

# Root Finding: Graphical Method

ME 2004



# Outline

- 1.1: Graphical Method



# Graphical Method

- To recap, the purpose of root finding:

Find the solution(s) of  $f(x) = 0$ .

- In this course, we will learn 4 root finding methods:
  - Bisection Method
  - Newton-Raphson
  - Built-in MATLAB solver
  - Plot!!



# Graphical Method

- Capital Recovery Factor:

$$A = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

$A$  = annual payment,  $P$  = present worth,  $n$  = number of years,  $i$  = interest rate

- Computing  $i$  or  $n$  is extremely difficult (if not impossible), so we must use a root finding method
  - More specifically, we are finding the root of  $f(x) = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right] - A$
- The simplest root finding method is to plot the function!

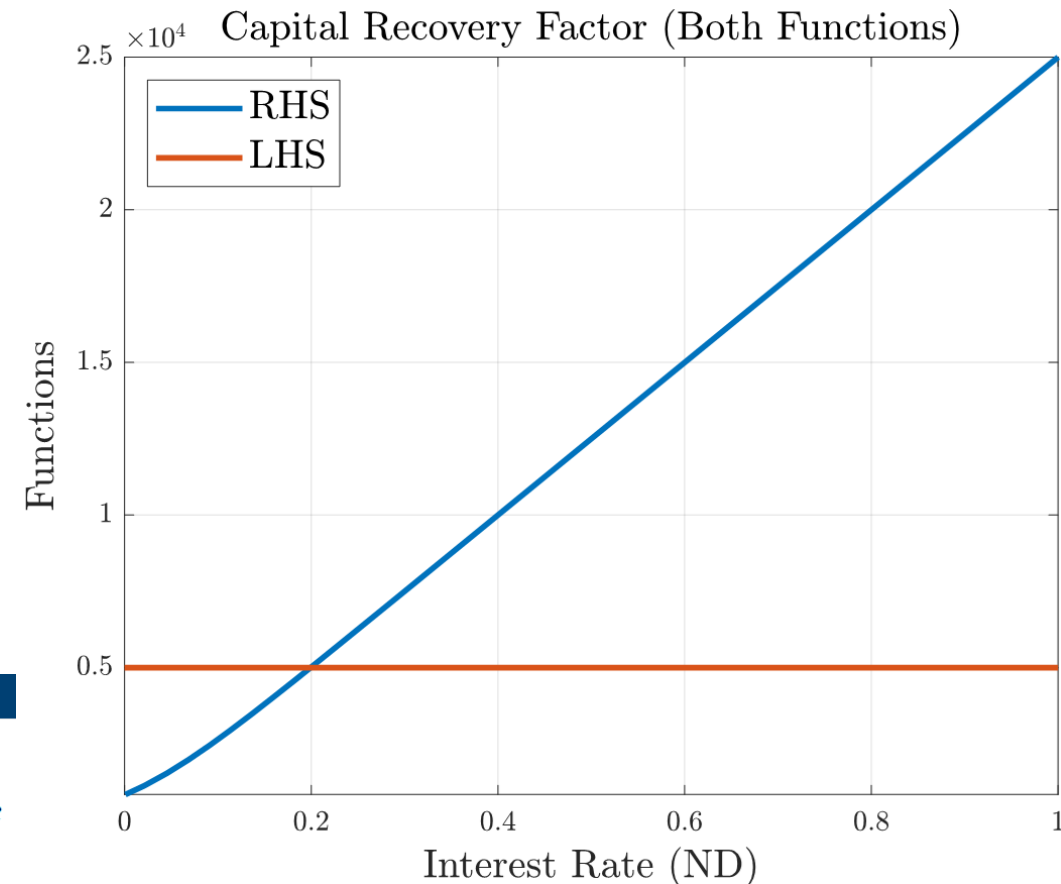
# Graphical Method

- We can plot both functions on the same figure and find the point of intersection

$$A = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

## Command Window

```
>> P=25e3; A=5e3; n=30;
>> rightHandSide = @(i) P*(i.*(1+i).^n)./((1+i).^n - 1);
>> leftHandSide = @(i) A;
>> figure; fplot(rightHandSide,[0 1],'linewidth',2)
>> grid on; hold on; fplot(leftHandSide,[0 1],'linewidth',2)
```



