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A Long-Term Perspective on the Determinants of Treasury Bond Stripping Levels

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We examine the proportion of individual Treasury bonds held as strips over the entire history of the STRIPS program. First, we document a secular decline in the Treasury bond stripping levels from 1985 to 2010, coincidental with the long-term decline in the interest rates. This pattern suggests that investors purchase strips to avoid reinvestment risk and to lock in the high interest rates in the 1980s and 1990s. Second, higher coupon and longer maturity bonds are shown to be more heavily stripped. Third, the suspension of new issues of 30-year bonds from 2001 through 2006 created a gap in the maturity structure of Treasury bonds and induced heavy stripping of 30-year bonds issued post 2006. Our findings suggest that stripping is motivated by several factors, including interest rate risk management, tax concerns and market completion.

I. INTRODUCTION

In January 1985, the U.S. Treasury introduced the STRIPS (Separate Trading of Registered Interest and Principal of Securities) program, which allows the coupon and principal payments of eligible Treasury notes and bonds to be traded separately as zero-coupon bonds, called Treasury strips. Two years later, the Treasury allowed reconstitution of the original Treasury notes and bonds by rebundling corresponding Treasury coupon strips and principal strips. The STRIPS program has been a huge success since its introduction in 1985. As of December 2009, \$152 billion, or 21% of the par value of all outstanding Treasury bonds, were held in stripped form. In addition, the amount of stripping and reconstituting is very large. For example, in the single month of December 2009, \$25.4 billion of Treasury bonds were stripped and \$23.7 billion were reconstituted.

Over time, strips have played an increasingly important role in government bond markets. Following the U.S. Treasury, 15 other countries introduced similar programs for their Treasury debts as well, including Germany, France, UK, Canada, Japan, Spain, Italy, Sweden, and the Netherlands. Because underlying bonds can be both stripped and reconstituted, arbitrage between strips and underlying bonds means that strips are the basic building blocks of the government bond markets, resembling Arrow-Debreu state securities. In addition, the yields on strips are increasingly used by the market to measure the term structure of interest rates, as evidenced by Merrill Lynch maintaining indexes of strips with maturities from 1 to 30-year.

Despite its growing importance in government bond markets of the United States and other countries, there is relatively little analysis on this important topic. Furthermore, the few studies on this active market, using data in the 1990s,

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focus on potential arbitrage opportunities and monthly stripping and reconstitution activities. Conspicuously missing is an investigation of the determinants of the relative level of stripping of individual Treasury bonds. While a significant amount of Treasury bonds are held in stripped form, there is very large cross sectional variation in the stripping of individual Treasury bonds. For example, as of December 2009, less than 8% of the February 2029, 5.25% coupon rate Treasury bond was held in stripped form, while more than 60% of the May 2030, 6.25% coupon rate Treasury bond was held in stripped form. In addition, there is significant intertemporal variation in stripping of Treasury bonds. In the early 1990s, about 45% of the par value of all eligible Treasury bonds was held in stripped form. The level of stripping has dropped to about 20% in the late 2000s.

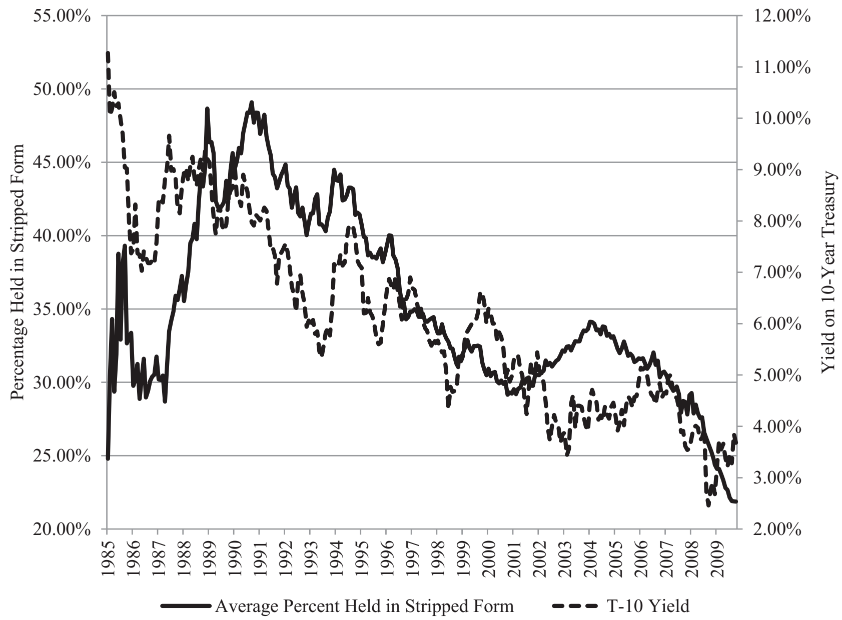
This paper attempts to explain the cross-sectional and intertemporal variations in the Treasury bond stripping levels.[1] Our empirical findings shed some light on the three major theories on the Treasury bond stripping: the Interest Rate Risk Hypothesis (Sundaresan, 2002), the Tax Hypothesis (Livingston & Gregory, 1989), and the Market Completion Hypothesis (Grinblatt & Longstaff, 2000).

According to the Interest Rate Risk Hypothesis, some investors want to avoid the reinvestment risk of bond coupons by holding strips. In addition, if investors expect future interest rates to decrease, they will hold strips to lock in the high prevailing interest rates. The Tax Hypothesis indicates that a portfolio of strips has a greater after-tax value than an underlying Treasury bond for upward sloping term structures. The Market Completion Hypothesis argues that strips allow some investors to create cash flow sequences that are unavailable using coupon bearing bonds.

Our empirical findings are consistent with all three hypotheses, suggesting that Treasury stripping is not driven by one single consideration but by several factors. First, we find a secular decline in the percentage of Treasury bonds held as strips from 1985 to 2010. This secular decline is coincidental with the long-term decline in the level of interest rates. This positive correlation between the level of Treasury bond stripping and the level of general interest rates is illustrated in Figure 1, which plots the monthly percentage of par value of Treasury bonds held in stripped form and the monthly average daily yields on 10-year Treasuries. In the 1980s and 1990s interest rates were high by historical standards. As a result, many investors preferred to hold strips to lock in the historically high interest rates. Indeed, we estimate that a change of 1% in the 10-year Treasury yield translates to an approximately 2% to 2.5% change of the Treasury bond stripping level in the same direction. This empirical pattern is consistent with the Interest Rate Risk hypothesis.

Second, we find a positive correlation between Treasury bond stripping and coupon rate. Figure 2 plots the average life-to-date percent of par value held in

[1] We concentrate on Treasury bonds instead of Treasury notes for two reasons. First, the proportion of Treasury notes held in stripped form is relatively small. Second, the maturities of Treasury notes are tightly bunched making it very difficult to distinguish between different motives for stripping of the underlying securities.



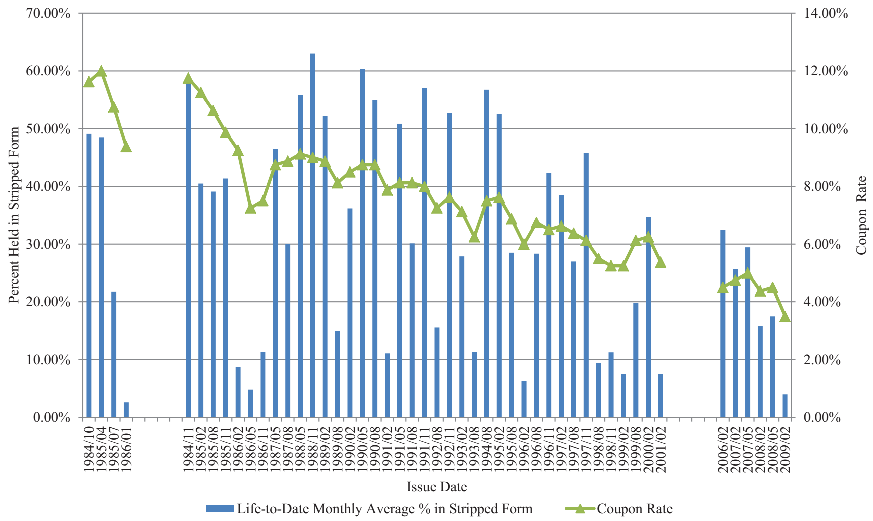
Note: This figure depicts the monthly average of the U.S Treasury bonds held in stripped form as a percent of the total amount outstanding and the yields on 10-year Treasury notes from May 1985 to February 2010.

Figure 1: Treasury Stripping and Interest Rates.

stripped form and coupon rate for each Treasury bond. As shown in Figure 2, the more recently issued Treasury bonds, with much lower coupon rates, are not as heavily stripped as the high coupon bonds issued in the 1980s and early 1990s. We estimate that a difference of 1% in coupon rates leads to a 10% difference in the Treasury bond stripping level. This finding is consistent with both the Interest Rate Risk and the Tax Hypotheses.

In addition, as shown in Figure 2, almost all bond issues with local maximum coupon rates are heavily stripped compared to adjacent maturities, suggesting that patterns of coupon rates of successive issues have an impact on stripping as well.

Third, the non-issuance of 30-year Treasury bonds between 2001 and 2006 created a gap in the maturity spectrum of Treasury securities as indicated by the gap in the x-axis of Figure 2. The first three Treasury bond issues after the Treasury re-initiated the 30-year program in February 2006 are actively stripped, despite their historically low coupon rates. The 30-year Treasury bonds issued beginning in 2006 play the unique role of allowing the creation of zero-coupon Treasuries with maturities after 2031, which cannot be otherwise synthesized by alternative means. This finding supports the Market Completion Hypothesis.



Note: The Figure depicts the Life-to-Date monthly average percent held in stripped form for every Treasury bond as of February 2010. The coupon rates are also plotted in the Figure. The leftmost four issues are 20-year bonds while the others are 30-year bonds. The two gaps in the x-axis indicate large gaps in the maturity spectrum of the Treasury bonds. There is an 8-year maturity gap between the 20-year Treasury bond issued in January 1986 and the 30-year Treasury bond issued in November 1984. Another 5-year maturity gap lies between the two 30-year Treasury bonds issued in February 2001 and February 2006.

Figure 2: Percent of Treasury Bonds Held in Stripped Form.

Fourth, we find that the level of Treasury bond stripping decreases with the age of the bond issue after the first few years of initial issuance. This suggests that older Treasury bonds are less likely to be stripped, probably due to their lower reinvestment risk as they approach maturity. This confirms the prediction of the Interest Rate Risk Hypothesis.

Finally, the slope of the yield curve has an impact on the proportion of Treasury bonds held as strips. The Treasury bond stripping level decreases when the yield curve is significantly downward sloping (inverted). Furthermore, stripping level increases with the steepness of the yield curves. This pattern is consistent with the Tax hypothesis.

