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History is repeating itself: Get ready for a long dry spell

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Abstract: The recent disappearance of a five-year-maturity gap from the set of Treasury bonds deliverable into the Chicago Board of Trade Treasury bond futures has resulted in a distinctive configuration, where a single T-Bond (the $4\frac{1}{2}\%$ of 2036) remains positioned at the top of the deliverable basket for a five-year period. This situation would have been inconsequential if three other conditions were not simultaneously present, ensuring that this single bond will most probably be the cheapest-to-deliver during the next five years. In this paper, we show that a similar alignment of conditions happened in 1994–1999, during the "long dry spell of the $11\frac{1}{4}\%$." We recall the detrimental repercussions of this dry spell on the bond markets, and we suggest some possible steps that could be taken to remedy the current situation.

Key Words: Futures, treasury bonds, short squeeze, cheapest-to-deliver, yield curve.

Résumé : La disparition récente d'un écart de cinq ans dans les échéances du panier d'obligations du Trésor faisant l'objet du contrat à terme du Chicago Board of Trade a donné lieu à une configuration particulière, où la même obligation ($4\frac{1}{2}\%$ échéant en 2036) demeurera située dans le haut du panier au cours des cinq prochaines années. Cette situation n'aurait pas été préoccupante si trois autres conditions ne s'étaient pas réalisées simultanément, impliquant que cette obligation demeurera vraisemblablement l'unique moins chère à livrer au cours de cette période.

Dans cet article, nous montrons qu'une situation semblable s'est produite entre 1994 et 1999, une époque qu'on a appelée la "longue période de sécheresse de la $11\frac{1}{4}\%$". Nous rappelons les répercussions néfastes de cette situation sur les marchés obligataires, et nous proposons quelques mesures qui pourraient être prises pour remédier à la situation actuelle.

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1 Introduction

The CBOT Treasury Bond Futures is the world's most actively traded futures contract, used extensively to hedge long-term interest-rate risk. This contract calls for the delivery of $100,000 of a long-term governmental bond. The notional underlying security is presently a T-Bond with a maturity of 20 years and a coupon rate of 6%. Since the notional bond is hypothetical and generally not traded in the marketplace, the CBOT offers the short trader the option to choose which issue to deliver among a set of deliverable bonds (the *delivery basket*). The CBOT uses a system of conversion factors to adjust for the quality of all the deliverable grades with respect to the hypothetical reference bond. Due to the imperfection of the conversion factor system, which is based on bond characteristics and does not account for changes in the yield curve, all eligible grades are not equal for delivery into the U.S. T-Bond futures, and the short trader will always find that some issues are more profitable to deliver than others. The security that is the most advantageous for the short trader to deliver is called the *cheapest-to-deliver* (CTD).

A bond cheapest-to-deliver status depends not only on its characteristics (coupon rate and term to maturity), but also on market conditions, namely, on the market price of the various grades, which prices are directly related to the yield curve of Treasury securities. As such, this status is not attached to a particular bond, and the CTD varies from contract to contract, and even from day to day during the trading period of a particular contract. Since the actual delivery day within the delivery month is also at the short trader's discretion, a variety of bonds may generally be delivered into T-Bond futures contracts. The possibility of delivering any bond among a large delivery basket, at any time during the month, is meant to alleviate the demand for a single issue and to avoid congestion, or market squeezes. Indeed, a market squeeze would occur if the amount of the CTD available to trade was insufficient to meet all the delivery requirements, resulting in an increased delivery cost or even delivery failures.

In this paper, we recall an episode in the history of CBOT T-Bond futures, where the occurrence of a combination of several conditions gave rise to an entrenchment and a progressive scarcity of the CTD during the five-year period spanning December 1994 to December 1999. This dry spell of the CTD had many negative repercussions on the futures and bond markets, and an analysis of this period is enlightening, given that a similar conjunction of unlikely conditions is currently developing, meaning that a second dry spell could very well occur in the near future, with foreseeable consequences. The aim of this paper is to show the similarity between the two situations and to suggest possible steps that could be taken to remedy the situation.

The contribution of this paper is of practical relevance to bond market participants for two main reasons. The first is the important role played by Treasury securities in the financial markets: they are used as benchmarks for the pricing of other securities, as collateral for financial transactions, as underlying assets for fixed-income derivatives, and as monetary policy instruments. The second reason is that short supply or market manipulation of Treasury securities, many episodes of which were recorded during the 1994–1999 period, are one of the main concerns of bond market participants, as price distortions of these securities severely impact pricing and liquidity in the cash, repo, and futures markets, as well as in the market for trading the T-Bond basis. We show that the situation presently developing in the T-Bond futures market would substantially increase the incentive for market manipulation as well as the likelihood of short squeezes in the upcoming five years, and we propose potential solutions that could be easily implemented by the CME Group to avert such a scenario, thereby not only significantly reducing the likelihood of short squeezes but also improving the hedging efficiency of the T-Bond futures contract.

The rest of this paper is organized as follows. Section 2 recalls the 1994–1999 episode, highlighting the causes and consequences of the entrenchment of the cheapest-to-deliver bond during that period. Section 3 analyzes the present situation and shows that all forecasts point to the repetition of a similar scenario. Section 4 analyzes the suitability of various steps that could be taken to prevent the adverse consequences of a dry spell of the CTD during the next five years. Section 5 is a conclusion.

2 The 1994–1999 long dry spell in the U.S. T-Bond futures market

In their book, Burghardt et al. (2005) list and describe different eras of U.S. T-Bond futures trading since the creation of the futures contract in 1977. These eras are distinguished by significant differences in the futures contract behavior, mainly attributed to variations in the underlying term structure of interest rates. One of these epochs is the period spanning 1994 to 1999, which the authors call "*the long dry spell of the* $11\frac{1}{4}\%$," mostly because the $11\frac{1}{4}\%$ of February 2015 T-Bond firmly secured its status as cheapest-to-deliver into the U.S. T-Bond futures contract during the entire period. We provide here a description of the particular characteristics of this period, including the main causes that led to the outright entrenchment of the $11\frac{1}{4}\%$ of February 2015 security as CTD, the severe issues that resulted from this situation, and the repercussions on all T-Bond market sectors.

2.1 An alignment of four concurrent conditions

2.1.1 A special configuration of the basket of deliverable bonds

Until March 2011, when the Ultra T-Bond futures contract was launched, Treasury securities with a time to maturity ranging between 15 and 30 years qualified for delivery into the U.S. T-Bond futures. All Treasury bonds issued before 1985 carried an American-style call feature allowing the issuer to redeem the bond's principal up to five years before maturity. Starting from the March 1985 contract, the set of eligible bonds thus included both callable and straight bonds.

The early-1980s period was characterized by high interest-rate levels and anomalous negatively sloped yield curves. Accordingly, all long-term issuances during that period bore substantially high coupon rates, reaching 14% for the November 1981 auction—their all-time peak. During the following two decades, interest rates declined dramatically, making the early exercise of the call option embedded in the 30-year callable T-Bonds deeply in the money, and effectively reducing the original term to maturity of T-Bonds issued between 1980 and 1985 by five years. This in turn created a five-year-maturity gap inside the deliverable sets of all U.S. T-Bond futures expiring before December 1994.

