

## Projecting Future College Costs in Massachusetts Based on 2004-2008 College Tuition Trends

**Introduction:** The cost of college tuition has been rising at a higher inflationary rate than the consumer price index over the past several years. In order to assist in budgeting their expenditures The National Education Foundation wants to know the length of time it will take for college costs to double in the future in each respective state.

For the state of Massachusetts they would like to know how long it will take the different types of institutions to double their cost with respect to the 2004-2005 school years. The data provided lists the types of colleges, tuition costs for the school years 2004-2005 and 2007-2008.

The average published tuition and fees for the state of Massachusetts is listed below

2 Year Public		4 Year Public		4 Year Private	
2004 - 2005	2007-2008	2004 - 2005	2007-2008	2004 - 2005	2007-2008
\$2,550.00	\$3,702.00	\$5,230.00	\$7897.00	\$22,550.00	\$31,052.00

To determine the answer to these questions, we will assume that the growth in tuition will continue to grow at a constant rate corresponding to the rate from the 2004-2005 school years to the 2007-2008 school years.

I used the above tuition at two and four year public colleges and four year private college to find an algebraic solution to the problem and then we will use a graphical solution to verify the algebraic equation.

I discovered that the two year public college tuition doubled to \$5,238.00 in the 2011-2012 school years, from \$2,550 in the 2004-2005 schools years. In addition tuition at the four year public colleges doubled from \$5,230.00 in 2004-2005 school years to \$10,564.00 in the 2010-2011 school years. This is summarized in the table below.

What makes this Intro so good is that it defines the problem (the starting point) and what was found (the ending point). It also mentions the basic approach (the road map) to get from the starting point to the ending point.

Nice background. It sets the context for what is being asked in the project. This is a good starting point.

This is a great table. You should always let your reader know what the data is that you will work with. Since there isn't too much here, a table is appropriate. If there had been a lot more data, a scatter plot would have been appropriate.

It is nice to give a very generic description of the strategy you will use. I might have mentioned that you'll use a pair to create a linear model for the data to determine when the cost would double, but that is being a bit nit picky. This is the road map to get from the starting point to the ending point.

Finally I discovered the four year public college tuition doubled to \$45,100.00 in the 2011-2002 school years, from \$22,550.00 in the 2012-2013 schools years.

2 Year Public		4 Year Public		4 Year Private	
Year Tuition Doubled	Cost of Doubled Tuition	Year Tuition Doubled	Cost of Doubled Tuition	Year Tuition Doubled	Cost of Doubled Tuition
2011-2012	\$5,328.00	2010-2011	\$10,564.00	2012-2013	\$45,220.00

The table is an excellent way to summarize what you found. The text above it is a bit duplicative, but is not wrong. I like how the earlier table's form parallels the form of this table with similar coloring and the types of colleges across the top. This is the ending point of what will be shown.

**Methods:** I will initially provide a graph of the increase in average published tuition and fees between college years 2005-2005 and 2007-2008 for the two and four year public and four private colleges. **The x value is the year of the tuition increase and the y value is the dollar increase in tuition.**

The Methods section provides the strategy for getting from the starting point to the ending point. It is basically clarifying the road map mentioned in the Intro.

As an example for two year public colleges I will utilize the (2004,2550) as the  $(x_2, y_2)$  values and (2007,3702) as the  $(x_1, y_1)$  values with the slope formula  $m = \frac{\text{rise}}{\text{run}} = m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1} =$

Excellent...you defined the variables that will be used.

$$\frac{3701 - 2550}{2007 - 2004} = \frac{1152}{3} = \frac{384}{1}$$

to find the slope and the point slope formula  $y - y_1 = m(x - x_1)$

using the values  $y - 2005 = 384(x - 2004) =$  to determine the y intercept and then convert this data to the formula  $y = mx + b$  to verify it is a linear function that passes through these two points.

Normally you don't carry out the calculations in the Methods. But since this project asks you to do the same basic calculation three times (for community colleges, public 4 year institutions and private 4 year institutions), it is acceptable to show a sample calculation as a template for the other types of institutions

I will then graph the linear function to insure it passes through the two points on the graph.