Different from other studies on Treasury bond stripping, this paper examines the variations in the net percent of Treasury bonds held in stripped form over the almost entire history of US Treasury STRIPS program. We do not study the monthly stripping or reconstitution activities as do Grinblatt and Longstaff (2000) because monthly stripping and reconstitution activities are very volatile and a significant amount of stripping is offset by reconstitution of the same

Treasury.[2] Discussions with U.S. Treasury primary dealers indicate that a very large amount of monthly stripping and reconstitution activities takes place for short-term portfolio considerations rather than economic fundamentals. Our focus on the variations in the proportion of Treasury bonds held as strips eliminates the need to examine stripping and reconstitution activities separately. An increase in the stripped amount indicates net stripping, while a decrease in the stripped amount is equivalent to net reconstitution.

This paper makes three main contributions to the literature. First, our study is the first to systematically test the three hypotheses of Treasury bond stripping. The Interest Rate Risk and Market Completion hypotheses imply that U.S. Treasury strips play important economic roles in the financial market. However, the Tax hypothesis indicates that U.S. Treasury strips are only a product of a tax distortion and do not create fundamental economic values. Our empirical findings that Treasury bond stripping is driven by all three factors suggest that the U.S. Treasury STRIPS program is a truly successful financial innovation that meets market demands and creates economic values.

Second, this study provides an updated and comprehensive examination of Treasury bond stripping. Existing studies on this important market deal with limited data from the early to mid-1990s. In contrast, this study uses almost the entire history of the STRIPS program from 1985 to date. This period covers both the high interest rate regime in the 1980s and the historically low interest rate environment in the late 2000s, which allows a robust perspective of the determinants of Treasury bond stripping under different interest rate regimes. Furthermore, the 25-year sample period covers the entire or a significant portion of the lives of many Treasury bonds in the sample, making it feasible to study the life-cycle patterns in the stripping of Treasury bonds.

The findings in the paper also have practical implications. Treasury strips play an important role in interest rate risk management, especially for pension funds and life insurance companies. Institutional investors need to understand the special features of this market in which they are investing large amounts of money. This research provides an enhanced understanding of Treasury bond stripping behavior.

The rest of the paper is organized as follows. Section II gives the background of the Treasury STRIPS program and summarizes the previous literature. Section III discusses the various hypotheses on Treasury stripping and their empirical implications. Section IV describes the data and Section V presents the empirical findings. Section VI concludes the paper.

II. BACKGROUND AND PREVIOUS LITERATURE

Development of Strips Market

Treasury dealers started stripping U.S. Treasury bonds in the mid-1970s. Until 1982, many Treasury bonds were held in bearer form, with coupons attached,

[2]For example, Grinblatt and Longstaff reports that, on average, a 1.09% increase in the amount stripped is associated with a 1% increase in reconstitution.

making stripping of the bonds more cumbersome (Kluber & Stauffacher, 1987). To overcome the limitations of the bearer bond market, Merrill Lynch was the first to introduce a financial innovation dubbed TIGRs (Treasury Investment Growth Receipts) in August 1982 (Stigum, 1990). Merrill Lynch bought long-term government bonds, placed them in a trust account, grouped coupons with the same maturity, and issued a series of zero-coupon bonds that were backed by the intervening cash flows from the Treasury. Soon other Treasury dealers began to market their own receipts. Salomon Brothers introduced CATs (Certificates of Accrual on Treasury Receipts) and Lehman Brothers began to offer LIONs (Lehman Investment Opportunity Notes). However, a severe drawback of these proprietary receipts was the lack of interchangeability.

In January 1985, the U.S. Treasury introduced the STRIPS (Separate Trading of Registered Interest and Principal of Securities) program, which allowed stripping of selected coupon bearing Treasuries. This program enables primary dealers to strip Treasuries, on demand, into semi-annual coupon strips and principal strips. The program offers a number of advantages. The registration and administration of coupon and principal strips is computerized via the Treasury's book entry system, which entails significant cost savings. Costs for primary dealers to strip or reconstitute bonds have been minimal and are currently zero.[3] Partly due to cost savings, but also due to standardization and liquidity enhancement, STRIPS became the *de facto* standard of the zero-coupon market. By 1985, the total par value of strips reached $45 billion (Kluber & Stauffacher, 1987). As a result, primary dealers stopped issuing proprietary receipts.

In May 1987, the U.S. Treasury allowed the reconstitution of the underlying Treasury bond by rebundling the corresponding coupon and principal strips. The reconstitution of strips allows dealers to arbitrage between strips and the underlying Treasury bond, eliminating price discrepancies between the two securities. Consequently, the growth of the Treasury STRIPS market accelerated substantially. As of December 2009, $152 billion in par value of Treasury bonds were held as strips, creating the world's largest and most liquid zero-coupon bond market.

Despite its popularity and size, there is little academic literature on this important market. The limited literature on Treasury strips centers on two issues: the potential arbitrage opportunities in the strips market and the relative pricing of coupon strips and principal strips.

Arbitrage and Strips

This line of literature on strips considers arbitrages between strips and underlying bonds. Arbitrageurs compare an underlying bond with a portfolio of strips that have the same future cash flows. The arbitrageur rebundles if the portfolio of strips can be purchased for a lower price than the underlying bond. Alternatively,

[3]Grinblatt and Longstaff (2000) report a $25 charge for a stripping or reconstitution order, regardless the order size. Discussions with the primary Treasury dealers indicate that it is currently free to strip or reconstitute Treasuries.

the arbitrageur strips an underlying bond if a portfolio of strips can be sold for a higher price. These arbitrages are virtually risk-free because a dealer can rapidly buy (sell) an underlying bond and sell (buy) the portfolio of strips at minimal cost.

Empirical studies generally find that arbitrage opportunities from stripping or reconstitution of Treasury bonds are fleeting and/or do not exist after the transaction costs are considered (Lim & Livingston, 1995; Jordan et al., 2000; Sack, 2000; Kung & Carverhill, 2005). Grinblatt and Longstaff (2000) find that there is, on average, no valuation difference between a portfolio of strips and a corresponding whole bond, although some cases of significant valuation differences are observed. However, monthly stripping and reconstitution activities are not driven by any observed valuation difference, suggesting that observed valuation differences do not represent real arbitrage opportunities but rather measurement errors.

Principal Strips Versus Coupon Strips

Another line of literature examines the relative pricing of principal and coupon strips. Maturity-matched principal and coupon strips offer the same future cash flows to investors. Liu and Longstaff (2004) show theoretically that principal strips can have different prices than coupon strips in equilibrium.

Daves and Ehrhardt (1993) document that principal strips typically have higher prices than coupon strips with the same maturity. They argue that the price premium on principal strips reflects the unique role of principal strips in the reconstitution of Treasuries. While coupon strips are fungible, that is, any coupon strips with the corresponding maturity dates can be used in reconstitution, principal strips derived from the underlying Treasuries must be used to reconstitute the original Treasuries. This effectively endows the principal strips with a valuable 'reconstitution option,' resulting in higher price than maturity-matched coupon strips. However, Jordan et al. (2000) document cases where principal strips consistently sell at a lower price than their maturity-matched coupon strips, inconsistent with the reconstitution option hypothesis. Instead, Jordan et al. (2000) find that the price differences between principal and coupon strips can be explained by the relative richness/cheapness, or idiosyncratic value, of the underlying Treasuries. The idiosyncratic value is estimated as the difference between the price of the underlying Treasury and its cash value based purely on the term structure of interest rates. Jordan et al. (2000) find that the higher the idiosyncratic value, or richer, the underlying Treasury, the higher price premium on its corresponding principal strips.

III. HYPOTHESES AND EMPIRICAL IMPLICATIONS

Although both Treasury notes and bonds are eligible for the STRIPS program, there is a large difference in the level of stripping between Treasury notes and bonds. For example, Jordan et al. (2000) document that, on average, only about

12% of 10-year Treasury notes in their sample are held in stripped form, but about 46% of 30-year Treasury bonds are held in stripped form. Furthermore, Grinblatt and Longstaff (2000) find that monthly stripping and reconstitution activities are much lower for 10-year Treasury notes than Treasury bonds.

While Treasury bonds, on average, are more heavily stripped than Treasury notes, there is also very large variation in the stripping of individual Treasury bonds. Though there is no study that systematically examines this issue, several hypotheses have been developed in the existing literature to explain the stripping of Treasuries. In this section, we summarize these hypotheses and elaborate on their testable empirical implications.

Interest Rate Risk Hypothesis

A common argument for stripping U.S. Treasuries is to manage the price and reinvestment risks of coupon bearing bonds due to fluctuating future interest rates (Sundaresan, 2002). By stripping Treasuries, investors can eliminate the reinvestment risks of the coupon payments. By doing so, investors can effectively lock in the prevailing interest rate on the bond until maturity. In addition, stripping Treasuries can create bonds with longer durations than those on coupon bearing bonds. For example, life insurance companies and pension funds prefer to invest in bonds with long duration to better match the duration of their long-term obligations. However, the demand for Treasuries with duration longer than 15 years cannot usually be met with coupon bearing Treasuries. Thus, Treasury strips play an important role in bond portfolio immunization strategies.

There are a few testable empirical implications for the Interest Rate Risk hypothesis. First, Treasury bonds are more likely (less likely) to be stripped under high (low) interest rate environments. When interest rates are high relative to historical average and if investors believe interest rates are mean reverting, strips are attractive because they allow investors to lock in the prevailing high interest rate until maturity.[4] Second, longer term Treasury bonds are more likely to be stripped. As longer term bonds have more coupons to reinvest and, hence, higher reinvestment risk, they are more likely to be stripped. Also, as the demand for 20-plus-year zeros can only be met by stripping of 30-year Treasuries, it follows that 30-year Treasuries are more likely to be stripped than 20-year Treasuries. Third, older Treasuries are less likely to be held in stripped form. As Treasuries approach their final maturities, the reinvestment risk decreases as there will be fewer coupons to reinvest.[5] Finally, higher coupon Treasuries will be more

[4]There is a vast literature on the mean reversion of interest rates. While some studies find evidence of mean reversion, particularly on short term interest rates, others do not (see, for example, Fama and Bliss, 1987; Wu & Zhang, 1996; Chan et al., 1992). Thus, in examining the relation between the levels of Treasury stripping and interest rates, we perform a joint test of the Interest Rate Risk hypothesis and the hypothesis that investors believe in the mean reversion of interest rates.

[5]Note that all Treasury bonds are issued as coupon-bearing securities and it takes some time for the newly issued Treasuries to be stripped. Naturally, the stripping level should increase with age in

heavily stripped than lower coupon Treasuries because of higher reinvestment risk associated with higher coupons.

