Lecture Note #13: Charts Part #2

BUSI 201: Business Data Analysis

Fall 2023

Topic 1. Line Charts

Line charts are created by connecting data points into a line, and are typically used in data that has a time dimension. The horizontal axis typically represents the progression of time, such as hours, days, months, etc. The vertical axis represents the numeric values for points that correspond to the variables defined on the horizontal axis.
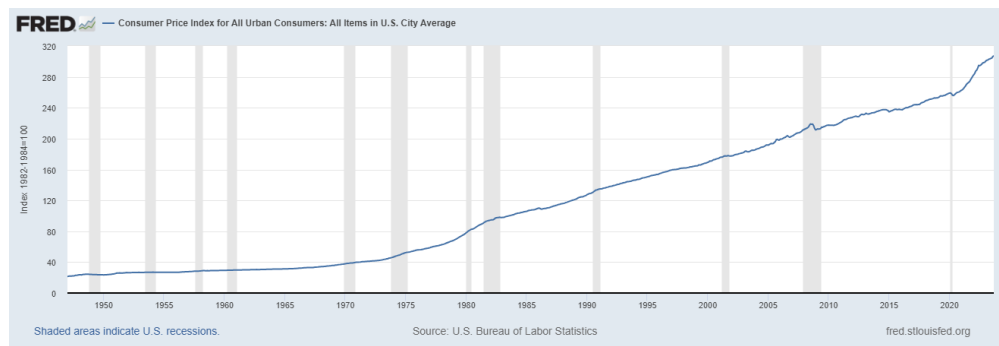

Figure 1: Line Chart: CPI

Many economic variables such as inflation, GDP, unemployment, are plotted using the line chart. You can see an example of a line chart used to depict rising price levels across time in the US in Figure 1. In another example, we plot new job postings by months in Figure 2.

Figure 2: Line Chart: Job Postings

Line Charts: When to Use

Line charts can be used in a wide variety of settings, but is most commonly used to show some variables' evolution over time. As long as the horizontal variable is continuous in nature, can be subdivided into discrete units, and has a natural progression baked-in, we can use the line chart. Navigate to the RETAIL worksheet in the workbook BUSI201-LEC13-Workbook.xlsx for an example of data that can be plotted using the line chart.
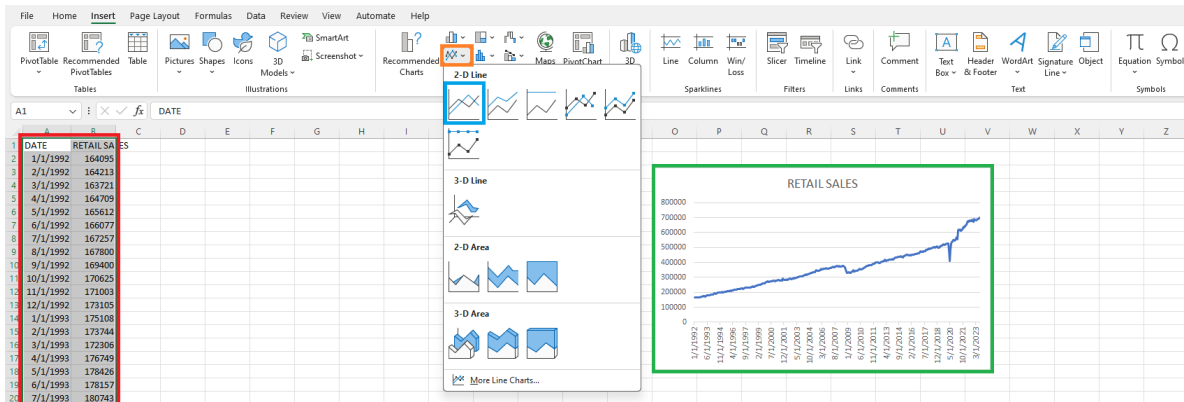

Figure 3: Line Chart: Retail Sales in the US

The worksheet contains data from the Federal Reserve System on monthly retail sales in the United States, seasonally adjusted, in the red box. The DATE column will serve as our horizontal variable, as it represents time. The corresponding values in the RETAIL SALES column are the total retail sales in the US for the given month, in terms of millions of USD.