In order to forecast the rise in tuition I will discover and interpret the slope of the graph, which is the rate of change in tuition in dollars per year. I will then use this function to find an algebraic formula to determine when the tuition will double at the respective colleges. Using the algebraic formula I will double the cost of the tuition in 2004-2005 for the two year public colleges, four year public colleges and four private colleges and put it in the y value of the equation. I will solve for the x value in the equation and this will give the year tuition doubles at each institution. Finally I will verify

Since you are laying out your strategy by doing a sample calculation, I would show the graph for the community colleges that proves these points. Use it to make your point.

my algebraic strategy by graphing both sides of the equation and finding point of intersection and the answers should match.

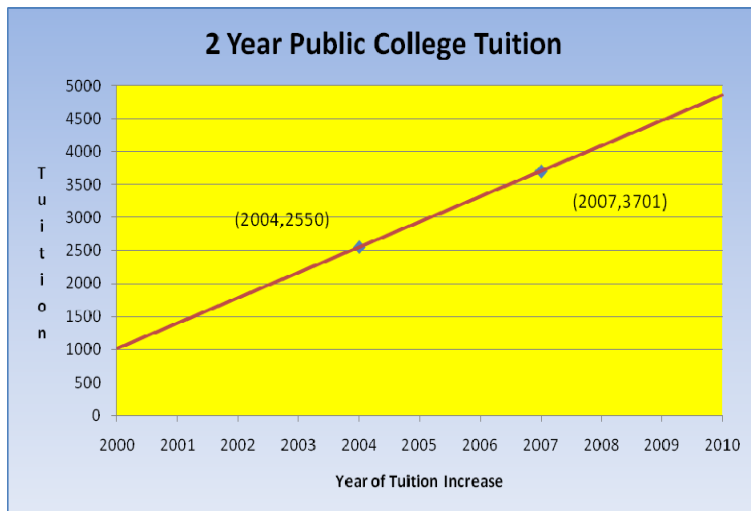
**Results:** The average cost of tuition in a 2 year public college in the state of Massachusetts in school year 2004-05 was \$2,550.00 and in the school year 2007-08 was \$3,702.00.

Using this information and assuming the cost of tuition will continue to grow at a constant rate corresponding to the rate from 2004-2005 school years to the 2007-2008 school years, calculate how long it will take for the tuition to double at the public two year colleges.

I will utilize the algebraic approach to solve this problem and then verify the results with the graphical solution.

Below I have graphed the data for the average published tuition and fees at public two year colleges for the 2004-2005 and 2007-2008 school years

Do the entire community college calculation and graphical verification in Methods to serve as a template for public and private 4 year colleges. Then your reader will understand exactly what to expect in Results and Discussion. You won't have to spend so much time documenting since your reader will already understand the process.



I like how each graph has the same coloring scheme and has a title that reflects exactly what is being shown. The axes are labeled appropriately and as an added bonus the two points are labeled which helps to demonstrate that the line passes through the points.

To find the algebraic solution I will utilize the (2004,2550) as  $(x_1, y_1)$  and (2007,3202)  $(x_2, y_2)$  tuition cost at a two year public college and the slope formula  $m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$  to find the slope and the point slope formula  $y - y_1 = M(x - x_1)$  to determine the y intercept and then convert this data to the formula  $y = mx + b$  to verify it is a linear function that passes through these two points and define what the variables in my function represent. I will then graph the linear function to insure it passes through the two points on the graph.

Put all of your community college calculation in the Methods section as a sample calculation, then follow the same structure (like you did below) to present the public and private 4 year institutions.

$$m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{3702 - 2550}{2007 - 2004} = \frac{1152}{3} = \frac{384}{1}$$

I will use the formula  $y - y_1 = M(x - x_1)$  to determine the y intercept

$$y - 2550 = 384(x - 2004)$$

$$y - 2550 = 384x - 769536 + 2550$$

$$y = 384x - 766986$$

The linear function is  $y = 384x - 766986$ , where  $y$  = the dollar increase in tuition and  $x$  = the year of the tuition increase.

The slope is the rate change in tuition per year in dollars and is  $384/1$ , which means the tuition is increasing an average of \$384.00 per year. I will check the accuracy of my algebraic equation using the 2004 and 2007 school years to verify the tuition.

Since the writer is discussing a result, ie. the slope, this belongs in the Discussion.

In the school 2004-2005 year the tuition is  $384 \times 2004 - 766986 = \$2,550$

In the school year 2007-2008 year the tuition is  $384 \times 2007 - 766986 = \$3,702$

Algebraically I will solve for  $y$  to determine the year the tuition doubles to \$5,100.00

$$5100 = 384x - 766986$$

$$5100 + 766986 = 384x$$

$$772086 = 384x$$

$$\frac{772086}{384} = \frac{384x}{384}$$

$$y \approx 2010.64$$

I like how all of the steps in the calculation are shown. It is NOT simply telling me what the answer is. Words are being used to help me understand what the process was.

