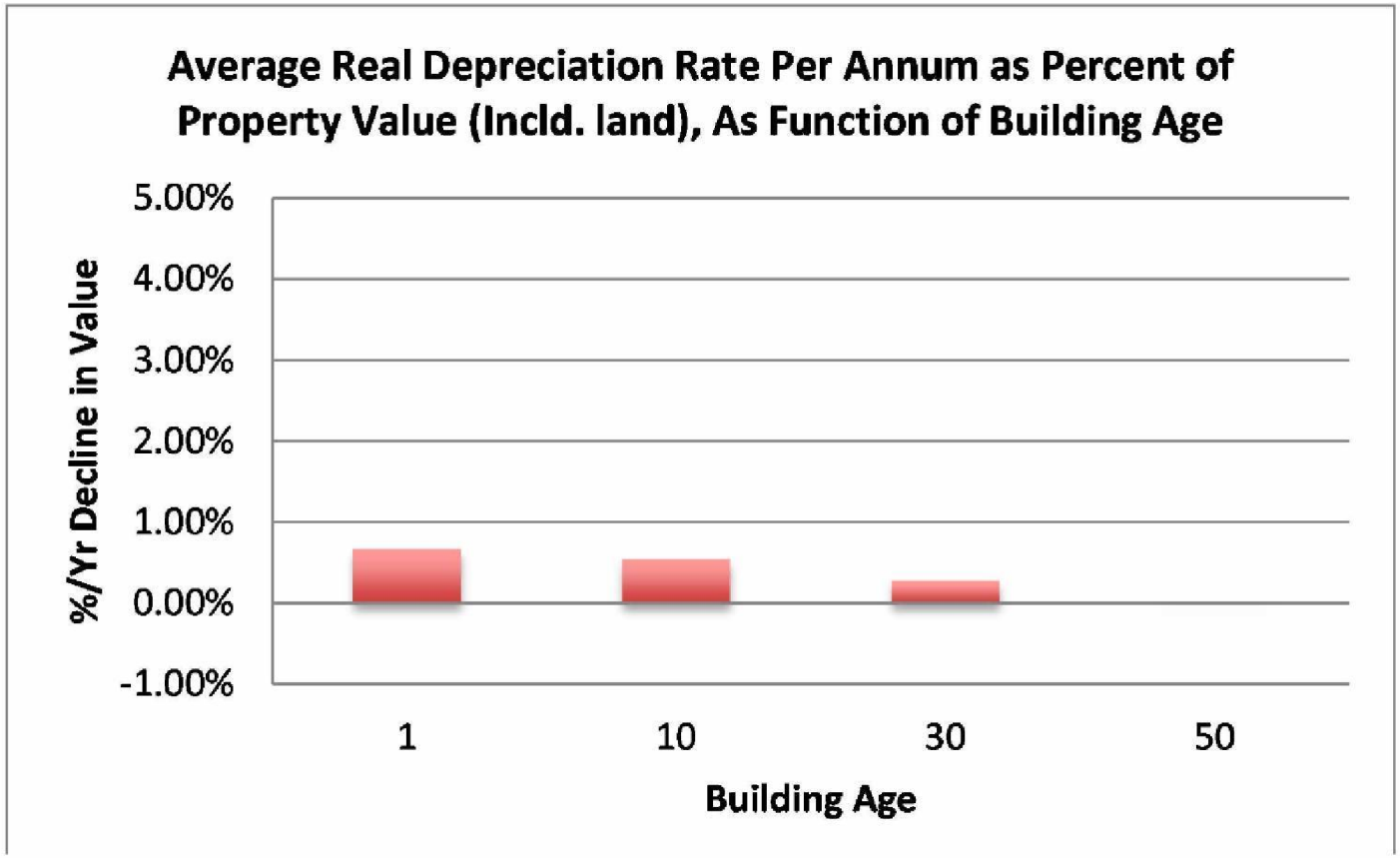


In some metros, old buildings (near 50 yrs) stop depreciating, perhaps because the structure is virtually worthless (all land value)… Here: Depreciation & bldg age in **South Florida** Metro:



So.Fla Metro is strongest example, but there are others among the top 25 RCA metros: Atlanta, Dallas, Phoenix, San Diego.