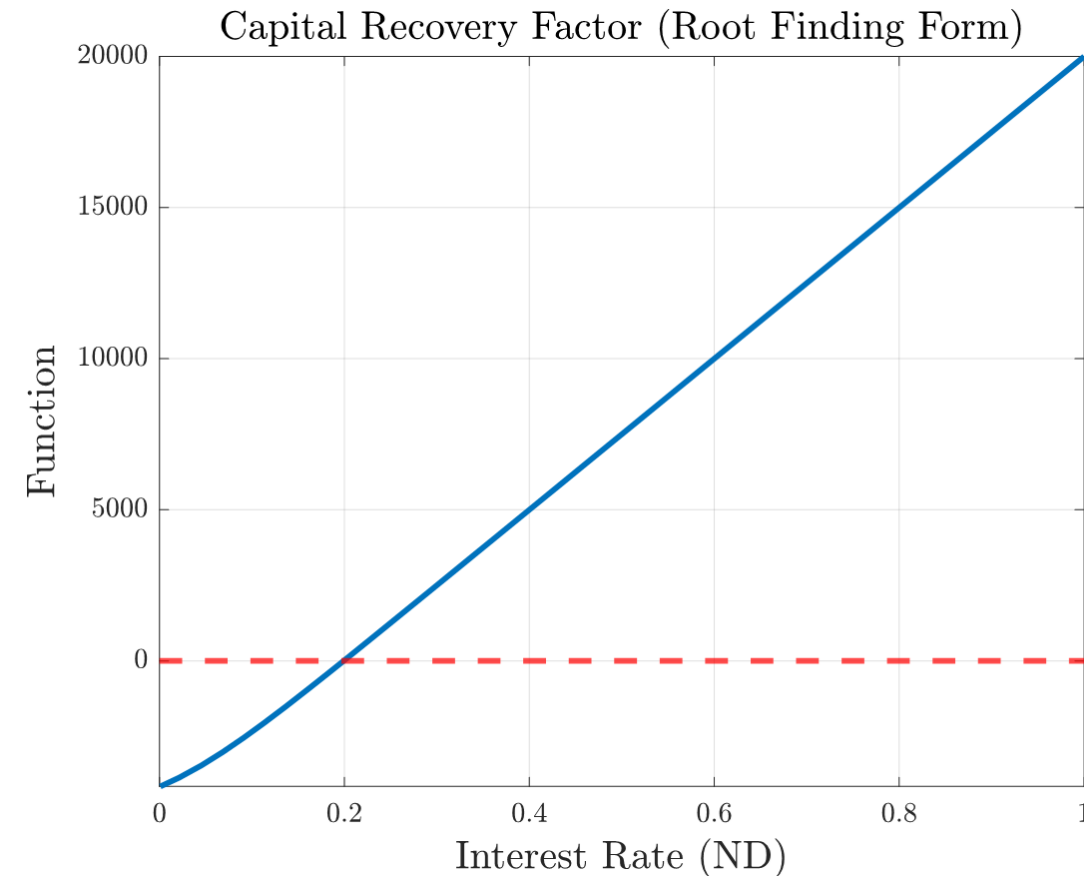
# Graphical Method

- Or, we can plot the root finding function  $f(x) = 0$  and find where it hits the x-axis (preferred)