In the above equation we will round off 2010.64 since the tuition increases on a yearly basis we will round off to 2011 for the equation. The tuition will double and reach approximately \$5,100 in the 2011-2012 school years. We can that use the linear function to determine the approximate tuition in the 2011-2012 school years

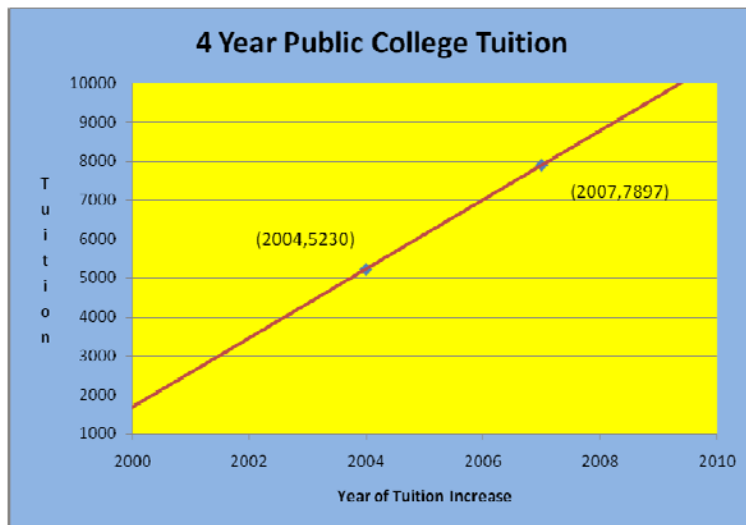
Since tuition is charged at the beginning of the year, this is reasonable right?

**In the 2011-2012 school years the tuition at a two year public school will be 384 X 2011-766986 = \$5,238.00 and this is double the \$2,550 tuition costs in 2004-2005.**

The average cost of tuition in a four year public college the state of Massachusetts in school year 2004-2005 was \$5,230.00 and in the school year 2007-08 was \$7,897.00 Using this information and assuming the cost of tuition will continue to grow at a constant rate corresponding to the rate from 2004-2005 school years to the 2007-2008 school years, calculate how long it will take for the tuition to double at the public four year colleges.

I will utilize the algebraic approach to solve this problem and then verify the results with the graphical solution.

Below I have graphed the data for the average published tuition and fees at public four year colleges for the 2004-2005 and 2007-2008 school years



Once the first calculation is complete, I like how the same basic format was used to present the calculations for public and private institutions. It means that I can focus on understanding the sample calculation. Once I understand that, the others are a piece of cake.

Not all projects will lend themselves to a sample calculation since they don't always involve repetitive tasks like this one did.

To find the algebraic solution I will utilize the (2004, 5230) as the values  $(x_1, y_1)$  and (2007, 7897) as the  $(x_2, y_2)$  values for tuition cost in the four year public college and the formula

$m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$  to find the slope and the formula  $y - y_1 = M(x - x_1)$  to determine the y

intercept and then convert this data to the formula  $y = mx + b$  to verify it is a linear function that passes through these two points and define what the variables in my function represent. I will then graph the linear function to insure it passes through the two points on the graph.

$$m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{7897 - 5230}{2007 - 2004} = \frac{2667}{3} = \frac{889}{1}$$

I will use the formula  $y - y_1 = M(x - x_1)$  to determine the y intercept

$$y - 5230 = 889(x - 2004)$$

$$y - 5230 = 889x - 1781556$$

$$y = 889x - 1781556 + 5230$$

$$y = 889x - 177326$$

**The linear function is  $y = 889x - 1776326$** , where y = the dollar increase in tuition and x = the year of the tuition increase.

**The slope is the rate change in tuition per year in dollars and is  $889/1$ , which means the tuition is increasing an average of \$889.00 per year.** I will check the accuracy of my algebraic equation using the 2004 and 2007 school years to verify the tuition.

