

Real Options 2020

Dean A. Paxson

Chapters 1 & 2 **Real Option Value**

Introduction to Real Options

Chapter 2

- #1 Valuing Perpetual American Options
 - Value Matching $ROV=NPV$ at Exercise Point
- #2 Simple Real Calls & Puts
 - Practical Real Estate Case Study
- #3 Exercises
- #4 Problems (Excel Exercises)

INTRODUCTORY TOPICS COVERED

Real Business Options

- Investment Opportunity
- Abandonment Opportunity
- Start-up with Inputs & Outputs
- Shut down with Inputs & Outputs
- Switching Outputs (or Inputs)
- Debt, and Equity Options

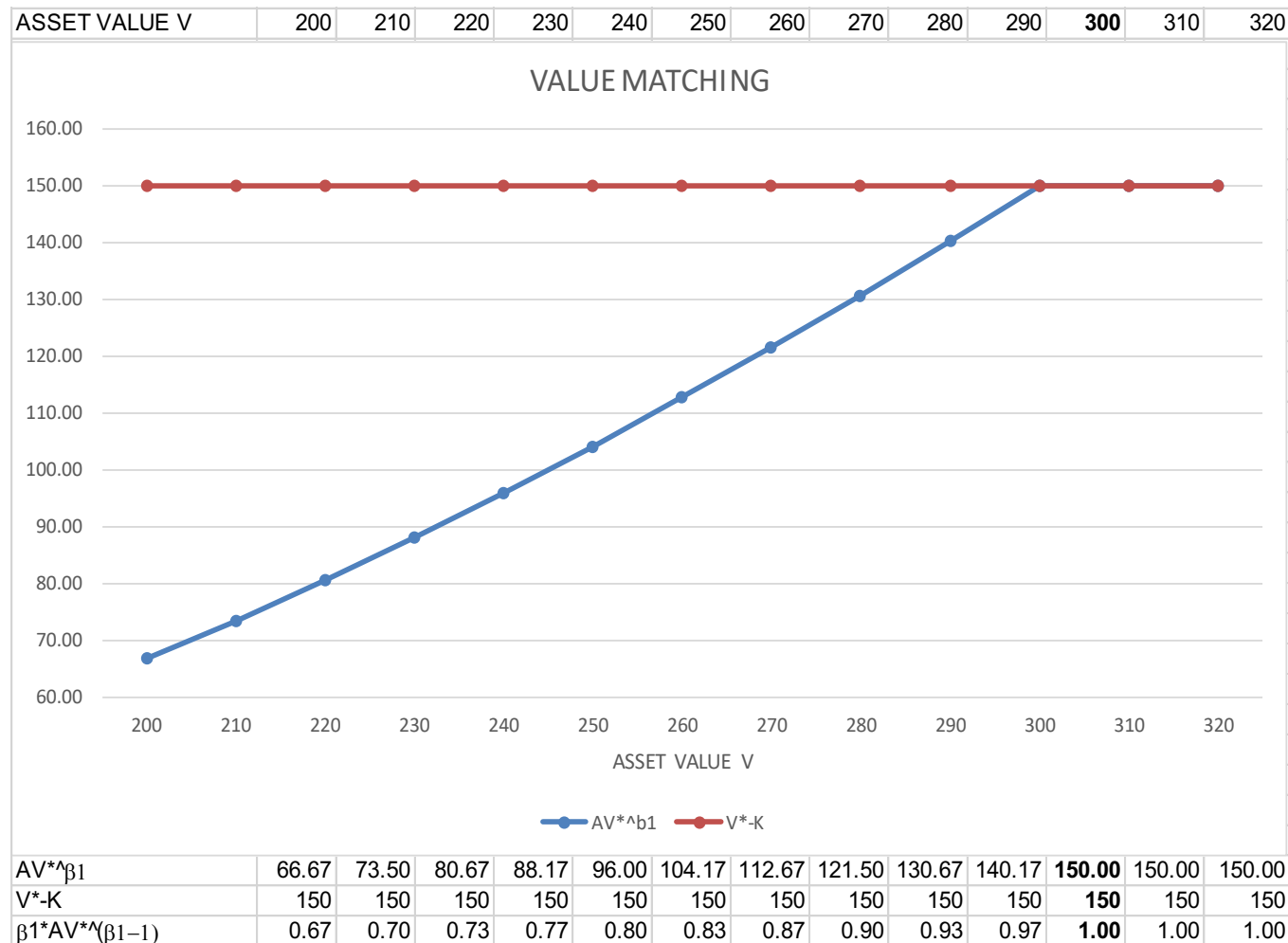
INTRODUCTION

- Real Options:
 - Why Options?
 - Because the holder is given the right but not the obligation to choose the alternative that best suits her interest;
 - Why “Real”?
 - Because they relate to real assets instead of financial assets
- Often concerns “intangibles” of corporation =no immediate +cash flow

INTRODUCTION

- The value of real options depends on six variables:
 - Value of the underlying asset V ;
 - Investment cost V ;
 - Time to expiration(optimal threshold to exercise option V^{\wedge});
 - Volatility in the value of the underlying asset;
 - Risk free interest rate; and
 - Expected yield on the underlying asset.

Value Matching =BASIC Principle of Valuing REAL OPTIONS



At \hat{V} the value of the option to invest equals the net present value of the investment.

$$ROV(\hat{V}) = A\hat{V}^{\beta_1} = \hat{V} - K$$

The smooth pasting condition states that at the trigger value the first derivatives of the LH and RHS of (2.8) must be equal.