LA_Metro also stops depreciating, but it almost never *starts* depreciating…



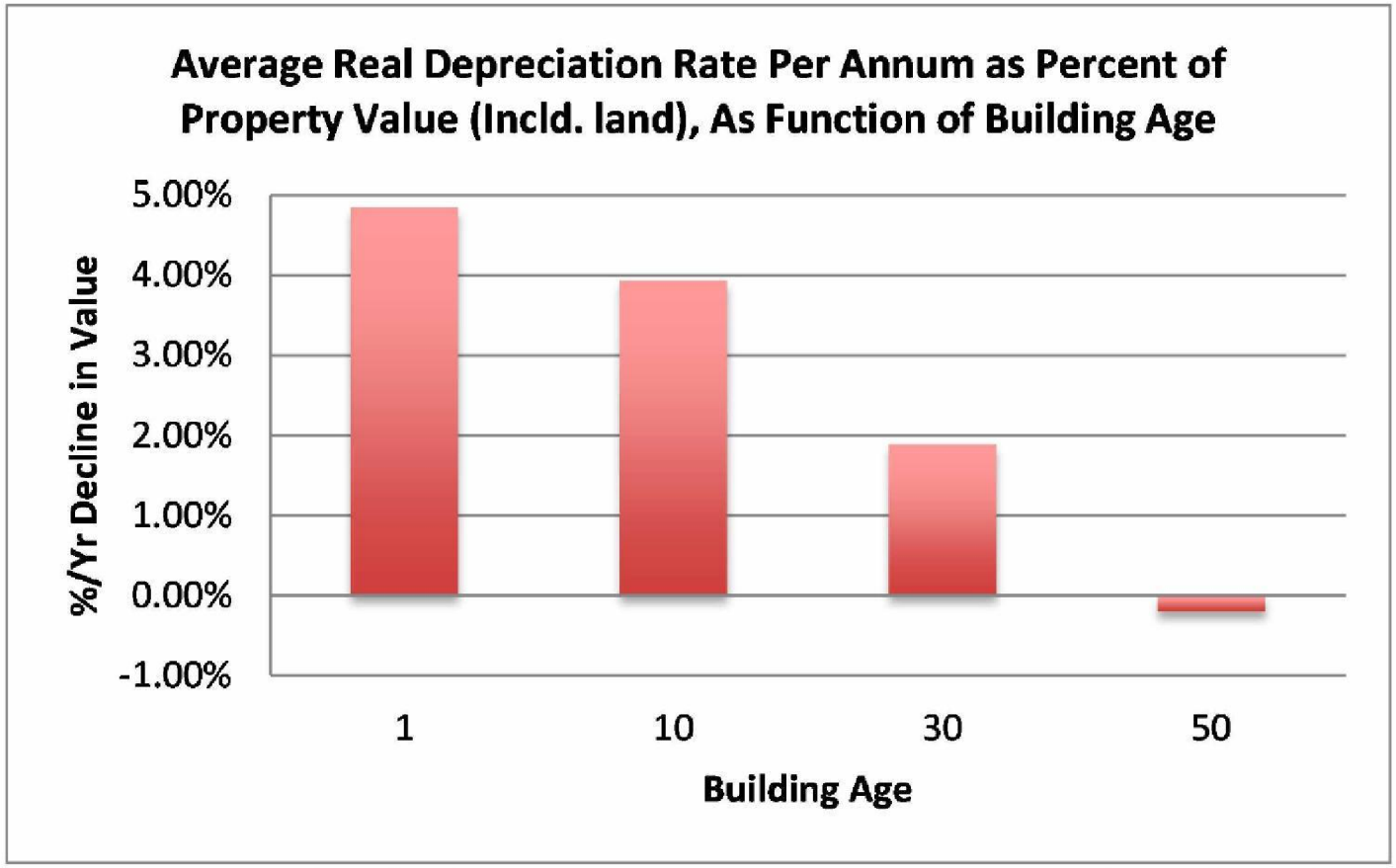
Los Angeles has very little depreciation.

(Note: LA_Metro has most data, hence, most precise depr estimates.)

Others with very low dep: Boston, SF, SD, Seattle.

