THE YIELD CURVE FOR TREASURY NOMINAL COUPON ISSUES

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Introduction

- This presentation introduces the Yield Curve for Treasury Nominal Coupon Issues (TNC yield curve). The TNC curve is derived from data for Treasury notes and bonds.
- The TNC yield curve uses the methodology developed at Treasury for the High Quality Market (HQM) Yield Curve for the Pension Protection Act (PPA), and extends this methodology to the Treasury market.
- This presentation discusses basic concepts for understanding and using the TNC yield curve, and presents an overview of the curve methodology. For links to more detailed documentation and technical descriptions, see the last slide.

TNC Yield Curve Summary

- A *yield curve* provides information about a sector of the bond market at a point in time. The information includes yields on different types of bonds in this sector at various maturities.
- The TNC yield curve provides information on Treasury nominal coupon issues, that is, notes and bonds that pay semiannual fixed coupons in dollars. The TNC curve includes both on-the-run issues (securities most recently issued of each maturity) and older off-the-run issues; however, in this presentation, the focus is on yields of off-the-run issues.
- The TNC methodology also projects yields beyond 30 years maturity out through 100 years maturity. The methodology ensures that the projections are consistent with yields before 30 years maturity and with long-term investment returns available in the market.

The Par Yield Curve

- One set of information provided by the TNC yield curve is the Treasury par yield curve.
- The par yield curve shows for each maturity the yield on a Treasury nominal coupon issue of that maturity that is selling at par (price excluding accrued interest equals 100).
- The par yield curve provides a picture of the Treasury market for coupon issues, and is used for market analysis.

The Spot Yield Curve

- Another set of information from the TNC yield curve is the Treasury spot yield curve.
- The spot yield curve shows for each maturity the yield on a Treasury security without coupons that provides a single nominal payment at that maturity. Such a security can be called a zero coupon bond. The yields are called spot rates.
- Because the TNC yield curve uses coupon issues, there are no actual zero coupon securities in the TNC dataset. Therefore, the spot rates are inferred from the TNC par yield curve.
- The TNC spot rates are used to discount future cash flows to get their present value.

The Spot Yield Curve, continued

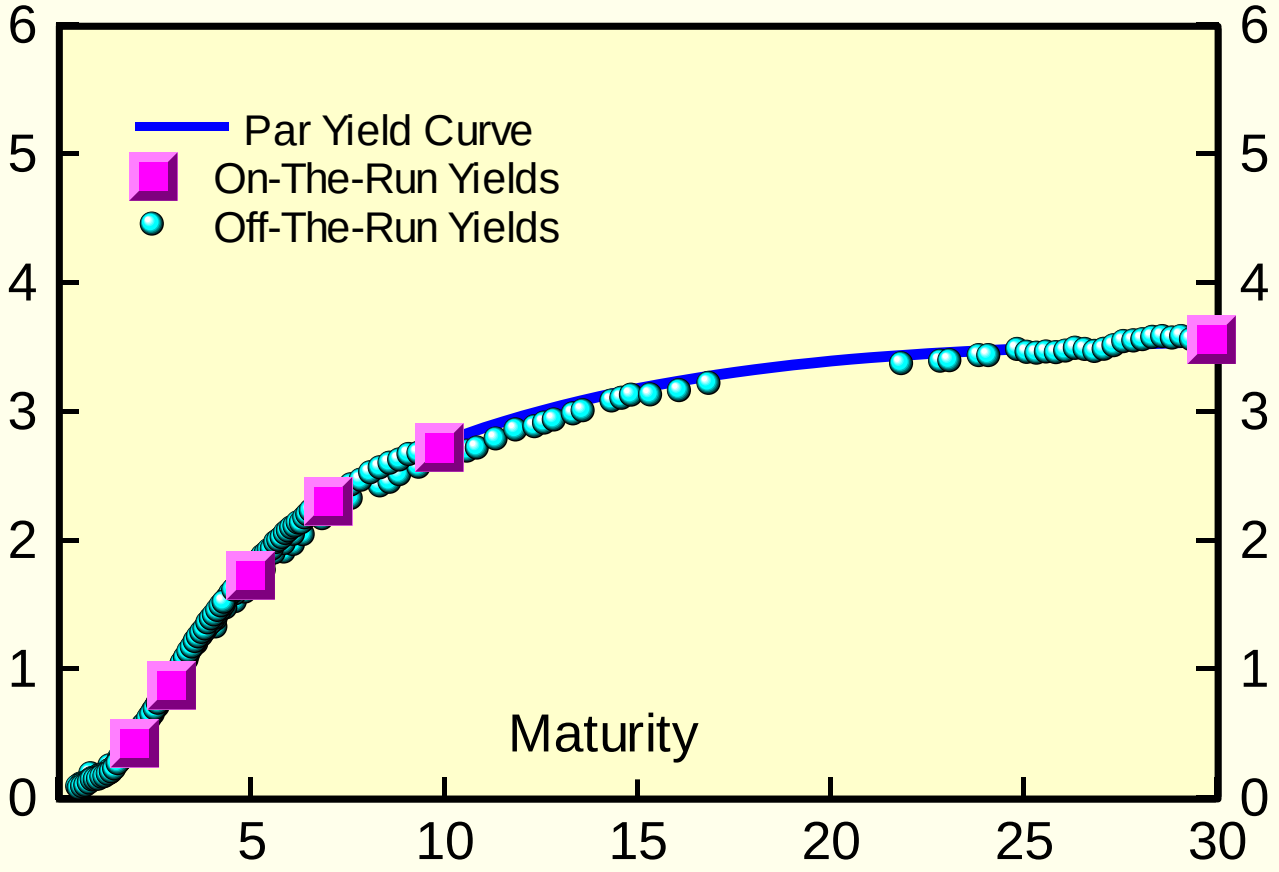
- For most applications, the TNC curve is used to generate spot rates for each maturity at half-year intervals for maturities of ½ year up through 100 years, for a total of 200 spot rates. The rates are semiannually compounded.
- The TNC yield curve is calculated late in the day for each business day, and the monthly TNC spot rate at each maturity is the average of rates at that maturity for the business days of the month. Quarterly TNC spot rates are averages of the three monthly rates at each maturity for the quarter.
- Off-the-run TNC spot rates can be interpreted as the risk-free social rates of time preference. Therefore, social preference is indifferent between future cash flows and their present values discounted by the TNC spot rates.

