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

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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. Can ultimately (but not necessarily) lead to economically profitable demolition of structure.”

“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: 107,805 obs 2001-14, sales > $2.5M, from RCA database of investment properties.
- Based on actual transaction prices not appraisals or assessments.
- Quantifies NOI effect vs “cap rate creep” effect.
- Sheds light on cause of differences in deprec rate 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 overall avg close to 150 bps/yr including land value (≈2.7% structure val) at median building age (25 yrs).
• 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 depreciation has “characteristics.” It varies across:
    • Metro markets (related to space mkt supply elasticity ➔ land value share)
    • 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:

\[
\ln(\text{Price/SF}) = f(\text{Property Attributes, Transaction Info, Location Controls, Time Dummies})
\]

- 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 **cap rates:**  
StandardizedCapRate = $f$(Hedonic Varbs, Time Dummies)

Hedonic varbs:  
Age, Age$^2$,  
LnSqft,  
cbd_fg,  
resolveddistress_fg,  
cmbs_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 *cross-sectional* 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.
Real Depreciation in U.S. Commercial Properties
Mostly due to NOI decline (only slightly to cap rate creep)

Results for the national all-property sample, 32481 trans obs, Price & Caprate models together...

Cumulative Effect of Real Depreciation on Property Value (including land): Due to:
NOI Effect, Cap Rate Effect, Total of the Two

Overall natl average = 1.5% of total property value per year during first 50 years since building construction. Younger properties depreciate faster, probably mostly because building structure is smaller fraction of older properties’ values.

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: 1.5% of total property value (inclu land) per year (based on median property age).
- E.g., if real deprec = 1.5% and inflation = 2.5% then observed nominal increase in same-property price is 2.5% - 1.5% = 1.0%/yr on avg.
- Slightly faster deprec rate in properties with younger buildings, mostly due to structure larger proportion of total property value (see next slides).
- Equates to approx 2.7%/yr of remaining structure value (excluding land) for median-age building (25 yrs old).
- This is in spite of capex. E.g., if capex averages 1% of property value/yr, then presumably without the capex the real depreciation would be at least 1.5%+1%=2.5% of prop val or about 4.6% of remaining structure value/yr.*

*At median building age structure is 54% of total property value depreciating at 2.7%/yr (of structure value). If capex is 1% of total property value, then it 1/.54=1.9% of structure value, hence, sum of depreciation + capex as fraction of remaining structure value is: 2.7% + 1.9% = 4.6%.
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 over 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 (May be alternatively defined as either P-C or P-L)
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):

\[ \ln(P/SF) = -0.0184657(Age) + 0.0000724(Age^2) \]

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). (Also checked with non-paremetric spec.)

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

\[ \frac{d\ln(P/SF)}{dAge} = -0.0184657 + 2 \times 0.0000724 \times Age = 0, \quad \Rightarrow \]

Age at which no further depreciation = \(0.0184657 / 0.0000724 = 128\) yrs.
Computing the implied land value fraction at (re)development...

Age at which no further depreciation = \(0.0184657 / 0.0000724 = 128\) 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):

\[
\text{Exp}(\ln(P/SF)) = \text{Exp}(-0.0184657(128) + 0.0000724 (128^2)) = 0.31.
\]

Land value fraction is 31% of newly-built property value (structure is 69%).

Methodology corrects for “right censoring” of structure age in transaction database.*

*Two step process:
1) Estimate bldg survival curve from age-at-demolition data;
2) Adjust transaction prices to uncondl expctd values = PriceXProbSurvive @ bldg age at time of Xction.
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 (economic obsolescence).
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:

\[
\left(\frac{1}{1.10}/\left(\frac{1}{1.08}\right)\right)^{1/50} - 1 = -0.0045
\]

Yet we find an average cap rate creep effect on value of only 17 bps/yr. This implies that the NOI source of real depreciation (rent – vacancy – oper expenses) accounts about 90% 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 could be consistent with (e.g.) non-instl rents approx 2/3 of otherwise equivalent instl rent.

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

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

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>Institutional</td>
<td>7.50%</td>
<td>7.40%</td>
<td>7.76%</td>
<td>6.29%</td>
<td>8.04%</td>
<td>8.33%</td>
<td>6.00%</td>
</tr>
<tr>
<td>Non-institutional</td>
<td>10.29%</td>
<td>9.90%</td>
<td>10.18%</td>
<td>7.99%</td>
<td>9.58%</td>
<td>10.50%</td>
<td>8.13%</td>
</tr>
</tbody>
</table>

*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, hence, smaller base of depreciation in total property value.