The $11\frac{3}{4}\%$ of November 2009–2014 security was the last callable bond issued by the Treasury. As it was redeemable as of November 15, 2009, it was eligible for the last time for delivery into the September 1994 futures contract. The disappearance of callable bonds from the set of bonds eligible for delivery resulted in a five-year jump in the minimum maturities of the deliverable baskets between the September 1994 and December 1994 futures contracts.

Starting with the December 1994 contract, all deliverable baskets consisted only of vanilla T-Bonds that met the futures contract's maturity specifications. The minimum maturity of the December 1994 contract deliverable basket was slightly above 20 years; it kept decreasing thereafter at a slow pace, finally reaching a little over 15 years with the December 1999 contract. It is worth noting that this minimum maturity was associated with the same T-Bond, namely, the $11\frac{1}{4}\%$ of February 2015 issue, which was located at the top of the basket during the period spanning December 1994 to December 1999 (a total of 21 futures contracts). This special configuration is illustrated in Table 1, where we present the evolution of the composition of the T-Bond futures deliverable baskets over the period covering March 1994 to March 2000, based on the computation of the remaining terms to maturity that define the eligibility of each grade.

2.1.2 Interest rates below the reference coupon rate

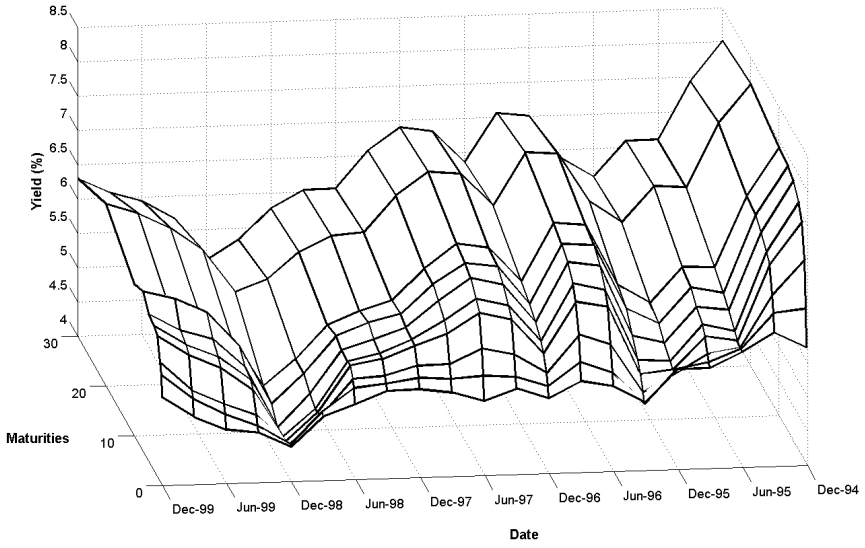
Figure 1 depicts the surface of the U.S. term structure of interest rates during the period from December 1994 to December 1999.

One observes that during this period the yield curve is well below the coupon rate of the futures contracts reference bond (8% at the time). Starting from March 1995, long-term yields never exceeded 8%, and plummeted to much lower levels at certain times. It is well known that when the yield curve is substantially lower than the reference coupon rate, bonds with lowest durations are the most plausible contenders for cheapest-to-deliver (see, e.g., Benninga & Wiener 1999).

Table 1: Composition of U.S. T-Bond futures deliverable baskets from March 1994 to March 2000.

CUSIP	Coupon	Issue Date	Maturity	Mar-94	Jun-94	Sep-94	Dec-94	Mar-95	Jun-95	Sep-95	Dec-95	Mar-96	Jun-96	Sep-96	Dec-96	Mar-97	Jun-97	Sep-97	Dec-97	Mar-98	Jun-98	Sep-98	Dec-98	Mar-99	Jun-99	Sep-99	Dec-99	Mar-00
912810DJ4	13 1/4	05/15/84	05/15/14	15.22	← Callable Issue																							
912810DL9	12 1/2	08/15/84	08/15/14	15.47	15.22	← Callable Issue																						
912810DN5	11 3/4	11/15/84	11/15/14	15.72	15.47	15.22	← Callable Issue																					
912810DP0	11 1/4	02/15/85	02/15/15	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97	15.72	15.47	15.22	
912810DS4	10 5/8	08/15/85	08/15/15	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.96	18.72	18.47	18.22	17.96	17.72	17.47	17.22	16.96	16.72	16.47	16.22	15.96	15.72	15.47
912810DT2	9 7/8	11/29/85	11/15/15	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97	15.72
912810DV7	9 1/4	02/15/86	02/15/16	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97
912810DW5	7 1/4	05/15/86	05/15/16	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22
912810DX3	7 1/2	11/15/86	11/15/16	22.73	22.47	22.22	21.97	21.73	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72
912810DY1	8 3/4	05/15/87	05/15/17	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22
912810DZ8	8 7/8	08/15/87	08/15/17	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47
912810EA2	9 1/8	05/15/88	05/15/18	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22
912810EB0	9	11/22/88	11/15/18	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72
912810EC8	8 7/8	02/15/89	02/15/19	24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.97
912810ED6	8 1/8	08/15/89	08/15/19	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47
912810EE4	8 1/2	02/15/90	02/15/20	25.98	25.73	25.47	25.22	24.98	24.73	24.47	24.22	23.98	23.72	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.97
912810EF1	8 3/4	05/15/90	05/15/20	26.22	25.97	25.72	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22
912810EG9	8 3/4	08/15/90	08/15/20	26.48	26.22	25.97	25.72	25.48	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47
912810EH7	7 7/8	02/15/91	02/15/21	26.98	26.73	26.48	26.23	25.98	25.73	25.48	25.23	24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.73	22.47	22.22	21.98	21.73	21.47	21.22	20.98
912810EJ3	8 1/8	05/15/91	05/15/21	27.22	26.97	26.72	26.47	26.22	25.97	25.72	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22
912810EK0	8 1/8	08/15/91	08/15/21	27.48	27.22	26.97	26.72	26.48	26.22	25.97	25.72	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47
912810EL8	8	11/15/91	11/15/21	27.73	27.48	27.22	26.98	26.73	26.48	26.22	25.98	25.73	25.47	25.22	24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.73	22.47	22.22	21.97	21.72
912810EM6	7 1/4	08/17/92	08/15/22	28.48	28.22	27.97	27.72	27.48	27.22	26.97	26.72	26.47	26.22	25.97	25.72	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47
912810EN4	7 5/8	11/15/92	11/15/22	28.73	28.48	28.22	27.98	27.73	27.48	27.22	26.98	26.73	26.47	26.22	25.97	25.73	25.47	25.22	24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.72
912810EP9	7 1/8	02/16/93	02/15/23	28.98	28.73	28.48	28.23	27.98	27.73	27.48	27.23	26.98	26.73	26.47	26.22	25.98	25.73	25.47	25.22	24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98
912810EQ7	6 1/4	08/16/93	08/15/23	29.48	29.22	28.97	28.72	28.48	28.22	27.97	27.72	27.47	27.22	26.97	26.72	26.47	26.22	25.97	25.72	25.47	25.22	24.97	24.72	24.47	24.22	23.97	23.72	23.47
912810ES3	7 1/2	08/15/94	11/15/24				29.98	29.73	29.48	29.23	28.98	28.73	28.48	28.22	27.98	27.73	27.48	27.22	26.98	26.73	26.48	26.22	25.98	25.73	25.48	25.22	24.98	24.73
912810ET1	7 5/8	02/15/95	02/15/25					29.98	29.73	29.48	29.23	28.98	28.73	28.48	28.23	27.98	27.73	27.48	27.23	26.98	26.73	26.48	26.23	25.98	25.73	25.48	25.23	24.98
912810EV6	6 7/8	08/15/95	08/15/25							29.98	29.73	29.48	29.22	28.97	28.72	28.48	28.22	27.97	27.72	27.48	27.22	26.97	26.72	26.48	26.22	25.97	25.72	25.47
912810EW4	6	02/15/96	02/15/26									29.98	29.73	29.48	29.23	28.98	28.73	28.48	28.23	27.98	27.73	27.48	27.23	26.98	26.73	26.48	26.23	25.98
912810EX2	6 3/4	08/15/96	08/15/26											29.97	29.72	29.48	29.22	28.97	28.72	28.48	28.22	27.97	27.72	27.48	27.22	26.97	26.72	26.47
912810EY0	6 1/2	11/15/96	11/15/26												29.98	29.73	29.48	29.22	28.98	28.73	28.48	28.22	27.98	27.73	27.48	27.22	26.98	26.73
912810EZ7	6 5/8	02/18/97	02/15/27													29.98	29.73	29.48	29.23	28.98	28.73	28.48	28.23	27.98	27.73	27.48	27.23	26.98
912810FA1	6 3/8	08/15/97	08/15/27															29.97	29.72	29.48	29.22	28.97	28.72	28.48	28.22	27.97	27.72	27.47
912810FB9	6 1/8	11/17/97	11/15/27																29.98	29.73	29.48	29.22	28.98	28.73	28.48	28.22	27.98	27.73
912810FE3	5 1/2	08/17/98	08/15/28																			29.98	29.73	29.48	29.23	28.98	28.73	28.48
912810FF0	5 1/4	11/16/98	11/15/28																				29.98	29.73	29.48	29.23	28.98	28.73
912810FG8	5 1/4	02/16/99	02/15/29																						29.73	29.48	29.23	28.98
912810FJ2	6 1/8	08/16/99	08/15/29																							29.98	29.73	29.48

