Mathematics Used In Introductory Economics

Suppose that your obnoxious little brother Luigi burps quite often during the day, and you wish to forecast how many times he will burp on Labor Day. How could you arrive at such a forecast?

- *Guess*: You could take a wild guess. Usually, this is a bad way to forecast.
- *Be Emotional*: Perhaps you simple FEEL strongly that Luigi will burp a certain number of times. So what? Strong feelings make for lousy forecasts.
- *Rely only upon past information*: Perhaps you counted Luigi's burps yesterday, figuring that he burped 200 times. So you forecast that he will burp 200 times on Labor Day. This technique is better than guessing or being emotional. Still, yesterday may be quite different from Labor Day, so a forecast based solely on what happened yesterday may be quite inaccurate.
- *<u>Use the scientific method</u>*: Figure out what causes Luigi to burp, and use past information to develop a precise relationship between the cause and the number of burps.

Having strong feelings about an issue doesn't make your view of it intelligent or correct. Some people feel strongly, for example, that skin color affects intelligence. These people are idiots.

Let's focus on the last forecasting methodology, since it is the methodology used in most sciences, including economics.

Suppose that you formulate a theory: the number of Luigi's burps per day depends upon how many ounces of soda that he drinks per day.

Next, you observe Luigi for four days, counting both the number of ounces of soda that he drinks and the number of times that he burps. You record your data:

	Ounces of Soda	Number of Burps
Day 1	24	50
Day 2	36	71
Day 3	72	146
Day 4	12	23

Notice that, roughly speaking, the number of burps is roughly double the number of ounces of soda. In other words, there are around two burps for every ounce of soda. This information allows you to refine your theory: Luigi's burps per day will be approximately twice the number of ounces of soda that he drinks that day:

Number of burps = 2 x number of ounces of soda

You don't want to write "number of burps" and "number of ounces of soda" a lot, because you are lazy, so you abbreviate: "B" means "number of burps," and "S" means "number of ounces of soda."

Often the hardest part about algebra is remembering what all of the letters stand for.