Market Completion Hypothesis

Grinblatt and Longstaff (2000) propose the Market Completion hypothesis, which argues that Treasuries are stripped to create zero-coupon bonds with maturities that cannot be synthesized by alternative means. In other words, the primary function of Treasury stripping is to make the market more complete. The basic idea is that, in a perfect market with unrestricted shortselling, zero-coupon Treasuries can be created without stripping if there is no gap in the maturity structure of Treasuries. For example, investors can synthetically create an N-year zero by taking a long position in an N-year Treasury and a series of short positions in 0.5-year, 1-year, 1.5-year, . . . , (N-0.5)-year Treasuries. Thus, it is not necessary to strip the N-year or longer maturity Treasuries to create the N-year zero.[6] However, if one or more of the shorter maturity (less than N years) Treasuries is not available or shortselling is costly or impossible, this synthetic method does not work. Since there are no Treasury bonds with maturities between February 2006 and February 2015, investors cannot synthesize zeros with maturities after 2006. To create such zeros, investors must strip Treasuries with maturity dates on or after February 2015. As a result, these Treasuries are expected to be heavily stripped, partly to make the market complete.

Indeed, Grinblatt and Longstaff (2000) find that Treasuries with maturities of February 2015 or later are more likely to be stripped and less likely to be reconstituted on a monthly basis, supporting the Market Completion hypothesis. However, the Treasury bonds with maturity on or after February 2015 in Grinblatt and Longstaff's sample are all 30-year bonds, while Treasuries with maturity on or prior to February 2006 are either 10-year Treasury notes or 20-year Treasury bonds. As the Interest Rate Risk hypothesis implies that longer maturity Treasuries are more likely to be stripped, the large maturity gap between the 30-year and 20-year Treasury bonds makes it harder to unambiguously test the Market Completion hypothesis.

In this paper, we take advantage of a maturity gap in the 30-year Treasury bonds to test the Market Completion hypothesis. The U.S. Treasury suspended the 30-year Treasury bond program in 2001 when the federal government was running a budget surplus. In 2006, in the face of mounting budget deficits, the U.S. Treasury re-initiated the 30-year Treasury bond program. As a result, there is a five-year gap in the maturity between the last 30-year Treasury bond issue

the first few years of the initial issuance. Thus, the Interest Rate Risk hypothesis does not predict a monotonic relation between the age of bond and the stripping level. Instead, the hypothesis suggests that the stripping level should decrease with age several years after the initial issuance. It is an empirical question as to when the turning point occurs.

[6]Note that there is another synthetic method to create zeros by a combination of short and long positions in two Treasuries of the same maturity and coupon dates but different coupon rates. However, there are no such pairs of Treasury bonds with maturities after 2006.

in 2001 (5.375%, February 2031 issue) and the first 30-year Treasury bond issue in February 2006 (4.5%, February 2036 issue) since 2001. Due to the 5-year maturity gap, the 30-year Treasuries issued after the re-initiation of the 30-year program must be stripped to create zero-coupon Treasuries with maturities after February 2031. The Market Completion hypothesis predicts that these recently issued 30-year Treasuries should be more heavily stripped.

Tax Hypothesis

Another argument for Treasury stripping is based on the different tax treatments of zero-coupon and coupon bearing Treasuries. Livingston and Gregory (1989) show that, under rising term structures, the present value of the tax liabilities for a portfolio of strips is lower than the tax liabilities for the underlying bond, making the portfolio of strips more valuable on an after-tax basis to investors in a positive tax bracket. Because of the tax advantages of strips under a rising term structure, many taxable investors will prefer to hold strips and dealers will strip underlying bonds and sell the strips to taxable investors. We call this the Tax hypothesis.

Livingston and Gregory (1989) further demonstrate through extensive numerical examples that, under an upward sloping term structure, higher coupon Treasuries have greater tax advantages than lower coupon Treasuries, and it is more advantageous to strip longer maturity Treasuries than shorter maturity Treasuries. Given that the term structure is normally upward sloping, the Tax hypothesis implies that higher coupon and longer maturity Treasuries are more likely to be held in stripped form than lower coupon and shorter maturity Treasuries. Furthermore, Livingston and Gregory show that the relative value of strips is higher when the slope of the term structure is steeper. Thus, the Tax hypothesis further implies that Treasuries are more likely to be stripped when the term structure slope is steeper and less likely to be stripped when the term structure is inverted (downward sloping). If there is no tax effect, then we should expect there is no relationship between stripping level and yield curve slope.

In an influential study, Greene and Odegaard (1997) estimate that the marginal market-clearing tax rate for U.S. Treasury securities became zero after the 1986 tax law changes. However, this finding does not imply that investors in positive tax brackets do not consider tax effects of their investment portfolios. On the contrary, a zero tax rate for the marginal market-clearing investor creates stronger incentives for investors with higher tax rates to prefer specific securities because of their tax positions. Indeed, Greene and Odegaard state that ‘if relative prices reflect the tax status of one group of investors, others can exploit these differences in their portfolio decisions.’

Summary

Table 1 provides a summary of the empirical implications of the three Treasury stripping hypotheses. The Market Completion hypothesis has the unique

Table 1: Testable Implications of Treasury Stripping Hypotheses upon the Level of Treasury Bond Stripping

The Table summarizes the testable implications of the three Treasury stripping hypotheses on the level of Treasury bond stripping.

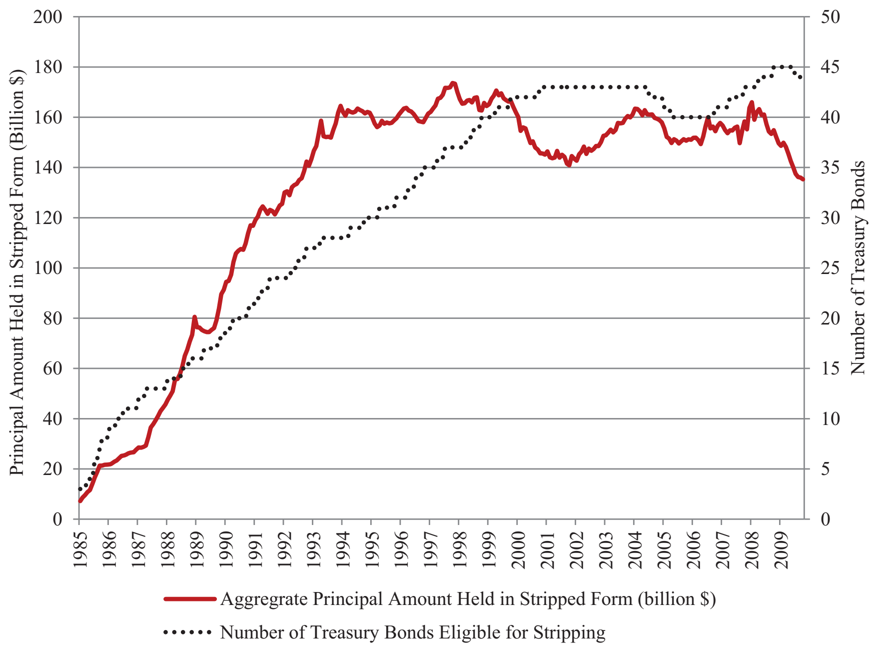
	Interest Rate Risk Hypothesis	Market Completion Hypothesis	Tax Hypothesis
Higher Coupon Rate	Increase	No Impact	Increase
Longer Maturity	Increase	No Impact	Increase
Large Maturity Gap	No Impact	Increase	No Impact
Age of Bond	Decrease*	No Impact	No Impact
Higher Interest Rate	Increase	No Impact	No Impact
Steeper Yield Curve	No Impact	No Impact	Increase

* Note that it takes some time for the newly issued Treasuries to be stripped and, naturally, the stripping level should increase with age in the first few years of the initial issuance. The Interest Rate Risk hypothesis suggests that the stripping level should decrease with age several years after the initial issuance.

empirical implication that a large gap in the Treasury bond maturity spectrum affects Treasury bond stripping. On the other hand, there is some overlap in the empirical implications of the Interest Rate Risk and Tax hypotheses. First, both hypotheses imply that there should be a positive relation between coupon rate and stripping. Second, they all suggest that longer term Treasuries are more likely to be held in stripped form. However, both have some distinct predictions that can separate each other. The Interest Rate Risk hypothesis predicts a positive impact of interest rates on the level of Treasury bond stripping and a negative relation between the age of Treasury bonds and the level of Treasury bond stripping. On the other hand, the Tax hypothesis implies that the stripping level increases with the steepness of the term structure, while the other two hypotheses do not have a similar prediction.

IV. DATA AND DESCRIPTIVE STATISTICS

Data on Treasury strips is hand collected from *The Monthly Statement of the Public Debt of the United States* (*MSPD*). The *MSPD* reports the amount of each Treasury security held in stripped form on a monthly basis. The sample covers the 25-year period from May 1985 to February 2010. Though the U.S. Treasury introduced the STRIPS program in January 1985, the *MSPD* did not start to report information on Treasury strips until May 1985. We exclude Treasury bonds that have less than 12 months of observations by the end of the sample period. Thus, all the Treasury bonds included in the sample were issued prior to March 2009. The sample contains a total of 45 30-year Treasury bonds and four 20-year Treasury bonds that are eligible for the STRIPS program. There are a few months when the



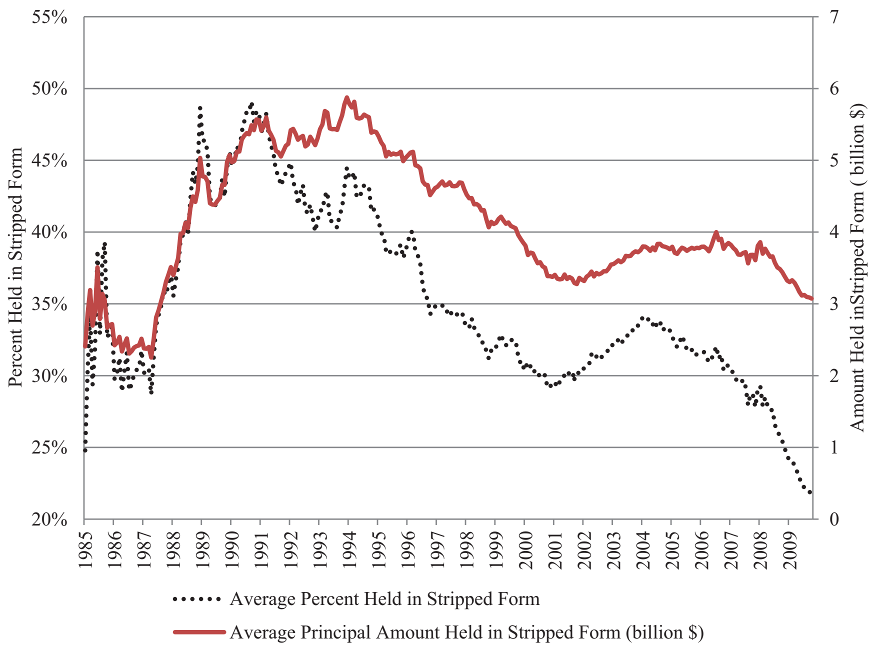
Note: The figure depicts the aggregate amount of U.S Treasury bonds, in par value, that are held in stripped form from May 1985 to February 2010. The number of Treasury bonds that are eligible for stripping is also plotted in the Figure.