This table presents the composition of the baskets deliverable into the U.S. T-Bond futures contracts from March 1994 to March 2000. For each grade eligible for delivery, this figure presents the CUSIP, the coupon rate, the issuance date as well as the maturity date. We also report the remaining maturity of each bond, defining its delivery eligibility. Data is obtained from the CBOT.



This figure plots the U.S. term structure of interest rates on the first day of T-Bond futures delivery months from December 1994 to December 1999. Data is obtained from the Federal Reserve.

Figure 1: U.S. yield curve surface from December 1994 to December 1999.

2.1.3 Fifteen years of falling long-term yields

Examination of the second column of Table 1 shows that all the T-Bonds issued between August 1985 and August 1999 bear coupon rates that are lower than that of the $11\frac{1}{4}\%$ T-Bond issued in February 1985. Due to the combination of the maturity gap and the falling long-term yields, the security with the shortest term to maturity also had the highest coupon, so that the lowest-duration bond (that is, the most plausible CTD) remained entrenched at the top of the deliverable basket for five years, from December 1994 to December 1999.

2.1.4 An increasing discrepancy between the long-term yield and the reference coupon rate

The CBOT conversion factors are determined in such a way that all bonds would be equal for delivery if the term structure of interest rates were flat at the reference coupon rate level (8% at the time). It is well acknowledged in the financial literature that all bonds are generally not equal for delivery (hence, the identification of the so-called CTD), and that the magnitude of the conversion-factor-system bias increases with the discrepancy between the long-term and the reference yield.[1]

During the second half of the 1990s, interest rates kept falling, with yields on long-term T-Bonds falling faster than those on short-term T-Bonds. Long-term Treasury yields declined gradually, from 8.02% on the first day of the December 1994 contract delivery month to 6.3% for the December 1999 contract, attaining a record low value of 5.06% for the December 1998 contract. As the discrepancy between long-term yields and the reference rate of 8% was increasing, the cost of delivering non-CTD issues also increased.

2.2 The resulting dry spell and its repercussions

The combination of these four conditions, namely, the five-year-maturity gap inside deliverable sets due to the callability feature, the position of the reference coupon rate with respect to the yield curve, the persisting decline of long-term yields, and the increasing conversion-factor-system bias, created a very particular environment propitious for the delivery of the lowest-duration bond, which remained unchanged at the top of the

[1] For a detailed discussion of the imperfections of the CBOT's equivalence formula, we refer to Grieves & Mann (2004), Oviedo (2006), and Ben-Abdallah et al. (2009).

deliverable baskets for more than five years, while delivery of alternate grades became increasingly expensive. More precisely, the $11\frac{1}{4}\%$ of February 2015 security was firmly established in its CTD status for the entire period spanning December 1994 to December 1999, and was consistently and by far the most delivered issue into the U.S. T-Bond futures contract over this period. This led to the so-called "long dry spell of the $11\frac{1}{4}\%$" (see, e.g., Sack 2000 for a discussion of the impact of this dry spell on the pricing of securities).

It is worthwhile emphasizing that this situation was remarkable, in that the absence of any one of the four above-mentioned conditions would have prevented its occurrence. Note also that, although newly issued bonds were incorporated into deliverable sets, increasing their size from 24 to 36 grades throughout the considered period, these were not able to overtake the entrenched $11\frac{1}{4}\%$ CTD. This is due to the fact that newly issued bonds were bearing low coupon rates, reflecting the lower interest-rate environment, and thus, were presenting higher durations that did not allow them to compete for CTD status.

We now present the repercussions of this remarkable situation, which lasted more than five years and negatively impacted all bond market sectors (see Burghardt et al. 2005).

2.2.1 Deteriorating effectiveness of T-Bond futures hedging

Recall that, before the launch of the Ultra T-Bond futures in March 2011, the U.S. T-Bond futures contract was the only instrument designed to hedge the entire 15- to 30-year maturity spectrum. The fact that the CTD—namely, the $11\frac{1}{4}\%$ of February 2015 issue—could be predicted with certainty a long time in advance throughout the whole 1994–1999 time period reduced the U.S. T-Bond futures contract to a forward contract written on that bond, thus greatly limiting its hedging efficiency. As time progressed during this period, the effective maturity of the futures contract was gradually diminishing, along with the remaining term to maturity of the $11\frac{1}{4}\%$ of February 2015 CTD issue. By the end of 1999, the effective maturity of the futures contract was down to approximately 15 years, rendering the contract useless for market participants wishing to hedge longer-term yield exposures, namely, the 25- to 30-year maturity sector.

2.2.2 A vanishing market for trading the T-Bond basis

The gross basis of a T-Bond deliverable into the U.S. T-Bond futures is defined as the difference between the cash price of the bond and the quoted futures price, adjusted by the associated conversion factor. This difference is supposed to stem from two effects, namely, bond carry (difference between the coupon rate and the financing rate) and the value of the strategic delivery options embedded in the futures contract (quality and timing options). A considerable literature, both theoretical and empirical, devoted to the valuation of these embedded quality and timing options shows that the quality option is by far the most valuable strategic embedded option (see, e.g., Chen et al. 2009 and Ben-Abdallah et al. 2012), driving most of the observed T-Bond basis variability. The market for trading the basis hence heavily relies on the optionality implied by changes in the CTD bond, a feature that had obviously disappeared during the 1994–1999 period because of the entrenchment of the $11\frac{1}{4}\%$ of February 2015 CTD issue. This situation led to the progressive dying out of the market for trading the T-Bond basis.