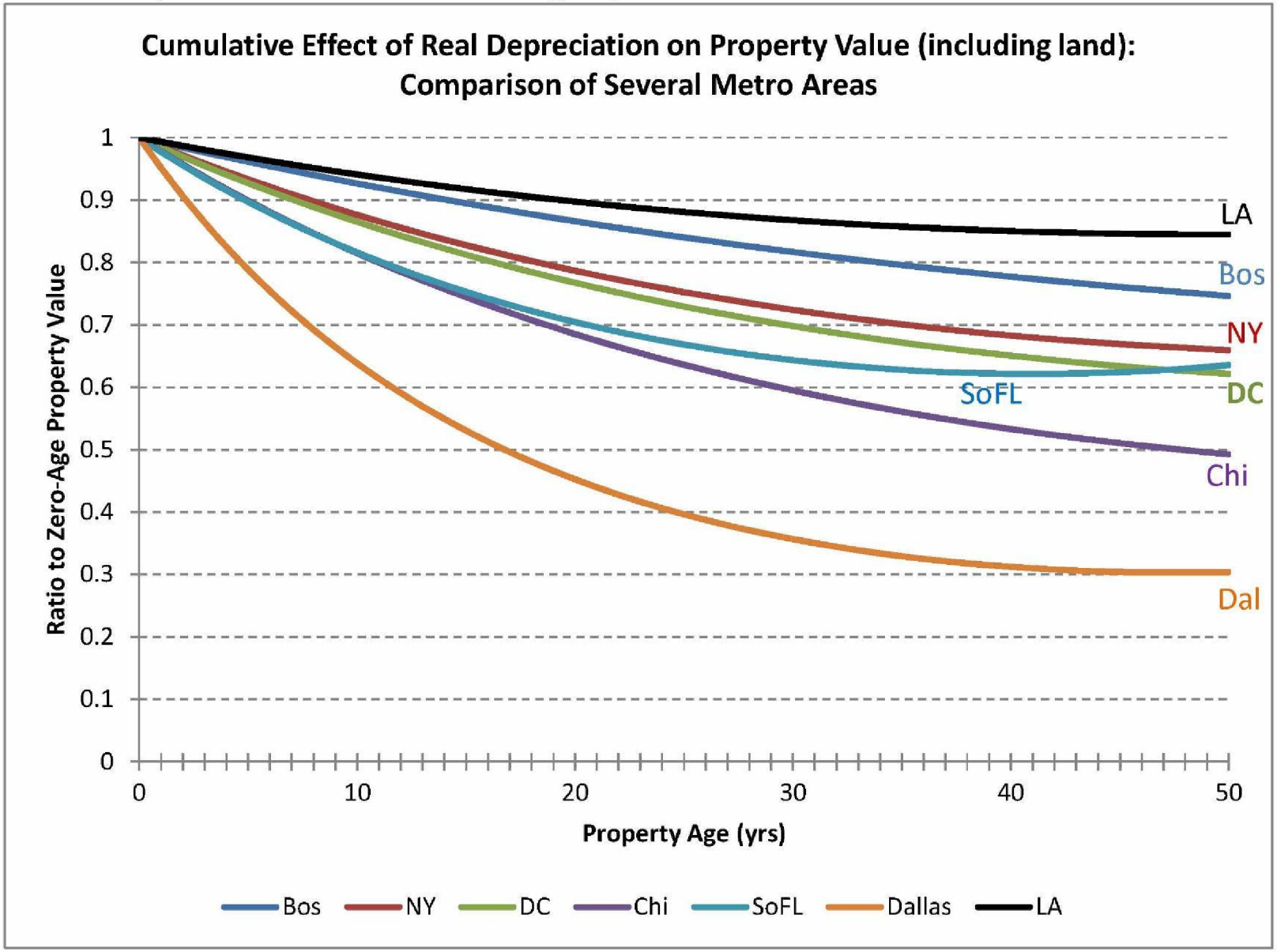
(NYC_Metro & DC_Metro are low but not as low due to their apts depreciate much faster than their non-resi comm, perhaps a non-CBD effect.)