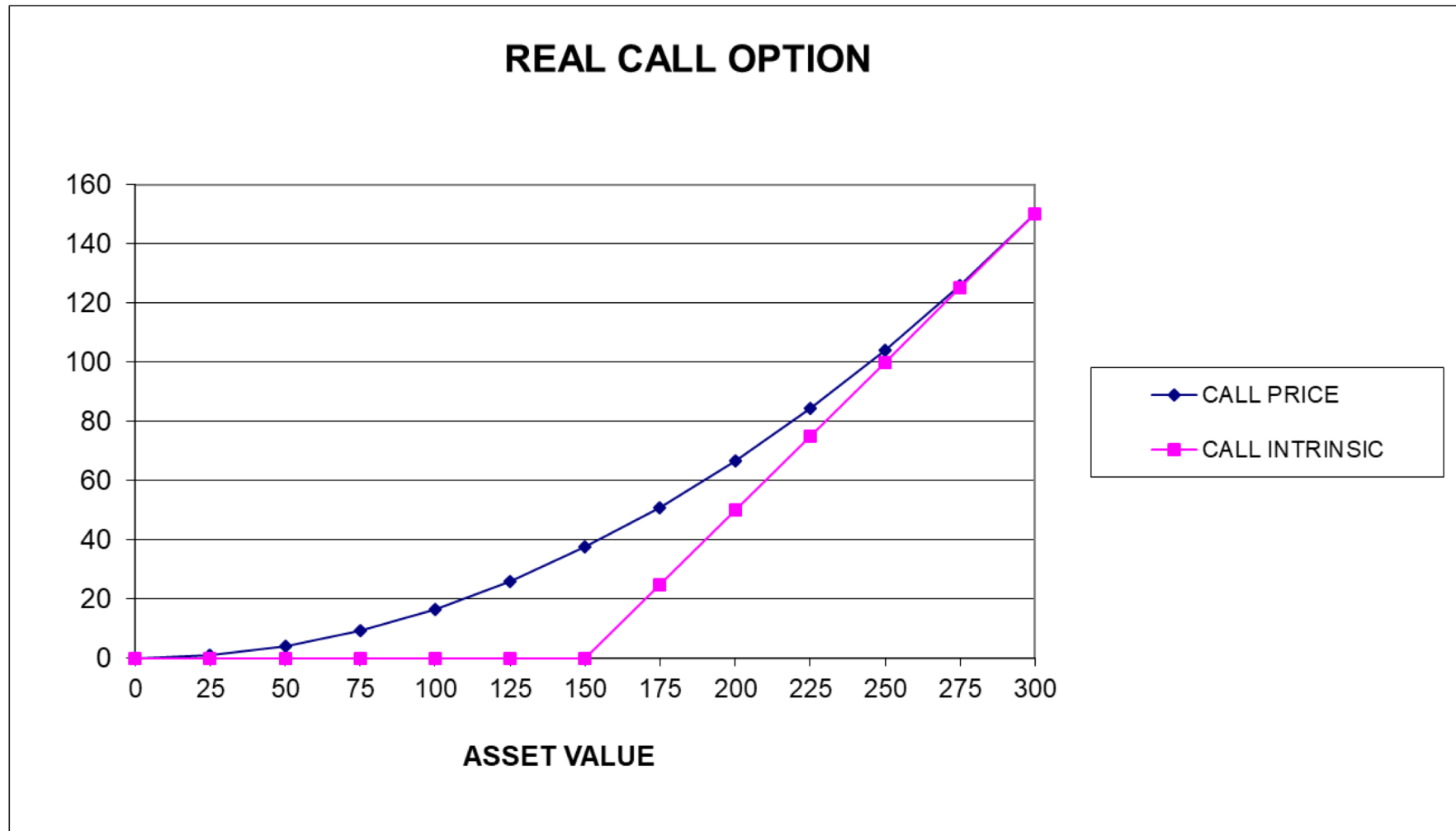
$$\beta_1 A \hat{V}^{\beta_1 - 1} = 1$$

$$A = \frac{\hat{V} - K}{\