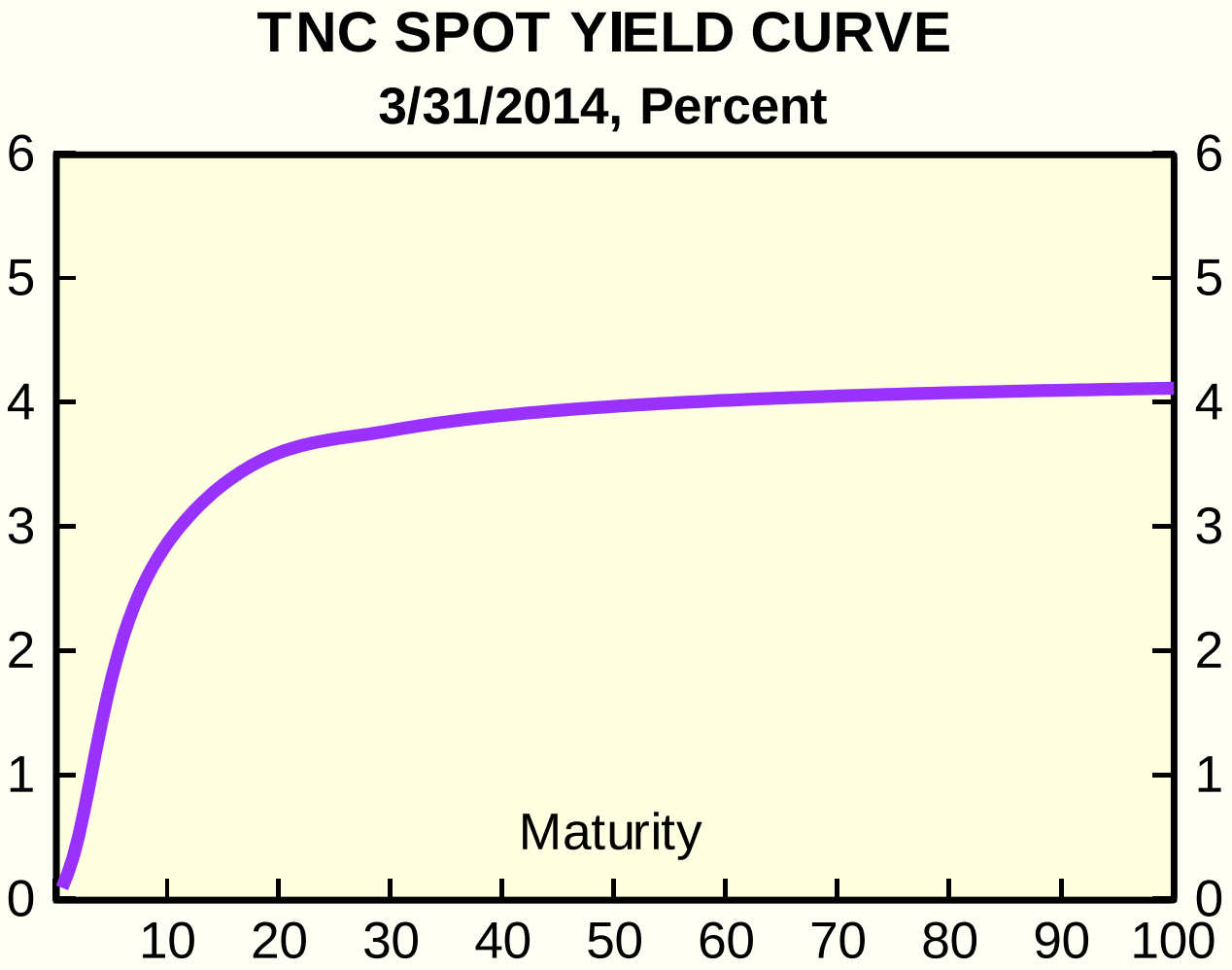
Yield Curves for End of March

- The next two slides contain the TNC off-the-run par and spot yield curves for March 31, 2014.
- There are 264 Treasury nominal coupon issues in the dataset for this day. The par yield curve in slide 8 includes a scatter diagram of the yields of these securities, with on-the-run securities indicated by squares. For this day, yields on the on-the-run securities are close to the curve.
- The spot yield curve in slide 9 is derived from the par curve, and is projected out to 100 years maturity. The spot rate is 3.78 percent at 30 years maturity, and the curve continues to rise beyond 30 years maturity reaching 4.12 percent at 100 years maturity.
- Both yield curves are very smooth without any hump.

TNC PAR YIELD CURVE

3/31/2014, Percent




TNC SPOT YIELD CURVE
3/31/2014, Percent
6
5
4
3
2
1
0
Maturity
10
20
30
40
50
60
70
80
90
100

TNC Yield Curve Methodology

- Different yield curve methodologies can produce different results, which affect discounted cash flows and everything else for which the curves are used. Therefore, it was essential for Treasury to develop and implement the methodology that accurately captures market behavior.
- Moreover, an understanding of the TNC methodology aids greatly in the appropriate use of the TNC curve.
- The TNC methodology is the same as the methodology used for the HQM corporate bond yield curve with modifications for the Treasury market.

TNC Methodology Features

The TNC yield curve methodology contains features and capabilities that do not appear in other yield curve approaches:

- The TNC methodology combines regression variables with the yield curve.
- The methodology projects yields beyond 30 years.
- The methodology makes use of established bond market characteristics to generate a stable yield curve that captures market movements.

TNC Methodology: Regression Variables

- The TNC methodology has the special capability of combining regression variables with the yield curve. The regression terms adjust for special features of the market and particular attributes of individual bonds.
- The TNC yield curve contains two sets of regression variables. The first variable measures the hump in yields that is sometimes seen around 20 years maturity.
- The second set of variables is for on-the-run and first off-the-run securities, and measures price differences of such securities relative to other off-the-run prices. As opposed to other approaches, the TNC yield curve includes both on- and off-the-run securities in the same model and takes account of on-the-run effects.

TNC Methodology: Projections

- The TNC methodology projects yields beyond 30 years maturity out to 100 years maturity. The projections provide discount rates for long-dated cash flows.
- The methodology ensures that the projections are consistent with yields before 30 years maturity and with long-term investment returns available in the market.
- Other yield curve approaches generally stop at 30 years maturity and contain no provision for projection. Therefore, there is no mechanism in those approaches to ensure that yields around 30 years maturity are consistent with earlier yields in the dataset. Building the projection methodology into the yield curve solves this problem.

