Breakeven & Sensitivity Analysis – Take Home Reading

Nothing is certain in the business world - input prices can change dramatically; your competitors can lower their prices or have "doorbuster sales" to pull in new customers. In businesses that are affected by weather, such as agriculture and construction, poor weather can lead to lower crop yields or slower building times. Managers take their best estimates ("guesses") of how many units they will sell in the upcoming year and of the average price they will charge for their goods and services. They use these estimates to build their income statements and enterprise budgets for the upcoming year. But they have no way of knowing how good their estimates are until the end of the year. For these reasons, managers like to do "breakeven analysis" and "sensitivity analysis" to see how sensitive their business profits are to changes in key items.

Breakeven analysis is a way to estimate the lowest selling price that you can charge so that you earn enough revenues to cover your costs. It can also be used to estimate the lowest amount of units that you need to sell at a certain price to cover your costs. Or, we can get fancy and calculate the highest price that you can afford to pay for one of your key inputs (labor, fertilizer, raw materials, etc.).

Sensitivity analysis is just a fancy term for estimating how your business' profits are going to be impacted by changes in one or more key factors, such as the purchase cost of an input or the amount of units you actually sell. There are no "hard and fast rules" for doing sensitivity analysis. I would recommend that you keep it simple – choose one main factor to change at a time, then, change that factor by 10-25%. For example, you can analyze how your profits (return above operating costs or return above total costs) are hurt by a 10% decrease in the number of units you actually sell. Computer spreadsheets are great tools to use for sensitivity analysis.

Let's look at the basics of breakeven analysis. "Breakeven" means that your revenues are just equal to your costs – so you're just breaking even – you're not making money, but you're not losing money either. We can calculate breakevens for the upcoming year (the short run) or for the next several years (the long run).

It might be easier to understand breakeven analysis if we apply it to your personal life. Let's assume that your monthly living expenses (rent, food, etc.) are $1,000. You are working at a local business that pays you $10/hour. For you to "breakeven", your monthly earnings must be equal to your monthly expenses. How many hours do you need to work per month so that you can breakeven?

Total Earnings = $10/hour x Hours Worked/month

Total Expenses = $1,000/month

Total Earnings = Total Expenses

$10/hour x Hours Worked/Month = $1,000/Month

Hours Worked/Month = $1,000 / $10/hour = 100 hours/month

So, your breakeven number of hours worked per month is 100 hours. If we assume that there are an average of 4 weeks per month you will need to work 25 hours/week (100 hours/ month / 4 weeks/month) to breakeven. We call this your "breakeven quantity".

What if you know that you can only work 80 hours/month? What is the minimum wage rate that you have to earn to breakeven? Let's start with the same basic formula:

Total Earnings = Total Expenses

Wage Rate/Hour x 80 Hours Worked/Month = $1,000/Month

Wage Rate/Hour = $1,000/Month / 80 Hours Worked/Month = $12.50/Hour

Your breakeven wage rate is $12.50/hour if you can only work 80 hours per month. We call this your "breakeven price".

In the business world we only use operating expenses for the "short run" (the upcoming year). In the short run, breakeven means that our total revenues are just equal to our total operating expenses. Let's create a formula that will help you learn how to calculate short run breakevens. In the short run (the upcoming year), Total Revenues are equal to Total Operating Expenses. But, we can rewrite Total Revenues as follows: Total Revenues = Units Sold x Price/Unit. So, our main short run breakeven formula is:

Units Sold x Price/Unit = Total Operating Costs

To calculate the minimum price that you need to charge to cover your operating costs, simply rearrange this formula to solve for Price/Unit:

Price/Unit = Total Operating Costs / Units Sold

Let's calculate the breakeven price for Greta's squash enterprise. She typically sells 100 pounds of squash per month. The operating expenses of her squash enterprise are $550 per month. Greta's breakeven price is:

Price/Unit = Total Operating Costs / Units Sold

Price/Unit = $550 / 100 pounds = $5.50/pound

Greta needs to charge at least $5.50/pound for her squash. At this price her total revenues will be just equal to her total operating expenses.

Total Revenues = 100 pounds of squash x $5.50/pound = $550

Total Operating Expenses = $550

So, Total Revenues = Total Operating Expenses when the selling price is $5.50/pound

Let's calculate the minimum number of pounds of squash that Greta needs to sell to breakeven is she charges $6.00/pound. We call this the "breakeven quantity". Assume that Greta has already purchased the squash and that her total operating expenses are still $550 for the month. Her breakeven quantity of squash is:

Units Sold x Price/Unit = Total Operating Costs

Units Sold x $6.00/pound = $550

Units Sold = $550 / $6.00/pound = 91.67 pounds of squash sold

Let's double-check our math:

Total Revenues = 91.67 pounds x $6/pound = $550

Total Operating Expenses = $550

So, Total Revenues = Total Operating Expenses at 91.67 pounds sold per month.

