

Yield Curve Visualizations

We begin our visualizations of the yield curve with a clever way to easily control which month-year yield curve to display. Our strategy will be to use a *Combo Box* form control to enable the user to select a date. The selected month-year will be connected to a cell in the sheet which we will use to get the yields via the *OFFSET* function. Finally, we will tie the chart to the selected yields by directly editing the *SERIES* formula. This will all make more sense as we actually do it.

STEP Click the *Developer* tab, then the *Insert* group, and select the *Combo Box* form control as shown in Figure 7.5. Click on the spreadsheet under your yield curve chart and drag to place the control on the sheet. Right-click the control and choose *Format Control*. For the *Input range*, select from cell A1 to the last row with data in column A. For the Cell link, select cell M1.

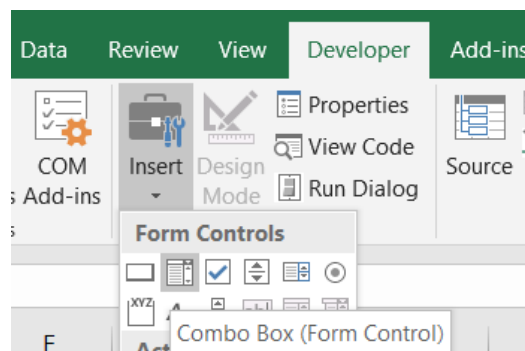


Figure 7.5: Selecting the ComboBox control.

It does not look like we have done anything, but we have. Our Combo Box is loaded with the dates in column A.

STEP Click on any cell in the sheet so that the Combo Box is not selected and then click the Combo Box control. Select any date.

Cell M1 now shows the row number of the date you selected. Next, we get the yield data for the chosen date.

STEP Enter the formula `=OFFSET(A1,M1,0)` in cell N1.

Excel displays the date for that row. The OFFSET function works by taking you to cell A1 and then going down however many rows are in cell M1 while staying in column A (that is what the zero says to do).

STEP Change cell M1 to 10. What happens?

Not only does the date change in cell N1 to the date in cell A10, but notice that the Combo Box control has also changed. Cell M1 is connected to the Combo Box so you can use the Combo Box to set cell M1's value or do the reverse and set the Combo Box's value by entering a number in cell M1.

STEP Select cell N1 and fill it right to cell X1.

Now you are displaying the yields for each maturity for that month-year. This means all we have to do is edit the chart's SERIES formula to display the yields in cells O1:X1.

STEP Click a point on the yield curve to see the SERIES formula in the formula bar. Remove the legend text and edit the *y*-axis so that the SERIES formula is: `=SERIES(,YieldCurve!B1:K1,YieldCurve!O1:X1,1)`.

We are ready to test our dynamic visualization of the yield curve.

STEP Click the Combo Box control and pick a date.

The chart immediately updates and shows you the yield curve for that date! The Combo Box control is an effective way to get user input.

STEP Use the Combo Box control to display yield curves from several dates. Try one from each decade. Definitely visualize the last row so you can see the current state of the yield curve.

If you play around a bit, you will see that the yield curve is usually upward sloping, but there are a variety of shapes. Inversion is when yields for longer maturities are lower than for shorter maturities. This does happen, but it is not the usual shape of the yield curve. Before we discuss the interpretation of inversion, we will do some 3D visualizations.

3D Viz in Excel

What if we visualized all of the month-year yield curves at once, in one chart? The yield would be the vertical axis in a 3D plot, with time and the maturities as the two horizontal axes.

STEP Delete the *date* text from cell A1 (the top-left corner of the data must be an empty cell). Select from cell A1 to the last row in column K. Click *Insert*, *Recommended Charts*, and select *3D Surface*.

Excel puts a chart on your spreadsheet, but it certainly needs some cleaning up. Below are the steps to produce Figure 7.6.