In the school 2004-2005 year the tuition is  $889 \times 2004 - 1776326 = \$5,230$

In the school year 2007-2008 year the tuition is  $889 \times 2007 - 1776326 = \$7,897$

Algebraically I will solve for x to determine the year the tuition doubles to \$10,460

$$10460 = 889x - 1776326$$

$$10460 + 1776326 = 889x$$

$$1786786 = 889x$$

$$\frac{1786786}{889} = \frac{889x}{889}$$

$$x = 2009.88$$

In the above equation we will round off 2009.88 since the tuition increases on a yearly basis we will round off to 2010 for the equation. The tuition will double and reach approximately \$10,460 in the 2010-2011 school years. We can that use the linear function to determine the approximate tuition in the 2010-2011 school years.

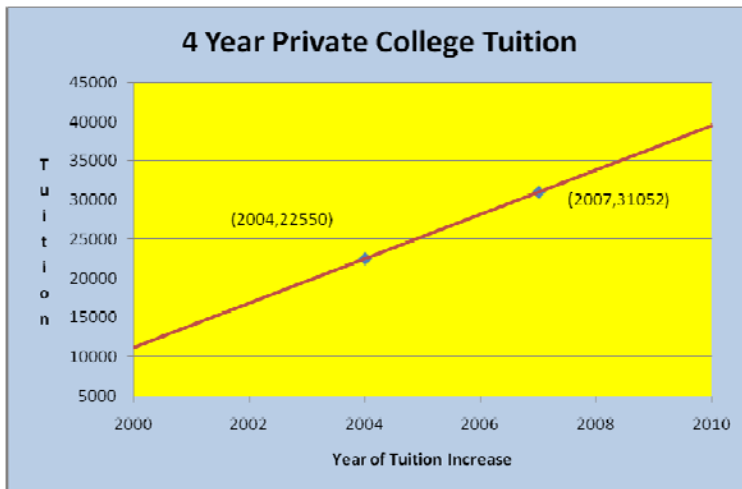
**In the 2010-2011 school years the tuition is  $889 \times 2010 - 1776326 = \$10,564$  and this is double the \$5,230.00 tuition costs in 2004-2005**

The average cost of tuition in a four year private college the state of Massachusetts in school year 2004-05 was \$22,550.00 and in the school year 2007-08 was \$31,052.00

Using this information and assuming the cost of tuition will continue to grow and at a constant rate corresponding to the rate from 2004-2005 school years to the 2007-2008 school years, calculate how long it will take for the tuition to double at the private four year colleges.

I will utilize the algebraic approach to solve this problem and then verify the results with the graphical solution.

Below I have graphed the data for the average published tuition and fees at private four year colleges for the 2004-2005 and 2007-2008 school years



Excellent. All of the steps the writer used are here and words are used to help the reader follow from step to step.

To find the algebraic solution I will utilize the 2004-05 and 2007-08 tuition cost in the four year private college and the formula  $m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$  to find the slope and the formula  $y - y_1 = M(x - x_1)$  to determine the y intercept and then convert this data to the formula  $y = mx + b$  to verify it is a linear function that passes through these two points and define what the variables in my function represent. I will then graph the linear function to insure it passes through the two points on the graph.

Since the writer already explained how slope and the point-slope form works in the sample calculation, they don't have to mention it over and over beyond that. Just say the slope was calculated (show the calculation and the point-slope form was used with the point (2004, 22,550) to get the line (show the line).

$$m(\text{slope}) = \frac{\text{rise}}{\text{run}} = \frac{31052 - 22550}{2007 - 2004} = \frac{8502}{3} = \frac{2834}{1}$$

I will use the formula  $y - y_1 = M(x - x_1)$  to determine the y intercept

$$y - 22550 = 2834(x - 2004)$$

$$y - 22550 = 2834x - 5679336$$

$$y = 2834x - 5679336 + 22550$$

$$y = 2834x - 5656786$$

To find the algebraic solution I will utilize the 2004-05 and 2007-08 tuition to determine the slope, which is the rate of change in the tuition between those years.

**The linear function is  $y = 2834x - 5656786$** , where  $y$  = the dollar increase in tuition and  $x$  = the year of the tuition increase.

**The slope is the rate change in tuition per year in dollars and is 2834/1, which indicates the tuition is increasing an average of \$2,843 per year.** I will check the accuracy of my algebraic equation using the 2004 and 2007 school years to verify the tuition.