How does Greta use these breakevens in managing her business? Greta looks at her competitor's prices for squash and sees that they are all charging an average of $3.50/pound. But she must be able to charge $5.50/pound to cover her operating costs. How can she compete with the other grocery stores if she has to charge $2.00/pound more than they do? This helps Greta see that she needs to either reduce the operating costs of her squash enterprise so that she can charge closer to $3.50/pound, or maybe she should think about not selling squash at all. Remember, we said that a business must always be able to cover its operating expenses in the short run. Breakeven analysis helps the manager make short run decisions.

Let's get a little more realistic. Most managers do not want to simply break even – they want to earn profits over their expenses. We can calculate the lowest price we need to charge, or the minimum amount of units we need to sell at a given price, that allows us to earn a desired profit. Now our total revenues must be equal to our total operating expenses plus our desired profit:

Total Revenues = (Total Operating Costs + Desired Profit)

Assume that Greta wants to earn at least $200 of profit per month from her squash enterprise if she sells an average of 100 pounds per month. Let's calculate the minimum selling price and quantity sold for her to earn $200 of profit:

Total Revenues = (Total Operating Costs + Desired Profit)

Units Sold x Price/Unit = (Total Operating Costs + Desired Profit)

100 pounds x Price/Unit = ($550 + $200)

Price/Unit = ($750) / 100 pounds = $7.50/pound

Greta must charge $7.50/pound to earn a profit of $200/month.

Units Sold x Price/Unit = (Total Operating Costs + Desired Profit)

Units Sold x $5/pound = ($550 + $200)

Units Sold = ($750) / $5/pound = 150 pounds sold per month

Greta must sell 150 pounds/month to earn a profit of $200/month under these assumptions.

Managers are not just concerned about the short run. They need to think about staying in business for several years – the long run. In the long run the business must generate enough revenues to cover its total costs (operating costs plus overhead costs). This is the only thing that is different between short run and long run breakeven. Here's the general long run equation:

Units Sold x Price/Unit = (Total Operating Costs + Total Overhead Costs)

Greta's overhead costs for the squash enterprise are $150/month. If she sells 100 pounds per month, with operating costs of $550/month, her breakeven long run selling price is:

Units Sold x Price/Unit = (Total Operating Costs + Total Overhead Costs)

Price/Unit = (Total Operating Costs + Total Overhead Costs) / Units Sold

Price/Unit = ($550 + $150) / 100 pounds = $7.00/pound

Great must charge a minimum of $7.00/pound for her squash for her to stay in business for more than a few years (the long run). This will allow her to just cover her total expenses. If she wants to earn a profit above those total costs, we can add in the desired profit to this calculation like we did for the short run.

Greta's minimum level of sales (units) for the long run is she charges $5.00pound is:

Units Sold x Price/Unit = (Total Operating Costs + Total Overhead Costs)

Units Sold = (Total Operating Costs + Total Overhead Costs) / Price/Unit

Units Sold = ($550 + $150) / $5.00/pound = 140 pounds of squash sold per month

We can use a computer spreadsheet to calculate our breakeven prices and quantities. There are 2 ways to calculate breakevens with a spreadsheet. First, we can enter formulas:

Short Run Breakeven Price = Total Operating Costs / Units Sold

Short Run Breakeven Units Sold = Total Operating Costs / Price/Unit

Long Run Breakeven Price = Total Costs / Units Sold

Long Run Breakeven Units Sold = Total Costs / Price/Unit

In this spreadsheet, we use "cell references" instead of actual numbers. To enter a formula for short run selling price, we need to divide the cell that contains the total operating costs by the cell that contains the units sold. The Total Operating Costs are in cell "H29" – Column H, row 29. Units Sold are in cell "D5" – Column D, row 5. So our formula should look like this:

Short Run Breakeven Price = H29 / D5

Click on cell H32 to see this formula for short run breakeven price. Now, look in the "formula bar" which is toward the top of the screen. You will see a formula that looks like:

= H29/D5

That's all there is to it! This formula will automatically take whatever number is in cell H29 (Greta's total operating costs) and divide it by the pounds sold (cell D5). Change the pounds sold to 200 pounds and see what happens to the breakeven selling price. Pretty neat, huh?!