hat{V}^{\beta_1}}$$

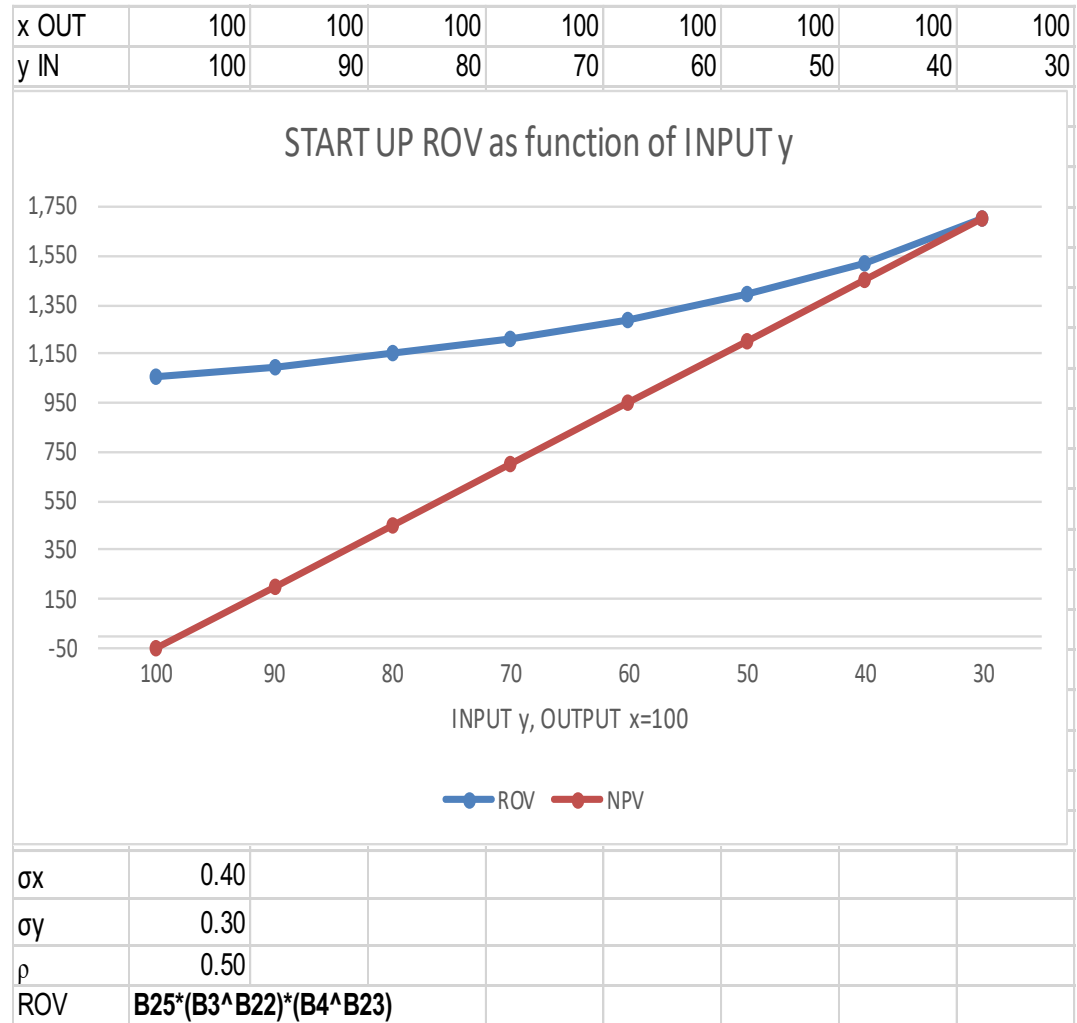
$$\hat{V} = \frac{\beta_1}{\beta_1 - 1} K$$