In the school 2004-2005 year the tuition is  $2834 \times 2004 - 5656786 = \$22,550.00$

In the school year 2007-2008 year the tuition is  $2834 \times 2007 - 5656786 = \$31,052.00$

Algebraically I will solve for  $x$  to determine the year the tuition doubles to \$45,100

$$45100 = 2834x - 5656786$$

$$45100 + 5656786 = 2834x$$

$$5701886 = 2843x$$

$$\frac{5701886}{2834} = \frac{2834x}{2834}$$

$$x = 2011.95$$

In the above equation we will round off 2011.95 since the tuition increases on a yearly basis we will round off to 2012. The tuition will double and reach approximately \$45,220 in the 2012-2013 school

years. We can that use the linear function to determine the approximate tuition in the 2012-2013 school years.

**In the 2012-2013 school year the tuition is  $2834 \times 2012 - 5656786 = \$45,222.00$  and this is double the  $\$22,500.00$  tuition costs in 2004-2005.**

**Discussion:** Utilizing the above algebraic solutions I was able to determine how long it will take the average two year public, four year public colleges and the four year private colleges to double their tuition costs with respect to the 2004-2005 school year. I have outlined the results in a table below.

Type of College	College Year the Tuition Doubles	Cost of Doubled Tuition
2-Year Public College	2011-2012	\$5,328.00
4-Year Public College	2010-2011	\$10,564.00
4-Year Private College	2012-2013	\$45,220.00

In the Discussion, the writer is discussing the Results by verifying that they are correct graphically. This is a great way to catch your own mistakes and to prove your point.

Good to summarize the Results in a table since the point of the Discussion is to discuss the results.

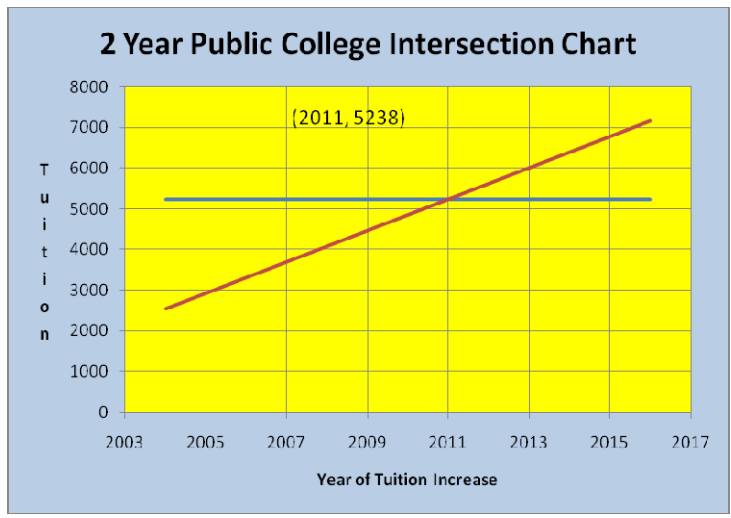
I found that at two year public colleges the average tuition will increase from \$2,550.00 in 2004 to \$5,328.00 in 2011. My actual formula revealed the tuition would double to \$5,100.00 in 2010.64, however, since the tuition increases on a yearly basis I rounded off to 2011 for the equation.

**In the 2011-2012 school years the tuition is  $384 \times 2011 - 766986 = \$5,238.00$  and this is double the  $\$2,550$  tuition costs in 2004-2005.**

We can than verify this with the graph below by showing the intersection of the two points on a graph based on  $y = \$5,238.00$ , which is the tuition in 2011 and  $y = 384x - 766986$  which is the algebraic equation used to solve for \$5,238.00 the year the tuition doubled.

When these two equations are graphed the point of intersection should equal the algebraic solution of \$5,238.00 in the year 2011, which verifies the algebraic solution used to determine when the tuition doubled.

