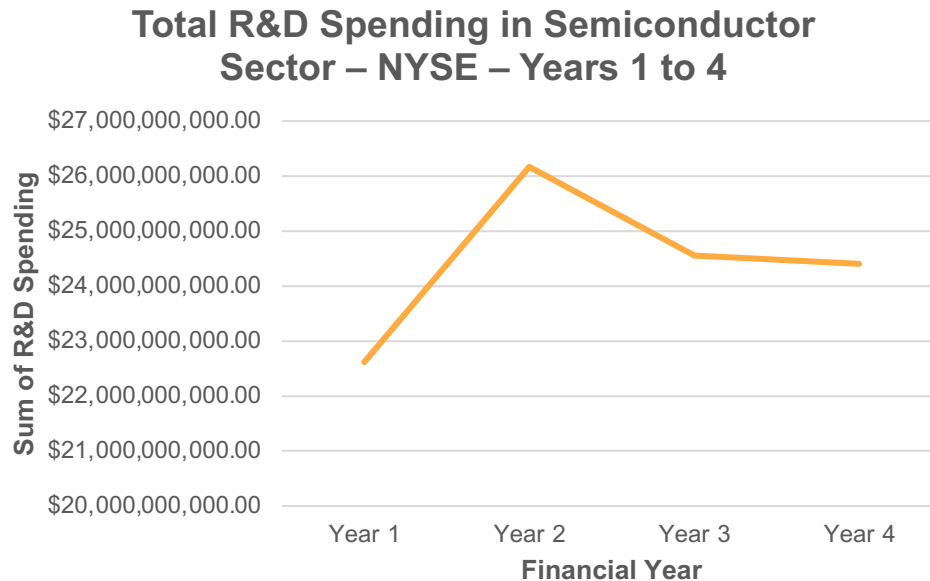


How did R&D spending evolve during the 4 year period in the Semiconductor sector?



How did R&D spending evolve in the semiconductor sector over the 4 years that we have data? For example, did companies commit to invest in R&D steadily over time or did they cut back?

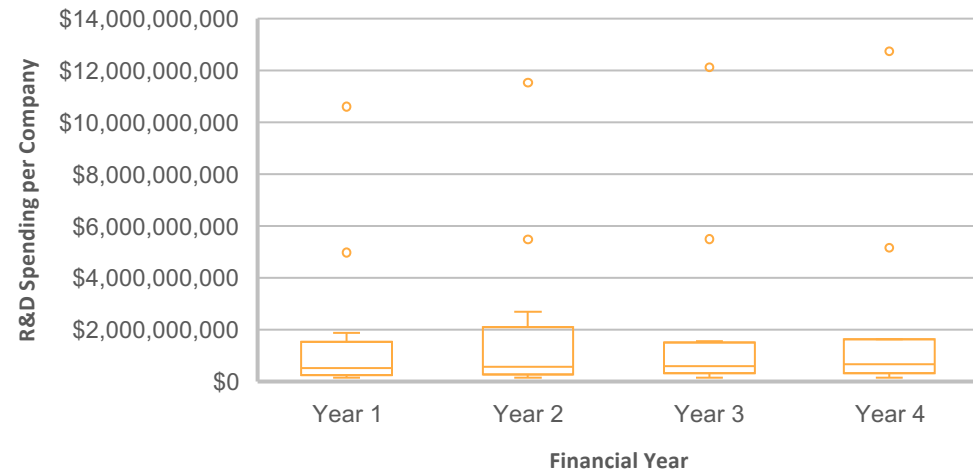
The chart on the left shows that the total R&D expenses in the semiconductor sector increased from year 1 to year 2, but then decreased in years 3 and 4.

It appears that after an initial jump companies cut back their spending. Story over, right? Not quite.

Let's examine what our summary statistics tell us.

How did R&D spending evolve during the 4 year period in the Semiconductor sector?

**R&D SPENDING IN SEMICONDUCTOR SECTOR-
NYSE – YEARS 1 TO 4**



Meas. of Center				
	Year 1	Year 2	Year 3	Year 4
Mean	\$1,739,751,923	\$2,012,969,538	\$2,045,953,333	\$2,218,068,909
Median	\$513,035,000	\$559,686,000	\$581,602,000	\$653,816,000
Meas. of Spread				
Range	\$10,478,540,000	\$11,402,700,000	\$11,984,031,000	\$12,609,407,000
Std Dev	2964239264	3219912753	3493538146	3765492620

Looking at our measures of center for each year (see the Summary Stats tab in the companion spreadsheet), we see that both the mean and median R&D spending actually increases each year. For example, the mean spending increases steadily from \$1,739,751,923 in year 1 to \$2,218,068,909 in year 4. Similarly, the median spending increases steadily from \$513,035,000 to \$653,816,000 over the 4 years.