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

- Since the cap rate essentially equals discount rate minus growth rate (cap = 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 (derivative, whether defined as “L” or “C”). 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 - OCC) for computing property present value, which must include a risk premium (OCC = r = rf + RP), increases with building age. Thus, in cap rate, while “g” increases, so does “r” (cap = y = r – g, hence, offset).
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, increase in “g” is offset by increase in “r” as land value is more risky than structure value. 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.

• Our empirical finding about magnitude of 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 8 bps above going-in cap rate if the going-in rate is 6%, or going-out cap rate only 14 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).

• However, appraisers & underwriters typically ignore (at least partially) the magnitude of real depreciation in the property NOI growth rate they project (e.g., ubiquitous “3% growth” assumption), thereby overstating NOI growth in the DCF analysis. Thus,…

• In order to get correct current discounted PV for the property (which they do on avg), appraisers & underwriters MUST do some combination of discount at unrealistically high opportunity cost of capital (r), &/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 & 1Q2014: More Comm than Apts, and Apts avg almost 10 yrs older than Comm...

![Graph showing transactions observations counts]

107,805 total obs with sufficient hedonic data

<table>
<thead>
<tr>
<th>Apts</th>
<th>Non-resi Comm</th>
</tr>
</thead>
<tbody>
<tr>
<td>17,316 Apts</td>
<td>55,913 Non-resi Comm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AGE Means &amp; Medians in the Samples:</th>
<th>Sample N</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natl-AllProp</td>
<td>107805</td>
<td>32</td>
<td>25</td>
</tr>
<tr>
<td>Natl-Apts</td>
<td>27374</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Natl-Comm</td>
<td>80431</td>
<td>29</td>
<td>23</td>
</tr>
<tr>
<td>Caprate subs</td>
<td>32481</td>
<td>26</td>
<td>21</td>
</tr>
</tbody>
</table>

Note: we have filtered out the few obs with property age > 150 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 & 2Q2014:

Max is LA_Metro with 15,380 obs; Min is Pittsburgh with 288 obs.
In the aggregate, apt & non-resi commercial depreciation is very similar (controlling for age, slightly more in apts, avg 1.9%/yr vs 1.5%/yr)

In our sample the avg apt is 10 yrs older than the avg non-resi comm property (median 35 vs 23 yrs old) and the depreciation rate of the median property is apts: 1.63% vs comm: 1.5%/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).

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

Depreciation Rates By Building Type & Age

Depreciation per year as fraction of total property value (including land)
Non-parametric estimation in CoStar & RCA databases:
(CoStar includes smaller properties. **RCA** corrected for right-censor bias.)
Results seem broadly consistent overall considering different methodology.

(Appreciation to Walter Page for CoStar results.)
Estimated depreciation rates as a function of building age, by RCA Metro Mkt, sorted from highest to lowest depreciation rates...