To add a line chart showing how retail sales evolved over time, first select the portion of the data that you wish to plot. Then, navigate to Insert, and select the line chart highlighted in orange box, and then select the basic line chart in the blue box. This will result in the line chart shown in the green box in Figure 3.

You may edit the format of the chart as we have seen in the previous topic. Select the element on the chart that you wish to edit, right click, and select the Format Chart.... This will make the formatting options available to you on the right hand side of Excel. For instance, suppose you are annoyed by the fact that the horizontal axis is not "regular."

Line Chart: Formatting Axes

To change the units of the axis, first click the chart you just created, right click, and then select `Format Chart Area`. You will see that the `Format Chart Area` "window" pops up to the right. Then, see Figure 4. Left clicking the axis in the red box will transition you over to the `Format Axis` window. Then, click on the blue box to access the axis options, and change the major units to 12 as shown in the orange box.
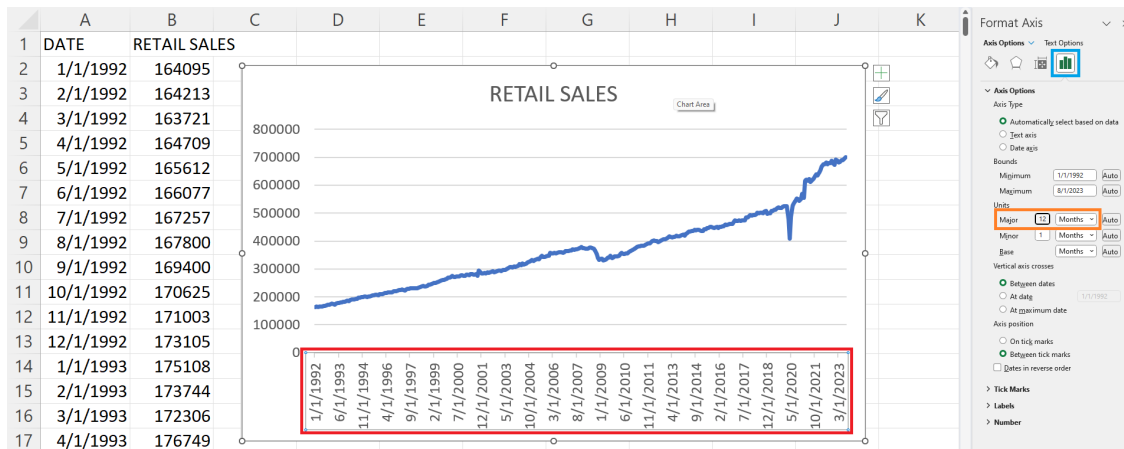

Figure 4: Line Chart: Format Axis

Then the horizontal time axis will now appear in intervals of 12 months as shown in Figure 5. Note that this does not remove or alter the data in any way. You will be able to verify this by comparing the charts before and after you apply changes to the axis, or by comparing Figures 4 and 5. This simply changes the values that show up on the axis.
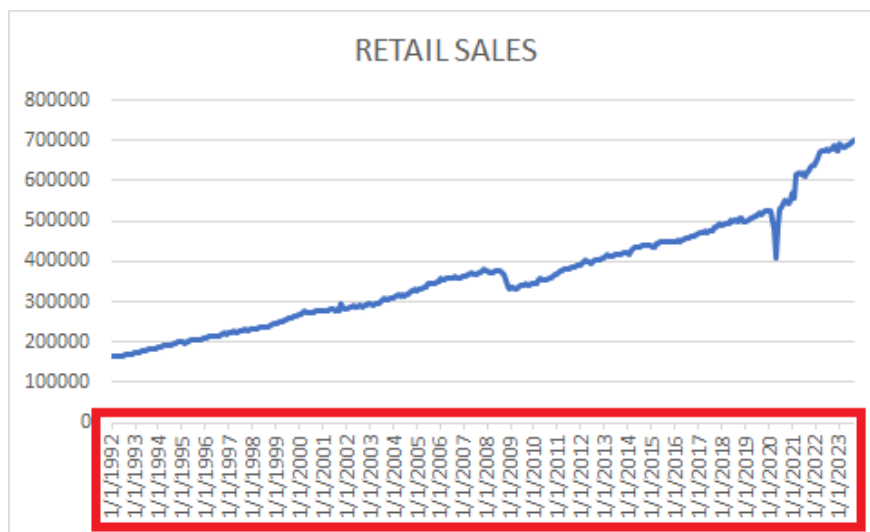

Figure 5: Line Chart: New Axis "Ticks"

Line Chart: 0 Baseline Axes?

