Real Estate Valuation using NumbaPro

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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:

$$\mathrm{dS}_t = \mu \mathrm{S}_t \mathrm{dt} + \sigma \mathrm{S}_\mathrm{t}^\gamma \, \mathrm{dW}_t$$

- The parameter γ controls the relationship between volatility and price, and is the central feature of the model.
- When γ <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

$$Rent_t = \eta_t * Rent_t$$

- The cash outflow is given by expenses, modeled by

$$Wk_t = \kappa_t * Wk_t$$

Discounted Cash Flow

- The Total Cash Flow for the system is given by

$$FCF_T = (1\text{-}\tau)(\eta_T * Rent_t \text{-} Exp_T \text{-} Wk_t) + \tau Dep_T + P_T \text{-} \tau * PV$$

- 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

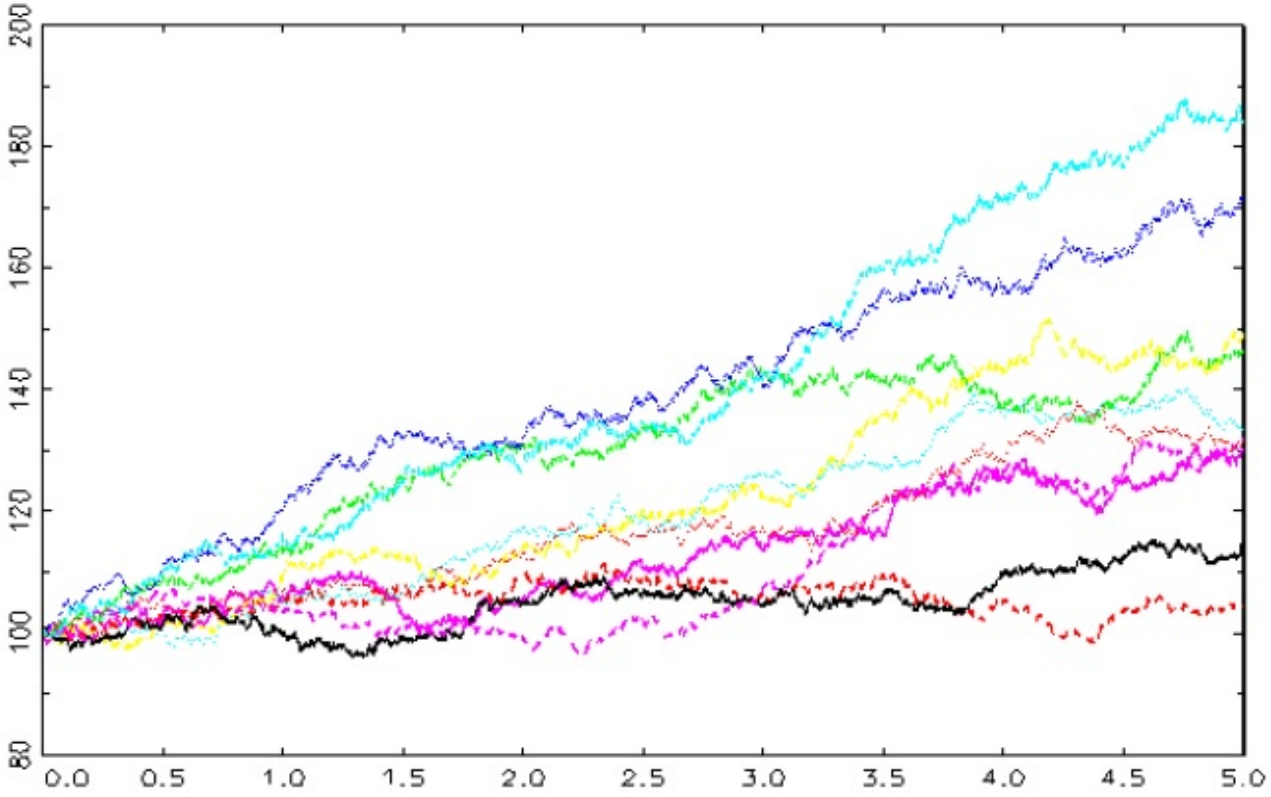
To overcome the drwabacks of the DCF model, the APV model is used.

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

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
τ	= tax rate

Simulation



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