Dallas has the most depreciation (among the largest 25)…

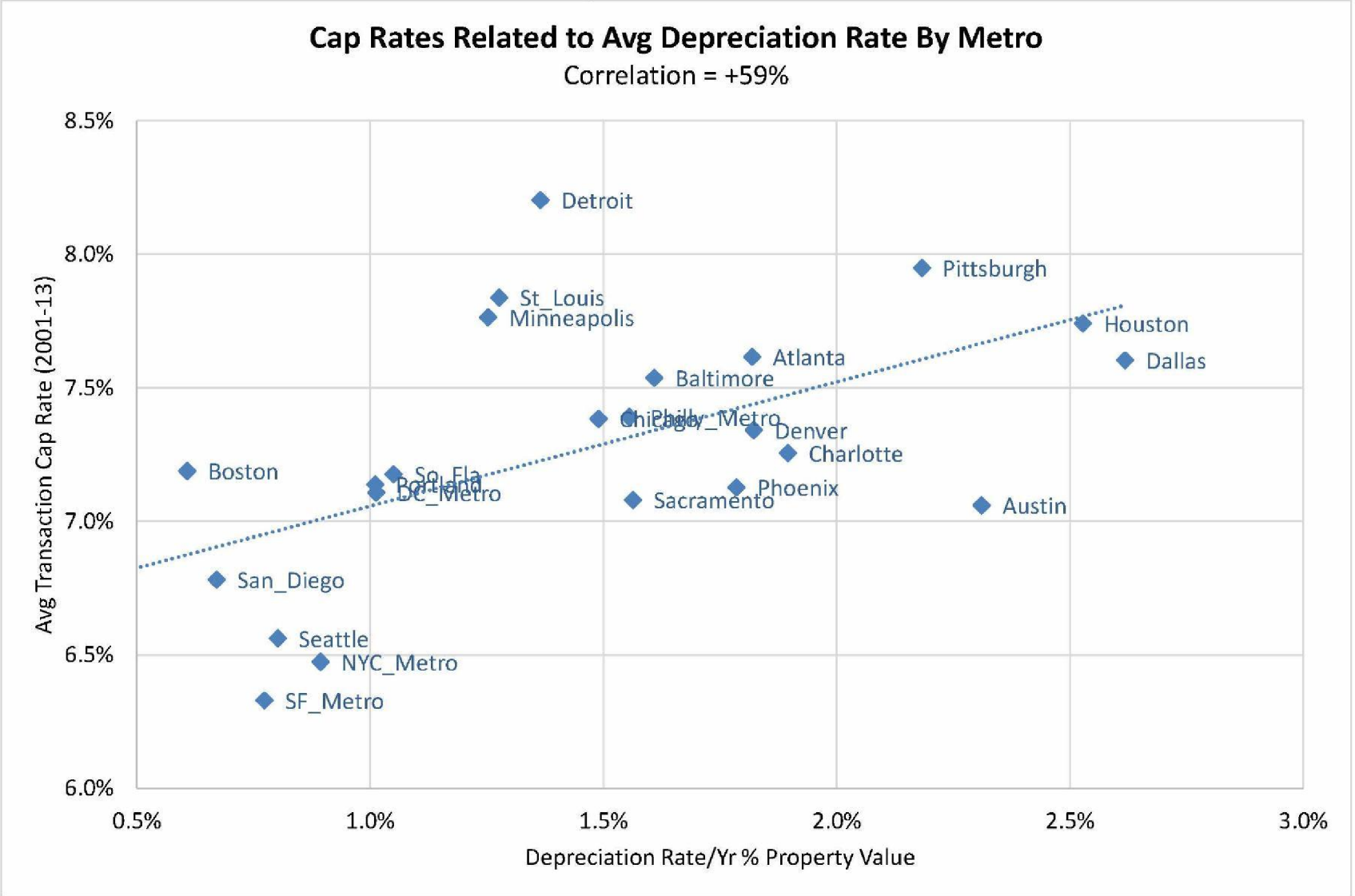


Others with very high dep: Houston, Austin, Pittsburgh, Charlotte (and unlike Dallas, these others show now sign of depreciation ending by age 50).