When it comes to line charts (as is true with most other charts), we should be wary of manipulating the axis scale too much. However (as is true with most cases of data visualization), the initiative lies in you. To demonstrate this point, navigate to the worksheet LINE, which contains the closing stock price for a generic index mutual fund tracking the S&P 500.

If we plot this series using a line chart, the default will be Figure 6. We can make out that the general trend of the stock market was "upward," but it is incredibly difficult to gather any detailed information about fluctuations. Meanwhile, if we adjust the axes' minimum and maximum values, we can get the chart in Figure 7. As illustrated by this example, these minute changes can greatly affect what information is communicated.
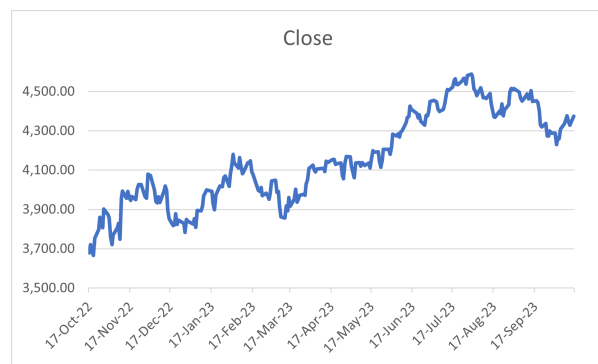
Figure 6: Default Line Chart   Figure 7: Axis Values Adjusted

You can adjust the minimum and maximum values of an axis by accessing the Axis Options following the steps illustrated in Figure 8. You can use the MAX and MIN functions to guide your decisions on finding the appropriate minimum and maximum values for the axis bounds.

Figure 8: Line Chart: Adjusting Bounds

Topic 2. Multiple Line Charts

Just as we were able to "stack" bar charts, we can present multiple time series in one line chart. Navigate to the worksheet `MINWAGEIL`, which has data describing the minimum wages at the Federal level, and Illinois State level between the years 1991 to 2023. Since this data contains information about a variable evolving over time, we may use the line plot to visualize this data.
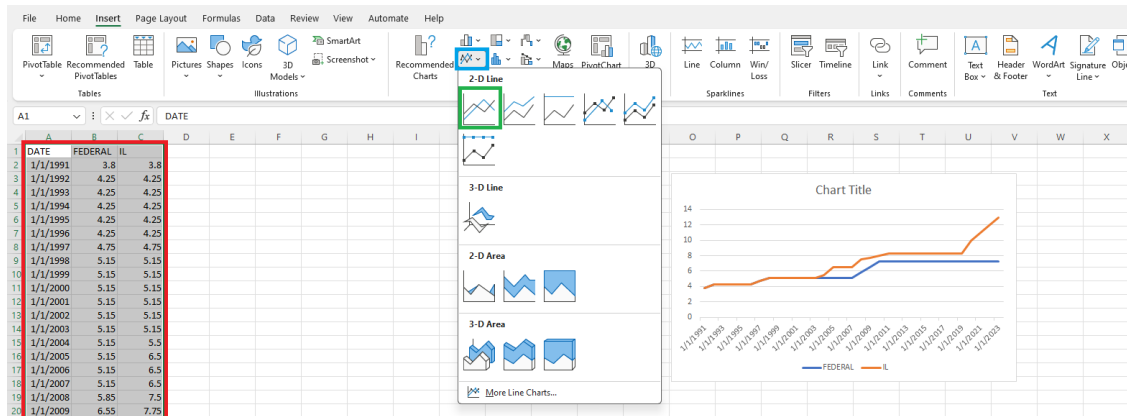

Figure 9: Line Chart: Minimum Wage

First, select the entire series of data including the variable names as displayed in the red box in Figure 9. Then, add a line chart by navigating to `Insert`, and then clicking on the blue box and then the green box. You cen see that a chart with two lines is created, with the legend automatically populating the bottom of the chart.