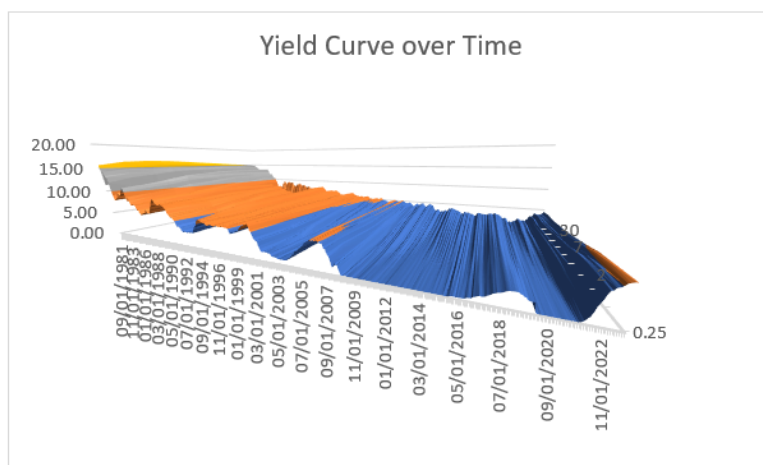


Figure 7.6: 3D Surface Excel chart of the yield curve.

STEP Make the title *Yield Curve over Time* and delete the legend.

The problem with the chart on your screen is that the time axis (near the front) is long and the maturity axis is too narrow. This is because there are many more rows than columns. We need to widen the maturity axis.

STEP Right-click the surface and select *3-D Rotation....* Repeatedly click the up arrow in the *Depth (% of base)* setting until you start to see the maturity axis start to widen. You can go up to 2,000 so directly enter this value.

Your chart should now look like Figure 7.6. It still needs more work. The maturity axis labels are unclear and there are too many dates displayed. The vertical axis needs a label and the way it is angled is not helpful. We will not bother trying to fix these issues because there is a big problem with Excel's charting interface: rotation is clumsy.

Excel provides X, Y, and Z rotation controls and you can try them, but they are difficult to work with. We want to be able to easily spin the chart with the cursor. To do this, we will use Python.

3D Viz in Python

Python is “an interpreted, object-oriented, high-level programming language with dynamic semantics” (www.python.org/doc/essays/blurb/). That sounds complicated, but do not worry, Python is really easy to access and use. It is open-source (free) and its many users provide a strong support system.

As of this writing, generative AI (especially ChatGPT) can be used to write effective Python code.

Although you can download and install it on your personal device, we will use an even simpler approach, Google's Colab environment.

STEP Click this link, colab.research.google.com, or enter it into your favorite browser. If needed, login to Google when prompted. Click on the *Welcome to Colaboratory* link and read it.

The Colab notebook that you read is composed of executable and text cells. Across the top of the Colab screen are the usual menu items and on the left is a table of contents with the sections in the notebook.

The yield data in the *YieldCurve.xlsx* workbook were uploaded to Google drive. A few lines of Python code create a 3D plot that is easy to rotate and spin.

STEP Click this link, tiny.cc/3DVizYieldCurve, or enter it into your favorite browser to see a Colab notebook that creates a 3D visualization of the data. Follow the instructions to spin the plot.

Figure 7.7 shows the Python visualization of the yield curve over time. Of course, the online version is live in the sense that you can spin it and use the cursor to get values at specific points on the surface.

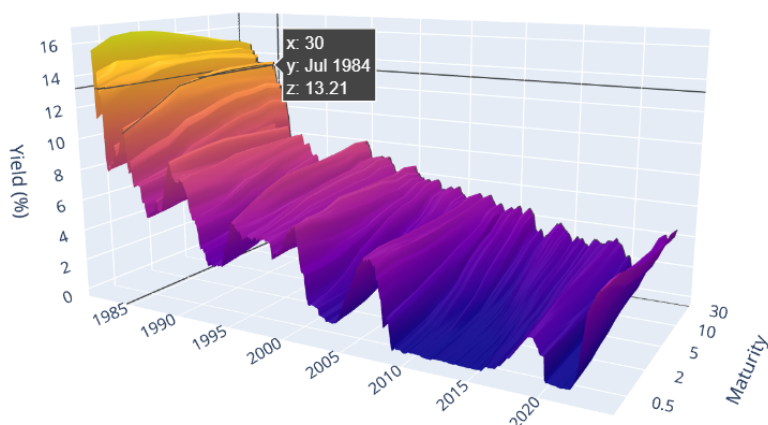


Figure 7.7: 3D chart in Python.