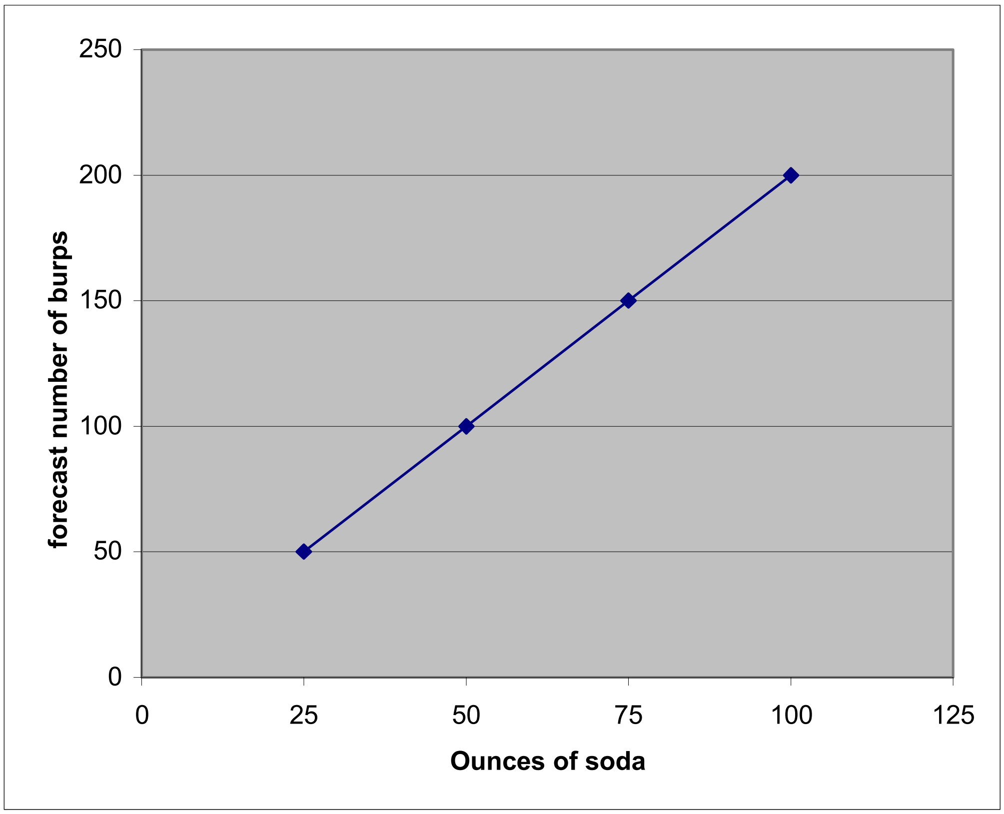
$$B = 2S$$

You are excited, so you construct a table, showing the hypothetical predictions of your model—that is, how many burps your model predicts—at various levels of soda consumption:

Ounces of Soda	Forecast Number of burps
25	50
50	100
75	150
100	200

Now, you want to illustrate your soda and burp relationship on a graph. But how?

Method one: Plot the numbers in the above table on a graph, and connect them with a line. We have enough data in the above table to plot four points. Here they are, plotted below, connected with a line.



Method two: Graph your equation, B = 2S.

Let us review how to graph linear equations, before we graph your equation.

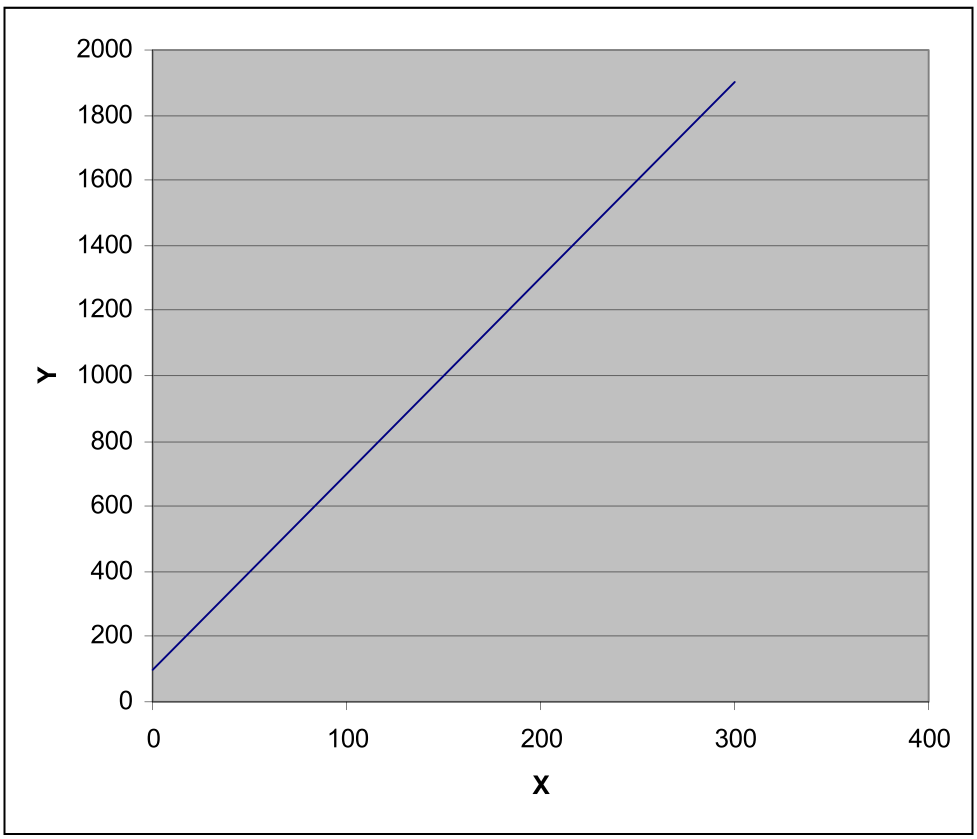
Consider this equation, which I am making up out of the blue:

$$Y = 100 + 6X$$

What can we say about this equation?