2.2.3 An increasing susceptibility to short squeezes in the T-Bond futures market

A short squeeze develops in the U.S. T-Bond futures market when short traders are unable to find a sufficient outstanding amount of the underlying CTD, either in the cash or repo markets, to fulfill the contract's delivery requirements, thus compelling them to cover their positions with more expensive deliverable grades. Such a short supply of the CTD may be attributable either to the size of the issuance being insufficient to meet delivery requirements, or to its market manipulation. When the CTD is predictable, a manipulative short-squeeze scheme could consist of, for instance, simultaneously acquiring substantial long positions in both the T-Bond futures and its underlying CTD, leading to a significant reduction in the outstanding CTD supply as well as to higher costs for short traders wishing to unwind their futures positions.

Short squeezes are usually accompanied by sizable pricing distortions affecting all T-Bond sectors, namely, the cash, repo, and futures markets. A significant amount of literature has been devoted to this subject (see, for instance, Cornell & Shapiro 1989, Jarrow 1992, Kumar & Seppi 1992, Jegadeesh 1993, Cooper &

Donaldson 1998, Järvinen & Käppi 2004, Merrick et al. 2005, and Pirrong 2011). Multiple short-squeeze episodes have been recorded throughout the history of bond futures markets and have resulted in acute bond and futures pricing distortions.

More specifically, the amount of $11\frac{1}{4}\%$ T-Bond issued in February 2015 was relatively small ($10.52 billion), and squeeze incentives reached significantly high levels during the period from 1994 to 1999 (see Connor & Yunnan 1996, Zuckerman 1998, and Zuckerman & Montgomery 1999 for documented instances of market manipulation and price distortion during that period). For instance, Ben-Abdallah & Breton (2015a) find that the incentive for manipulating the CTD, as measured by the difference in costs between delivering the first and second CTDs, peaked for the futures contract of December 1998 at $690 per contract, while severe price distortions were reported in both the bond and futures markets (the $11\frac{1}{4}\%$ of February 2015 issue was trading 0.99% above its intrinsic value and the futures contract 0.39% above its theoretical price on the first day of the December 1998 futures contract). These observations suggest that a short squeeze took place in December 1998, which is in line with the aforementioned substantial drop in long-term yields observed at that time, which intensified the imperfections of the conversion factor system and lead to higher costs for delivering alternative bonds.

3 "History, with all her volumes vast, hath but one page"[2]

In this section, we show that, two decades after the above-described "long dry spell of the $11\frac{1}{4}\%$," a similar situation is now underway in the U.S. T-Bond futures market, which could lead to the entrenchment of a single CTD, namely, the $4\frac{1}{2}\%$ of February 2036, until it no longer fits the contract specifications and loses delivery eligibility in March 2021. In fact, we argue that, despite being the result of different circumstances, the same four conditions that underpinned in 1994 the development of the long dry spell of the $11\frac{1}{4}\%$ currently coexist. As such an alignment of these four conditions is at the same time unfortunate and improbable, we contend that it is important to investigate the increasing possibility that an even longer dry spell episode will occur, for the second time in the history of the U.S. T-Bond futures. Since the episode we foresee is still in its beginnings, we feel it is still possible to prevent its potential future repercussions if appropriate measures are taken.

Recall the four conditions that, combined, led to the 1994 dry spell episode:

- The end of the five-year-maturity gap in the deliverable basket, following the disappearance of the last callable T-Bond from the sets of deliverable grades in December 1994;
- The persistence of yields at levels below the reference coupon rate of 8% (favoring the delivery of the lowest-duration T-Bond);
- A deliverable basket where the highest coupons are borne by older issues (with the shortest remaining maturities);
- The increasing bias built into the conversion factor system, making the delivery of alternative grades substantially more expensive.

The following four corresponding conditions can currently be observed:

- The disappearance in June 2015 of a five-year-maturity gap inside the deliverable baskets of the U.S. T-Bond futures, resulting from the suspension of the issuance of 30-year T-Bonds over the period spanning early 2001 to early 2006;
- The persistence of yields at levels that are below the reference coupon rate, now at 6%;
- The prevailing environment of record low interest rates in the aftermath of the 2007–2008 global financial crisis;
- The large discrepancy between long-term yields and the reference coupon rate, giving rise to unusually high incentives for manipulative squeezes.

[2] Lord George Gordon Byron (1788–1824).

We now provide a detailed discussion of the current combination of these last four conditions and analyze their potential future impacts.

3.1 Four concurrent conditions

3.1.1 A special configuration of the basket of deliverable bonds

Between early 2001 and early 2006, the U.S. Department of the Treasury suspended the issuance of 30-year T-Bonds in anticipation of budget surpluses. As a result, for the second time in the history of U.S. T-Bond futures, a five-year-maturity gap arose inside the deliverable baskets, starting with the March 2006 futures contract, and more precisely, between the $5\frac{3}{8}\%$ of February 2031 issue and the $4\frac{1}{2}\%$ of February 2036 issue. Under the futures contract specifications that followed the launch of the Ultra T-Bond futures in March 2011, bonds with remaining maturities ranging between 15 and 25 years qualify for delivery into what then became known as "classic" T-Bond futures. Therefore, the $5\frac{3}{8}\%$ of February 2031 issue no longer qualifies as of March 2016, which should result in the disappearance of the five-year-maturity gap thereafter.

However, unlike the first maturity gap, which was caused by the presence of callable grades inside deliverable baskets, this second gap, resulting from the issuance suspension—and which has become known among practitioners as the "*five-year-gap issue*" in the U.S. T-Bond futures—represented a significant problem for the CME Group. In fact, since under the current low-interest-rate environment, the bond with the lowest duration secures CTD status, the CME Group raised the issue in 2013 that plausible candidates for the CTD during the years 2014 and 2015 were the isolated and aged Treasury securities issued before 2001, which presented significant differences compared to the rest of the basket in terms of their futures equivalent prices, and which had a relatively limited combined outstanding supply (see CME Group 2013a and 2013b). After extensive consultations with specialists from the bond and futures markets, the path chosen by the CME Group consisted of excluding the $5\frac{3}{8}\%$ of February 2031 issue from delivery eligibility into the contracts of June 2015, September 2015 and December 2015 (see CME Group 2013c, 2013d and 2014). According to the CME Group, this solution would reduce basis volatility and duration uncertainty, as well as prevent a short squeeze from developing inadvertently in the U.S. T-Bond futures market.[3] In Table 2, we present the resulting composition of the deliverable baskets from March 2015 to March 2021, showing the impacts of the 30-year bond-issuance suspension as well as of the solution chosen by the CME Group to address the five-year-gap issue.

Examination of Table 2 shows that the implementation of the solution chosen by the CME Group has accelerated the disappearance of the five-year-maturity gap from the deliverable baskets. This disapearance can now be seen in June 2015 instead of March 2016. Furthermore, it is worthwhile taking note in Table 2 that the $4\frac{1}{2}\%$ of February 2036 T-Bond remains positioned at the top of all the deliverable baskets for the whole period spanning June 2015 to December 2020 (23 futures contracts). This configuration is comparable to the one depicted in Table 1, where a single issue remains at the top of the basket from December 1994 to December 1999 (21 futures contracts) as a consequence of a similar disappearance of a five-year-maturity gap.