Similar to the bar chart's case, we do not want to add too many series in one chart. Navigate to the worksheet `MINWAGEMIDWEST`, where we have data on the evolution of minimum wage laws at the Federal level, and at the state level in 12 states that are considered by the Census to be "Midwest." The line chart with all 13 variables included can be found in Figure 10.
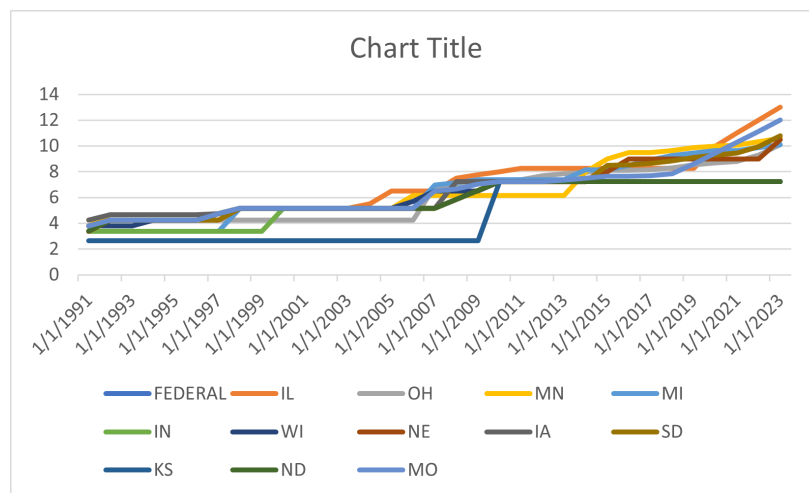

Figure 10: Line Chart: Series of 13 Variables

Date and Scaling Issues

When we are plotting multiple series in one chart, it is not a given that the "scales" should match. Navigate to the worksheet COMBO, which contains data on the number of marriages in Illinois on an annual basis, and information on the marriage rate for that given year. You can see that there is a big difference in the magnitudes of each series.
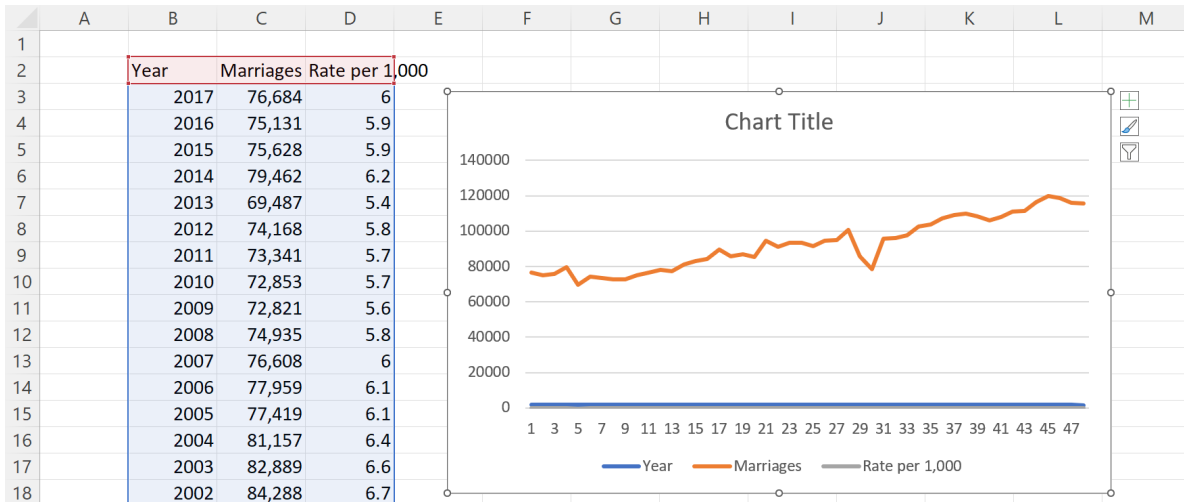