TNC Methodology: Established Market Views

- The TNC methodology is derived from basic hypotheses about bond markets. The hypotheses inform the setting of the parameters that underpin the TNC yield curve.
- Other yield curve approaches typically use mathematical functions that don't have any foundation in market hypotheses.
- Consequently, differences among yield curves given by other approaches with different mathematics are arbitrary, in that there is no way to choose among them.

Estimation of the TNC Yield Curve

- Estimation of the TNC yield curve at a point in time starts with Treasury nominal coupon issues in the market at that time (certain issues are eliminated, as described later).
- The regression terms are chosen to capture any hump and also to sort out the on-the-run and first off-the-run issues.
- The par and spot rates are chosen to be those rates that give the best statistical fit (by least squares) to all the prices in the market. This means that the estimated prices of the issues, given as their cash flows discounted by the rates, come closest on average to their actual prices.

Estimation of the TNC Yield Curve, continued

- The TNC yield curve methodology employs a model of bond prices. The methodology does not directly use yields or averages of yields of the securities.
- However, the description so far of the estimation is too general to actually compute yield curves. To carry out the estimation, yields must be assumed to follow a mathematical pattern or functional form.
- The main source of differences among yield curve approaches is their different choices of functional forms, and as noted, functional forms in other approaches typically are not grounded in market hypotheses. The TNC methodology bases the functional form on hypotheses about maturity ranges in the market.

The Forward Rate

- The concept of the forward rate is useful for picking a functional form for estimating the yield curve.
- The forward rate is straightforward: for each maturity, consider entering into a contract to invest some money at the time of that maturity for a small amount of time beyond that maturity. The forward rate at that maturity is the future interest rate on this investment.

The Forward Rate, continued

- Analogous to spot rates, the market in general does not provide explicit forward rates, and they must be inferred from other yields in the market.
- The forward rate is higher at a given maturity when investors who are trading at that maturity are less eager to lend based on their assessment of uncertainty and their expectations and purposes, while borrowers are more eager to borrow based on their perceptions. The forward rate summarizes market views for each maturity in a single number.

Maturity Ranges

- Moreover, trading in securities tends to divide into maturity ranges, such that the trading activity in each range on average reflects similar purposes, similar views of risk, and similar expectations about securities in that range.
- Because market views can be considered similar for securities in the same range, the forward rates in each maturity range can be assumed to be related to each other in a simple fashion.
- Consequently, the TNC methodology models the forward rates in each maturity range as a smooth (cubic) function, and joins the functions together smoothly across ranges (as a cubic spline).

Maturity Ranges, continued

- The TNC methodology at the present time uses five maturity ranges, delineated by the maturity points 0, 1.5, 3, 7, 15, and 30 years maturity. These points provide separate ranges for the critical maturities of 2 years, 5 years, the benchmark 10 years, and 30 years.
- The choice of fixed maturity ranges increases significantly the stability of the TNC yield curve estimates over time.
- In addition, the TNC methodology is statistically straightforward to estimate. In contrast, certain other yield curve approaches generate statistical models that are ill-conditioned and unstable.

The Long-Term Forward Rate

- The methodology must include the capability of projecting forward rates beyond 30 years maturity so as to obtain yields out through 100 years maturity.
- First of all, the long-term forward rate beyond 30 years maturity is set to a constant, because there are not enough data to estimate accurately movements in the forward rate beyond 30 years maturity.

The Long-Term Forward Rate, continued

- Next, the TNC methodology postulates that the long-term forward rate is determined by the same factors that affect forward rates in the longest 15- to 30-year maturity range, since that range is sufficiently distant in time to reveal underlying long-term attitudes toward risk and return.
- Therefore, the constant long-term forward rate from 30 years maturity up through 100 years maturity is taken to be the average forward rate in the 15- to 30-year maturity range.

Estimation

- The forward rates in the maturity ranges are estimated by least squares, and the par and spot yields are derived from the estimated forward rate curve.
- The regression terms are simultaneously estimated. Before estimation, the Treasury security data are weighted by the (square root of the) inverse of duration.