Figure 3: Aggregate Stripping of U.S Treasury Bonds.

MSPD does not contain the information on Treasury strips or the information is incomplete. To fill in the gaps in some monthly observations, we take the average amount held in stripped form from the previous and the subsequent months.[7] The number of monthly observations for each Treasury bond in the sample varies from 13 to 298 with an average of 192. Thus, the sample contains a total of 9,394 bond-month observations.

Figure 3 depicts the total amount of par value of Treasury bonds held in stripped form and the number of eligible Treasury bonds over the sample period. The number of eligible Treasury bonds increased steadily from 1985 to 2001, reflecting an increasing number of Treasury bonds issued since 1985. It remained stable from 2001 to 2004 and decreased slightly from 2004 to 2006. This decrease is due to the Treasury's discontinuation of the 30-year Treasury bond program in 2001 and maturing of the 20-year Treasury bonds. The number of Treasury bonds increased again from 2006 as the U.S. Treasury re-introduced the 30-year Treasury bonds that year. While the number of eligible Treasury bonds increased until 2001, the total amount of par value of stripped Treasury bonds leveled off by 1994 and

[7]Excluding these monthly observations do not change our results.



Note: The figure depicts the monthly average of the U.S Treasury bonds held in stripped form, both the dollar amount and the percent of the total amount outstanding, from May 1985 to February 2010.

Figure 4: Average U.S Treasury Bonds Held in Stripped Form.

bounced between $140 billion and $160 billion in the last ten years, suggesting that the amount held in stripped form per Treasury bond declined since 1994.[8]

To confirm this conjecture, Figure 4 shows the monthly average dollar amount held in stripped form as well as average percent of par value held in stripped form. The average amount held in stripped form increased from about $2.5 billion in the 1980s to almost $6 billion in 1994, but has since declined steadily to about $3 billion now. The amount held in stripped form as a percent of the par value peaked at close to 50% in 1991, but has declined gradually to about 20%. The larger and quicker decline in the percent held in stripped form partially reflects the larger issue size (or par value) of newer Treasury bonds compared to the 1980s and 1990s.

The steady decline in the aggregate Treasury stripping level from early 1990 to 2000s coincides with a secular decline in the general level of interest rates in the

[8]The decline in the total amount of par value held in stripped form in 2009 and 2010 is due to the exclusion of Treasury bond issues with less than 12 months of observations by the end of the sample period. If we include these issues, the total amount held in stripped from is fairly stable at about $150 billion in 2009 and early 2010.

same period. Yields on 10-year Treasury decreased from about 10% in the early 1990s to about 3% in recent years. A plot of the average percent held in stripped form and the 10-year Treasury yields shows a high degree of correlation between Treasury bond stripping and interest rates (see Figure 1). This positive correlation between the level of Treasury bond stripping and the 10-year Treasury yields is consistent with the Interest Rate Risk hypothesis.

Table 2 lists the CUSIP numbers, issuing dates, maturity dates and coupon rates for the 49 Treasury bonds in our sample. The Table also reports the life-to-date average monthly percent of par value of each bond held in stripped form. While the sample mean of the average percent held in stripped form is about 31%, there is wide variation among different Treasury bonds. For example, the 7.25%, 2022 Treasury bond only averages 16% of its par value held in stripped form, while the 7.625%, 2022 Treasury bond has an average stripping level of 53%.

The cross-sectional differences in Treasury stripping are also obvious in Figure 2, which plots the average life-to-date monthly percent held in stripped form. The four leftmost issues are 20-year bonds while the others are 30-year bonds in order of their issue dates. The coupon rates are plotted on the right-hand axis to illustrate the relationship between coupon rate and stripping.

The more recently issued Treasury bonds, with historically low coupon rates, are not as heavily stripped as the bonds issued in the 1980s and early 1990s which carry very high coupon rates. This pattern indicates a positive correlation between Treasury bond stripping and coupon rates, consistent with both Interest Rate Risk and Tax Hypotheses.

More interestingly, Figure 2 shows that almost all bond issues with local minimum (maximum) coupon rates are very lightly (heavily) stripped, indicating that patterns of coupon rates of successive issues also have an impact on stripping. This pattern suggests that Treasuries with close maturity dates are competing candidates for stripping. When higher coupon bonds with similar maturity dates are heavily stripped, the market has an ample supply of strips of similar maturity structures, reducing the need to strip lower coupon Treasuries with adjacent maturities.

The two gaps in the x-axis of Figure 2 indicate large gaps in the maturity spectrum of the Treasury bonds. There is an 8-year maturity gap between the 20-year Treasury bond issued in January 1986 and the 30-year Treasury bond issued in November 1984. Another 5-year maturity gap lies between the two 30-year Treasury bonds issued in February 2001 and the February 2006. The first three issues of 30-year bonds issued since February 2006 are particularly noteworthy. Though the coupon rates on the three issues are significantly lower than all their predecessors, they are nonetheless actively stripped, suggesting a heavy demand for zeros created from these bonds, possibly to fill the 5-year maturity gap.

Part of the cross-sectional variation in the percent of Treasury bonds held as strips observed in Table 2 and Figure 2 might be attributed to the aging effect on stripping because the Treasury bonds differ widely in their ages at the end of the sample period. The Interest Rate Risk hypothesis suggests that Treasury bonds are more likely to be reconstituted when they are closer to their maturities.

Table 2: Average Percent of Treasury Bond Principal Held in Stripped Form

The Table reports the Life-to-Date average monthly percent held in stripped form for each Treasury bond in the sample. Also reported are the percent held in stripped form during five points in the life of each Treasury bond: 12th, 36th, 60th, 120th and 180th months.

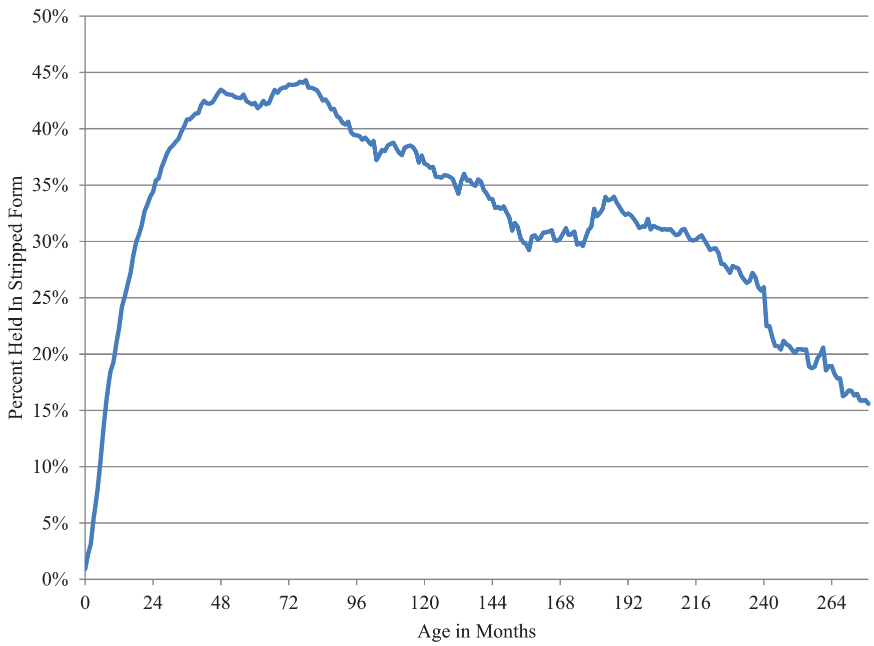
CUSIP*	Issue Date	Maturity Date	Coupon Rate	Avg.% in Stripped Form	Min.	Max.	Standard Deviation	12th Month	36th Month	60th Month	120th Month	180th Month
DM	198410	200410	11.625%	49.13%	22.36%	72.97%	11.86%	59.26%	69.32%	56.26%	34.67%	46.74%
DQ	198504	200504	12.000%	48.48%	19.48%	64.07%	11.37%	45.99%	55.56%	55.81%	34.97%	60.48%
DR	198507	200507	10.750%	21.77%	4.65%	44.87%	12.20%	7.34%	21.37%	9.11%	14.63%	41.52%
DU	198601	200601	9.375%	2.56%	0.00%	16.67%	4.47%	0.00%	0.00%	0.00%	0.06%	1.45%
DN	198411	201411	11.750%	58.11%	10.80%	78.07%	12.76%	27.95%	68.95%	51.17%	72.24%	59.11%
DP	198502	201502	11.250%	40.49%	8.52%	84.29%	26.89%	64.16%	77.04%	81.22%	51.02%	39.19%
DS	198508	201508	10.625%	39.23%	2.13%	78.12%	26.48%	41.39%	72.84%	69.71%	67.81%	31.17%
DT	198511	201511	9.875%	41.22%	0.00%	73.46%	18.17%	5.40%	50.69%	67.55%	46.10%	44.28%
DV	198602	201602	9.250%	8.73%	0.15%	36.79%	6.81%	0.84%	29.27%	6.67%	8.19%	5.71%
DW	198605	201605	7.250%	4.80%	0.00%	36.45%	5.32%	0.00%	25.20%	8.94%	1.35%	1.98%
DX	198611	201611	7.500%	11.28%	0.00%	54.94%	11.95%	19.64%	38.80%	11.50%	3.50%	7.60%
DY	198705	201705	8.750%	46.44%	0.00%	80.33%	15.77%	30.65%	60.53%	70.77%	50.16%	49.71%
DZ	198708	201708	8.875%	30.02%	0.00%	63.74%	13.14%	11.87%	35.99%	33.21%	46.62%	27.93%
EA	198805	201805	9.125%	55.82%	0.00%	83.43%	17.37%	42.05%	72.57%	74.26%	65.09%	51.33%
EB	198811	201811	9.000%	63.01%	1.63%	91.24%	17.58%	70.98%	85.63%	91.24%	77.08%	47.43%
EC	198902	201902	8.875%	52.16%	1.27%	84.05%	19.47%	53.90%	64.58%	83.77%	66.90%	45.11%
ED	198908	201908	8.125%	14.96%	0.00%	47.85%	11.97%	45.13%	34.41%	15.59%	4.36%	9.96%
EE	199002	202002	8.500%	36.17%	0.00%	70.09%	16.24%	66.03%	64.63%	51.71%	19.80%	43.97%
EF	199005	202005	8.750%	60.36%	0.00%	82.52%	13.71%	72.36%	75.92%	68.50%	64.19%	50.07%
EG	199008	202008	8.750%	54.93%	0.00%	86.01%	20.95%	64.29%	82.97%	70.45%	52.06%	48.25%
EH	199102	202102	7.875%	11.07%	0.84%	23.62%	4.12%	18.35%	13.25%	10.33%	7.36%	7.54%
EJ	199105	202105	8.125%	50.85%	0.18%	67.81%	11.97%	55.03%	61.55%	58.19%	42.82%	57.19%
EK	199108	202108	8.125%	30.13%	0.00%	72.50%	19.54%	15.79%	62.44%	64.53%	14.64%	12.69%

