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Option Pricing under Stochastic Volatility of US REITs

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Agenda

- Background
- M&As within REITs Industry
- Data
- REITs Margrabe (1978) Model
- Stochastic Process
- Empirical Results
  - GARCH (1;1) Parameters
  - Call Option Values
- Conclusion

Introduction/Motivation

- During the mid-1990s the US economy was booming.
- IPOs (REOCs) or M&As (REITs).
- Sometimes NAVs ≠ Share Prices.
- Possible reasons: best valuation technique, arbitrage opportunities or extra value.
- Debate on how best to value transactions.
  - DCFs, Earnings Based Valuations (DDM or AFFO) & NAVs.
  - NAV(stable asset base), although EBVs robust but subjective.
- Unconventional Pricing: Exchange Options.

Literature Review

- Economies of scale: Gordon (1998), Mooradian & Yang (2001), & Born *et al.* 1989.
- REITs grew from $9 bn to $128 bn by 1997: Clayton *et al.* 2007:
- Direct Investment Portfolios (DIPs) vs. Stock Investment Portfolios (SIPs): Anderson *et al.* 2002.
- Acquisition supports REITs' long-term growth
  - lower dividend payout and rest for acquisition ,
  - external funding.
- M&A induces growth:
  - Easier to growth small-caps, but mega-caps benefited more.
  - Managing REITs & corporate control (UPREIT in 1992).

Data

- SNL Financials:
  - 179 (92 on REOCs & 87 on REITs) completed US M&A deals
  - From 1994 to 2009.
- M&A deals with no specific trend
  - REOCs & REOCs, REOCs & REITs, and REITs & REITs.
- Cleaning
  - 92 on REOCs and on 47 REITs poor recorded data.

- Final sample: 40 completed M&A deals on REITs merging with REITs
  - M&As of acquirers and targets were in the same/similar line of business at different times.
- Restrictions to be relaxed to increase the sample

Model 1

- Margrabe (1978) and Sebehela (2008) illustrated that a call option of Margrabe (1978) model can be written as:

$$C\left[S_1, S_2, (T-\tau)\right] = S_1 e^{-\gamma_1 (T-\tau)} N(d_1) - S_2 e^{-\gamma_2 (T-\tau)} N(d_2)$$

$$where\ d_1 = \frac{\ln(S_1/S_2) + (\gamma_1 - \gamma_2 + {\sigma_p^2}/{2}) * (T-\tau)}{\sigma_p \sqrt{T-\tau}} \quad and\ d_2 = \frac{\ln(S_1/S_2) + \left(\gamma_1 - \gamma_2 - {\sigma_p^2}/{2}\right) * (T-\tau)}{\sigma_p \sqrt{T-\tau}}$$

- Lagging effect in real estate markets (i.e. IPD yearly appraisal).

Model 2

- NAVs account for the lagging effect that is not captured by share prices.
- Injected funds (external or internal) treated as "extra value" to existing project's value: Ahnefeld and Mehler-Bicher (2002), Davis *et al. 2004*, Jaimungal and Lawryshyn (2009).
- Lambda (λ) will represent the "extra value".
- REITs Margrabe (1978) model before and after taking into lambda (λ).

Model 2: Continue

$$C[(NAV_1 + \lambda), NAV_2, (T-\tau)] = (NAV_1 + \lambda)e^{-\gamma_1(T-\tau)}N(d_1) - NAV_2 e^{-\gamma_2(T-\tau)}N(d_2)$$

$$d_1 = \frac{\ln\left[(NAV_1 + \lambda)/NAV_2\right] + \left(\gamma_1 - \gamma_2 + {}^{\sigma_p^2}/_2\right) * (T-\tau)}{\sigma_p\sqrt{T-\tau}}$$

$$d_2 = \frac{\ln\left[(NAV_1 + \lambda)/NAV_2\right] + \left(\gamma_1 - \gamma_2 - {}^{\sigma_p^2}/_2\right) * (T-\tau)}{\sigma_p\sqrt{T-\tau}} \quad or\ d_2 = d_1 - \sigma_p\sqrt{T-\tau}$$

Stochastic Process

- Stochastic process is Martingale is for all $s \leq t$ and its expectation should be represented as follows;

$$E\left[X_t - X_s \middle| (X_s)_{\tau \leq s}\right] = 0$$

$$E\left[NAV_t \middle| F_s = \left[NAV_s + NAV_t - NAV_s \middle| F_s\right]\right.$$

$$= E\left[NAV_s \middle| F_s\right] + E\left[NAV_t - NAV_s \middle| F_s\right]$$

$$= NAV_s + E\left[NAV_t - NAV_s \middle| F_s\right]$$

Main Results 1

Ticker	Long tern vol.	Stochastic vol.	Omega	P (O)	Alpha	P(A)	Error term	P(ET)	Lambda	P(L)	Beta	P(B)	Alpha+Beta
SPG_1	0.01	0.18	0.000058	0.000	0.20	0.00	0.001	0.06	0.002	0.96	0.44	0.00	0.64
SPG_2	0.02	0.90	0.000004	0.020	0.08	0.00	0.040	0.78	0.040	0.17	0.91	0.00	0.99
SPG_3	0.03	0.99	0.000003	0.483	0.13	0.14	0.003	0.17	0.100	0.31	0.92	0.00	1.00
SLG	0.01	0.16	0.000061	0.000	0.17	0.00	0.001	0.11	0.028	0.39	0.43	0.00	0.60
UDR	0.01	0.32	0.000050	0.000	0.10	0.01	0.000	0.68	0.311	0.01	0.61	0.00	0.71
VNO	0.02	0.39	0.000043	0.000	0.27	0.00	0.000	1.00	0.137	0.00	0.56	0.00	0.83