$$F(V) = (\hat{V} - K) \left(\frac{V}{\hat{V}} \right)^{\beta_1}$$

REAL CALL OPTION

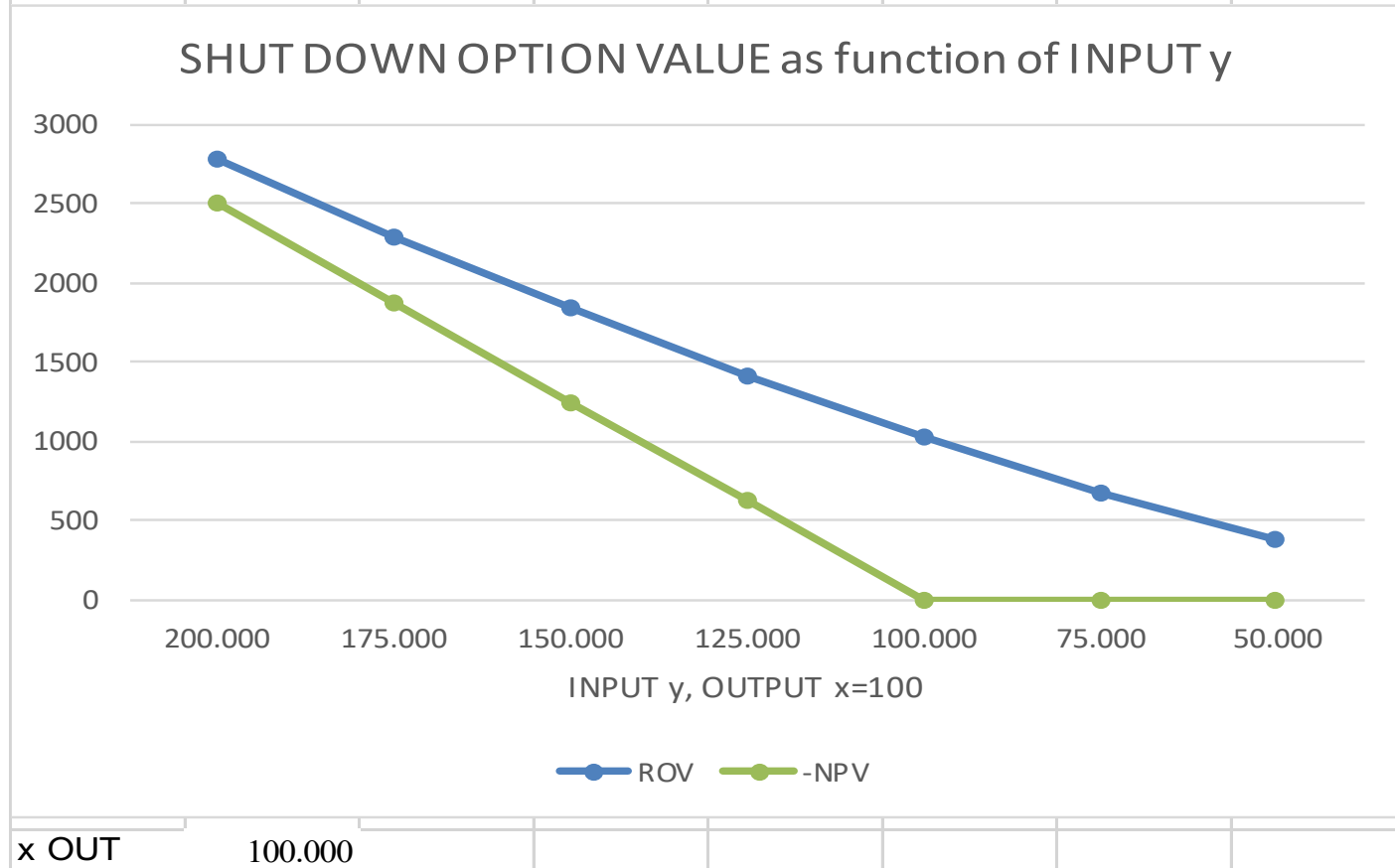


REAL Start Up OPTION



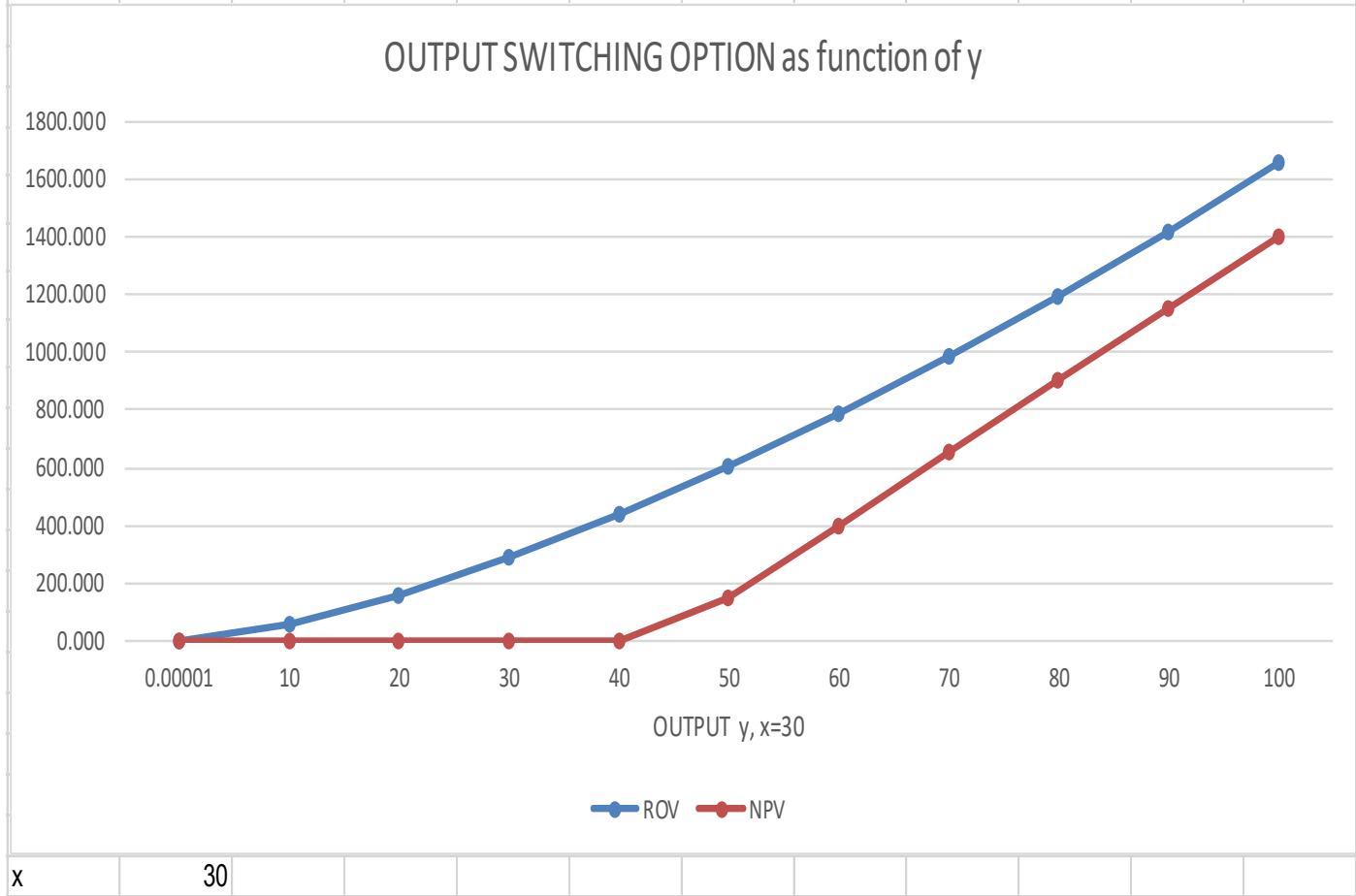
REAL Shut Down OPTION

y INPUT	200	175	150	125	100	75	50
ROV	2780	2296	1840	1417	1029	681	381
-NPV	2500	1875	1250	625	0	0	0

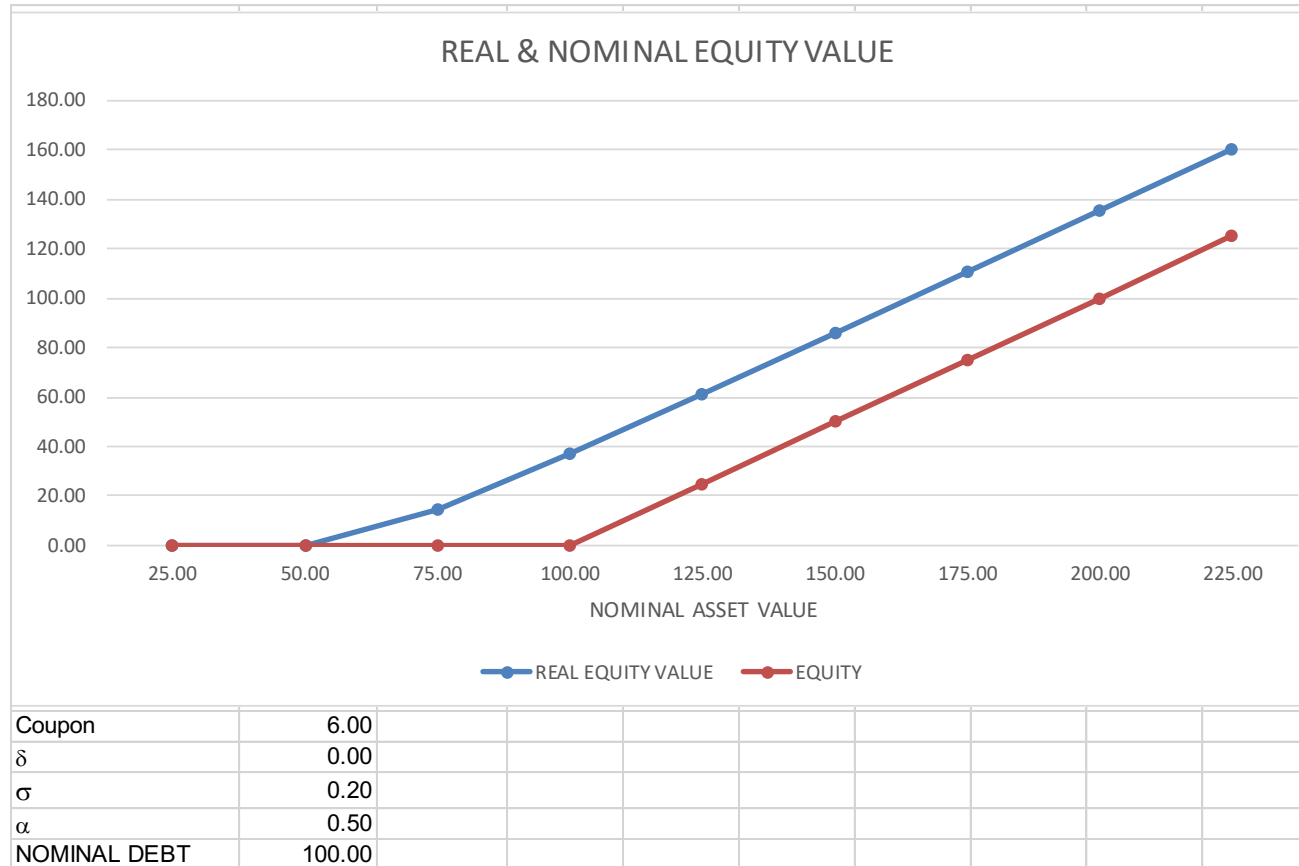


REAL Output Switching OPTION

ROV	0.000	58.372	159.747	287.868	437.179	604.526	787.808	985.500	1196.427	1419.652	1654.405
NPV	0.000	0.000	0.000	0.000	0.000	150.000	400.000	650.000	900.000	1150.000	1400.000