Figure 11: Line Chart: Issues

Following the usual steps, we find two major issues. Excel did not automatically use our Year variable in the horizontal (time) axis, and any fluctuations in the Rate per 1,000 is not visible due to the massive difference in scales of the two series. We will fix the horizontal axis first. Right click the chart, and select Select Data in the red box. Then, in the pop-up window, select and remove the Year from the Legend Entries in the orange box. Then, Edit the Horizontal Axis Labels in the green box, and select the years in the blue box.
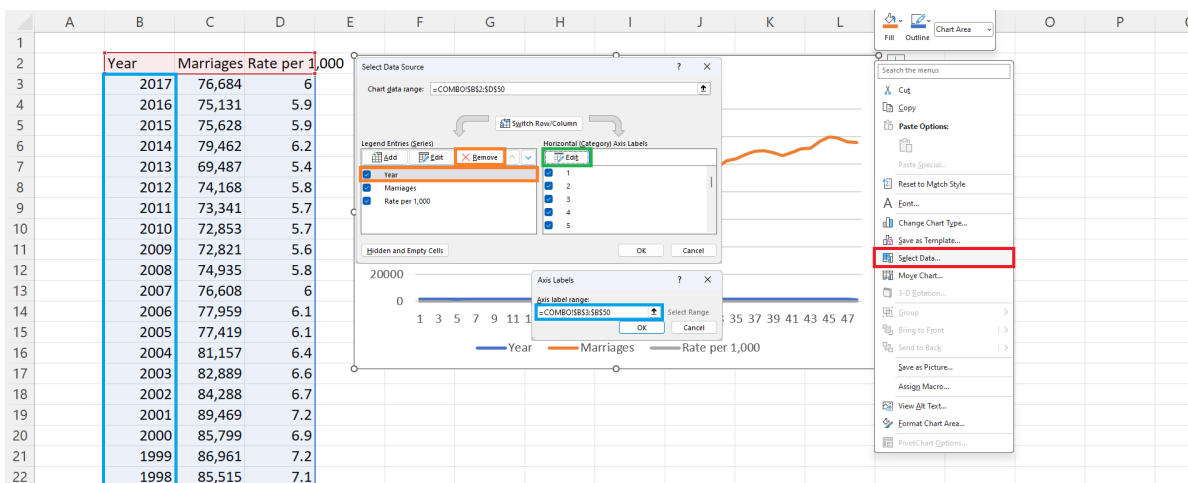

Figure 12: Line Chart: Resolving Some Issues

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Now we have years as the horizontal axis, and the series `Year` is now removed from the chart. However, the horizontal axis is not free with issues, as the years are listed in reverse order. To turn this around, right click the horizontal axis in the red box, then click `Categories in Reverse Order` so that there is a check mark in the orange box.
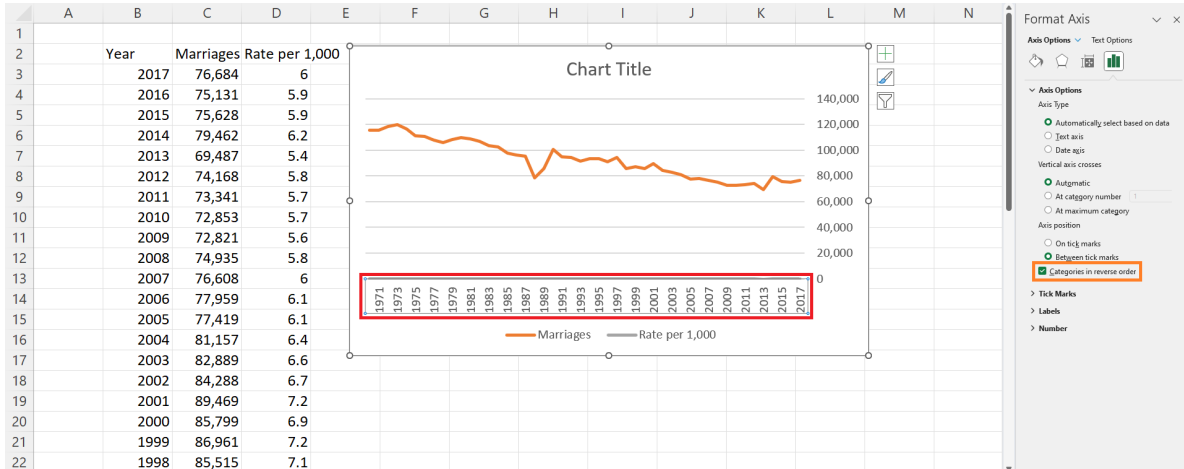