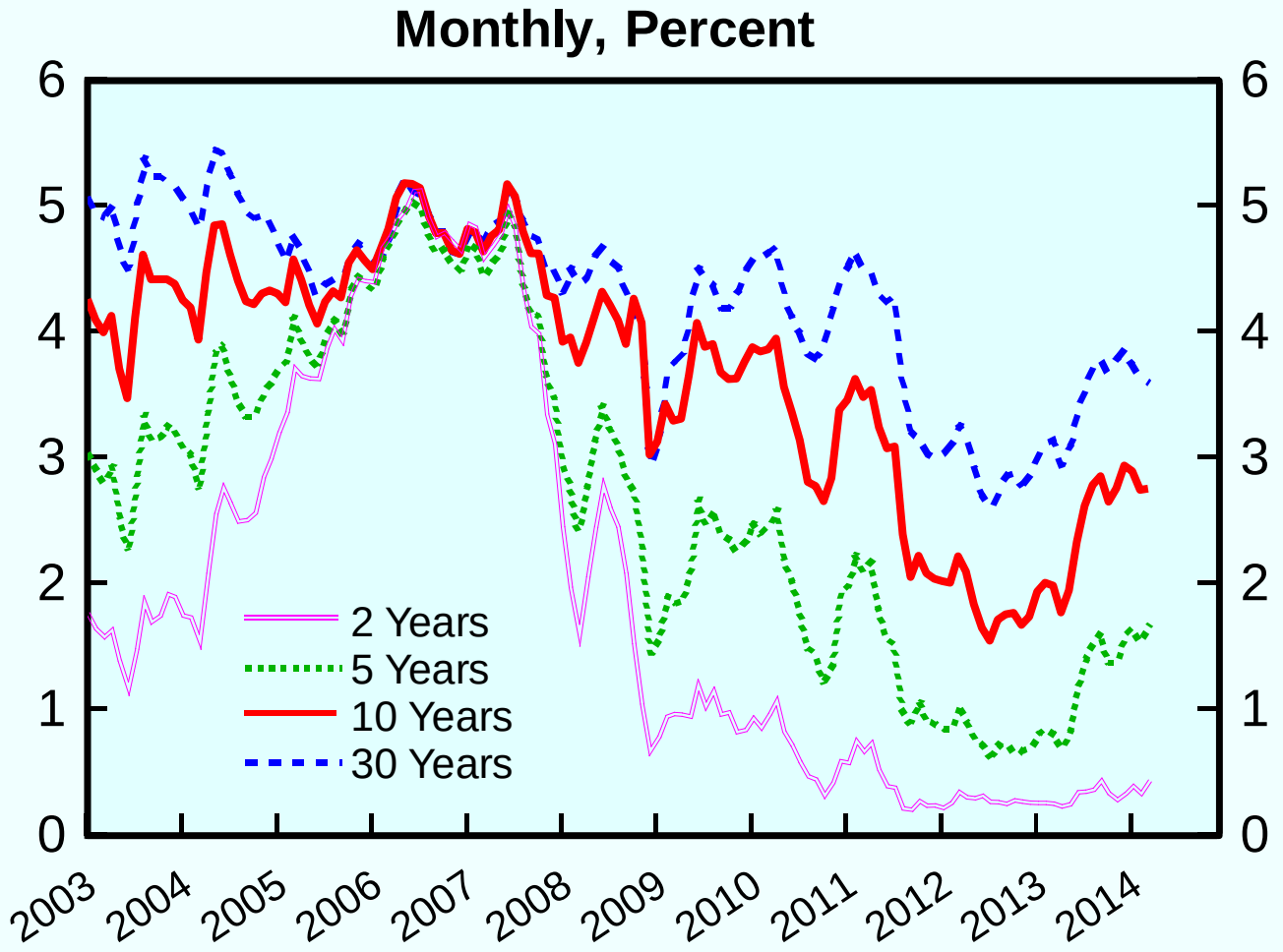
Data

- The TNC yield curve represents all nominal coupon issues, and the dataset for each business day is derived from issues that are priced on that day. Bid prices are used.
- However, the dataset for each day excludes issues with fewer than two coupon payments remaining.
- Also, the TNC curve here presented from 2003 forward excludes the 14 callable issues that were outstanding at some time during this period. The last callable issue was called in 2009, callables are no longer issued, and the callables do not affect results enough to add in the machinery to deal with call options.