Source: SNL Financials

Note: Parameters were simulated using Eviews

GARCH (1;1) Parameters

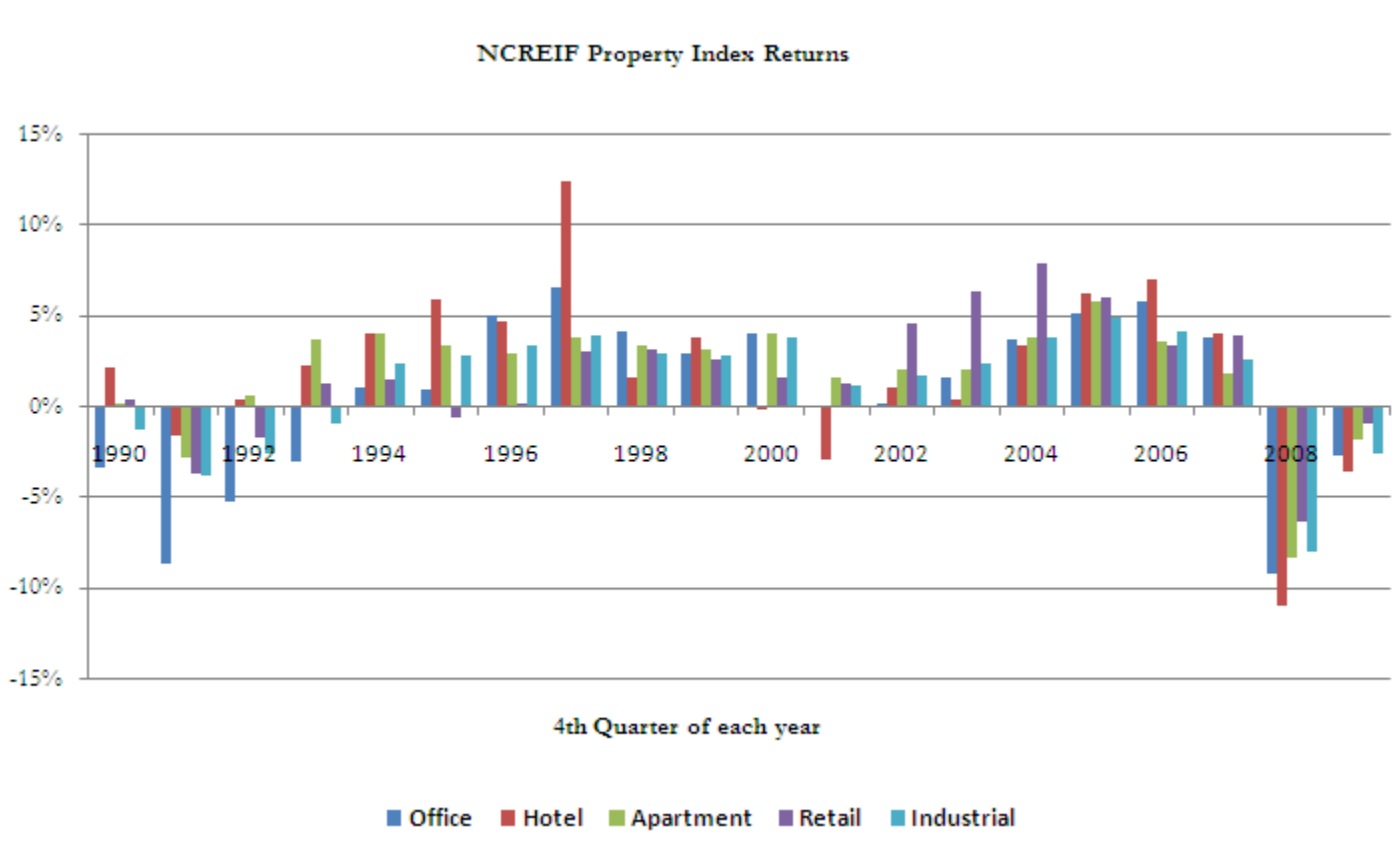
Main Results 2

Acquirer's Ticker	Target	Acquirer's line of business	Target's line of business	Call (Share Prices)	Call (Share Prices & Funds)	Funds Factor (SP)	Call (NAVs)	Call (NAVs & Funds	Funds Factor (NAV)
SPG_1	Chelsea Property Group	Region Mall	Outlet Center	-1.01	-0.1	0.897	0.3	0.34	0.139
SPG_2	DeBartolo Realty Corp.	Region Mall	Region Mall	7.57	8.49	0.122	7.2	7.28	0.011
SPG_3	MSA Realty Corp.	Region Mall	Shopping Centre	18.8	16.98	0.097	0.54	0.54	0.002
SLG	Reckson Associates Realty Corp.	Office	Office	41.33	40.6	0.018	5.09	7.48	0.47
UDR	American Apartment Com.	Multi-Family	Multi-Family	-1.55	-1.38	0.106	8.43	8.82	0.046
VNO	Arbor Property Trust	Diversified	Region Mall	23.67	24.41	0.031	11.43	11.47	0.003

Source: SNL Financials

Call Option Values

Figure 1



Source: National Council of Real Estate Investment Fiduciaries (NCREIF)

Conclusions

- When one REIT takes over another, there is “extra” occurring value from M&A.
- Although, NAV is not robust, it gives a better picture about the real situation.
- Share prices lead to misleading conclusions about M&A of REITs.
- M&A increase value without a REIT changing anything operationally.

Further Research

- Option pricing of REITs M&A under bearish market.
- When analysing REITs, when is it better to use share prices and when is it better to use NAVs.
- Option pricing of REOCs M&A using Margrabe (1978) model.

Thank You

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QUESTIONS?