- If we graph this equation, then we will get a straight line, since the equation contains no exponents or logarithms.
- "Y" is an abbreviation meaning "number of units of the thing measured on the vertical axis of the graph."
- "X" is an abbreviation meaning "number of units of the thing measured on the horizontal axis of the graph."
- "100" is the vertical intercept—the point at which the line will intersect the vertical axis.
- "6" is the slope, or steepness, of the line. In this case, the line will rise 6 units vertically for every 1 unit that it moves rightward horizontally.

Let's graph the equation:



To be completely accurate, all lines really should be drawn to have no endpoints; this line should continue way up and to the right, and down and to the left (into negative territory)

Now, let's graph your equation:

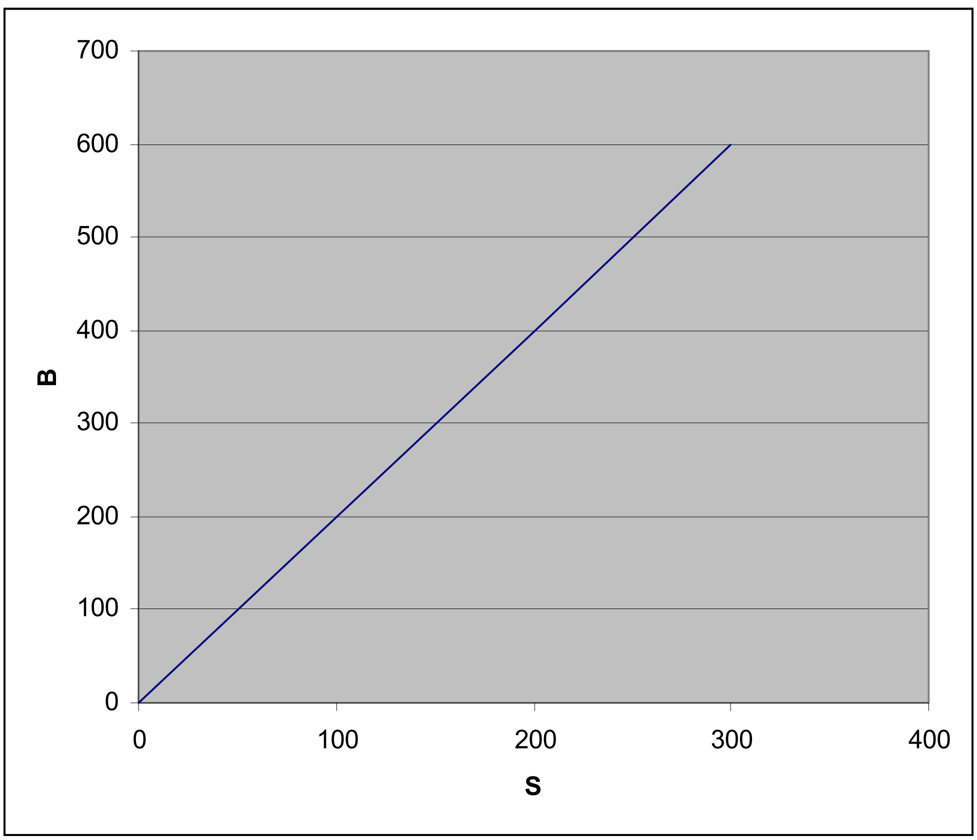
Consider your equation

$B = 2S$ (note: you can also write this equation $B = 0 + 2S$)

What can we say about this equation?