3.1.2 An environment of current and projected historic low interest rates

Interest rates have been at a historic low—well below the reference rate of the U.S. T-Bond futures contract of 6%—for almost seven years, and the general expectation is that interest rates will slowly increase in the near future.

Table 3 reports a consensus forecast of the latest yield projections for the current and next five quarters, based on a Bloomberg survey of analysts completed on December 10, 2015. Note that, despite the increasing likelihood of an imminent short-term interest-rate hike, the analysts surveyed by Bloomberg generally lowered their 30-year yield projections compared to the last survey completed on November 13, 2015. A projection of the consensus forecast trend over the next five years leaves all rates below the 6% threshold.

[3] We refer to Ben-Abdallah & Breton (2015b) for a broad ex-post empirical assessment of the effectiveness of the solution actually implemented by the CME Group to address the five-year-gap issue compared to other potential options.

Table 2: Composition of U.S. T-Bond futures deliverable baskets from March 2015 to March 2021.

CUSIP	Coupon	Issue Date	Maturity	Mar-15	Jun-15	Sep-15	Dec-15	Mar-16	Jun-16	Sep-16	Dec-16	Mar-17	Jun-17	Sep-17	Dec-17	Mar-18	Jun-18	Sep-18	Dec-18	Mar-19	Jun-19	Sep-19	Dec-19	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21
912810FM5	6 1/4	02/15/00	05/15/30	15.22																								
912810FP8	5 3/8	02/15/01	02/15/31	15.97	15.72	15.47	15.22	← Issue excluded from deliverability eligibilty for these three contracts																				
912810FT0	4 1/2	02/15/06	02/15/36	20.98	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97	15.72	15.47	15.22	
912810PT9	4 3/4	02/15/07	02/15/37	21.98	21.73	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.98	18.72	18.47	18.22	17.98	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97
912810PU6	5	08/15/07	05/15/37	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.96	16.71	16.46	16.22
912810PW2	4 3/8	02/15/08	02/15/38	22.98	22.73	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.98	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97
912810PX0	4 1/2	08/15/08	05/15/38	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.96	17.71	17.46	17.22
912810QA9	3 1/2	02/17/09	02/15/39	23.98	23.73	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97
912810QB7	4 1/4	05/15/09	05/15/39	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.96	18.71	18.46	18.22
912810QC5	4 1/2	08/17/09	08/15/39	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.96	18.72	18.47
912810QD3	4 3/8	11/16/09	11/15/39	24.73	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72
912810QE1	4 5/8	02/16/10	02/15/40	24.98	24.73	24.47	24.22	23.98	23.72	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97
912810QH4	4 3/8	05/17/10	05/15/40		24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22
912810QK7	3 7/8	08/16/10	08/15/40			24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47
912810QL5	4 1/4	11/15/10	11/15/40				24.98	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.73	22.47	22.22	21.97	21.73	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72
912810QN1	4 3/4	02/15/11	02/15/41					24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.73	22.47	22.22	21.98	21.73	21.47	21.22	20.98	20.72	20.47	20.22	19.98
912810QQ4	4 3/8	05/16/11	05/15/41						24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22
912810QS0	3 3/4	08/15/11	08/15/41							24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47
912810QT8	3 1/8	11/15/11	11/15/41								24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.73	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72
912810QU5	3 1/8	02/15/12	02/15/42									24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.73	22.47	22.22	21.98	21.72	21.47	21.22	20.98
912810QW1	3	05/15/12	05/15/42										24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22
912810QX9	2 3/4	08/15/12	08/15/42											24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47
912810QY7	2 3/4	11/15/12	11/15/42												24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72
912810QZ4	3 1/8	02/15/13	02/15/43													24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.72	22.47	22.22	21.98
912810RB6	2 7/8	05/15/13	05/15/43														24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22
912810RC4	3 5/8	08/15/13	08/15/43															24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47
912810RD2	3 3/4	11/15/13	11/15/43																24.97	24.73	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72
912810RE0	3 5/8	02/18/14	02/15/44																	24.98	24.73	24.47	24.22	23.98	23.72	23.47	23.22	22.98
912810RG5	3 3/8	05/15/14	05/15/44																		24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22
912810RH3	3 1/8	08/15/14	08/15/44																			24.97	24.72	24.47	24.22	23.97	23.72	23.47
912810RJ9	3	11/17/14	11/15/44																				24.98	24.73	24.47	24.22	23.97	23.73
912810RK6	2 1/2	02/17/15	02/15/45																					24.98	24.73	24.47	24.22	23.98
912810RM2	3	05/15/15	05/15/45																						24.97	24.72	24.47	24.22
912810RN0	2 7/8	08/17/15	08/15/45																							24.97	24.72	24.47
912810RP5	3	11/16/15	11/15/45																								24.97	24.73

This table presents the composition of the baskets deliverable into the U.S. T-Bond futures contracts from March 2015 to March 2021. For each grade eligible for delivery, this figure reports the CUSIP, the coupon rate, the issuance date as well as the maturity date. We also report the remaining maturity of each bond, defining its delivery eligibility. Although the $5\frac{3}{8}\%$ of February 2031 bond would have been eligible for delivery into the June 2015, September 2015 and December 2015 contracts according to the contract specifications, the CME decided to exclude it from their deliverable baskets in order to address the five-year-maturity-gap issue caused by the suspension of T-Bond issuances between 2001 and 2006. Data is obtained from the CBOT.

Table 3: Interest-rate forecast of the Bloomberg analyst consensus.

	Fed Funds Rate (%)	3-Month Libor (%)	U.S. 2-Year (%)	U.S. 10-Year (%)	U.S. 30-Year (%)
Q4 15	0.50	0.49	0.93	2.32	3.07
Q1 16	0.65	0.71	1.15	2.48	3.19
Q2 16	0.85	0.93	1.34	2.63	3.30
Q3 16	1.05	1.14	1.53	2.74	3.39
Q4 16	1.30	1.34	1.72	2.86	3.49
Q1 17	1.50	1.61	1.96	3.03	3.56
Number of analysts	76	37	54	61	45

This table presents the interest rates forecasted for the next six quarters by the Bloomberg consensus, on December 10, 2015. Data is obtained from Bloomberg.

It is interesting to note significant differences in the views of the analysts, who in some case are much more conservative than the consensus. For instance, an examination of the interest-rate forecasts of the CME Group (reported in Table 4) shows that they are consistently lower than those of the Bloomberg consensus, while also rising at a lower pace. Another example is the views of HSBC's analyst Steven Major on November 13, 2015, reported in Table 5, where the bond-yield forecasts are not only considerably lower than the consensus, but also exhibit a consistent decreasing pace in the future. Steven Major's bullish forecasts for the bond market are interesting, as he was among the very few analysts who rightly predicted the 2014 bond rally and the resulting fall in interest rates when the market was strongly convinced otherwise (see Cottle 2015 and Meakin 2015).

Table 4: Interest-rate forecast of analyst Bluford Putnam, Chicago Mercantile Exchange.