Yield Curve Meaning

Our yield curve visualizations are certainly eye-catching, but what does the yield curve actually tell us? There are several ways to answer this question, but the most important use of the yield curve is as the market's expectation of future economic performance.

Before we dig into how the yield curve can be used as a predictor, consider this: you follow a sports team that is expected to be really good this year, but they have aging stars at key positions. Then the betting odds of your team winning a championship would be higher for this season than a few years from now.

Conversely, if your team was bad now, but had young players who could develop into superstars, their odds of winning in future years are higher than now.

You can stretch the time horizon even farther and think about odds a decade or longer from now. For so far into the future, all of the teams would have similar odds (almost none of the current players would be active) unless there is some reason to believe that the ownership or management of a team is especially good or bad.

This thought exercise is quite similar to what the yield curve is doing. The yields are produced by supply and demand for each maturity. In a real sense, the yields for different maturities reflect the market participants overall outlook on the economy at different times in the future.

When the yield curve inverts, and longer maturities have lower yields than shorter ones, it means that investors think yields and interest rates will be lower in the future. This is interpreted as pessimism because low interest rates are associated with the Fed trying to stimulate an economy in recession.

So is the yield curve any good at predicting the future?

STEP Return to your *YieldCurve.xlsx* workbook and insert a blank sheet. Use FRED's *Data Search* tool to search for *yield curve*. Select the top 2 hits, *T10Y2Y* and *T10Y2YM*. Get the data and make separate charts with recession shading.

The daily chart is more jagged, but it tells the same story as the monthly frequency chart, shown in Figure 7.8. When the series dips below zero (so 2-year are higher than 10-year yields), the yield curve is inverted.



Figure 7.8: FRED *Series ID T10Y2YM*: Inversion when below zero.

Since 1969, an inverted yield curve has correctly predicted recessions shortly after the inversion (roughly within 15 months). Figure 7.8 shows that when the series goes below zero, a shaded bar soon follows —except the last one.

Is this time different? As of this writing, in early 2024, the yield curve has been inverted for months and strongly so, yet the US economy seems strong. Time will tell if the yield curve got it right again.

Takeaways

Excel can be used to make charts and adding controls can make an Excel chart responsive to user input. We used a Combo Box control to allow the user to display the yield curve for a particular month-year.

Excel is not, however, a strong data visualization software. In particular, its ability to manipulate charts, such as spinning a 3D plot, is quite limited.

Python, on the other hand, has extensive data display libraries. We used Google’s Colab environment to produce a 3D plot of the yield curve over time. It is simple to share the chart and users can easily click and rotate it.

The yield curve itself has been the subject of extensive research. Analysts model the shape and fit curves to yield data.

Usually, there is a *term premium* for bonds with longer maturities. Investors have to be rewarded with higher yields when they lock up their money for longer periods of time.

One especially keen area of interest is the concept of an *inverted yield curve*.

Inversion occurs when long-term yields are lower than short-term (this is not common).

An inverted yield curve is strongly associated with a recession in the near future.

The yield curve, measured by 10 year minus 2 year YTM, inverted on July 11, 2023. It has remained inverted in the early part of 2024. There is great debate about whether this time it’s different.

References

For an overview of the yield curve with excellent graphics and an explanation of the meaning of the yield curve, see Bruce-Lockhart, C., Lewis, E., and Stubbington, T. “An inverted yield curve: why investors are watching closely,” *Financial Times*, April 6 2022, available online at [ig.ft.com/the-yield-curve-explained/](https://www.ft.com/content/ig.ft.com/the-yield-curve-explained/)