- If we graph this equation, then we will get a straight line, since the equation contains no exponents or logarithms.
- "B" is an abbreviation meaning "number of burps", measured on the vertical axis of the graph."
- "S" is an abbreviation meaning "number of ounces of soda", measured on the horizontal axis of the graph."
- "0" is the vertical intercept—the point at which the line will intersect the vertical axis.
- "2" is the slope, or steepness, of the line. In this case, the line will rise 2 units vertically for every 1 unit that it moves rightward horizontally.

Let's graph the equation:



To be completely accurate, all lines really should be drawn to have no endpoints; this line should continue way up and to the right, and down and to the left (into negative territory)

Well, now that we've completely examined your model of Luigi and his burping habits, we're ready to forecast how many times he will burp on Labor Day, right?

Not so fast! To forecast Luigi's burps on Labor Day, we need a forecast for how many ounces of soda that he will drink on Labor Day. Our model is incomplete!

So you theorize anew: the number of ounces of soda that Luigi drinks in any given day depends upon the high temperature of that day.

Next, you observe anew:

	High temperature	Ounces of Soda
Day 5	80	120
Day 6	90	136
Day 7	100	149
Day 8	70	106

Notice that, roughly speaking, the number of ounces of soda is roughly 1.5 times the high temperature. In other words, there are around 1.5 ounces of soda for every degree of temperature. This information allows you to refine your theory: Luigi's ounces of soda per day will be approximately 1.5 times the high temperature that day:

Number of ounces of soda = 1.5 x high temperature

You don't want to write "high temperature" and "number of ounces of soda" a lot, because you are lazy, so you abbreviate: "T" means "high temperature," and "S" means "number of ounces of soda."

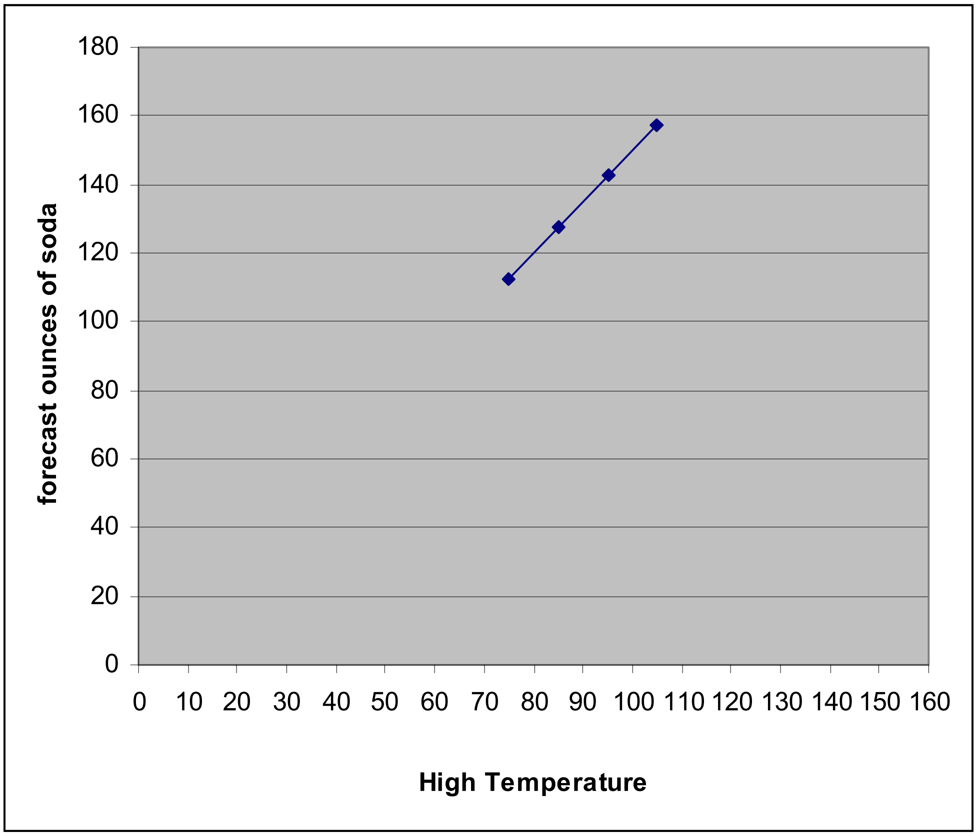
$S = 1.5T$

You are excited, so you construct a table, showing the hypothetical predictions of your model—that is, how many ounces of soda your model predicts—at various levels of temperature:

High Temperature	Forecast Ounces of Soda
75	112.5
85	127.5
95	142.5
105	157.5

Now, you want to illustrate your temperature and soda relationship on a graph. But how?

Method one: Plot the numbers in the above table on a graph, and connect them with a line. We have enough data in the above table to plot four points. Here they are, plotted on the next page, connected with a line.



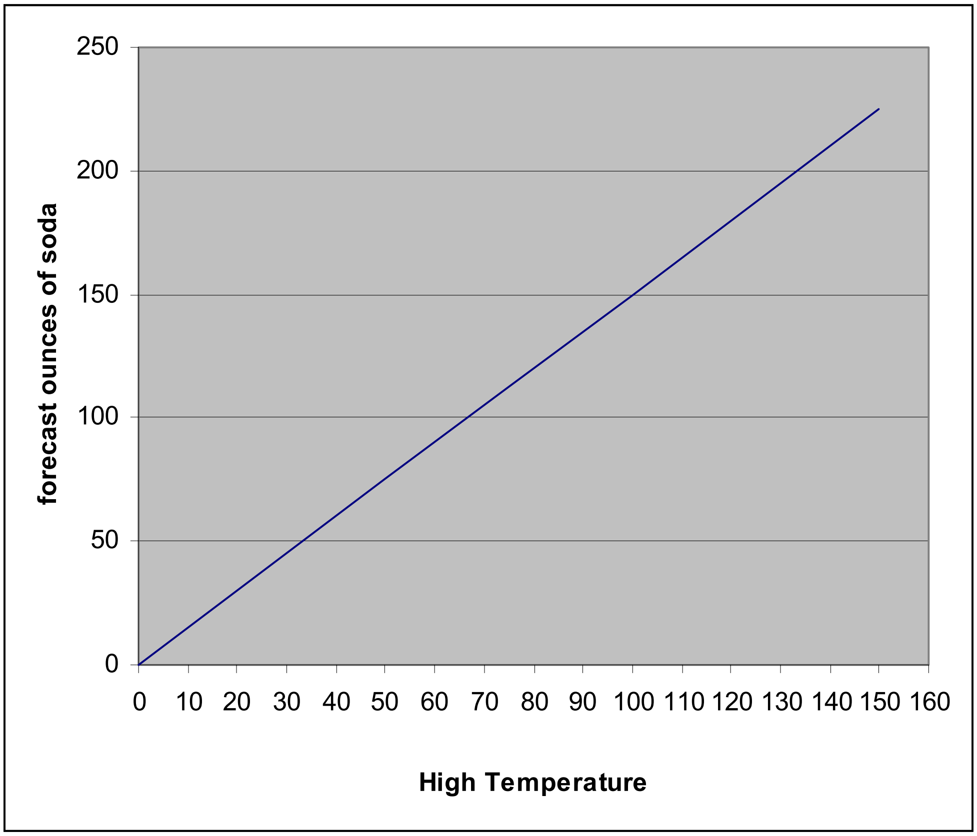
Method two: Graph your equation, S = 1.5T

(note: you can also write this equation S = 0 + 1.5T)

What can we say about this equation?