We can do the same thing for the other breakeven formulas. Look at these cells to see the formulas:

Cell H31 is Short Run Breakeven Units Sold = H29/F5

Cell H32 is Short Run Breakeven Selling Price = H29/D5

Cell H42 is Long Run Breakeven Units Sold = H39/F5

Cell H43 is Long Run Breakeven Selling Price = H39/D5

The second method of calculating breakevens on a spreadsheet is by using a function called "Goal Seek". The Goal Seek function is found on the "Data tab" – click on the Data tab. Now click on the "What-If Analysis" button. Then select "Goal Seek" from the menu.

Goal Seek basically need 3 pieces of information to calculate a breakeven:

1. The cell that contains the Return Above Operating Costs (RAOC) for short run breakevens, or the cell for Return Above Total Costs (RATC) for long run breakevens,
2. What you want to set the RAOC or RATC equal to. Use zero ($0) to calculate the breakeven. Or, use the desired profit to calculate the minimum price or quantity needed to earn that profit,
3. The cell containing the factor you want to calculate. For breakeven selling price, choose the cell that contains the current selling price; for breakeven units sold, enter the cell that contains the current level of sales.

Here's how to use Goal Seek to calculate the short run breakeven selling price for Greta's Squash Enterprise:

Open Greta's squash enterprise budget spreadsheet

Click on the Data tab

Click on the "What-If Analysis" button

Select "Goal Seek" from the dropdown menu

A box will appear that asks you for the 3 pieces of information that are needed:

1. Set cell – this is the RAOC or RATC cell reference
2. To value – this is what you want RAOC or RATC to be equal to
3. By changing cell – this is what you are solving for

To calculate Greta's short run breakeven selling price, enter the following information in the input box:

1. Set cell: H30

   - H30 is the cell reference for Greta's Return Above Operating Costs

2. To value: $0

   - this tells the spreadsheet to set the RAOC to $0

3. By changing cell: F5

   - F5 is the cell reference for the current selling price

Once you have this information entered into the box press the "OK" button to solve for the short run breakeven selling price. You will get a message that says "Goal Seeking with Cell H30 found a solution." This means that it solved for the breakeven price. If you look at cell H30, it will show a value of $0 – this means that Greta earned just enough revenue to cover her operating costs. Now, look at cell F5 to see what the breakeven selling price is – you will see that the price changed from $5.00/pound to $5.50/pound. This means that Greta's short run breakeven selling price is $5.50/pound. This is what we calculated by hand and with the spreadsheet formula – if nothing else, Goal Seek will help you double-check your answers to your formulas!

Click "Cancel" to return the selling price to the original value of $5.00/pound. If you accidently click "OK" the spreadsheet will keep the $5.50/pound price instead of the original $5.00/pound --- not a problem, just type "5" into cell F5 to go back to the original price.

If you want to calculate the short run breakeven units sold, do the exact same thing we just did, except in enter the cell for the units sold (D5) in the "By changing cell" box. You should get 110 pounds as your short run breakeven units sold.

Reset your units sold back to the original 100 pounds and be sure that your price is $5.00/pound. You can calculate the long run breakevens in the same fashion – the only difference is that you want to use the cell reference for the Return Above Total Cost (RATC) for the "Set cell" input. Everything else is the same! Try it and see if you get the same results as we got by hand.

Now, what if Greta wants to determine the price she needs to charge to earn a Return Above Operating Costs of $200. This is a short run decision because she is only interested in covering her operating costs. The only thing that we have to do differently is enter $200 instead of $0 in the "To value:" input box. Here's what it will look like:

Set cell:	H30	(cell reference for RAOC)
To value:	$200	(Greta's desired profit)
By changing cell:	F5	(Cell reference for selling price)

Press OK to solve. You should get a selling price of $7.50/pound.

Sensitivity analysis is similar to breakeven analysis, but it's a lot easier. All you have to do is select a key factor that you want to analyze, and change the original value to something new. Again, I usually look at changes of 10-25% in these factors. Let's do some sensitivity analysis for Greta. Let's look at how a 10% decrease in units sold will impact her Return Above Operating Costs. Simply change the value in cell D5 (Units Sold) from 100 to 90. This represents a 10% decrease in the number of pounds of squash that are sold. (100 x (100% - 10%) = 90). When you change the units sold from 100 to 90 you should see the following changes:

Total Revenues drops from $500 to $450

Total Operating Expenses remain the same at $550

Return Above Operating Costs drops from negative $50 to negative $100

Minimum Price Necessary to Cover Operating Costs increases from $5.50 to $6.11/pound.

This sensitivity analysis tells Greta that if her sales drop from 100 pounds to 90 pounds (a 10% decrease), her short run profits will decrease by another $50 to a total short run loss of $100.