Figure 13: Line Chart: Resolving Some More Issues

Another (Better) Way

In order to fix the next issue, it is often better if we sort the data properly before creating the chart. We will discuss some complications that may arise when we attempt this process with incorrectly sorted data. If the data has been properly sorted, we will adjust the vertical axes so that the `Rate per 1,000` is actually visible. Right click the chart again, and select `Change Chart Type` in the red box. Then, select `Combo` in the orange box, and mimic the settings in the blue box in Figure 14.
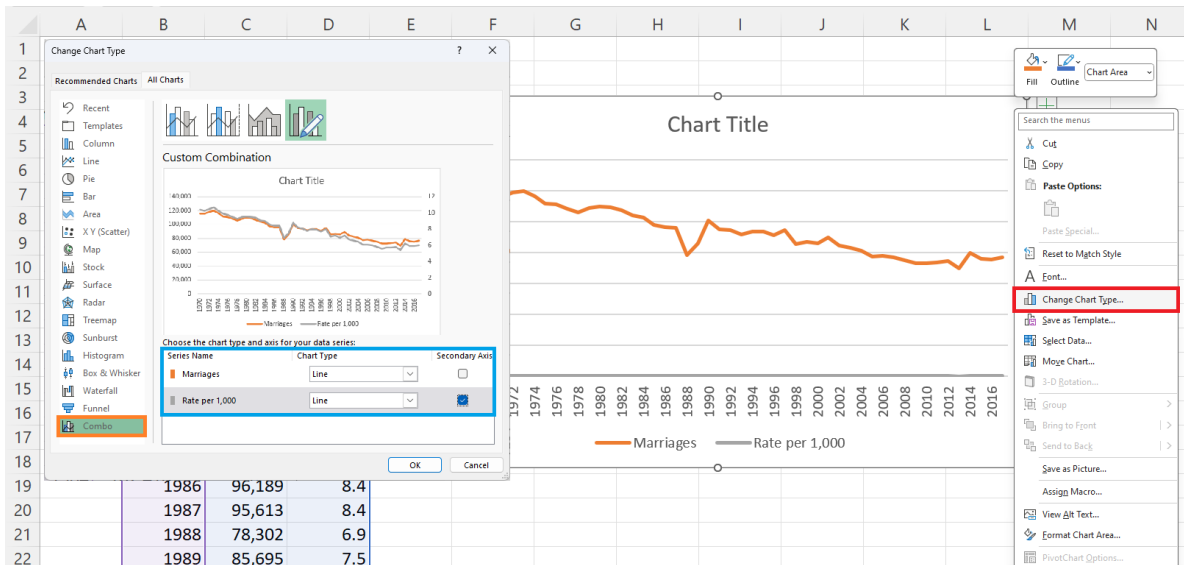

Figure 14: Line Chart: Resolving Issues with Sorted Data

You will be able to check that both trends are now clearly visible, where `Marriage` is indexed by the vertical axis to the left hand side, and the `Rate per 100` by the secondary vertical axis to the right hand side.
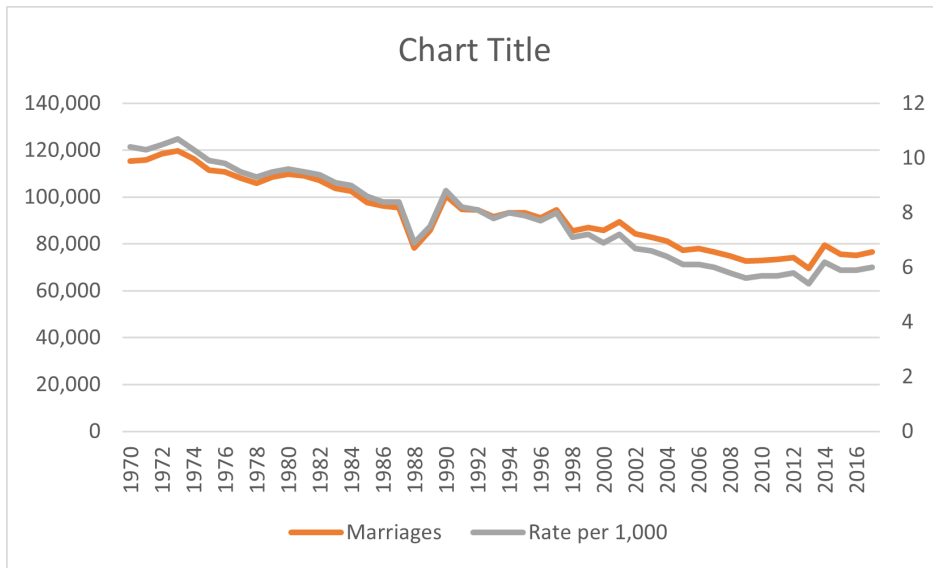