**$Y = 5238$  and  $y = 384x - 766986$**



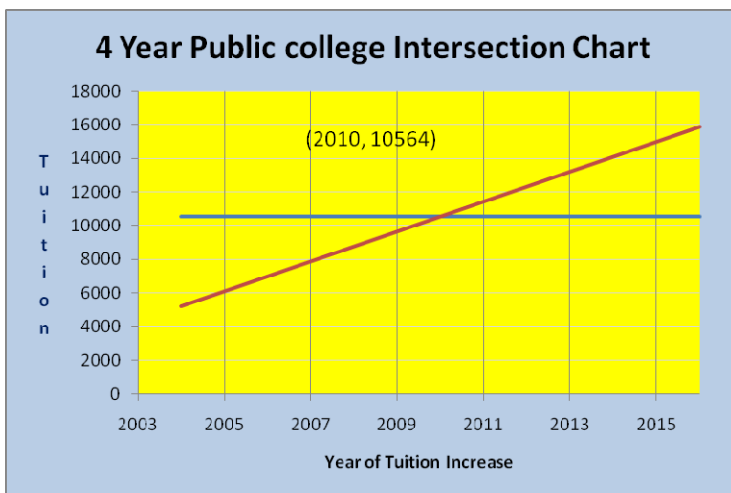
I also found that at four year public colleges the average tuition will increase from \$5,230.00 in 2004 to \$10,564.00 in 2011. My actual formula revealed the tuition would double to \$10,460.00 in 2009.88. My actual formula revealed the tuition would double to \$10,460.00 in 2009.88.64, however, since the tuition increases on a yearly basis I rounded off to 2010 for the equation. I used the linear function formula to determine the approximate tuition in the 2010-2011 school years.

**In the 2010 school year the tuition is  $889 \times 2010 - 1776326 = \$10,564$  and this is double the \$5,230.00 tuition costs in 2004-2005.**

We can then verify this with the graph below by showing the intersection of the two points on a graph based on  $y = \$10,564.00$ , which is the tuition in 2010 and  $y = 889x - 1776326$ , which is the algebraic equation used to solve for  $\$10,564.00$  the year the tuition doubled.

When these two equations are graphed the point of intersection should equal the algebraic solution of  $\$10,564.00$  in the year 2010, which verifies the algebraic solution used to determine when the tuition doubled.

**$Y = 10564$  and  $y = 889x - 1776326$**



Lastly I found at four year private colleges the average tuition will increase from  $\$22,500.00$  in 2004 to  $\$45,222.00$  in 2011. My actual formula revealed the tuition would double to  $\$45,220.00$  in 2011.95, however, since the tuition increases on a yearly basis I rounded off to 2012 for the equation.

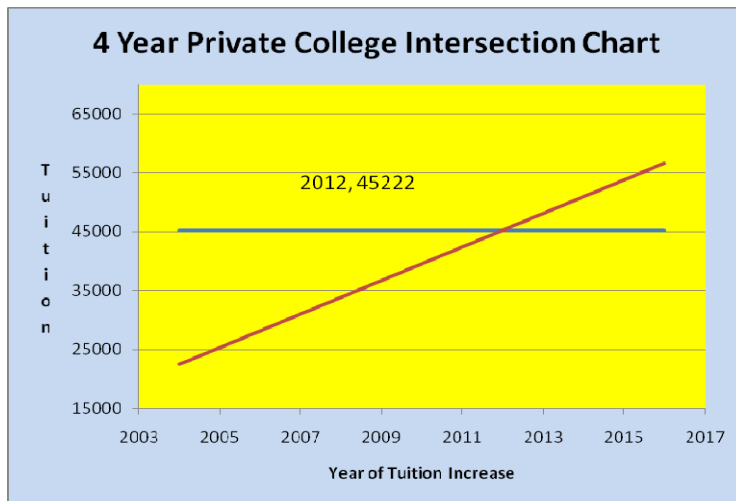
The tuition will double and reach approximately \$45,222 in the 2012-2013 school years.

**In the 2012-2013 school year the tuition is  $2834 \times 2012 - 5656786 = \$45,222.00$  and this is double the \$22,500.00 tuition costs in 2004-2005.**

We can then verify this with the graph below by showing the intersection of the two points on a graph based on  $y = \$45,222.00$ , which is the tuition in 2012 and  $y = 2834x - 5656786$ , which is the algebraic equation used to solve for \$45,222.00, the year the tuition doubled.

When these two equations are graphed the point of intersection should equal the algebraic solution of \$45,222.00 in the year 2012, which verifies the algebraic solution used to determine when the tuition doubled.

**$Y = 45222$  and  $y = 2834y - 5656786$**



Based on these graphs, are you convinced that college costs will double in the times indicated by the writer? I think the writer has definitely made their case.

The above data suggests that the tuition costs will double on the average within 6 years at all the institutions. This will pose a significant financial hardship on prospective future students and provide a barrier to students seeking higher education as the cost of college education substantially outpaces the consumer price and wage inflation. It is a major challenge for educational institutions to control costs while attempting to provide a quality education.

This is great! The writer noticed some commonality between each of the different types of institutions and noted it. This might have also been a good place to talk about the slopes of the lines which tell you how fast the costs are rising.