"Alternative investments" and real estate

2014 Aon report: CRE is 13% of invested capital (80% of which is not publicly traded)
Why focus on asset-specific attributes

Idiosyncratic risk matters

- Much investment-grade RE held by individuals/families (Geltner et al., 2013)
- RE investments underwritten at asset-level
  - Secured debt/CMBS
  - Managerial incentives

Current literature: Typically models asset price as random walk (diffusion)
Stock Price Dynamics

![Graph showing stock price dynamics over 10 years. The x-axis represents years (0 to 10), and the y-axis represents stock price (0.5 to 3.0). The graph illustrates volatility and trends in stock prices.]
Properties as stocks

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Estimating risk with infrequent observations: Stocks

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Estimating reward with infrequent observations: Stocks

Market-adjusted Expected Log-Returns

Holding Period

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Results: Holding period residual return variance

![Graph showing the relationship between market-adjusted variance of log-price appreciation and holding period.](image-url)
Results: Holding period residual return alphas

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Robustness

- Other asset classes
  - Residential real estate (Case & Shiller, 1987; Goetzmann, 1993; Peng, 2015, Giacoletti, 2016)
  - Private equity (Axelson et al. 2015; Lopez et al., 2016)
- Alternative cuts on data, appraised HP returns, including/excluding income in returns
- Selection bias 1: Safer assets held longer
- Selection bias 2: Optimal disposition

Need an alternative way to think about this
Summary of this paper

- Individual property prices do not appear to follow a pure diffusion process
  - Why?
- Market illiquidity leads to substantial
  - Transaction risk
  - Selection bias in holding periods
- Quantitative model of transaction risk delivers
  - Great fit to data
  - Quantifiable transaction risk: Probability of transacting given reservation price
- Can extend to other highly illiquid assets
Modeling repeat transactions in an illiquid market

Assumptions

- Investors-owners heterogeneous in valuation
- Type transition is slow and mean-reverting
- Limited trading opportunities
- Transaction costs
- No capital or inventory constraints
Type $a$ (ex-dividend and post-transition) calculates the value of property ownership $(p_{t,a})$ using discount factor $e^{-r_a}$.

Property owned by type $a$

Owner’s type transitions to $\hat{a}$

Offer rejected or accepted & ownership is transferred

$t+1$

Owner receives

$dt_{t+1} = dt e^{\mu - \frac{\sigma^2}{2} + \sigma \epsilon_{t+1}}$

$t+2$

Owner receives offer from type $a'$
Private value of ownership

\[ p_{t,a} = e^{-r_a} E \left[ \tilde{d}_{t+1} + \tilde{p}_{t+1} \hat{a} + \tilde{\lambda} \left\{ \tilde{p}_{t+1,a'} - \tilde{p}_{t+1} \hat{a} - c \tilde{d}_{t+1} \right\}^{+} \right] \quad (1) \]

- \{x\}^+ \equiv \max\{0, x\}
- \hat{a} and \ a' are seller’s and buyer’s types at date \ t + 1 (independent)
- \tilde{\lambda} is random allocation of gains from trade (relative bargaining power) — independent of other random variables

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Definitions

Equilibrium
A equilibrium is a set of prices, \( p_{t,a} \) solving (1) — bakes in option value of selling to someone with higher valuation.

Equilibrium steady state
A steady state is achieved once the distribution of ownership across properties is not expected to change.
Closed-form solutions for risk-adjusted HP returns

Calculate probability of observing a repeat transaction path:

- $Q_a$ is the private value to NOI ratio of investor of type “$a$”
- Asset bought by type $a$ at date $t$ from a steady-state owner $o$
- Held, despite offers and type transitions, for $\tau - 1$ periods
- Sold by owner, now type $\hat{a}$, to a bidder of type $b$ at $t + \tau$

\[
\ln \tilde{R}^I_{t,\tau}(o, a, \hat{a}, b) = \sigma_I \sqrt{\tau \tilde{n}_{I,i}} - \frac{\sigma^2_I}{2} \tau + \ln \left( Q_{\hat{a}} + \tilde{\lambda}'(Q_b - Q_{\hat{a}} - c) \right) \]