Depreciation rates & age-profiles differ across metros

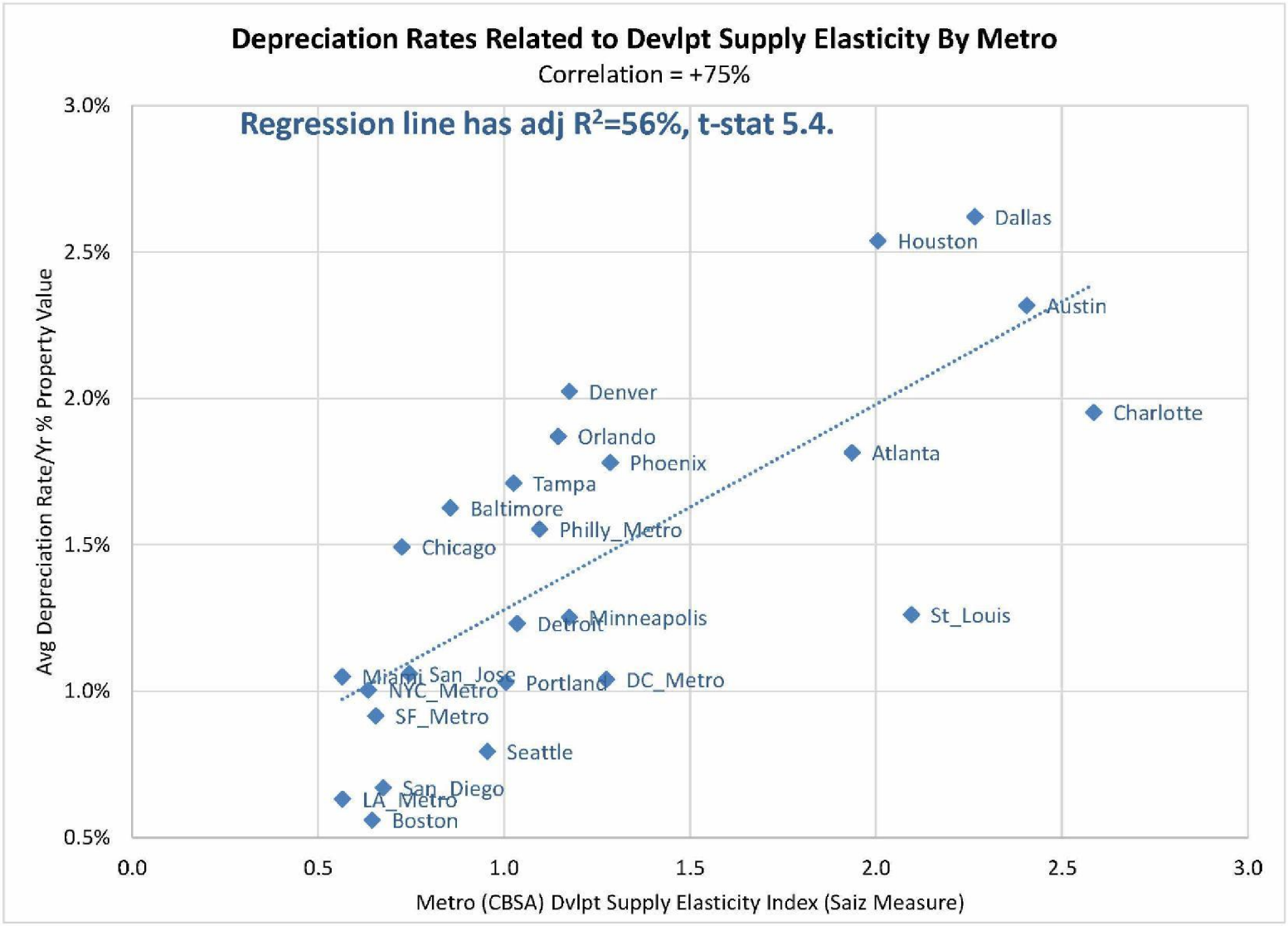


Transaction price cap rates seem to reflect investor awareness of differences in real depreciation rates across metros