	Fed Funds Rate (%)	3-Month Libor (%)	U.S. 10-Year (%)
Q4 15	0.50	0.50	2.25
Q1 16	0.50	0.50	2.35
Q2 16	0.75	0.75	2.45
Q3 16	1.00	1.00	2.55
Q4 16	1.00	1.00	2.65
Q1 17	1.25	1.25	2.75

This table presents the interest rates forecasted for the next six quarters by Bluford Putnam, Managing Director and Chief Economist at the Chicago Mercantile Exchange, on December 10, 2015. Data is obtained from Bloomberg.

Table 5: Interest-rate forecast of analyst Steven Major, HSBC.

	U.S. 2-Year (%)	U.S. 10-Year (%)	U.S. 30-Year (%)
Q4 15	0.50	2.10	2.90
Q1 16	0.50	1.90	2.80
Q2 16	0.50	1.70	2.70
Q3 16	0.50	1.50	2.60
Q4 16	0.50	1.50	2.60

This table presents the interest rates forecasted for the next five quarters by Steven Major, Global Head of Fixed Income Research at HSBC Bank, on November 13, 2015. Data is obtained from Bloomberg.

On December 16, 2015, the Federal Open Market Committee (FOMC) had its most anticipated and closely watched meeting, where it was announced that the Fed is raising its benchmark short-term interest rate for the first time in nearly a decade, now ranging between 0.25% and 0.50%. Note that during this December meeting, the Federal Reserve kept its long-run forecast for the Federal funds rate unchanged at 3.5% after it had been revised downwards during the September 2015 meeting from its 3.8% June forecast

(see FOMC 2015a, 2015b, 2015c). Although the Federal Reserve has started its cycle of interest-rate hikes, the Fed repeatedly stressed during the December meeting that any further interest-rate increases will be very gradual and largely data-dependent. According to Mohamed El-Erian, chief economic adviser at Allianz SE and chairman of Barack Obama's Global Development Council, the policy rate will be below historical averages even after the Fed ends its interest-rate-hike cycle (see El-Erian 2015). Market analysts however do not all agree about the future direction of longer-term Treasury yields, as these are much more affected by factors such as the inflation rate and GDP growth than by the Fed funds rate (see, for instance, Karunakar 2015 and Major 2015). In fact, as a result of the Fed's December announcement, yields on 10-year T-Notes and 30-year T-Bonds, which were normally expected to rise, instead fell considerably in the following two days, from 2.30% and 3.02% to 2.19% and 2.90%, respectively (Oxlade 2015).

To conclude, the most plausible scenario for the next five years is that the yield curve will remain below the reference rate of the U.S. T-Bond futures contract, favoring the delivery of the lowest-duration bonds, as was the case in 1994–1999.

3.1.3 A deliverable basket where coupon rates are generally decreasing with remaining maturity

In the aftereffects of the 2007–2008 global financial crisis, interest rates in the U.S. dropped to historic lows as a result of the easing monetary policy followed by the Federal Reserve, as well as its numerous stimulus programs through unconventional measures. Indeed, since December 2008, the Fed's key short-term interest rate has been pinned to levels close to zero (ranging between 0 and 25 basis points) while long-term T-Bond yields also dropped steeply to all-time lows (e.g., as low as 2.25% on February 02, 2015).

Examination of the second column of Table 2 shows that only four bonds issued after June 2006 bear coupons that are higher than $4\frac{1}{2}\%$, and that only one of these (the 5% of May 2037) could possibly compete with the $4\frac{1}{2}\%$ of February 2036 for CTD status on the basis of duration.

Again, this environment is comparable with the situation prevailing in 1994–1999. The Treasury has been issuing long-term debt bearing record low coupon rates during the last nine years, and long-term Treasury yields are not expected to rise precipitously in the near future, so that the lowest-duration bond should remain at the top of the basket for the coming five years.

3.1.4 The ubiquitous bias of the conversion factor system

Figure 2 illustrates the evolution of the discrepancy between the 30-year T-Bond yield and the reference coupon rate since 1985.This discrepancy peaked at 3.47% in June 2012, and is expected to remain sizable in the foreseeable future, as interest rates are not expected to rise sharply. For instance, on the first day of the December 2015 delivery month, the difference was 3.09%. As long as the reference rate used to compute the conversion factors remains at 6%, the equivalence system will continue to perform poorly by making the delivery of non-CTD bonds inordinately expensive. Moreover, as shown in the preceding paragraph, the CTD is highly predictable and will remain the same (the $4\frac{1}{2}\%$ of February 2036 issue), most likely for the next five years. Under such circumstances, both the incentive for manipulating the CTD and the adverse consequences of a short squeeze are high.

This environment, fostering the occurrence of short squeezes, is to be compared with the situation prevailing in 1994–1999. At 3.09%, the current discrepancy is even higher than the record value of 2.94% observed in December 1998. However, it is worth underlining a major difference between both scenarios. In 1995, long-term yields were starting a slow decreasing pace that gradually conferred a growing delivery advantage to the $11\frac{1}{4}\%$ of February 2015 issue, until it became firmly entrenched by the end of the 1990s. The current interest-rate environment is different, as yields are already far from the hypothetical reference rate, and the delivery advantage of the CTD is presently more significant than was the case for the $11\frac{1}{4}\%$ of February 2015 when the dry spell episode started in 1994.

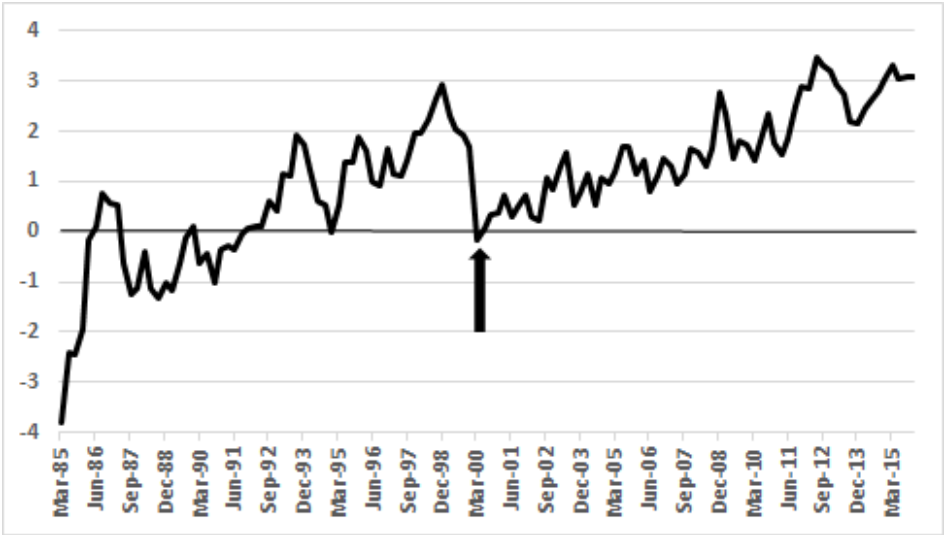


Figure 2: Discrepancy between the U.S. 30-year T-Bond yield and the reference coupon rate.

This figure plots the difference between the coupon rate of the notional bond of the U.S. T-Bond futures and the long-term T-Bond yield over the period spanning March 1985 to December 2015. The reference coupon rate was lowered from 8% to 6% in March 2000. Interest-rate data is obtained from the Federal Reserve.