Results

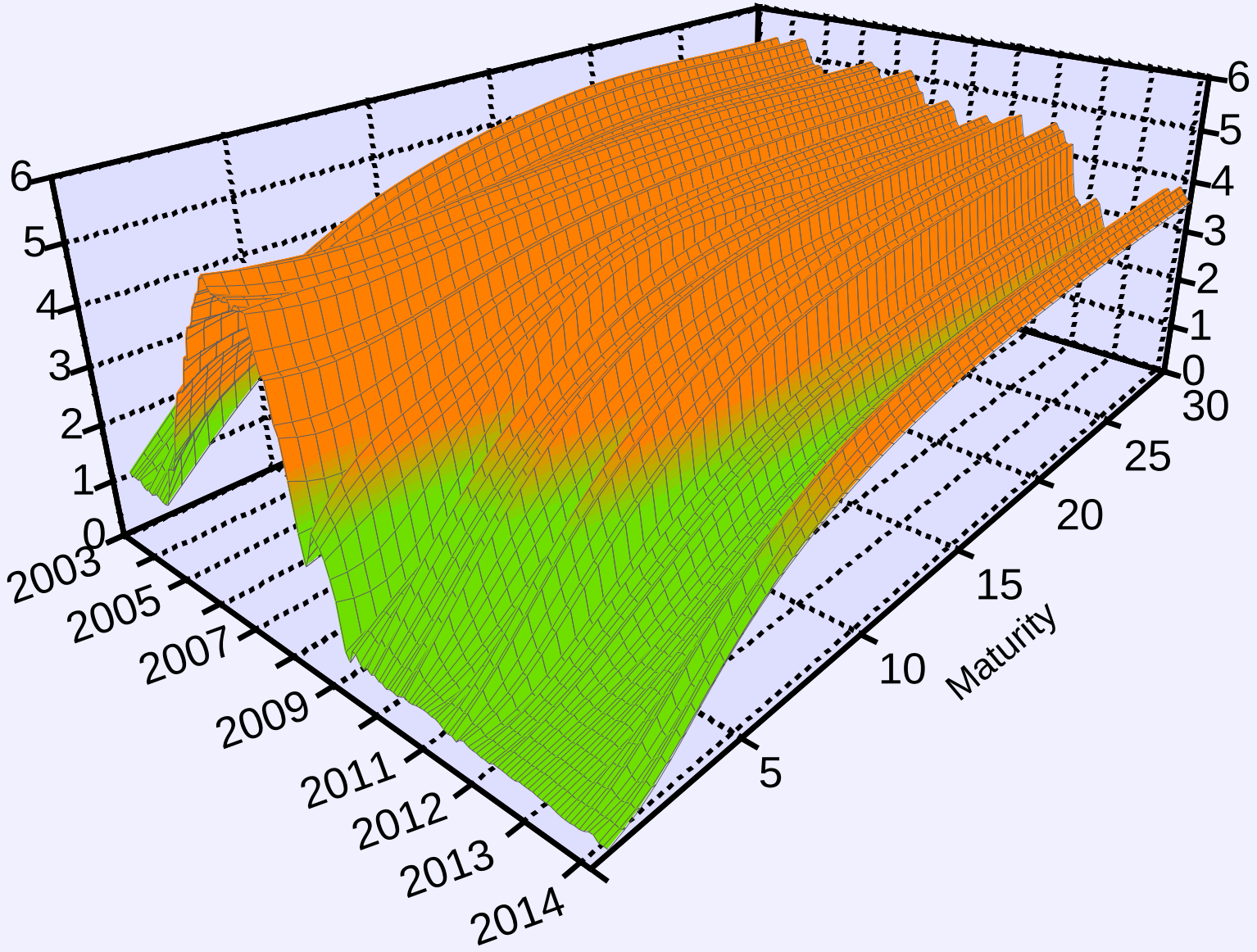
- The following charts show results for the TNC yield curve over the period January 2003 through March 2014, for a total of 2,080 business days and 135 months.
- The first chart in slide 26 shows monthly off-the-run par yields at 2 years, 5 years, 10 years, and 30 years maturities. The second chart in slide 27 shows the monthly off-the-run par yield curve over the entire period.
- The charts show that the par yield curve flattened out before the 2007-2009 recession, and that yield spreads were large in the financial crisis of 2009 forward. After that, spreads decreased a bit.

