Real Estate Valuation using NumbaPro

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March 6, 2013
Overview

Equity in real estate

Cash Flow Model

Adjusted Present Value Model
Demonstration

- The purpose of this presentation is to demonstrate the NumbaPro package published by Continuum Analytics, which is a CUDA API in Python. It is capable of running simulations for Real Estate Valuations both with and without Monte Carlo Methods.

- Most of the information on the slides are lifted from Wikipedia, since it is mostly filler and is not the focus of the presentation.
Why Monte Carlo?

- There are several analytic models that deal with financial engineering with respect to real estate. Most of them are fairly accurate.
- These analytic models fail to capture uncertainty, which leads to inconsistency in predicted and observed values.
- The Monte Carlo approach is very useful in incorporating uncertainty in these models, which brings the predicted values much closer to real world situations.
Equity in Real Estate

- Equity of redemption: This equity is valued at the difference between the market price of the property and the amount of any mortgage or other encumbrance.
- There are many factors that affect the market price that have to be taken into account. Some might exhibit Markov Chain characteristics.
- The Equity of Redemption can be modeled as a Stochastic Differential Equation with the Constant Elasticity of Variance model.
Constant Elasticity of Variance Model

The CEV model describes a process which evolves according to the following stochastic differential equation:

\[ dS_t = \mu S_t \, dt + \sigma S_t^\gamma \, dW_t \]

- The parameter \( \gamma \) controls the relationship between volatility and price, and is the central feature of the model.

- When \( \gamma < 1 \) we see the leverage effect, commonly observed in equity markets; where the volatility of an asset increases as its price falls.
Discounted Cash Flow

- The DCF model attempts to attach a value to a property based in cash flows.
- The cash inflow is given by rent, modeled by
  \[ Rent_t = \eta_t \times Rent_t \]
- The cash outflow is given by expenses, modeled by
  \[ Wk_t = \kappa_t \times Wk_t \]
Discounted Cash Flow

- The Total Cash Flow for the system is given by

\[ FCF_T = (1-\tau)(\eta_T \times Rent_t - Exp_T - Wk_t) + \tau Dep_T + P_T - \tau \times PV \]

- DCF model makes some deterministic assumptions. The discount rate is assumed to be constant.

- Another drawback of the DCF method is that there is a circularity problem when part of the asset is financed by debt.
Adjusted Present Value Model

To overcome the drawbacks of the DCF model, the APV model is used.

\[ PV_0 = \sum_{t=1}^{T} \frac{FCF_t}{(1+k_u)^t} + \sum_{t=1}^{T} \frac{k_i \times \tau \times D_{t-1}}{(1+k_i)^t} + \frac{TV_T}{(1+k_u)^T} \]

where

- \( PV_0 \) = value of the property at time \( t=0 \)
- \( FCF_t \) = free cash-to-property at time \( t \) (\( t = 1 \) to \( T \))
- \( D_t \) = value of debt at time \( t \)
- \( TV_T \) = terminal value at time \( T \)
- \( k_{u} \) = cost of capital for a fully equity-financed property
- \( k_i \) = pre-tax cost of debt
- \( \tau \) = tax rate
Simulation
References

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Monte Carlo Methods in Financial Engineering

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Hoesli, Martin; Jani, Elion and Bender, Andre
Monte Carlo Simulations for Real Estate Valuation