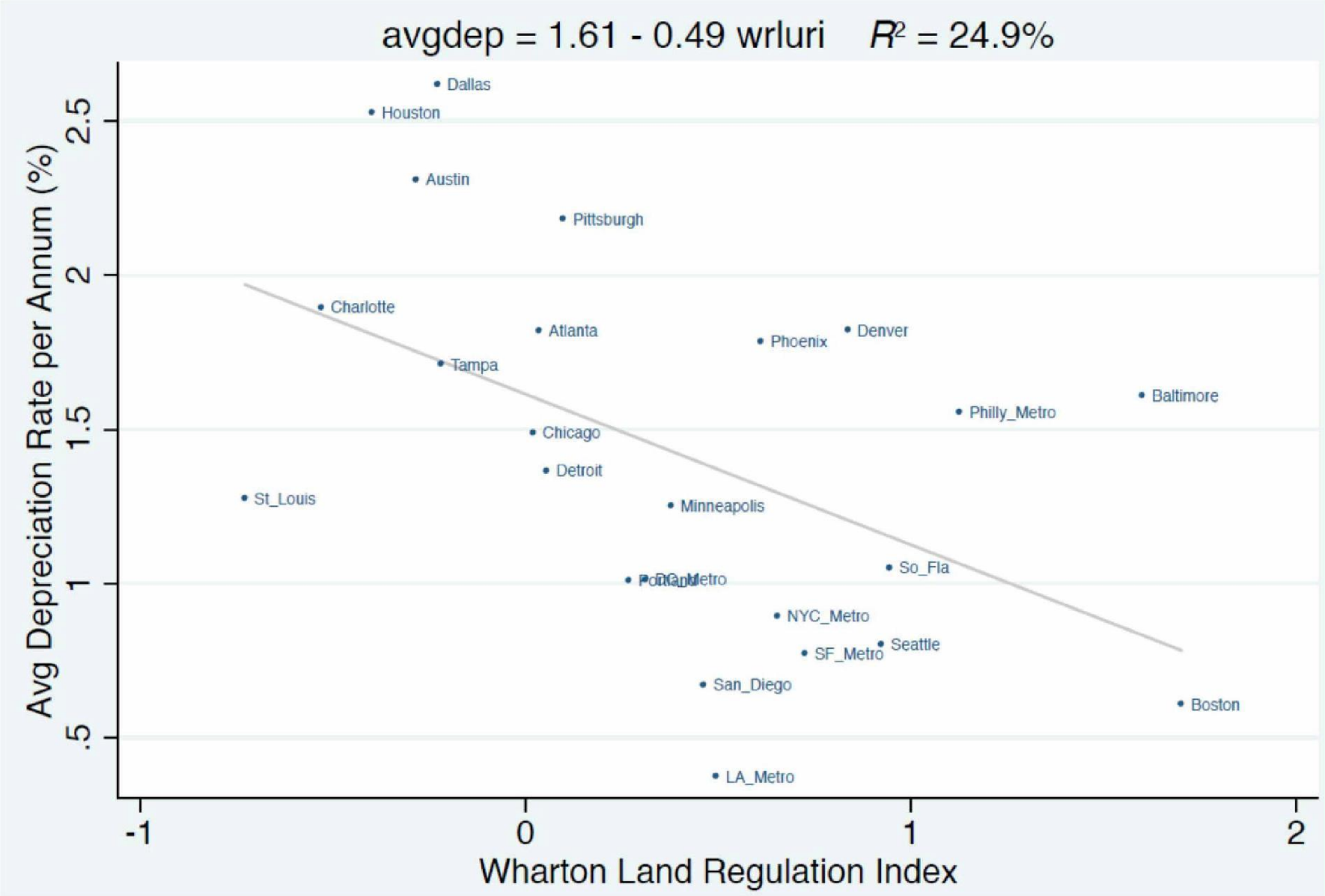
Slope of regression line is 0.47(t-stat = 3.5, R^2=35%). Real depreciation alone apparently can explain an important amount of the difference in cap rates across metros.

And avg real depreciation rates reflect the differences in supply elasticity for development in space market across metros