Figure 15: Line Chart: Two Vertical Axes

Topic 3. Combos

In the previous example, we used combos to "combine" two graphs in one. In the previous example, we used it simply to add a secondary vertical axis, but we can actually combine two differnt types of charts. For instance, using the same data in COMBO, we can replicate Figure 16.
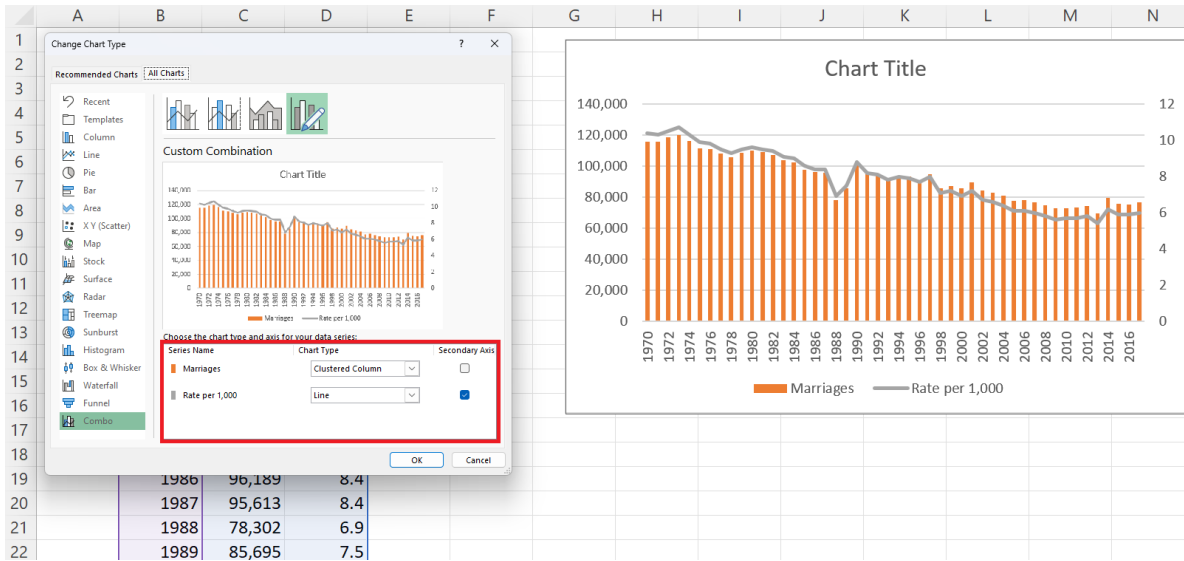

Figure 16: Combo: Bars and Lines

One reason that you may want to use different types of charts (bar&line) combined is to send a more clear signal to the viewer that the two series are measuring on a different scale. When we present some series of data on dual axes, it would be easy to "manipulate" the data to exaggerate some trends over another. For instance, compare the two charts below:
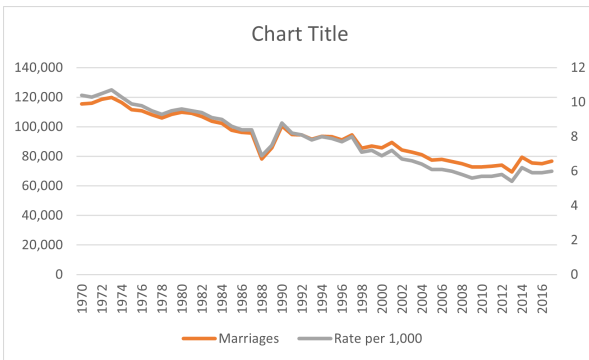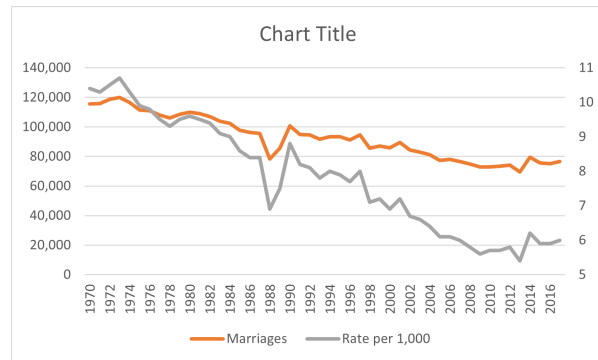

Figure 17: Default Combo Chart

Figure 18: Manipulated Axes

Even though these two charts are plotted using the exact same data, viewers may be mislead to draw different conclusions by manipulating the axes. Meanwhile, when the two series are presented using differnt "types," the risk is minimized.