- If we graph this equation, then we will get a straight line, since the equation contains no exponents or logarithms.
- "T" is an abbreviation meaning "high temperature", measured on the horizontal axis of the graph."
- "S" is an abbreviation meaning "number of ounces of soda", measured on the vertical axis of the graph."
- "0" is the vertical intercept—the point at which the line will intersect the vertical axis.
- "1.5" is the slope, or steepness, of the line. In this case, the line will rise 1.5 units vertically for every 1 unit that it moves rightward horizontally.

Let's graph the equation:



Now, your model is complete. It consists of two equations:

B = 2S and S = 1.5T

You must now consult another scientist to forecast the average high temperature on Labor Day. You call Dr. Neil Frank, and he gives you his best forecast of 93 for a high temperature on Labor Day.

Be sure to consult a reputable scientist; meteorologists have very complex mathematical models, with thousands of equations, that they use to do forecasting.

Now you can forecast Luigi's number of burps:

Step 1: Forecast the number of ounces of soda that he will drink on Labor Day

S = 1.5(93) = 139.5 ounces

Step 2: Forecast the number of burps

B = 2S = 2(139.5) = 279 burps !!!

This is your best estimate of the number of times that Luigi will burp on Labor Day

Note that your forecast will almost undoubtedly be wrong!!! Why? Because the high temperature may be different than Dr. Neil's forecast, or you may have missed some other important variable that affects Luigi's burping tendencies. But, your forecast is undoubtedly better than relying upon a guess or emotion to gauge Luigi's burping. Notice, also, that the task of modeling Luigi allowed you to gain insight into him. You know now, for example, that to reduce his burping you must either reduce his soda consumption, or move to Alaska.

Luigi and Macroeconomics

Economists model the economy in the same way that you modeled Luigi's burping. Of course, the economy is complicated, and models of the economy often have thousands of equations (not all of them linear). Forecasts gleaned from the economists' models will almost always be wrong, but they will be better than mere guesses. In addition, through their modeling endeavors, macroeconomists have learned more about how the economy works, and can perhaps offer suggestions that will get the economy working better.

Not all economists agree on how the economy works. Hence there are different "schools" of macro-economics, each with a different model. More on this in a later set of notes.

Finally, our Luigi example has allowed us to use many of the mathematical tools that we will use in this course.

<u>And Now, A Brief Review of Other Math Concepts</u>

Introductory economics requires the use of some other math concepts. We will briefly review 3 of the concepts below: ratios, averages, and percentage changes.

Ratios

A ratio is one number divided by another number

Example: The ratio of weekend days to number of days in the week

= 2/7 = .2857 (rounded)

Averages

An unweighted average (aka a simple average) is the total quantity of something spread evenly over the total number of units of something else.

Example 1: You bowled 4 games, shooting 180 in game 1, 175 in game 2, 190 in game 3, and 260 in game 4. (Maybe you should join the pro bowlers tour)

Your bowling average = (180 + 175 + 190 + 260) / 4 = 201.25 pins per game

Example 2: Per capita income in Haiti in 1999 (converted to U.S. dollars)

= total income of all Haitians / population of Haiti

= $9,000,000,000 /6,884,000 = $1307.38 per person

A weighted average gives each averaged item a different weight. The total of the weights must equal 100%.

Example 1: In Dr. Smith's Psychology class, the midterm is worth 30% of the semester grade, the paper is worth 25% of the semester grade, and the final exam is worth the rest of the semester grade. You score an 85 on the midterm, a 90 on the paper, and a 95 on the final exam.

Your semester average = .30(85) + .25(90) + .45(95) = 90.75 points

Percentage changes

Suppose the value of something changes over time. By what percentage did it change? One way to measure this is to use this formula:

Percentage change = (newer value – older value) / older value

Example 1: A person who quit smoking went from weighing 150 pounds to 160 pounds

Percentage change in weight = (160 – 150) / 150 = .0667 (rounded), or 6.67%

Example 2: The temperature went from 95 at noon to 78 at midnight

Percentage change in temperature = (78 – 95) / 95 = -.1789 (rounded), or –17.89%