<table>
<thead>
<tr>
<th>Metro Market</th>
<th>Building Age (Yrs):</th>
<th></th>
<th></th>
<th></th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Dallas</td>
<td>3.32%</td>
<td>3.17%</td>
<td>2.83%</td>
<td>2.50%</td>
<td>2.95%</td>
</tr>
<tr>
<td>Houston</td>
<td>2.29%</td>
<td>2.52%</td>
<td>3.04%</td>
<td>3.56%</td>
<td>2.85%</td>
</tr>
<tr>
<td>Phoenix</td>
<td>1.50%</td>
<td>1.90%</td>
<td>2.78%</td>
<td>3.66%</td>
<td>2.46%</td>
</tr>
<tr>
<td>Austin</td>
<td>2.31%</td>
<td>2.35%</td>
<td>2.45%</td>
<td>2.54%</td>
<td>2.41%</td>
</tr>
<tr>
<td>Atlanta</td>
<td>1.77%</td>
<td>2.03%</td>
<td>2.61%</td>
<td>3.18%</td>
<td>2.40%</td>
</tr>
<tr>
<td>Charlotte</td>
<td>2.00%</td>
<td>2.10%</td>
<td>2.33%</td>
<td>2.55%</td>
<td>2.25%</td>
</tr>
<tr>
<td>Denver</td>
<td>2.36%</td>
<td>2.22%</td>
<td>1.92%</td>
<td>1.62%</td>
<td>2.03%</td>
</tr>
<tr>
<td>Tampa</td>
<td>1.62%</td>
<td>1.79%</td>
<td>2.16%</td>
<td>2.53%</td>
<td>2.02%</td>
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<tr>
<td>Pittsburgh</td>
<td>2.10%</td>
<td>1.97%</td>
<td>1.68%</td>
<td>1.39%</td>
<td>1.78%</td>
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<tr>
<td>Sacramento</td>
<td>1.74%</td>
<td>1.76%</td>
<td>1.80%</td>
<td>1.83%</td>
<td>1.78%</td>
</tr>
<tr>
<td>Baltimore</td>
<td>1.59%</td>
<td>1.59%</td>
<td>1.61%</td>
<td>1.62%</td>
<td>1.60%</td>
</tr>
<tr>
<td>St_Louis</td>
<td>1.71%</td>
<td>1.66%</td>
<td>1.54%</td>
<td>1.43%</td>
<td>1.59%</td>
</tr>
<tr>
<td>Chicago</td>
<td>1.65%</td>
<td>1.57%</td>
<td>1.38%</td>
<td>1.19%</td>
<td>1.45%</td>
</tr>
<tr>
<td>Philly_Metro</td>
<td>1.69%</td>
<td>1.59%</td>
<td>1.36%</td>
<td>1.13%</td>
<td>1.44%</td>
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<tr>
<td>Minneapolis</td>
<td>1.36%</td>
<td>1.38%</td>
<td>1.43%</td>
<td>1.48%</td>
<td>1.41%</td>
</tr>
<tr>
<td>So_Fla</td>
<td>1.54%</td>
<td>1.49%</td>
<td>1.37%</td>
<td>1.25%</td>
<td>1.41%</td>
</tr>
<tr>
<td>Detroit</td>
<td>1.61%</td>
<td>1.52%</td>
<td>1.31%</td>
<td>1.11%</td>
<td>1.39%</td>
</tr>
<tr>
<td>Portland</td>
<td>1.24%</td>
<td>1.21%</td>
<td>1.15%</td>
<td>1.08%</td>
<td>1.17%</td>
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<tr>
<td>DC_Metro</td>
<td>1.17%</td>
<td>1.16%</td>
<td>1.12%</td>
<td>1.09%</td>
<td>1.14%</td>
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<tr>
<td>SanDiego</td>
<td>0.70%</td>
<td>0.81%</td>
<td>1.06%</td>
<td>1.31%</td>
<td>0.97%</td>
</tr>
<tr>
<td>Seattle</td>
<td>0.76%</td>
<td>0.83%</td>
<td>0.99%</td>
<td>1.15%</td>
<td>0.93%</td>
</tr>
<tr>
<td>NYC_Metro</td>
<td>1.19%</td>
<td>1.06%</td>
<td>0.78%</td>
<td>0.49%</td>
<td>0.88%</td>
</tr>
<tr>
<td>SF_Metro</td>
<td>1.09%</td>
<td>1.00%</td>
<td>0.79%</td>
<td>0.59%</td>
<td>0.87%</td>
</tr>
<tr>
<td>Boston</td>
<td>0.69%</td>
<td>0.70%</td>
<td>0.73%</td>
<td>0.76%</td>
<td>0.72%</td>
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<tr>
<td>LA_Metro</td>
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<td>0.32%</td>
<td>0.47%</td>
<td>0.63%</td>
<td>0.42%</td>
</tr>
<tr>
<td>Average</td>
<td>1.57%</td>
<td>1.59%</td>
<td>1.63%</td>
<td>1.67%</td>
<td>1.61%</td>
</tr>
</tbody>
</table>

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.)
Depreciation rates & age-profiles differ across metros

*There can be quite a difference...*

NY has high land values (⇒ high structure econ obsolescence). Dallas has high econ obsolescence for a low land value city.
Transaction price cap rates seem to reflect investor awareness of differences in real depreciation rates across metros.

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

$$\text{avgdep} = 0.62 + 0.68 \text{ elasticity} \quad R^2 = 56.1\%$$

Direction of Causality is: Supply elasticity $\Rightarrow$ Depreciation rates $\Rightarrow$ Cap Rates
Regulatory constraints reduce depreciation somewhat, but...

\[ \text{avgdep} = 1.82 - 0.57 \times \text{wrluri} \quad R^2 = 27.8\% \]

Greater regulation ➔ lower depreciation.
Physical land supply constraints reduce depreciation even more...

\[
\text{avgdep} = 2.15 - 0.88 \ \text{physcons} - t \quad R^2 = 40.5\%
\]

\[
\begin{align*}
\text{n} &= 24 \quad \text{RMSE} = 0.5424448
\end{align*}
\]

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

• Real depreciation in CRE averages around 1.5%/yr, with interesting differences across metro areas.
• Depreciation is slightly 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, & land doesn’t depreciate). 
• 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 31% of (newly-developed) property value, building life expectancy is 128 yrs, and real depreciation of the structure alone averages is about 2.7%/yr at median building age (25yrs). However these are aggregate overall averages.
• Apartment properties depreciate only very slightly more than non-resi commercial properties (1.6% vs 1.5%/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.