Equity as Call Option



CONSTRÓI CASE STUDY

- CONSTRÓI, SA, a real estate developer based in the north of Portugal, can start a housing development on a farm close to Almada. The farm is derelict; it is not possible to carry on any type of farming on the site.
- Immediate development of the project cost €150 million (in present value terms).
- Gross present value of the development is €150 million. The volatility of real estate developments has been 20% in Portugal, property asset yield 4%, interest rates 4%.

CONSTRÓI CASE STUDY

- The opportunity to invest in developing a site is equivalent to holding a call option, with the investment cost as the exercise price.
- **CONSTRÓI's management team is worried about the uncertainty, and is thinking of selling this prospect for 30 million euro.**

Solution

	A	B	C
1	Perpetual American Call Option		
2	INPUT		
3	V	150.00	
4	K	150.00	
5	σ	0.20	
6	r	0.04	
7	δ	0.04	
8	OUTPUT		
9	F(V)	37.50	IF(B3<B12,B13*(B3^B14),B10)
10	V-K	0.00	B3-B4
11	F'(V)	0.50	IF(B3<B12,B13*B14*(B3^(B14-1)),1)
12	V*	300.00	(B14/(B14-1))*B4
13	A	0.0017	(B12-B4)/(B12^B14)
14	β_1	2.00	
15	F(V)	37.50	IF(B3<B12,((B12-B4)*(B3/B12)^B14),B10)

DEFERRAL OPTION

- A deferral option is normally an option found in most projects where the owner holds the right to delay the date at which the project will start to be developed.

GROWTH OPTION

- An option to expand or make a follow up investment is a call option, giving the corresponding holder the right or ability to enter a market or scale up its operations by paying a certain (exercise) price.

OPTION TO ABANDON

An option to abandon is a put option that gives its holder the right to abandon a project or market by paying the corresponding costs (exercise price).