Continued

Table 2: Continued

CUSIP*	Issue Date	Maturity Date	Coupon Rate	Avg.% in Stripped Form	Min.	Max.	Standard Deviation	12th Month	36th Month	60th Month	120th Month	180th Month
EL	199111	202111	8.000%	57.07%	0.00%	83.57%	16.25%	29.47%	78.16%	80.02%	52.66%	55.93%
EM	199208	202208	7.250%	15.57%	0.02%	31.31%	6.29%	13.81%	31.20%	10.01%	9.36%	15.42%
EN	199211	202211	7.625%	52.75%	0.37%	74.65%	17.40%	15.34%	72.50%	73.71%	43.64%	32.75%
EP	199302	202302	7.125%	28.01%	0.00%	43.71%	10.74%	2.22%	20.83%	41.34%	33.66%	20.68%
EQ	199308	202308	6.250%	11.34%	0.00%	22.11%	6.51%	0.32%	1.55%	17.76%	12.31%	5.71%
ES	199411	202411	7.500%	56.75%	0.00%	79.07%	20.07%	26.72%	73.26%	70.07%	62.51%	20.74%
ET	199502	202502	7.625%	52.58%	0.00%	78.07%	19.69%	33.40%	77.13%	74.32%	59.05%	45.57%
EV	199508	202508	6.875%	28.52%	0.00%	54.39%	14.90%	1.87%	22.66%	37.44%	39.86%	n.a
EW	199602	202602	6.000%	6.32%	0.00%	16.01%	3.76%	1.11%	2.82%	10.87%	10.28%	n.a
EX	199608	202608	6.750%	28.35%	0.00%	55.53%	13.77%	4.28%	31.75%	29.44%	35.82%	n.a
EY	199611	202611	6.500%	42.32%	0.01%	67.07%	20.02%	0.59%	28.29%	54.96%	57.98%	n.a
EZ	199702	202702	6.625%	38.50%	0.00%	57.99%	14.84%	14.64%	43.26%	35.06%	50.23%	n.a
FA	199708	202708	6.375%	27.00%	0.00%	47.93%	14.43%	3.20%	13.09%	28.40%	44.81%	n.a
FB	199711	202711	6.125%	45.77%	0.00%	68.99%	21.95%	0.56%	25.32%	58.50%	63.08%	n.a
FE	199808	202808	5.500%	9.46%	0.00%	23.01%	6.06%	1.42%	5.36%	8.52%	13.82%	n.a
FF	199811	202811	5.250%	11.25%	0.00%	26.35%	7.50%	2.20%	4.67%	7.20%	20.67%	n.a
FG	199902	202902	5.250%	7.53%	0.00%	18.24%	4.84%	0.24%	4.04%	8.69%	10.29%	n.a
FJ	199908	202908	6.125%	19.84%	0.00%	50.14%	16.03%	0.03%	7.17%	16.46%	47.18%	n.a
FM	200005	203005	6.250%	34.67%	0.00%	68.43%	25.99%	0.07%	4.97%	43.20%	n.a	n.a
FP	200102	203102	5.375%	7.48%	0.00%	28.96%	8.53%	0.84%	1.28%	2.45%	n.a	n.a
FT	200602	203602	4.500%	32.44%	0.04%	47.04%	13.87%	39.07%	37.29%	n.a	n.a	n.a
PT	200702	203702	4.750%	25.73%	14.57%	33.66%	5.42%	28.10%	26.93%	n.a	n.a	n.a
PU	200705	203705	5.000%	29.45%	11.39%	36.22%	5.01%	33.79%	n.a	n.a	n.a	n.a
PW	200802	203802	4.375%	15.77%	0.04%	29.99%	7.01%	6.22%	n.a	n.a	n.a	n.a
PX	200805	203805	4.500%	17.48%	11.58%	32.23%	6.72%	12.66%	n.a	n.a	n.a	n.a
QA	200902	203902	3.500%	3.98%	2.29%	6.86%	1.30%	2.50%	n.a	n.a	n.a	n.a
Average				31.38%				22.31%	40.82%	42.30%	36.90%	32.91%

* The first six digits CUSIP of all Treasury bonds are 912810.



Note: The figure depicts the average percent of U.S. Treasury bonds held in stripped form by the age (in months) of the Treasury bonds for the sample period May 1985 to February 2010. The number of observations for each month is not constant because not all Treasury bonds in the sample are 279 months old. However, there are at least seven issues in each month.

Figure 5: Aging and U.S. Treasury Bond Stripping.

Figure 5 depicts the average percent held in stripped form categorized by the age of Treasury bonds (in months).[9] A newly issued Treasury bond typically experiences a significant increase in stripping in the first four years.[10] The percent held in stripped form remains fairly stable at about 40–45% of the par value from year 4 to year 6 and starts a steady decline after that. By year 20, only about 20% of the par value is held in stripped form. The steady decline in the proportion of par value held in stripped form six years after the initial issuance supports the Interest Rate Risk hypothesis. This finding extends a similar pattern observed by Jordan et al. (2000), whose sample stops at the age of 10 years.

[9]The number of Treasuries for each month is not constant because not all Treasury bonds in the sample are 279 months old. However, there are at least seven issues in each month.

[10]Note that the newly issued Treasury bonds are not heavily stripped. Two unique features of newly issued Treasuries may explain such a pattern. First, on-the-run issues usually have superior liquidity. Second, newly issued Treasury bonds are often "on special" in the repo market. These two desirable properties are lost when the newly issued Treasury bonds are stripped.

Given the impact of age on stripping level, Table 2 reports the percent held in stripped form for each Treasury bond at five points during its life: 12^{th}, 36^{th}, 60^{th}, 120^{th} and 180^{th} months. After controlling for the aging effect, there are still significant differences in the percent held in stripped form across different Treasury bonds. Indeed, Treasuries that are heavily stripped in each of the five months are also heavily stripped throughout their entire life (up to the end of the sample period).

V. EMPIRICAL FINDINGS

Figure 2 and Table 2 indicate that the percent of individual Treasury bonds held in stripped form has significant cross-sectional variation, while Figures 1, 3, 4 and 5 suggest that there is also significant intertemporal variation. We try to explain such variations through the examination of the determinants of Treasury bond stripping. The empirical findings in this section can shed some light on the different hypotheses about Treasury bond stripping.

Most variables used in the empirical investigation are self-explanatory, such as coupon rate and amount outstanding. Two sets of variables need detailed descriptions.

The first set of variables is used to test whether coupon patterns of successive issues of Treasury bonds have an impact on their stripping behavior. For each Treasury bond in the sample, we identify two other Treasury bonds that have the closest maturity dates, one prior to and another after the maturity date of the issue in interest. $\Delta CR(-1)$ is defined as the coupon rate of the issue in question minus the coupon rate of the Treasury bond with the closest shorter maturity date. Similarly, $\Delta CR(+1)$ is defined as the coupon rate of the issue in question minus the coupon rate of the Treasury bond with the closest longer maturity date.

If $\Delta CR(-1)$ is positive (negative), the Treasury bond has a higher (lower) coupon rate than its most immediate predecessor. If $\Delta CR(+1)$ is positive (negative), the Treasury bond has a higher (lower) coupon rate than its most immediate successor. Consider a set of three bonds with adjacent maturities. If both $\Delta CR(-1)$ and $\Delta CR(+1)$ are positive (negative), the bond in the middle has the highest (lowest) coupon of the three. Thus, these two variables describe the coupon rate of a particular Treasury bond relative to two others with the closest maturity dates.

Another variable that needs some explanation is Packet Size. Prior to March 2001, the U.S. Treasury required that Treasury strips must be created in multiple amounts of \$1,000.[11] Thus, the minimum number of Treasury bonds needed for stripping varies with the coupon rate. For example, an 8% Treasury bond with \$1,000 par value makes semi-annual coupon payments of \$40. It takes a multiple of 25 units of the Treasury bond to create \$1,000 par value of coupon strips. The minimum multiple of Treasuries needed to create coupon strips is called Packet

[11] From March 2001, Treasury strips can be held in amount to the penny, simplifying the STRIPS market and making Packet Size irrelevant (U.S. Treasury, 2000).

Size. The Packet Size of the Treasury bonds in the sample ranges from 25 units to 1,600 units. Large Packet Size might make stripping more difficulty because of large amount of Treasuries needed.

Univariate Analysis

Panel A of Table 3 reports the descriptive statistics for the sample of 49 Treasury bonds. The average coupon rate is 7.57% and the average amount outstanding is $13 billion. The average maturity is very close to 30 years because there are only four 20-year Treasury bonds in the sample. The average age of the Treasury bonds at the end of sample period is 192 months, or about 16 years. The average ΔCR(−1) is negative and the average ΔCR(+1) is positive because the coupon rates on the Treasury bonds generally decline over the sample period.

Next, we break the sample into two subsamples in Panel B: Heavily Stripped and Lightly Stripped subsamples, based on whether a Treasury bond's average Life-to-Date monthly percent held in stripped form is above or below the sample median. For the Heavily Stripped subsample, the average percent held as strips is about 46%, significantly higher than the 15% for the Lightly Stripped subsample by design. The average coupon rate for the Heavily Stripped subsample is 8.59%, significantly higher than the 6.52% for the Lightly Stripped subsample, indicating coupon rate has a significant impact on stripping. Interestingly, the two difference-in-coupon variables (ΔCR(+1) and ΔCR(−1)) are all positive for the Heavily Stripped subsample and all negative for the Lightly Stripped subsample. Furthermore, the difference between the two subsamples is statistically significant for ΔCR(−1). This pattern shows that the heavily (lightly) stripped Treasury bonds tend to have coupon rates higher (lower) than other Treasury bonds of the nearest maturity dates, indicating that coupon patterns for bonds of close maturity dates have an impact on stripping, in addition to the Treasury bond's own coupon rate.