3.2 Current corroborating facts

Currently, the CME Group provides the quotes for the front U.S. T-Bond futures contract of December 2015 as well as the first- and second-deferred contracts of March 2016 and June 2016, respectively, so that it is possible to examine the history of the daily ranking of the issues making up the delivery baskets associated with these three contracts since they began trading. In Table 6, we report the history of the first, second and third CTDs on December 18, 2015, as provided by Bloomberg for the contracts of December 2015, March 2016 and June 2016. Observation of Table 6 shows that the $4\frac{1}{2}\%$ of February 2036 issue has consistently been dominating the other two most plausible contenders for December 2015 and March 2016, and has finally become first CTD without interruption since early August 2015 for both contracts. The $4\frac{1}{2}\%$ of February 2036 issue is also the first CTD on all 61 trading days of the June 2016 contract reported until December 18, 2015. Moreover, the $4\frac{1}{2}\%$ of February 2036 was the only bond delivered into the September 2015 and December 2015 contracts (3788 and 6823 actual deliveries,[4] respectively). This corroborates the gradual establishment of the $4\frac{1}{2}\%$ of February 2036 issue as first CTD for the upcoming futures contracts. It is also worth noting from Table 6 that the bonds competing for CTD status are always the same three T-Bonds, situated at the top of the basket and presenting the lowest durations. The fact that the T-Bond maturing in May 2037 bears a 5% coupon rate has helped it overtake the shorter $4\frac{3}{4}\%$ of February 2037 issue most of the time. However, despite its higher coupon rate, the 5% of May 2037 issue is not expected to represent a serious threat to the $4\frac{1}{2}\%$ of February 2036 issue when competing for the status of first CTD.

3.3 The foreseeable 2015–2020 dry spell and its repercussions

We contend that, due to the simultaneous combination of the four above-mentioned conditions, we are now entering an episode similar to the 1994–1999 "long dry spell." This episode, the second in the history of the U.S. T-Bond futures (see Figure 3), will take place over the coming five years. In this section, we provide a forecast of eligible bond prices and rankings, using current yield curve forecasts. We then analyze the possible repercussions of a dry spell scenario in terms of squeeze propensity, futures hedging effectiveness, as well as price distortions.

[4]Source: CBOT.

Table 6: Historical CTD bond into the futures contracts of December 2015, March 2016 and June 2016.

T-Bond	# of Times	Dec-15	Mar-16	Jun-16
$4\frac{1}{2}$% of 02/15/36	CTD	151	95	61
	2nd CTD	11	9	0
	3rd CTD	27	21	0
CTD without interruption since		08/05/2015	08/04/2015	
$4\frac{3}{4}$% of 02/15/37	CTD	10	2	0
	2nd CTD	43	22	33
	3rd CTD	136	101	28
5% of 05/15/37	CTD	28	28	0
	2nd CTD	135	94	28
	3rd CTD	26	3	33
	Start Date	03/23/2015	06/22/2015	09/22/2015
	End Date	12/18/2015	12/18/2015	12/18/2015

This table presents, for December 18, 2015, the historical cheapest-, 2nd-cheapest- and 3rd-cheapest-to-deliver bonds into the U.S. T-Bond futures contracts of December 2015, March 2016 and June 2016. Data is obtained from Bloomberg.

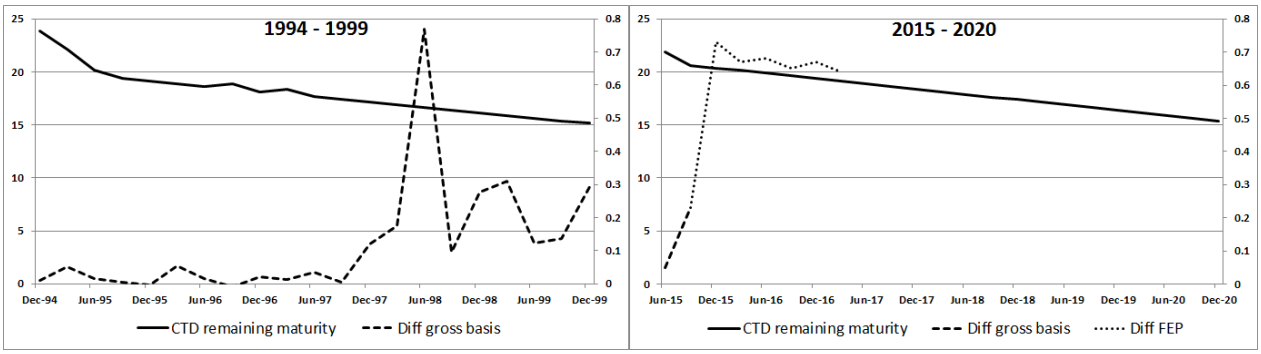


Figure 3: Two dry spell episodes in the history of U.S. T-Bond futures.

This figure represents remaining CTD maturity and the squeeze propensity from December 1994 to December 1999, and from June 2015 to December 2020. The solid line (left axis) is the remaining maturity of the CTD bond on the last day of the delivery month. Historical values are obtained from the CBOT, and predicted values are taken from Table 7. The dashed (dotted) line (right axis) evaluates the loss incurred from delivering the CTD2 instead of the CTD1. Historical values (dashed line) are the difference in gross basis, obtained from the CBOT. Forecasts (dotted line) are the difference in futures equivalent prices, taken from Table 7.

3.3.1 CTD forecast

A bond's futures equivalent price (FEP) is defined as its cash price divided by its conversion factor, and provides an approximate rule for the ranking of bonds, according to which the bond that minimizes its FEP amongst deliverable grades is the CTD.[5] We now perform a CTD forecast analysis based on the computation of the futures equivalent prices of the bonds composing the deliverable baskets. In order to do so, we compute the theoretical prices of all eligible bonds, based on their intrinsic value on the last day of the futures contract delivery month, until the end of the first quarter of 2017. Projected yield curves are obtained by fitting the Svensson Nelson and Siegel model (see Svensson 1994 and Björk & Christensen 1999) to the yield curve forecasts of the Bloomberg consensus provided in Table 3. A bond ranking based on the forecast of futures equivalent prices is then obtained for all the deliverable baskets until March 2017. The result of this analysis is reported in Table 7 and shows that the $4\frac{1}{2}$% of February 2036 issue would be the cheapest-to-deliver bond against all the considered futures contracts.

[5]This practice was used by the CME Group to rank eligible grades in their analysis of the five-year-gap issue.

Table 7: Futures equivalent prices and ranking of deliverable T-Bonds from December 2015 to March 2017.