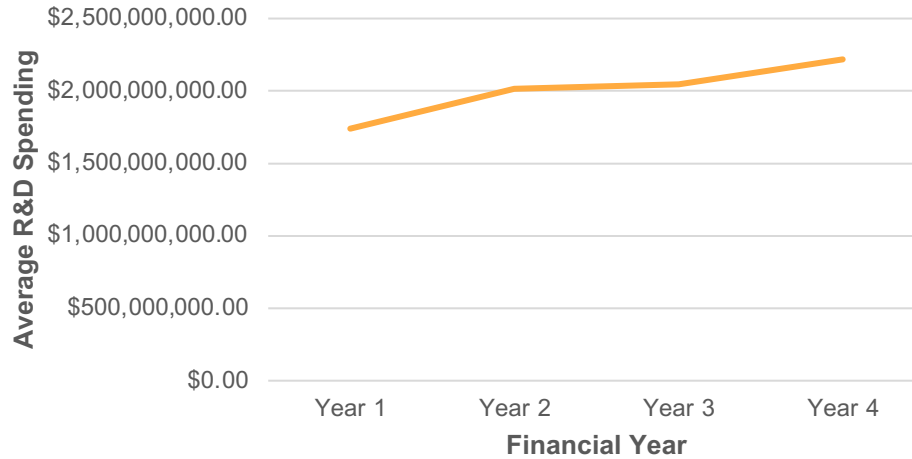
A box and whisker plot (see left) shows 2 outliers, which spend much higher amounts. The furthest from the center (Intel Corporation), grows steadily. The second furthest (Texas Instruments) increases from year 1 to year 3, then decreases in the final year.

If we look at the range of our data, we see that it is greater than \$10 billion each year, while the standard deviation for each year exceeds 2.9 million. But the box and whisker chart shows that non-outlier companies have spending of less than \$2 billion each year, which is much smaller than either the range or the standard deviation. Therefore, it is fair to ask how these outliers might have skewed the results of the total spending.

Let's look more closely at how the mean and median actually change from year to year.

How did R&D spending evolve during the 4 year period in the Semiconductor sector?

Average R&D Spending in Semiconductor Sector – NYSE – Years 1 to 4



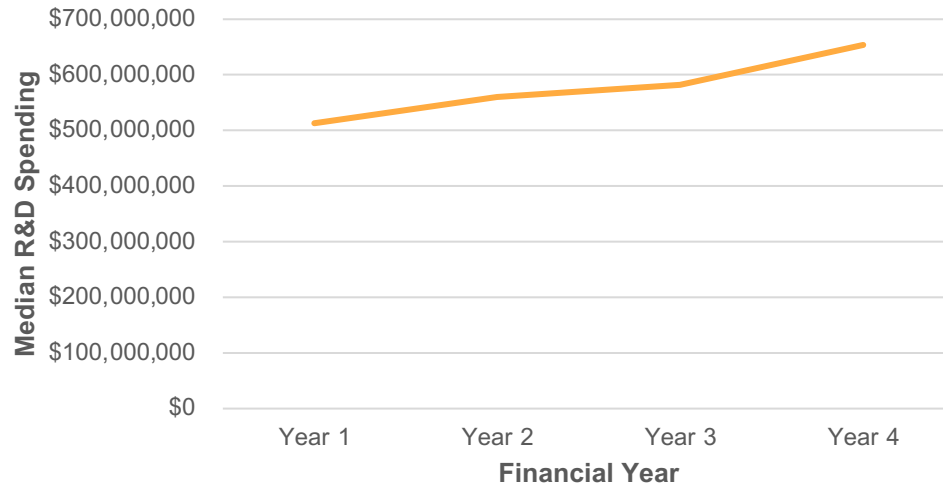
Transition	Ave R&D Spending Growth Rate
Year 1 to 2	15.70%
Year 2 to 3	1.64%
Year 3 to 4	8.41%

If we plot out the average R&D spending for companies in the semiconductor sector over the four years, we can see that it grows each year. The most significant growth is from year 1 to year 2 (15.7%). Growth from years 2 to 3 slows to only 1.64%, however in the final period (years 3 to 4), the average growth is 8.41%.

However, the average may still be skewed by our outliers.

How did R&D spending evolve during the 4 year period in the Semiconductor sector?

Median R&D Spending in Semiconductor Sector – NYSE – Years 1 to 4



Transition	Median R&D Spending Growth Rate
Year 1 to 2	9.09%
Year 2 to 3	3.92%
Year 3 to 4	12.42%

Period	Inflation Rate (Source: SmartAsset.com)
2012 to 2013	1.46%
2013 to 2014	1.62%
2014 to 2015	0.12%
2015 to 2016	1.26%
Average	1.12%

Because we had two outliers, let's look at the growth of the median of R&D expenses, which might be more representative of the spending of the average company in the sector.

As we can see, the median spending also grows each year. However, it grows differently from the average. The highest increase was from year 3 to 4 (12.42%), followed by 9.09% from year 1 to 2. If you go back to slide 2, you can see that the box and whisker plot shows this as well, as the R&D expenses of the smaller players increased the most between the last two years.

In conclusion, we can see that even though *total* R&D spending initially increased, then decreased, the *average* and *median* spending actually increased steadily from year to year throughout the 4-year period. If we take a look at inflation rates during the years in question, we can see that the average and median R&D spending increases were well in excess of inflation (see left), which is a good indication that on average companies in the sector were making real investments in R&D over the 4-year period.