The average Age of the Heavily Stripped subsample is 222 months, significantly higher than the average Age of the Lightly Stripped subsample (160 months). This seems inconsistent with the negative relation between age (after year six) and the percent held in stripped form as observed in Figure 5. This seemingly contradictory finding can be explained by the strong correlation between the Age of the Treasury bonds and their coupon rates. Younger Treasury bonds in the sample were issued during a lower interest rate environment in the late 1990s and 2000s and carry lower coupon rates. Thus, it is more appropriate to examine the impact of Age on the Treasury stripping level in multivariate regression models where coupon rates are controlled. The Maturity, Packet Size, and the Amount Outstanding are not statistically different at the 1% or 5% level between the two subsamples.

To isolate the aging effect on Treasury stripping, a sample of 45 Treasury bonds that have at least 36 months of observations is examined. This sample is divided into Heavily Stripped and Lightly Stripped subsamples, based on the sample median 36^{th}-month percent held in stripped form. The descriptive statistics are reported in Panel C of Table 3. Almost identical patterns as those in Panel B

Table 3: Descriptive Statistics

The Table reports the descriptive statistics of the 49 Treasury bonds in the sample. $\Delta CR(-1)$ is defined as the coupon rate of the issue in question minus the coupon rate of the Treasury bond that has the closest prior maturity date. Similarly, $\Delta CR(+1)$ is defined as the coupon rate of the issue in question minus the coupon rate of the Treasury bond that has the closest subsequent maturity date. Panel A reports the descriptive statistics for the whole sample. Panel B breaks the sample into two subsamples: Heavily Stripped and Lightly Stripped, based on the sample median Life-to-Date percent held in stripped form. Panel C breaks the sample into two subsamples: Heavily Stripped and Lightly Stripped, based on the sample median 36th month percent held in stripped form. The numbers in the parentheses are the numbers of Treasury bonds.

	Panel A Whole Sample	Panel B Subsamples Based on Sample Median Life-to-Date% Held in Stripped Form		Panel C Subsamples Based on Sample Median 36th Month% Held in Stripped Form	
	All T-Bonds	Heavily Stripped	Lightly Stripped	Heavily Stripped	Lightly Stripped
% in Stripped Form (Life-to-Date)	31.38% (49)	46.78% (25)	15.34% (24)***	46.00% (23)	18.77% (22)***
% in Stripped Form (36th Month)	40.82% (45)	60.06% (25)	16.78% (20)***	64.42% (23)	16.16% (22)***
Coupon Rate	7.57% (49)	8.59% (25)	6.52% (24)***	8.84% (23)	6.84% (22)***
Amount Outstanding (in billion $)	$13.025 (49)	$11.517 (25)	$14.596 (24)*	$11.164 (23)	$13.004 (22)
Age (in months)	192 (49)	222 (25)	160 (24)***	235 (23)	177 (22)***
Maturity	29.18 (49)	29.20 (25)	29.17 (24)	29.13 (23)	29.09 (22)
Packet Size	720 (49)	735 (25)	703 (24)	715 (23)	803 (22)
$\Delta CR(-1)$	−0.17% (48)	0.15% (24)	−0.49% (24)***	0.19% (22)	−0.51% (22)***
$\Delta CR(+1)$	0.15% (49)	0.32% (25)	−0.03% (24)	0.23% (23)	0.06% (22)

***,**,* indicate the variable means for the Lightly Stripped subsample is significantly different from the variable means for the Heavily Stripped subsample at the 1%, 5% or 10% level.

are observed. The Heavily (Lightly) Stripped subsample has significantly higher (lower) coupon rates and the coupon rates tend to be higher (lower) than other Treasuries of adjacent maturity dates. Most other variables are not statistically different between the two subsamples.

Time-Series, Cross-Sectional Panel Regression Analysis

Given the panel data, we use time-series, cross-sectional regression models to examine both the intertemporal and cross-sectional variations of stripping in this section. Since this methodology is well established in the literature, we do not dwell on its technical details. Baltagi (2005) and Wooldridge (2002) provide details on this methodology.[12]

The dependent variable is the monthly percent of par value held in stripped form, or $\text{STRIP}_{i,t}$. The explanatory variables include both the time-series and cross-sectional variables. The regression model is as follows:

$$\begin{aligned}\text{STRIP}_{i,t} = {} & \alpha + \beta_1{}^{*}\ \text{Age}_{i,t} + \beta_2{}^{*}\ \text{Age Squared}_{i,t} + \beta_3{}^{*}\ \text{T-10 Yield}_t \\ & + \beta_4{}^{*}\ \text{Yield Curve Slope}_t + \beta_5{}^{*}\ \text{Vol.T-10 Yield}_t + \beta_6{}^{*}\ \text{Change T-10} \\ & \text{Yield}_t + \beta_7{}^{*}\ \text{On-the-run Dummy}_{i,t} + \beta_8{}^{*}\ \text{20-year T-bond Dummy}_i \\ & + \beta_9{}^{*}\ \text{Market Completion Dummy}_i + \beta_{10}{}^{*}\ \text{Coupon Rate}_i \\ & + \beta_{11}{}^{*}\ \text{Packet Size}_i + \beta_{12}{}^{*}\ \text{Amount Outstanding}_i \\ & + \beta_{13}{}^{*}\ \text{1980s Dummy}_i + \beta_{14}{}^{*}\ \text{1990s Dummy}_i \\ & + \sum_{k=1}^{2} \gamma_k^{*}\text{Coupon Pattern Variable}_{k,i} \end{aligned} \tag{1}$$

We briefly lay out the time-series and cross-sectional explanatory variables and their expected coefficients in the next two subsections.

Time-Series Explanatory Variables

Two hypotheses have clear predictions about the intertemporal variations of the treasury stripping levels. First, the Interest Rate Risk hypothesis predicts a positive relation between the level of Treasury stripping and the level of interest rates. The idea is that strips allow investors to lock in historically high interest rates, making it more attractive. On the other hand, when interest rates are very low, investors prefer not to lock in the prevailing low interest rate, lowering the demand for Treasury strips. To test this, we use the average daily yields on 10-year Treasuries (T-10 Yield) for the observation month as a proxy for the level of general interest rates. Second, as discussed earlier, the Interest Rate Risk hypothesis suggests

[12]We use the *xtreg* procedure in *Stata* to run the time-series, cross-sectional regression models. See StataCorp (2009) for details of this procedure.

that the level of stripping should decrease and net reconstitution should occur as Treasury bonds approach maturity. However, this relation cannot be linear because stripping naturally increases in the first few years after bond issuance. Thus, we create two explanatory variables: Age and Age Squared. Age is defined as the number of months since the initial issuance at the observation month. These two variables are designed to capture the non-linear relation between age and percent held in stripped form as observed in Figure 5. The two age variables are also intended to test the Interest Rate Risk hypothesis.

Finally, the Tax hypothesis predicts that the steepness of the yield curve has an impact on the stripping of Treasury bonds. To test this, we create a variable, Yield Curve Slope, which equals the difference between the average yields of the 10-year Treasury note and the 1-year T-bill for the observation month.

In addition, we conjecture that changes in the interest rate environment over time affect the level of stripping. Because the Interest Rate Risk hypothesis suggests that Treasuries are stripped to manage the risks due to fluctuating interest rates, it is quite plausible that the percent held as strips fluctuates in response to the variability of the interest rate environment. To capture the effect of variability of the interest rate environment, we construct the following two explanatory variables. First, we use the standard deviation of the daily 10-year Treasury yield of the observation month, or Vol. in T-10 Yield, as a proxy for interest rate volatility. Second, we construct a variable, Change T-10 Yield, to capture the month-to-month changes in the general interest rate. It is defined as the difference between the T-10 Yield of the observation month and that of the previous month.

Another time-series explanatory variable is the on-the-run dummy variable. Newly issued, or on-the-run, Treasuries enjoy high liquidity in the secondary market and, as a result, are often ‘on-special’ in the repo market and their prices command a liquidity premium. These desirable properties are lost when on-the-run Treasuries are stripped into generic coupon strips. Consequently, on-the-run Treasuries are less likely to be stripped. We designate a Treasury bond as on-the-run for the months between its initial issue date and the month a newer, same-maturity Treasury bond is issued. Depending on the Treasury bond issuing cycle, a Treasury bond can be defined as on-the-run for as short as three months and as long as one year.[13]

Cross-Sectional Explanatory Variables

The 20-year T-bond Dummy equals one for 20-year Treasury bonds and zero for 30-year Treasury bonds. This dummy variable is intended to capture the effect of maturity on the stripping of Treasuries and it is expected to have a negative coefficient under both the Interest Rate Risk and Tax hypotheses which predict heavier stripping for longer term bonds. Note, however, there is an

[13]There is no other issue of 20-year Treasury bond after the 9.375% January 2006 issue. Also, for the 5.375% February 2031 30-year Treasury bond, the next 30-year Treasury bond is not issued until 5 years later. Thus, for these two issues, we designate them to be on-the-run for the first 12 months of their lives.

8-year gap between the maturities of the longest-maturity dated 20-year Treasury bond (February 2006) and the earliest-maturity dated 30-year Treasury bond. Thus, stripping of the 30-year Treasury bonds is the only method to create zero-coupon bonds with maturities after February 2006. The 20-year T-Bond Dummy might also capture the market completion effect, and consequently, we expect the coefficient on the dummy variable to be negative under the Market Completion hypothesis as well.

Since the U.S. Treasury did not issue 30-year Treasury bonds between March 2001 and January 2006, there is a 5-year maturity gap (from February 2031 to February 2036). According to the Market Completion hypothesis, market participants must strip the Treasuries issued after January 2006 to create zero-coupon bonds to fill in this maturity gap. In order to measure the influence of the maturity gap from February 2031 to February 2036, we create a dummy variable called the Market Completion Dummy with a value of one for Treasury bonds issued on or after February 2006 and zero otherwise. If these Treasuries are more heavily stripped, the coefficient on the Market Completion Dummy will be positive, meaning that the maturity gap has a significant impact on the proportion of individual Treasury bonds held in stripped form.

The Coupon Rate is expected to have a positive coefficient under all hypotheses except the Market Completion Hypothesis. In addition, as the univariate analysis indicates, patterns of coupon rates of successive issues of Treasuries also have an impact on the stripping level. We use two indicator variables, based on the variables $\Delta CR(-1)$ and $\Delta CR(+1)$, to capture the coupon pattern of successive Treasury issues. Sign($\Delta CR(-1)$) equals -1 ($+1$) if $\Delta CR(-1)$ is negative (positive), or the coupon rate of the issue is less (greater) than the coupon rate of the Treasury bond that has the closest prior maturity date, 0 otherwise. Similarly, Sign($\Delta CR(+1)$) equals -1 ($+1$) if $\Delta CR(+1)$ is negative (positive), or the coupon rate of the issue is less (greater) than the coupon rate of the Treasury bond that has the closest subsequent maturity date, 0 otherwise.