Selling shock

\[
- \ln \left( Q_o + c + \tilde{\lambda}(Q_a - Q_o - c) \right) \]

Purchasing shock
Fitting to data

- 11 investor types with growth adjusted discount rate
  \[ \eta_a = e^{r_a - \mu} \]

- Distribution of discount rates determined by two parameters:
  \[ \eta_H, \eta_L \]

- \( \tilde{\lambda} \) is a fair coin

- Remaining parameters are \( c \) and risk-adjusted property income volatility, \( \sigma_I \).

**Five** degrees of freedom: \( x, \eta_H, \eta_L, c, \sigma_I \). Fit to **nine** statistics from data.
### Fit to data

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Point estimate</th>
<th>SD</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly Turnover</td>
<td>0.031</td>
<td>0.015</td>
<td>0.031</td>
</tr>
<tr>
<td>Average Transaction Costs</td>
<td>0.0201</td>
<td>0.0062</td>
<td>0.0226</td>
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<tr>
<td>Average Acquisition Cap Rate</td>
<td>0.071</td>
<td>0.014</td>
<td>0.070</td>
</tr>
<tr>
<td>Fraction Sold within 5 Years</td>
<td>0.33</td>
<td>0.16</td>
<td>0.43</td>
</tr>
</tbody>
</table>

**Holding Period Return Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Point estimate</th>
<th>SD</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1yr Adj. Exp. Return</td>
<td>0.0401</td>
<td>0.0210</td>
<td>0.0397</td>
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<tr>
<td>1yr Adj. Variance</td>
<td>0.0310</td>
<td>0.0067</td>
<td>0.0308</td>
</tr>
<tr>
<td>6yr Adj. Exp. Return</td>
<td>-0.1057</td>
<td>0.0308</td>
<td>-0.0714</td>
</tr>
<tr>
<td>8yr Adj. Exp. Return</td>
<td>-0.1182</td>
<td>0.0313</td>
<td>-0.0882</td>
</tr>
<tr>
<td>8yr Adj. Variance</td>
<td>0.1050</td>
<td>0.0168</td>
<td>0.1134</td>
</tr>
</tbody>
</table>
Fitting the risk-adjusted returns

Market-adjusted Expected Log-Price Appreciation

Holding Period (years)

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Fitting the risk-adjusted variance
Quantifying Transaction Risk: Large right skew

- Probability the property is sold within one quarter
- Seller's reservation cap rate (gross of costs)

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Time on market: Calibrated Model

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Time on market: CoStar Data

Market Liquidity Indicators, Data Through October 2016

- Days On Market
- Sale Price-to- Asking Price Ratio

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Model price of immediacy

![Graph showing the relationship between expected discount relative to average market transaction and need for immediacy (years)].

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Private equity contract terms

Waterfall terms and extension options can be affected by transaction risk

- Closed-end fund manager face acquisition and disposition pressures
- Promote provides optionality and option value increases with risk.
  - Transaction risk is large and highly right skewed

Should CEF contracts separately stipulate terms and incentives for navigating the large transaction risk?
Banks holding defaulted properties can be considered “impatient” RE investors

- Bank will want property off its balance sheet ASAP

To sell with high probability within one quarter must expect a steep discount

- Model implies a discount of \( \approx 20\% \) to prevailing transaction prices of similar properties

Model can be used to back out the opportunity cost of bank capital
Summary

- Risk/return attributes of individual properties likely do not follow a diffusion
- Transaction risk is large and has substantial right skew
- Model can be generalized to
  - Large whole loans
  - Private equity transactions
  - M & A
  - Other real assets (ships, oil rigs, mines, etc....)
- Model can facilitate
  - Measurement of illiquidity
  - Pricing of assets
  - Pricing of derivatives (loans, structured financing, securitized assets)
  - Separation between default and liquidity effects
<table>
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<tr>
<th>Introduction</th>
<th>An empirical conundrum</th>
<th>Model</th>
<th>Key takeaways and potential applications</th>
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