Topic 4. Stacked Line Charts

Navigate to the worksheet ENERGY, which we reuse from the previous lecture. This time, we will be using each and every year's worth of information to plot a stacked line chart. Similar to the case with the stacked bar charts, we can use the Stacked Line Chart, or the 100% Stacked Line Chart depending on the aspect of the data we want to concentrate on.
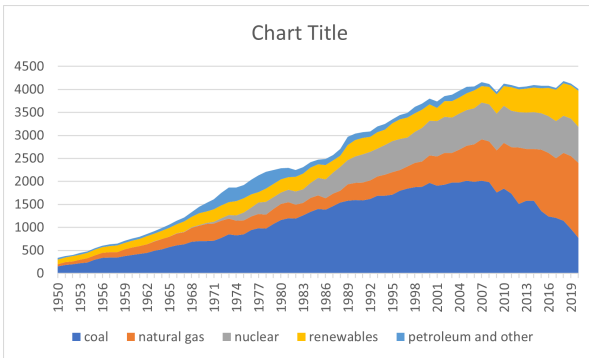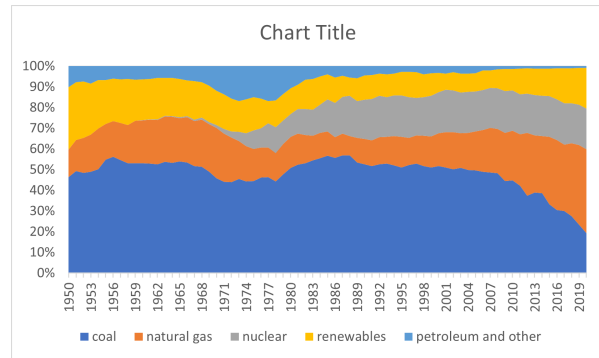

Figure 19: Stacked Line Chart

Figure 20: 100% Stacked Line Chart

Topic 5. Extension: Stock

As a spinoff to the line chart, we will briefly examine stock charts. Navigate to the worksheet STOCK, which contains a dataset on the trade Volume, Opening, Closing, High, and Low price of SCHW stock. When we have this information, we can use Excel to plot the following types of charts which are conventional in reporting stock performance over time.
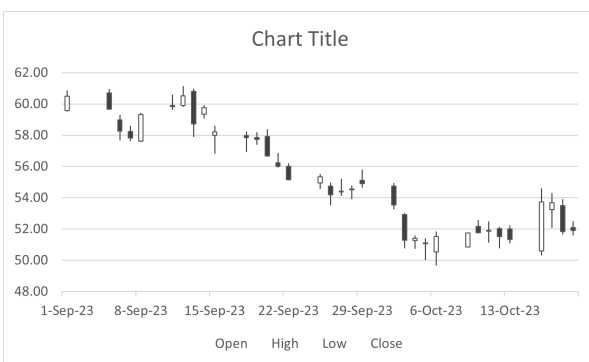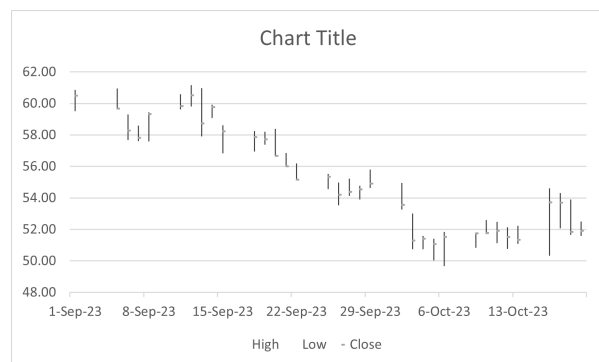

Figure 21: Open-High-Low-Close

Figure 22: High-Low-Close