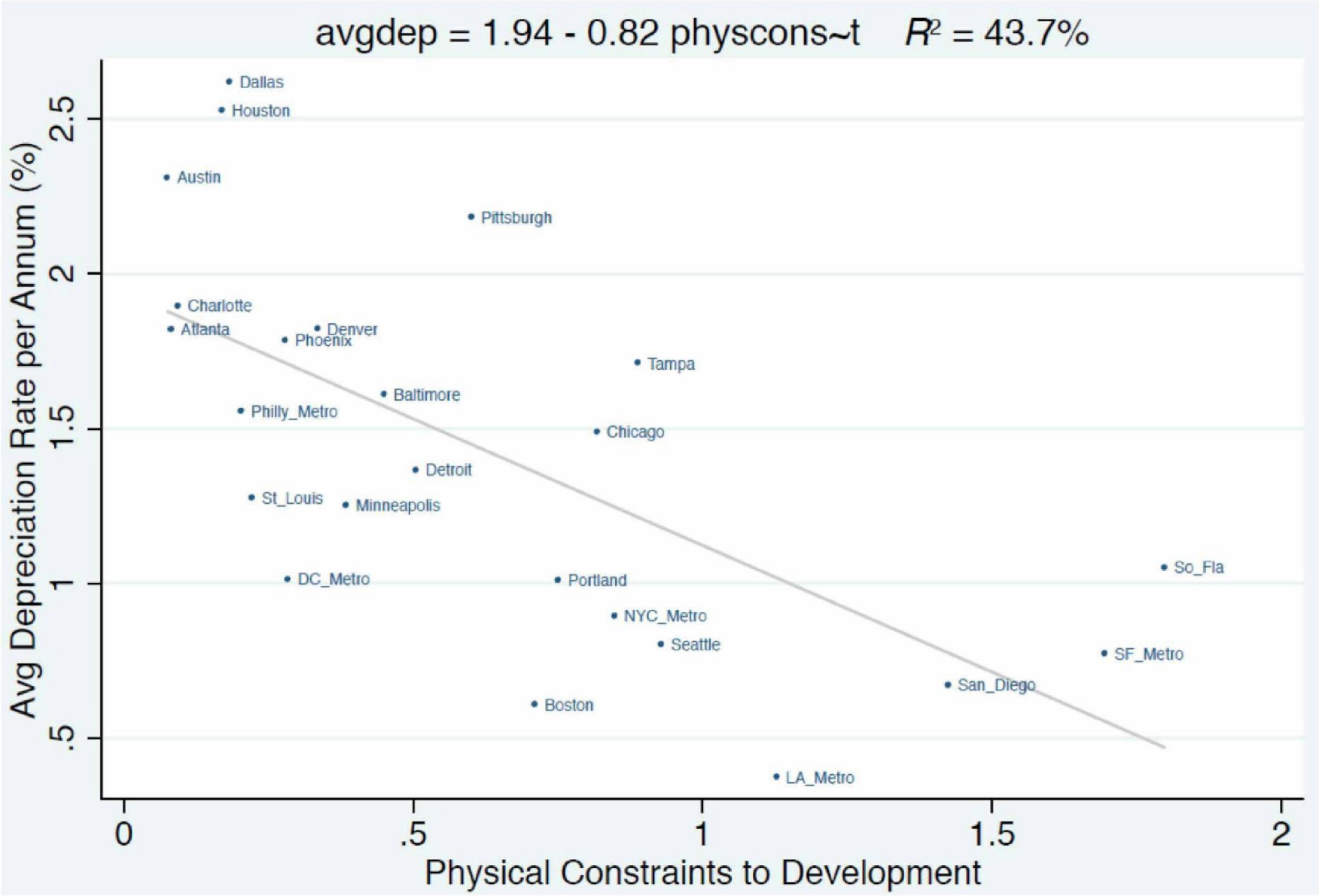
Direction of Causality is: Supply elasticity ➔ Depreciation rates ➔ Cap Rates