$$f(x) = P \left[ \frac{i(1+i)^n}{(1+i)^n - 1} \right] - A$$

## Command Window

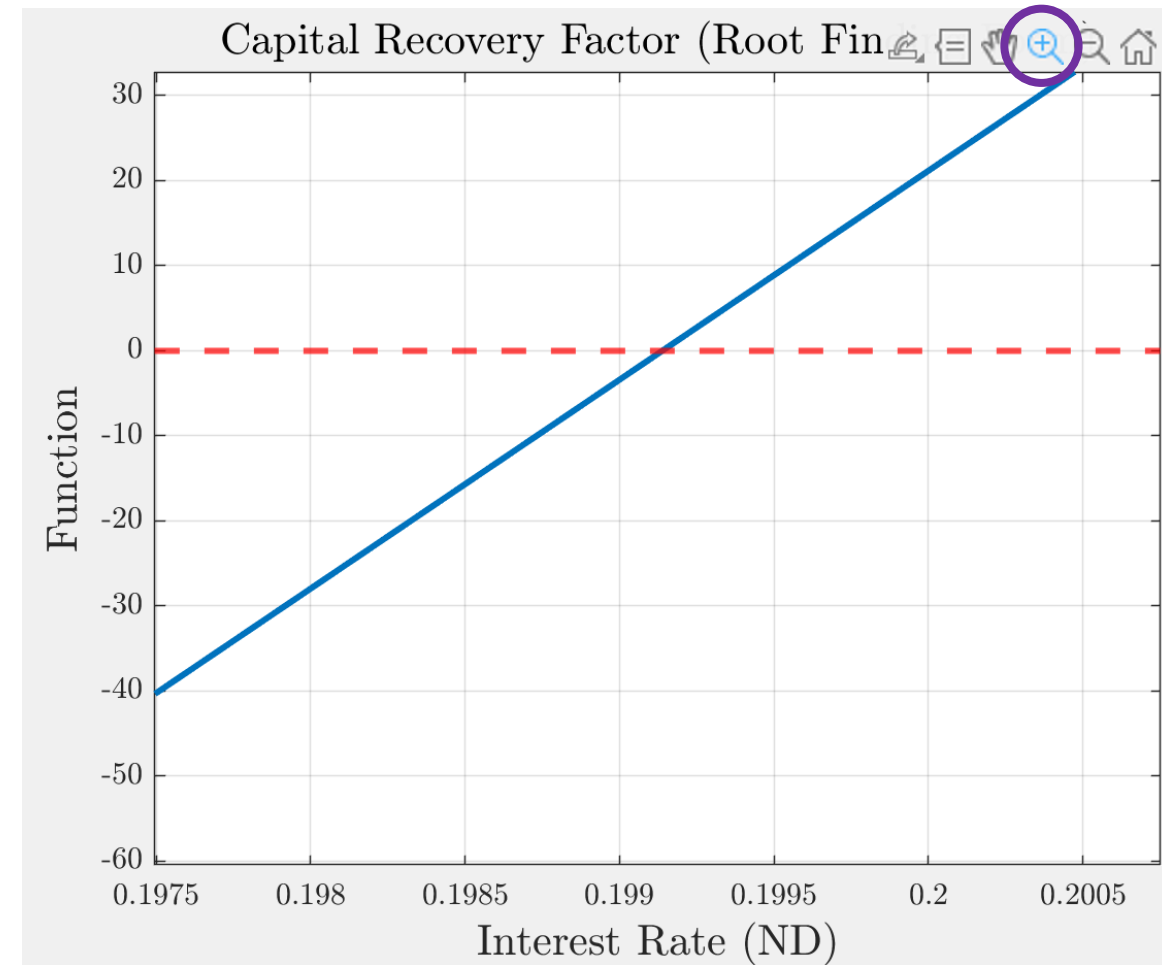
```
>> P=25e3; A=5e3; n=30;
>> func = @(i) P*(i.*(1+i).^n)./((1+i).^n - 1) - A;
>> figure; fplot(func,[0 1],'linewidth',2)
>> grid on; hold on; yline(0,'r--','linewidth',2)
```



# Graphical Method

- Progressively zooming in allows us to hone in on the root

$$\rightarrow i \approx 19.91\%$$





# Graphical Method

- Benefits of plotting:
  - It's just good practice
  - It provides you with a rough estimate of the root which you can use to corroborate fancier root finding techniques
  - It provides you with suitable initial guess(es) for fancier root finding techniques
  - You understand the behavior of the function





# Graphical Method

- Limitations of plotting
  - Prone to typos/bugs/errors
  - Not very precise, especially as more decimals become involved

# Summary

- Plotting the function (either both functions on the same plot or the function in root finding form,  $f(x)$ ) should instinctively be the first step
- While it can't give exact answers, you can get a very good estimate
- Use your plot to corroborate fancier root finding methods
- Always plot!!