We can look at other changes besides price and units sold. Change the units sold back to 100 and the price to $5.00 so that you are at the original numbers. What if Greta can reduce her labor for transplanting and for hand harvest to $40/acre for each? How will this impact her short run profits? Change the price for "planting transplants" to $40/acre. Change the price for "hand harvest" to $40/acre. What happens to Greta's short run profits? With this change her Return Above Operating Costs is now $31.20/acre (positive) instead of negative $50/acre. This tells Greta that labor is an important resource that she needs to be able to control to make profits!

Here are a few tips for doing sensitivity analysis:

1. Always start from the original situation. This way you can easily compare the impact of all the changes.
2. Don't change too many factors at the same time. I usually look at 1 or 2 changes at a time. This makes it easier to see how sensitive the business is to those 1-2 changes. If you change 5-10 factors at the same time it is hard to determine what is really causing the changes. Keep it simple!
3. Focus on the most important factors of the business: selling price, units sold, and a few of the most expensive inputs.

Good managers always have an idea of their breakeven selling prices and/or breakeven units sold. This helps them make day-to-day decisions much more easily. For example, a local restaurant has a breakeven units sold of 50 breakfasts per day. If the manager doesn't expect to sell at least 50 breakfasts in a day he may think about not offering breakfasts anymore; instead, he will focus on the busier lunch and dinner times. Or, assume the restaurant has breakeven daily sales of 200 meals, and the restaurant is located in a college town. When the students leave for holiday break the restaurant may only have sales of 50 meals per day. If this is the case, the manager may decide to close the restaurant until the students come back into town.

Greta's Squash Enterprise

Revenues		Quantity	Units/Acre	Price		Total	
Squash		100	pounds	$5.00	/pound	$500.00	
Other						$0.00	
Total Revenues						**$500.00**	**/acre**
Operating Expenses							
Fertilizer							
Nitrogen		80	lbs	$0.45	/lb	$36.00	
Phosphorus		100	lbs	$0.32	/lb	$32.00	
Potassium		150	lbs	$0.30	/lb	$45.00	
Lime		0.5	tons	$30.00	/ton	$15.00	
Custom Application		1	acre	$21.00	/acre	$21.00	
Pest Scouting		2	times	$10.00	/time	$20.00	
Herbicides		1	acre	$25.00	/acre	$25.00	
Fungicides		1	acre	$25.00	/acre	$25.00	
Insecticides		1	acre	$25.00	/acre	$25.00	
Labor							
Planting transplants		1	acre	$80.00	/acre	$80.00	
Marketing & advertising		1	acre	$50.00	/acre	$50.00	
Hand harvest		1	acre	$80.00	/acre	$80.00	
Pest Control		1	acre	$33.00	/acre	$33.00	
Cartons, lids, shipping		50	cartons	$0.20	/carton	$10.00	
Fuel		15	gallons	$2.20	/gallon	$33.00	
Repairs - Tractors & implements		1	acre	$11.87	/acre	$11.87	
Interest on Operating Capital	6%	3	months	$541.87	/acre	$8.13	
Total Operating Expenses						**$550.00**	**/acre**
Return Above Operating Costs						**($50.00)**	**/acre**
Minimum Yield Necessary to Cover Operating Costs						**110.0**	**pounds/acre**
Minimum Price Necessary to Cover Operating Costs						**$5.50**	**/pound**
Fixed Costs							
Tractors & Implements		1	acre	$75	/acre	$75.00	
Land Charge		1	acre	$75	/acre	$75.00	
Total Fixed Costs						**$150.00**	**/acre**
Total Costs						**$700.00**	**/acre**
Return Above Total Costs						**($200.00)**	**/acre**
Minimum Yield Necessary to Cover Total Costs						**140.0**	**pounds/acre**
Minimum Price Necessary to Cover Total Costs						**$7.00**	**/pound**

Interest on Operating Capital	6%	3 months	$461.87 /acre	$6.93	
Total Operating Expenses				**$468.80**	**/acre**
Return Above Operating Costs				**$31.20**	**/acre**
Minimum Yield Necessary to Cover Operating Costs				**93.8**	**pounds/acre**
Minimum Price Necessary to Cover Operating Costs				**$4.69**	**/pound**
Fixed Costs					
Tractors & Implements		1 acre	$75 /acre	$75.00	
Land Charge		1 acre	$75 /acre	$75.00	
Total Fixed Costs				**$150.00**	**/acre**
Total Costs				**$618.80**	**/acre**
Return Above Total Costs				**($118.80)**	**/acre**
Minimum Yield Necessary to Cover Total Costs				**123.8**	**pounds/acre**
Minimum Price Necessary to Cover Total Costs				**$6.19**	**/pound**