TNC PAR YIELDS AT SELECTED MATURITIES



TNC PAR YIELD CURVE

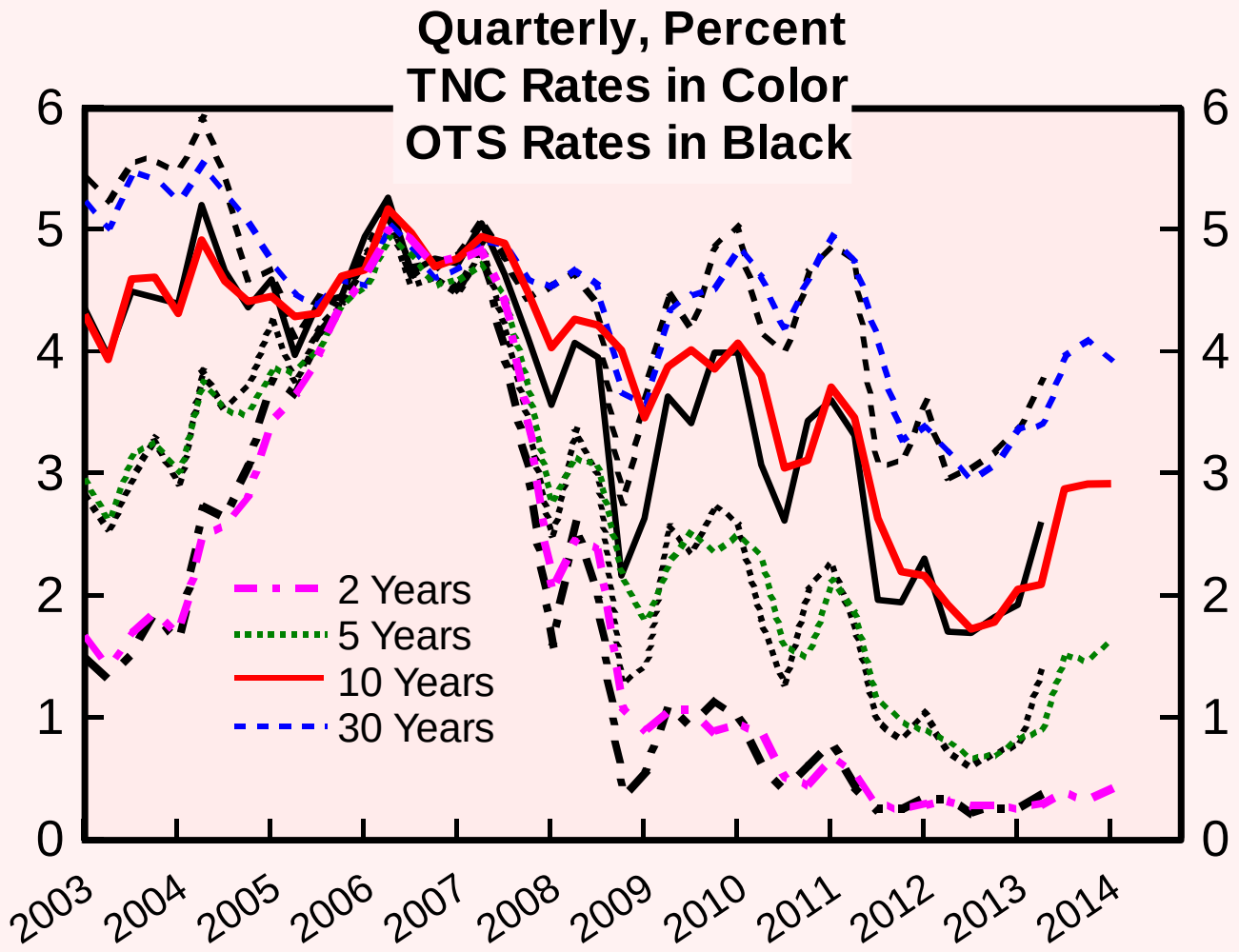
Monthly, Percent



Results, continued

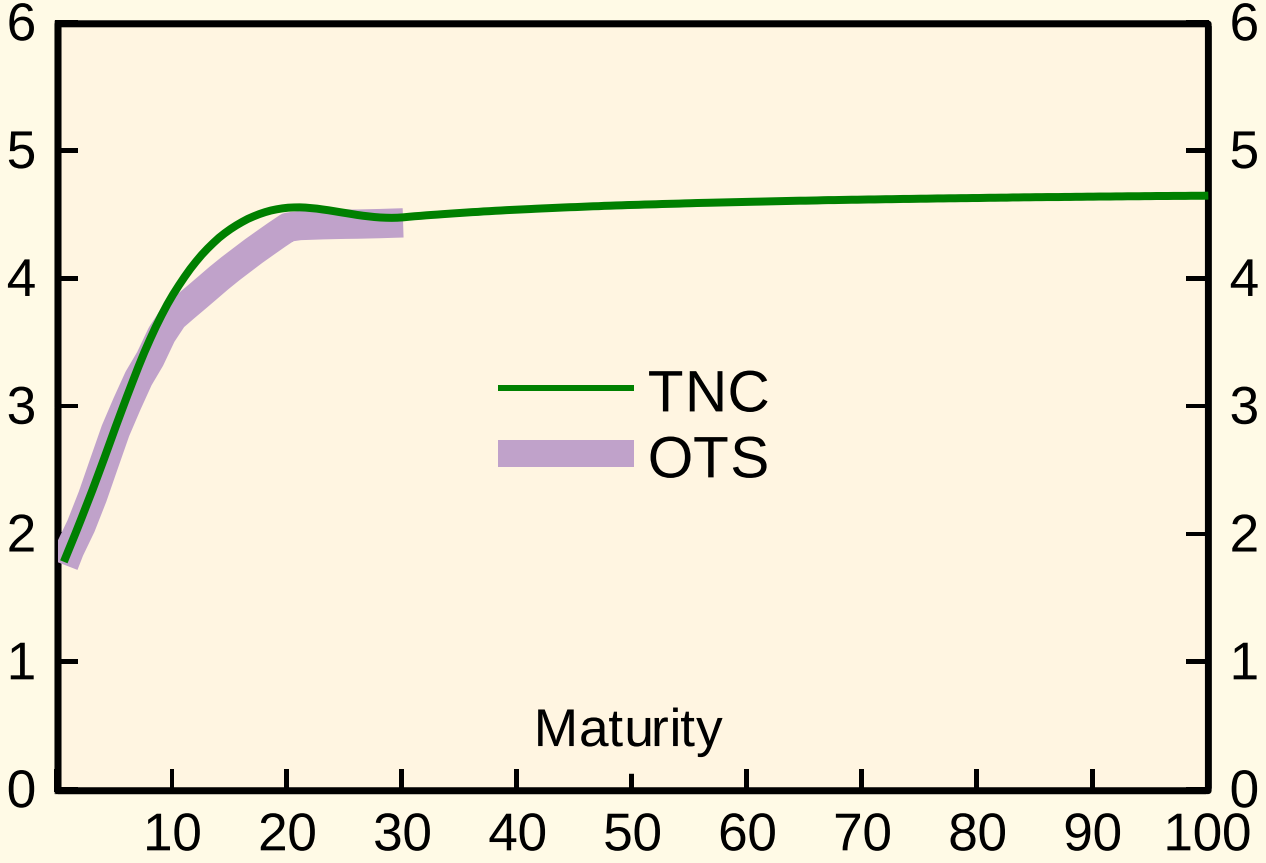
- The next chart in slide 29 shows the TNC quarterly average spot rates over the entire period at the maturities of 2 years, 5 years, 10 years, and 30 years, compared with the legacy Treasury spot rates from the Office of Thrift Supervision (OTS rates). And the chart after that in slide 30 shows the 10-year average of the TNC quarterly spot yield curve from 2003QII through 2013QI compared with the 10-year average of the OTS legacy spot yield curve.
- The charts indicate that TNC spot rates are generally above OTS rates. In the last chart, the average difference between the two curves is 14 basis points through 30 years maturity.

TNC AND OTS SPOT RATES AT SELECTED MATURITIES



TNC AND OTS SPOT YIELD CURVES

10-Year Average Through March 2013, Percent



For More Information

- The High Quality Market (HQM) Corporate Bond Yield Curve for the Pension Protection Act (PPA) is published by the IRS each month. Data are also available on the Economic Policy website.
- For more details on the mathematics behind the HQM and TNC curves, and for more documentation in general, visit the Office of Economic Policy website. Go to www.treasury.gov, under "Resource Center" choose "Economic Policy," then choose "Corporate Bond Yield Curve Papers."
- The methodology here presented has been applied to Treasury inflation-indexed securities (TIPS). See papers 0601 and 0501 in the Economic Policy Research Paper Series on the Office of Economic Policy website.