In addition to these variables, we also include four control variables. The first control variable is the Amount Outstanding. It might be easier to strip Treasury bonds with large amounts outstanding because they are more readily available. Furthermore, stripping of Treasury bonds of large size is less likely to have a price impact than stripping of Treasury bonds with smaller amounts outstanding. The second control variable is the Packet Size and is expected to have a negative coefficient because larger packet size requires a larger number of Treasury bonds for stripping, making it relatively harder to do.

The other two control variables are the 1980s Dummy and 1990s Dummy, equal to one for bonds issued in the 1980s and 1990s respectively, and zero otherwise. The base case is bonds issued in the 2000s. We include these two decade dummies to control for the possible path-dependence of Treasury bond stripping. It might be the case that the Treasuries issued in the earlier years are more heavily stripped because there were relatively fewer eligible Treasuries for stripping then, and once stripped, they tend to remain in stripped form.

Panel Regression Results

Columns A of Table 4 reports the regression results for the whole sample.[14] The sample only contains a very small number of 20-year Treasury bonds. In addition, the 20-year bonds are all issued in the mid-1980s and carry high coupon rates. To avoid potential interaction between coupon rates and maturity, we exclude 20-year Treasury bonds in all other regression models in Table 4.[15]

Times Series Variables. The coefficient on T-10 Yield is consistently positive and significant, implying that the percent held as strips is higher when the general interest rate is high. The coefficient on the T-10 Yield is about 2, indicating that the drop in the 10-year Treasury yields from approximately 10% in the 1980s down to 3% in recent years resulted in a drop of approximately 14% (7 times 2) in the level of Treasury bond stripping. This pattern is consistent with the Interest Rate Risk Hypothesis. In the 1980s, many investors preferred to hold strips to lock in the historically high interest rates and avoid reinvestment risk. In the 2000s, it is less desirable to lock in the historically low rates by holding strips. The pattern of heavy (light) stripping of Treasury bonds when interest rates appear high (low) relative to historical averages is consistent with many investors believing that interest rates are mean reverting.

The coefficient on the Yield Curve Slope is positive and significant in all model specifications, suggesting that a steeper yield curve induces more stripping of Treasury bonds. This finding supports the Tax hypothesis. The Tax hypothesis further suggests that level of Treasury bond stripping should decrease when the yield curve is inverted. To test this, we replace the Yield Curve Slope variable with two dummy variables: Inverted Slope Dummy and Flat Slope Dummy. The Inverted Slope Dummy equals one if the Yield Curve Slope is less than -0.3% and zero otherwise. The Flat Slope Dummy equals one if the Yield Curve Slope is between -0.3% and 0.3%, zero otherwise.[16] Column C of Table 4 reports the results for this regression specification. The coefficient on the Inverted Slope dummy variable is significantly negative, suggesting that the proportion of bonds held as strips is lower when the yield curve is significantly inverted compared to an upward sloping yield curve. This finding supports the Tax hypothesis. The

[14]The whole sample includes 8,866 bond-month observations for 47 Treasury bonds. The regression sample excludes the Treasury bond with the earliest maturity date (the 11.625%, Nov. 2004 issue) because the Sign(ΔCR(-1)) variable is not defined for this issue. In addition, the regression sample also excludes one callable thirty-year Treasury bond (the 11.75%, November 2014 issue). Due to the uncertainty of the cash flows, this Treasury bond is stripped differently from other Treasuries. Inclusion of this callable bond in the regression, however, does not change our results significantly.

[15]Inclusion of the 20-year bonds in the sample, however, does not materially change the empirical results.

[16]The Inverted Slope Dummy equals one for about 4% of bond-month observations and the Flat Slope Dummy equals one for about 19% of the sample. While the choices of the cutoff points for the two dummy variables are somewhat arbitrary, they roughly correspond to the 5^{th} and 25^{th} percentiles of the sample. If we use the 5^{th} and 25^{th} percentiles as the cutoff points, the results are qualitatively the same.

Table 4: Treasury Bond Stripping: Time-Series, Cross-Sectional Regressions

The Table reports the results of the time-series, cross-sectional regression analysis of monthly percent of individual bonds held in stripped form. The dependent variable is the monthly percent of par value held in stripped form for each Treasury bond from May 1985 to Feb. 2010. Column A reports the results of the full sample. Results in Columns B to D are based on the subsample of thirty-year bond issues. Column D further limits the sample to monthly observations when the yield curve is upward sloping. Age is the number of months since the initial issuance as of the observation month. T-10 Yield is the average daily yield on the 10-year Treasury for the observation month. Vol. T-10 Yield is the standard deviation of the daily 10-year Treasury yield for the observation month. Change T-10 Yield is the difference between the T-10 Yield of the observation month and the previous month. Yield Curve Slope is the difference between the T-10 Yield and the average one-year Treasury yield of the observation month. Inverted Slope Dummy equals 1 if Yield Curve Slope $< -0.3\%$, and 0 otherwise. Flat Slope Dummy equals 1 if Yield Curve Slope $< 0.3\%$ but $> -0.3\%$, and 0 otherwise. On-the-run Dummy equals 1 for observation months when a particular Treasury bond is the most recent issue and 0 otherwise. The 20-year T-Bond Dummy equals 1 for 20-year Treasuries and 0 for 30-year Treasuries. The Market Completion Dummy equals 1 for Treasury bonds issued on or after February 2006 and 0 otherwise. Coupon Rate is the annual coupon rate in percent. Amount Outstanding is the total par value of each Treasury bond in billions of dollar. Packet Size is the minimum multiple of Treasuries needed to create coupon strips with $1,000 par value. Sign($\Delta$CR($-1$)) equals -1 ($+1$) if the coupon rate of the issue is less (greater) than the coupon rate of the Treasury bond that has the closest prior maturity date, 0 otherwise. Sign(ΔCR($+1$)) equals -1 ($+1$) if the coupon rate of the issue in question is less (greater) than the coupon rate of the Treasury bond that has the closest subsequent maturity date, 0 otherwise. The 1980s Dummy (1990s Dummy) equals 1 for Treasury bonds issued in the 1980s (1990s) and 0 otherwise. The base case is Treasury bonds issued in the 2000s. 5–10 Year Old (10–15 Year Old) dummy equals to 1 for observation month when the Treasury bond is between 5 to 10 years old (10–15 years old), and 0 otherwise. 20+ Year Old dummy equals to 1 for observation month when the Treasury bond is more than 20 years old, and 0 otherwise. The base case is observation month when the Treasury bond is less than 5 years old. The statistical significance is based on the Huber White Sandwich estimator of variance which is robust to cross-sectional heteroscedasticity and within-panel (serial) correlation (Wooldridge, 2002, Rogers, 1993).

	Column A Full Sample	Column B Thirty-year Bond Sample	Column C Thirty-year Bond Sample	Column D Normal Yield Curve Subsample	Column E Thirty-year Bond Sample
Intercept	-70.589^{***}	-74.738^{***}	-70.927^{***}	-77.407^{***}	-71.693^{***}
Age (in month)	0.194^{***}	0.214^{***}	0.199^{***}	0.205^{***}	

Continued

Table 4: Continued

	Column A Full Sample	Column B Thirty-year Bond Sample	Column C Thirty-year Bond Sample	Column D Normal Yield Curve Subsample	Column E Thirty-year Bond Sample
Age Squared	−0.001***	−0.001***	−0.001***	−0.001***	
Less than 5 Year Old					2.514
5–10 Year Old					11.352***
15–20 Year Old					−5.447***
20+ Year Old					−12.664***
T-10 Yield	1.979*	2.580**	1.931**	2.309**	1.916**
Yield Curve Slope	0.977*	1.236**		1.424**	0.959*
Inverted Slope			−2.311**		
Flat Slope			−1.005		
Vol. T-10 Yield	−3.054	−1.301	2.444	0.426	−0.991
Change T-10 Yield	−0.580	−0.915	−0.251	−1.394*	−0.581
On-the-run	−24.952***	−25.933***	−26.216***	−26.125***	−29.751***
20-year T-Bond	−26.791***				
Market Completion	23.791***	24.057***	23.734***	24.352***	23.743***
Coupon Rate	9.243***	9.190***	9.460***	9.571***	9.760***
Sign (ΔCR(-1))	11.923***	11.736***	11.695***	11.480***	11.871***
Sign (ΔCR(+1))	8.764**	8.935**	8.753*	8.963**	8.656**
Packet Size	0.000	0.000	0.000	0.001	0.000
Amount Outstanding	0.556	0.576	0.592	0.591	0.640
1980s Dummy	−9.635	−9.957	−9.419	−8.688	−8.732
1990s Dummy	5.419	5.209	5.338	6.548	7.107
No. of Obs.	8,866	8,164	8,164	7,201	8,164

***,**, * indicate the coefficient is statistically significant at the 1%, 5% or 10% level.

coefficient on the Flat Slope Dummy is negative, but not significant. This raises the concern that the significantly positive coefficient on the Yield Curve Slope in Column B is driven by the observations with severely inverted yield curves. To check if the positive relation between the yield curve slope and stripping holds for upward sloping yield curves, we re-run the Column B regression on a subsample of observations with upward sloping yield curves. Column D of Table 4 reports the results. The coefficient on the Yield Curve Slope is still positive and significant at the 5% level for the upward sloping yield curve subsample, indicating that the finding of a positive relation between yield curve slope and the percent of bonds held as strips is not solely driven by the inverted yield curve observations.

In all regression specifications, the coefficient on Age is significantly positive and the coefficient on Age Squared is significantly negative. This finding indicates that the percent of individual bonds held in stripped form increases until the bond is about 100 months-old (or 8-years old) and then decreases with age.[17] This pattern confirms the non-linear relation between stripping and age of Treasury bonds as evidenced in Figure 5, though the estimated turning-point is slightly longer than the 6-year turning-point in Figure 5. The decrease in stripping level as Treasury bonds approach maturity is consistent with the Interest Rate Risk hypothesis.

The coefficients on the interest rate volatility and interest rate change variables are not statistically significant. The coefficient on the On-the-run Dummy is about −25 and highly significant, indicating that on-the-run Treasuries are often not stripped.