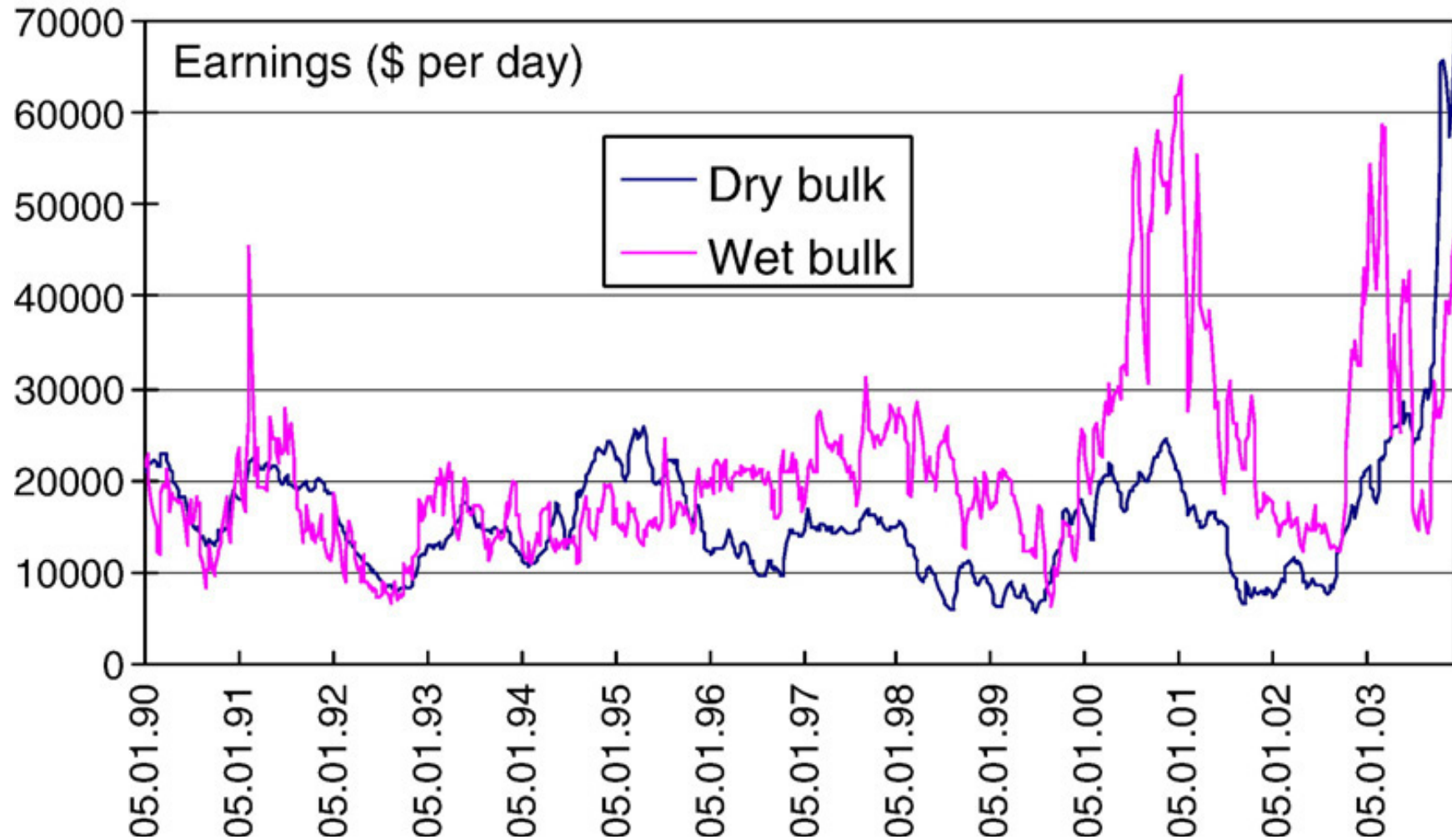
SWITCHING OPTIONS



- Switching options are options that allow the holder to change modes of operation at a fixed cost (e.g. switch between the cheapest of two inputs, or to the most profitable of two outputs).
- Examples are switching between drilling for natural gas or natural gas liquids (propane) for six U.S. Frackers.
- Switching between coal and renewables for Europe, U.S. & China.

OUTPUT SWITCHES

Sødal et al. 2008 SHIPPING SWITCHES



RELEVANT QUESTION

In what circumstances can a real options valuation provide a final decision that is different from a traditional NPV approach?

- Real options value tends to be higher when:
 - Uncertainty is high;
 - Managers have flexibility;
 - The NPV is close to zero, little immediate + cash inflow, and time to defer a decision.

Review of Chapter 2

- Use of Real Options
- Types of Real Options: Invest, Abandon, Start up, Shut Down, Switch Outputs
- Default or Equity Strategy Options

Class Exercise

EXERCISE 2.3. Citibank has an option to take up to an additional 100,000 square feet of space in Canary Wharf at $R=£45/\text{SF}$. Space in Canary Wharf is worth R/δ , where $\delta=4\%$, current rent is $£42/\text{SF}$, rent volatility is 20% and the risk-free rate is 4%, so $\beta_1=2$. What is the value of this option?

Class Exercise Formulae

$$A = \frac{\hat{V} - K}{\hat{V}^{\beta_1}}$$

$$\hat{V} = \frac{\beta_1}{\beta_1 - 1} K$$

$$F(V) = (\hat{V} - K) \left(\frac{V}{\hat{V}} \right)^{\beta_1}$$