Regulatory constraints reduce depreciation somewhat, but…



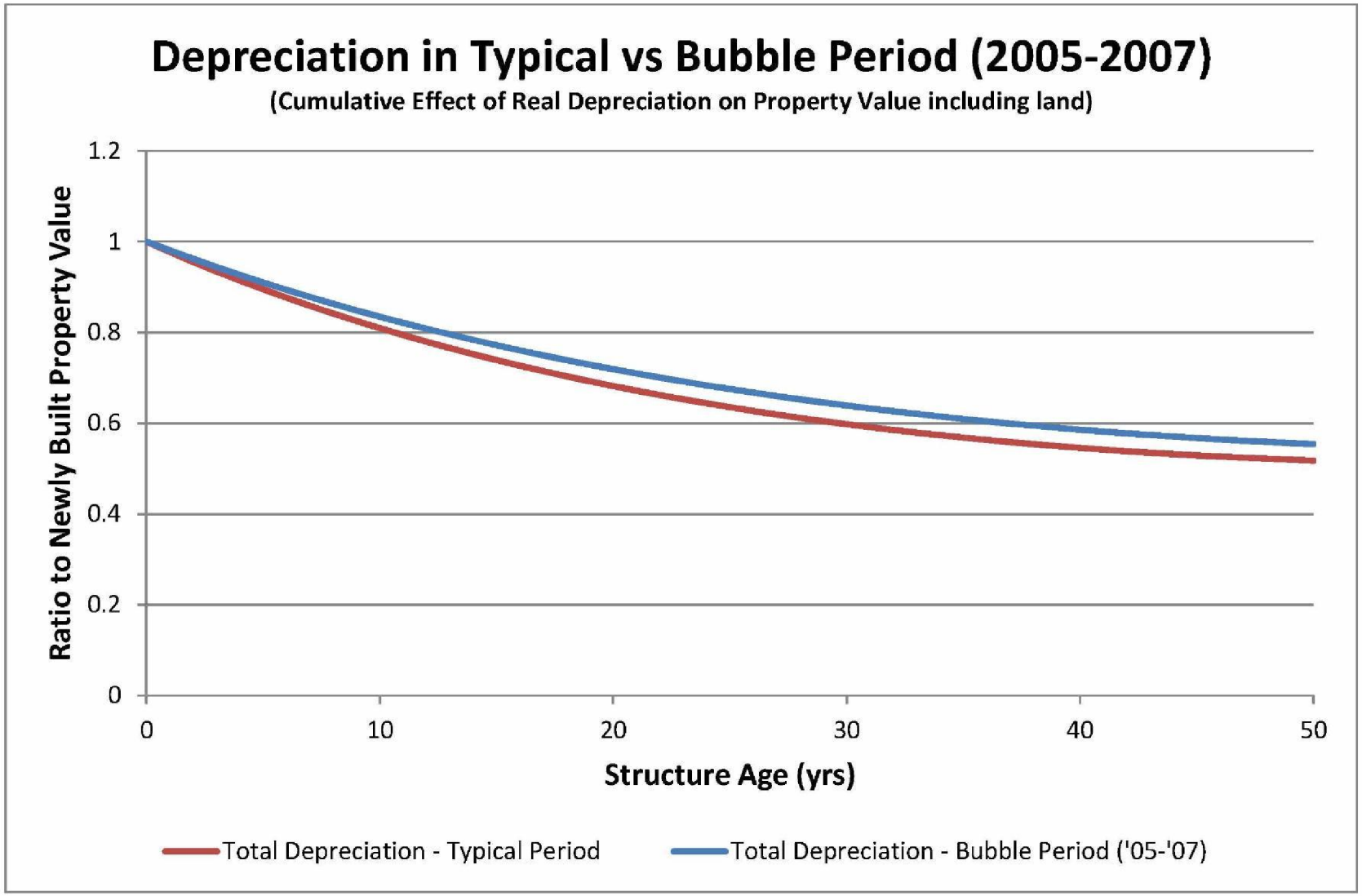
Greater regulation ➔ lower depreciation.

Physical land supply constraints reduce depreciation even more…



Land Constraint ➔ Supply Constraint + High land value fraction ➔ Lower depr 2 ways

Effect of Property Asset Market Conditions on Depreciation:
During the "bubble" period (2005-07) depreciation was only slightly (though statistically significantly) lower than during other years: 1.2% vs 1.3%/yr.



Conclusions:

- Real depreciation in CRE averages around 1.3%/yr, with interesting differences across metro areas.
- Depreciation is faster in "younger" properties (newer buildings, reflecting the larger share of the structure value (of newer buildings) in the total property value (smaller land value fraction).
- Cap rate creep is very minor and much less than typical appraisal & underwriting assumptions (almost all depreciation from real decline in NOI).
- Implication of our model & findings are that land value averages 52% of (newly-developed) property value, average building lifetime is 60 yrs, and real depreciation of the structure alone averages is about 6%/yr at median building age (24yrs).
- Apartment properties depreciate only very slightly more than non-resi commercial properties (1.7% vs 1.3%/yr), not enough to justify the IRS policy differential (although, IRS depreciation rules also ignore inflation which renders depreciation expense deduction "recapture" ubiquitous anyway).
- Metros with less supply elasticity (per the Saiz measure) show significantly lower depreciation rates (probably reflecting greater land value component).
- Physical land constraints have bigger impact on depreciation than regulations.
- Asset transaction cap rates are positively correlated with, and are importantly explained by the difference in depreciation rates across metros.