Cross Sectional Variables. With regard to the cross-sectional explanatory variables, we have the following findings. First, the coefficient on the 20-year T-Bond Dummy is significantly negative as reported in Column A, indicating that 20-year Treasury bonds are less heavily stripped than 30-year Treasury bonds. Second, the coefficient on the Market Completion Dummy is significantly positive as well in all model specifications, indicating that Treasuries issued after the re-initiation of the 30-year Treasury bond program in 2006 are more heavily stripped. Third, the coefficient on Coupon Rate is significantly positive in all models, suggesting that higher coupon rate leads to heavier stripping. A 1% difference in coupon rate leads to a difference of 9% in the stripping level. With regard to coupon patterns, the coefficients on the coupon pattern indicator variables, Sign(ΔCR(−1)) and Sign(ΔCR(+1)), are both positive and significant. This finding indicates that Treasury bonds with higher coupon rates than their immediate predecessor and/or successor are more likely to be held in stripped form.[18]

[17]The inflection point can be estimated by dividing the coefficient on Age by two times the coefficient on Age Squared, because the first derivative of the function ax^2+bx+c changes sign at $x = -b/2a$.

[18]We have used a different specification with one categorical variable, Peak_Trough, to proxy for the coupon pattern. The variable is set to −1 (+1) if both ΔCR(-1) and ΔCR(+1) are negative (positive), and 0 otherwise. The coefficient on this variable is significantly positive, suggesting that a Treasury bond with coupon rate higher than its immediate adjacent issues is more heavily stripped. For the sake of brevity, we do not report these results, but they are available upon request.

Finally, the coefficient on Amount Outstanding is insignificant.[19] The coefficient on Packet Size is effectively zero and insignificant, implying that packet size is not a binding constraint on Treasury bond stripping. The coefficients on the two decade dummies are not significant, showing that the percent held as strips does not depend on the time of issuance.[20]

Overall, the empirical results provide support for all three hypotheses on Treasury bond stripping.

Robustness Checks

Our analysis of stripping level determinants does not consider the price differentials of Treasury bonds and their corresponding strips. Potential arbitrage opportunities between the two markets might affect the stripping levels of individual Treasuries. However, existing literature indicates that the two markets are highly integrated and the potential arbitrage opportunities are, according to Jordan et al. (2000), 'fleeting and rarely economically significant.' Furthermore, Grinblatt and Longstaff (2000) find that the monthly stripping and reconstitution activities are not related to any observed valuation differentials, suggesting that investors do not strip or reconstitute Treasury bonds to take advantage of potential arbitrage opportunities. As a result, we do not consider potential arbitrage in our analysis.

A related concern is the potential impact of the idiosyncratic value of Treasury bonds on stripping level. Idiosyncratic value is often defined as the difference between the price of a Treasury bond and its cash flow value, or the present value of its future cash flows based on the term structure[21,22] Merrick (2005) observes that Treasury bonds with higher idiosyncratic values are less stripped. When a Treasury bond with higher idiosyncratic value is stripped, its principal strips are priced higher than maturity-matched fungible coupon strips (Jordan et al., 2000). Assuming investors in strips do not value coupon and principal strips differently, Merrick argues that dealers would prefer not to strip bonds with higher idiosyncratic value because it will be harder to sell higher-priced principal strips.

While intuitive, this argument ignores the fact that Treasury bond idiosyncratic value is not exogenous. For example, Jordan et al. (1998) argues that differential tax treatment of strips and whole bonds creates a wedge between price of a whole bond and its cash flow value, or the idiosyncratic value. They find that the idiosyncratic value due to the tax effect is larger for discount bonds. The bond price

[19]As a robustness check, we have also adjusted the Amount Outstanding variable for inflation and the results are essentially the same.

[20]We do not report R-Squared in Table 4 because there is no equivalent measure of goodness-of-fit in time-series, cross-sectional regression models as the traditional R-Squared in OLS model. The R-Squared reported in some statistics packages is not comparable or consistent with the R-Squared measure in OLS (StataCorp, 2009).

[21]Two methods have been used to estimate the cash flow value. Jordan et al. (2000) use the cubic spline method to estimate the cash flow value. Other studies use the prices of the generic coupon strips to estimate the cash flow value (see, for example, Kuiper, 2008, Lamoureux and Theocharides, 2012).

[22]Different terms have been used to reference the idiosyncratic value. Jordan et al. (200) use the term 'richness.' Kuipers (2008) refers it as 'relative value' while Lamoureux and Theocharides (2012) call it 'coupon spread.'

discount, in term, is determined by its coupon rate, prevailing market interest rates and time to maturity. Other studies find that the idiosyncratic value is attributable to the delivery option of Treasury bonds against Futures contracts, particularly to the 'cheapest-to-deliver' status of some Treasury bonds (Kuipers, 2008, and Lamoureux and Theocharides, 2012). Again, the cheapness-to-deliver, in term, depends on the bond coupon rate, maturity, and the interest rate environment (see, for example, Hegde, 1988, Kane and Marcus, 1984, and Livingston, 1987).[23]

Thus, the idiosyncratic value is not exogenous but rather a function of the characteristics of the underlying bonds and the interest rate environment. Indeed, using the data on the 32 Treasury bonds in Merrick's study, we find that about 75% of the variation of the idiosyncratic values can be explained by three variables: Age, Age Squared and Coupon Rate. In addition, the explanatory power of the idiosyncratic value on stripping level disappears after controlling for the bond characteristics variables (Age, Age Squared, and other cross-sectional variables used in Table 4).

Furthermore, directly testing the impact of idiosyncratic value on stripping level requires high quality pricing data on Treasury strips, which is hard to obtain, particularly for the earlier years of the sample (see Jordan et al., 2000 and Grinblatt and Longstaff, 2000 for a discussion on the quality of strips pricing data). That being said, we nevertheless look further into the issue indirectly by examining the impact of Treasury bond deliverability on Treasury stripping as a robustness check.[24]

The 30-year Treasury Bond Futures Contract allows the delivery of Treasury bonds with at least 15 years remaining until maturity as of the delivery date. Thus, all 30-year Treasury bonds have a delivery option in the first 15 years of their lives, and the option expires after that. The delivery options endow deliverable Treasury bonds with some idiosyncratic value, which shall decrease upon the expiration of the option. Indeed, Kuipers (2008) finds that the idiosyncratic value of 30-year Treasury bonds drop by 6.4 cents per $100 par when they lose their delivery option. Similarly, Lamourreux and Theocharides (2012) find that the deliverable 10-year Treasury notes against 10-year Treasury notes Futures contracts enjoy an idiosyncratic value of 34 cents per $100 par, while undeliverable 10-year Treasury notes do not have any idiosyncratic value.

Thus, if idiosyncratic value of Treasury bonds affects Treasury stripping, we would expect that the stripping level increases after a Treasury bond becomes ineligible for delivery due to its lack of or reduced idiosyncratic value. To test this, we estimate a modified version of equation 1 model on 30-year Treasury bonds. We replace the Age and Age Squared variables by five age dummy variables: Less

[23] Another driver of idiosyncratic value is the specialness in the repo market of the on-the-run Treasury bonds. We control for this factor in the earlier analysis.

[24] An alternative is to examine the stripping level of the 'cheapest to deliver' Treasury bonds since the idiosyncratic value is likely to be higher for such bonds. However, it is hard to track the 'cheapest to deliver' Treasury bonds because they may change over time. Further, cheapest to deliver bonds and stripping levels may be jointly determined by some common factors, such as coupon rates, ages, and interest rates. Thus, we do not examine the stripping levels of cheapest to deliver bonds.

than 5 Year Old, 5–10 Year Old, 10–15 Year Old, 15–20 Year Old and 20+ Year Old, and use the 10–15 Year Old Treasury bonds as the base case. If Treasury bond deliverability affects the stripping level, we would expect that the stripping level should increase once the Treasury loses its delivery option, or when the Treasury has less than 15 years to maturity. In other words, we should expect the coefficient on the 15–20 Year Old dummy to be significantly positive. Column E of Table 4 reports the regression results. The coefficient on the Less than 5 Year Old dummy is not significant, indicating the stripping levels of younger Treasuries are similar to those 10–15 year old ones. On the other hand, the coefficient on the 5–10 Year Old dummy is significantly positive, suggesting that 5–10 year old Treasuries are more heavily stripped than both their younger counterparts and the 10–15 year old Treasuries. This confirms the earlier finding of the non-linear relation between stripping and age of Treasuries. Most interestingly, the coefficient on the 15–20 Year Old dummy is significantly negative, showing that non-deliverable Treasuries are actually less stripped than deliverable, 10–15 year old counterparts. This finding is inconsistent with the conjecture that the Treasury bond deliverability has a major impact on Treasury stripping.

As a further robustness check, we examine a 24-month window around the expiration of the delivery option. We identify 23 30-year Treasury bonds that have at least 192 monthly observations (or at least 16 years old at the end of the sample period) and calculate their average stripping levels shortly before and after the expiration of the delivery option. We exclude the eight monthly observations (from month 176 to month 184) because the delivery option might expire a few months before the bond turns exactly 15-year old and it may take a few months for the stripping level to build up after the option expiration.[25] Thus, we calculate the average stripping levels for the 23 Treasury bonds from months 168 to 175 (or shortly prior to delivery option expiration) and the average stripping levels from months 185 to 192 (or shortly after the option expiration). If the delivery option affects the stripping level, we expect to observe an increase in stripping level after the option expiration. The evidence does not support the conjecture. The average stripping level between months 168 and 175 is 30.65%, and the average stripping level between months 185 and 192 is 30.96%. The difference is not statistically significant.

VI. CONCLUSION

We document wide cross-sectional and intertemporal variation in the level of individual U.S. Treasury bonds held as strips. To explain such variation, we examine the determinants of Treasury bond stripping, using almost the entire history of the U.S. Treasury STRIPS program from May 1985 to February 2010. Our empirical findings shed light on the three major hypotheses of the Treasury bond stripping. First, when interest rates were high in the 1980s and 1990s, a large

[25]Inclusion of the eight monthly observations, however, yields qualitatively same result.

proportion of Treasury bonds were held in stripped form because many investors preferred to avoid reinvestment risk and lock in historically high interest rates. Second, we find that Treasuries with higher coupon rates and longer maturities are more heavily stripped, consistent with both Interest Rate Risk and Tax hypotheses. In addition, we find that the patterns of coupon rates of successive issues of Treasury have a significant impact on stripping. Stripping is higher for bonds with high coupons relative to adjacent maturity bonds. Third, we find that Treasuries issued after the re-initiation of the 30-year program in 2006 are more heavily stripped, as predicted by the Market Completion hypothesis. Fourth, as Treasury bonds approach maturity, the percent held in stripped form decreases, confirming the Interest Rate Risk hypothesis. Finally, stripping level decreases when the yield curve is inverted and increases with the steepness of the yield curve, providing support for the Tax hypothesis. Overall, the empirical findings offer some support to all three hypotheses, suggesting that Treasury stripping is not driven by only one consideration, but by several factors.

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VIII. Notes on Contributors/Acknowledgments

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