

## Lecture 2 T

Produced by Dr. Worldwide

#### **Excel: Break-Even**

- Download BreakEven.xlsx from website link called Sheet 1
- Enter fixed cost  $(c_f)$ , variable cost  $(c_v)$ , and price (p)
- Excel formula used to find break-even point ( $x^* = \frac{c_f}{p-c_p}$ )

	А	В
1	Break-even problem	
2		
3	Fixed cost (cf)	10000
4		
5	Variable cost (cv)	8
6		
7	Price (p)	23
8		
9	Break-even point:	666.666667

#### **Excel: Break-Even**

- Use of Excel QM software for break-even analysis
- Begin by opening Excel QM software from computer shortcut
- Select Excel QM tab and select Alphabetical



- In drop down menu, select Break-even Analysis and then Breakeven (Cost vs Revenue)
- Enter name of report, sheet title, and insert checkmark for graph



#### **Excel: Break-Even**

Hello **Breakeven Analysis** Cost vs. Revenue Enter the fixed and variable costs and the selling price in the data area. You may enter a volume at which to perform a volume analysis. Data 35000 30000 Option 1 25000 Fixed cost 10000 20000 15000 Variable cost 8 10000 Revenue 23 5000 200 400 Costs Results **Breakeven points** Units 666.6666667 Dollars \$ 15,333.33



-Revenue

- Beaver Creek Pottery produces the hottest clay bowls and mugs
  - Bowls require 1 hr. of labor and 4 lbs. of clay
  - Mugs require 2 hrs. of labor and 3 lbs. of clay
- Daily Limitations of resources
  - 40 hrs. of labor
  - 120 lbs. of clay
- Profit
  - Bowls return profit of \$40
  - Mugs return profit of \$50
- Q: What number of clay bowls and mugs should the company make each day to maximize daily profit?



#### **Linear Programming**

- Linear programming is the process of optimizing a linear objective function subject to linear constraints.
- Seven steps of linear programming
  - Define the decision variables
  - Define the linear objective function
  - Use linear inequalities to define constraints
  - Graph resulting system of inequalities (use lines and shading)
  - Find the corners of the region
  - Substitute the coordinates of each corner into the objective function
  - Select the appropriate result based on when the objective function is optimized (either maximized or mininized) and interpret



- Decision variables
  - *x* = *Number of Bowls to Produce in* 1 *Day*
  - *y* = *Number of Mugs to Produce in 1 Day*
- Objective function
  - We seek to maximize profit
  - f(x, y) = Z = 40x + 50y





- Constraints
  - $x + 2y \le 40$  (labor hours)
  - $4x + 3y \le 120$  (pounds of clay)
  - $x \ge 0$  (nonnegativity)
  - $y \ge 0$  (nonnegativity
- Feasible region
  - Constraints lie on a two-dimensional plane
  - The feasible region is the set of all (x, y) points where none of the constraints are violated
  - The set  $\{(x, y): x + 2y \le 40 \cap 4x + 3y \le 120 \cap x \ge 0 \cap y \ge 0\}$
  - Helpful to get constraints in form comfortable for plotting

Constraints in Slope-Intercept Form

$$x + 2y \le 40 \rightarrow y \le 20 - \frac{1}{2}x$$
 &  $4x + 3y \le 120 \rightarrow y \le 40 - \frac{4}{3}x$ 

#### Linear Program

Maximize	Z = 40x + 50y
Subject to	$x + 2y \le 40$
	$4x + 3y \le 120$
	$x \ge 0$
	$y \ge 0$



- Plotting the feasible region
  - Based on nonnegativity constraints, the feasible region exists somewhere in the positive quadrant
  - Plot inequalities as if they were equalities
  - Shade according to the inequality symbol (check if the origin satisfies the inequality or not
  - The feasible region is the intersection of the shaded areas

#### Constraints in Slope-Intercept Form

$$y \le 20 - \frac{1}{2}x$$
  

$$y \le 40 - \frac{4}{3}x$$
  

$$x \ge 0 \text{ (vertical line)}$$
  

$$y \ge 0 \text{ (horizontal line)}$$



• Plotting the feasible region (Continued)







- Find the corners of the feasible region
  - Origin: (0,0)
  - Intercepts: (0,20) & (30,0)
  - Intersection Point: (24,8)

$$y = 20 - \frac{1}{2}x = 40 - \frac{4}{3}x = y$$
$$-\frac{1}{2}x + \frac{4}{3}x = 20$$
$$\frac{5}{6}x = 20$$
$$x = 24$$

When x=24,

$$y = 20 - \frac{1}{2} * 24 = 8$$



- Find the corners of the feasible region (Continued)
  - Optimal choice of decision variables is one of the corner points around feasible region
  - Plug into objective function

**Corner Points and Profit** 

 $(0,0) \rightarrow 40(0) + 50(0) = \$0$  $(0,20) \rightarrow 40(0) + 50(20) = \$1000$  $(30,0) \rightarrow 40(30) + 50(0) = \$1200$  $(24,8) \rightarrow 40(24) + 50(8) = \$1360$ 

- Find optimal solution and interpret
  - Ideally, we want to produce 24 bowls and 8 mugs
  - This decision will lead to a maximum profit of \$1360

- Another creative look at finding the optimal solution
  - Recall the objective function: Z = 40x + 50y





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- Another creative look at finding the optimal solution (Continued)
  - Objective function grows in the direction of the vector (40,50)
  - Lines that are perpendicular to this vector are level curves
  - In a maximization problem, the optimal solution will be the point in the feasible region farthest in the direction of growth





### **Using Desmos**

- Use Link Provided on Course Website for Online Graphing Calculator
- Start with a Blank Coordinate Plane and Zoom Out as Necessary

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## **Using Desmos**

• Type Inequalities for Constraints in the Left Panel



# Using Desmos

• Darkest Region Represents the Feasible Region



- Points of Intersection Can Be Easily Selected
- Need to Use a Screen Shot to Capture Image to Save on Your Computer









#### The End



#### Dale