	Dec-15		Mar-16		Jun-16		Sep-16		Dec-16		Mar-17	
T-Bond	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#
$4\frac{1}{2}$ 02/36	155.92	CTD	152.33	CTD	149.14	CTD	146.66	CTD	144.13	CTD	141.32	CTD
$4\frac{3}{4}$ 02/37	156.81	3	153.19	3	149.96	3	147.47	3	144.90	3	142.09	3
5 05/37	156.65	2	153.00	2	149.82	2	147.31	2	144.80	2	141.96	2
$4\frac{3}{8}$ 02/38	159.27	4	155.49	4	152.14	4	149.53	4	146.84	4	143.96	4
$4\frac{1}{2}$ 05/38	159.35	5	155.52	5	152.20	5	149.57	5	146.93	5	144.01	5
$3\frac{1}{2}$ 02/39	163.67	12	159.61	13	155.97	13	153.16	13	150.25	12	147.23	12
$4\frac{1}{4}$ 05/39	161.50	8	157.55	8	154.09	8	151.37	8	148.64	8	145.65	7
$4\frac{1}{2}$ 08/39	161.07	6	157.21	6	153.76	6	151.09	6	148.31	6	145.42	6
$4\frac{3}{8}$ 11/39	161.79	9	157.83	9	154.37	9	151.65	9	148.87	9	145.91	9
$4\frac{5}{8}$ 02/40	161.36	7	157.51	7	154.03	7	151.37	7	148.56	7	145.67	8
$4\frac{3}{8}$ 05/40	162.47	10	158.49	11	154.99	11	152.23	11	149.44	11	146.46	11
$3\frac{7}{8}$ 08/40	164.45	13	160.38	14	156.73	15	153.91	15	150.94	15	147.94	15
$4\frac{1}{4}$ 11/40	163.51	11	159.46	12	155.91	12	153.11	12	150.25	13	147.25	13
$4\frac{3}{4}$ 02/41			158.41	10	154.90	10	152.18	10	149.33	10	146.45	10
$4\frac{3}{8}$ 05/41					156.17	14	153.36	14	150.49	14	147.50	14
$3\frac{3}{4}$ 08/41							155.46	16	152.39	16	149.37	16
$3\frac{1}{8}$ 11/41									154.80	17	151.60	17
$3\frac{1}{8}$ 02/42											151.90	18
Difference (CTD2-CTD1)	0.73		0.67		0.68		0.65		0.67		0.64	

This table reports the theoretical futures equivalent prices (FEP) and the ranking (#) of T-Bonds composing the deliverable baskets of U.S. T-Bond futures from December 2015 to March 2017. The futures equivalent prices are obtained by dividing bond cash prices by their conversion factors. Bond cash prices are computed on the last day of the delivery month as the theoretical intrinsic value of the bond, obtained by discounting its future cashflows using the Svensson Nelson and Siegel estimation of the yield curve forecasted by the Bloomberg consensus, and adjusted for accrued interests. The theoretical conversion factors are computed using the CBOT formula available at www.cmegroup.com/trading/interest-rates/calculating-us-treasury-futures-conversion-factors.html. The CTD is identified as the bond with the lowest futures equivalent price.

3.3.2 High short-squeeze propensity

In the spirit of Merrick et al. (2005), the difference between the prices of two futures contracts, obtained by either assuming that the first or the second CTD is delivered to fulfill the contract's requirements, can be used as an approximate indicator of the squeeze propensity in the futures market. We therefore use the difference between the futures equivalent prices of the first and second CTDs reported in Table 7, namely, between the $4\frac{1}{2}$% of February 2036 issue and the 5% of May 2037 issue, respectively, in order to assess the squeeze propensity in the U.S. T-Bond futures until March 2017. These differences are reported in Table 7 and show that the cost of delivering the second CTD is sizable, ranging from $640 to $730 per contract. This indicates a relatively high short-squeeze propensity in the upcoming year (see Figure 3, where these values can be compared to the ones observed during the 1994–1999 episode). Moreover, it is worth noting that the high predictability of the CTD, combined with the small amount of its issue ($24 billion) considerably increases the likelihood that a manipulative short squeeze will hit the market of the CTD in the future. Finally, note that, as the market is convinced that interest rates will rise in the future, an unexpected decline in yields (as predicted by Steven Major) might also lead to the development of a short squeeze, as was the case during the unexpected bond rally in 2014 (see Eisen 2014a and 2014b).

3.3.3 Concerns about the effectiveness of futures hedging

If the $4\frac{1}{2}$% of February 2036 T-Bond consistently remains the CTD for the upcoming five years, then the effective maturity of the U.S. T-Bond futures contract would coincide with the remaining maturity of this bond, which will progressively decrease from 20 years to 15 years before the issue loses deliverability eligibility

(see Figure 3). As a result, in the near future, the difference in the terms to maturity between the classic and Ultra T-Bond futures will be only five years, gradually increasing thereafter.

This is particularly important, as the CME Group has already expressed the concern that the term-to-maturity relationship between the classic and Ultra futures now substantially departs from what was intended at the creation of the Ultra contract (that is, a difference of roughly ten years). Indeed, according to the CME Group, closer terms to maturity between the classic and Ultra T-Bond futures could result in a long-end liquidity pool because of the higher correlation between these contracts (see CME Group 2013b). Note that this difference in the shortest terms to maturity between the classic and Ultra T-Bond futures had already shrunk to less than five years in June 2015 when the $5\frac{3}{8}\%$ of February 2031 issue was excluded from delivery eligibility (see Table 2).

3.3.4 Impact on the cash, repo, and basis markets

The foreseeable 2015–2020 "long dry spell of the $4\frac{1}{2}\%$ " could possibly lead to the progressive dying out of the market for trading the T-Bond basis, since the optionality related to CTD switches is this market main driver. On the other hand, as the incentives to manipulate the market of the CTD are substantially high when the CTD is known with certainty a long time in advance, the CTD issue could become unavailable in the cash and repo markets. Such a short supply of the CTD pushes both its price and the price of the futures contract up, making it expensive for short traders to either unwind their futures positions or fulfill the contract by delivery. When the CTD is squeezed, it trades on special with respect to other T-Bonds in the repo market, lowering the borrowing costs when the unavailable issue is pledged in a repurchase agreement (Cornell & Shapiro 1989). Finally, it is worth noting that bonds contending for CTD status usually carry a CTD premium, especially when they are highly predictable (see Kuipers 2008 and Sihvonen 2013), thus creating an additional source of price distortion for the $4\frac{1}{2}\%$ of February 2036 T-Bond.

4 Potential options to address the foreseeable 2015–2020 long dry spell

Unlike in 1994–1999, where the $11\frac{1}{4}\%$ of February 2015 issue gradually became increasingly entrenched during a five-year period, the upcoming long dry spell is predictable, and the $4\frac{1}{2}\%$ of February 2036 issue is already firmly entrenched as the CTD, and may remain so for a time, affecting up to 23 T-Bond futures contracts (starting with the contract of June 2015), thus severely impacting all T-Bond market sectors.

While some of the conditions actuating the entrenchment of a single T-Bond for a long period of time cannot be controlled, it is worthwhile noticing that removing a single condition would be sufficient to prevent history from repeating itself. In the following sections, we examine the effectiveness of two potential options that could be easily implemented by the CME Group, and that would fend off the reappearance of a long dry spell scenario.

4.1 Revisiting the CME Group's Option C

One of the options proposed in 2013 by the CME Group to address the five-year-gap issue consisted of redefining the contract's specifications by operating a shift in the terms to maturity of deliverable grades. According to this option (identified as Option C), the shortest terms to maturity of deliverable bonds could be shifted to some value between 10 and 14 years, whereas the longest terms to maturity could be shifted to some value between 20 and 24 years. This would shift the bonds contending for CTD from the ones impacted by the five-year-maturity gap to newly incorporated issues, which necessarily present lower durations. Under this option, the five-year-gap issue would be postponed to a later date, to be determined by the extent of the shift.

Despite the multiple benefits expected from implementing Option C that were put forward in 2013 (see CME Group 2013b), this course of action was not selected by the CME Group. This might be attributable to the fact that this option would have entailed the most considerable changes, while also postponing the issue at hand to a later date and giving rise to substantial calendar spreads that would require management.

Table 8 provides an appreciation of the impact of such a solution on the configuration of deliverable baskets. More specifically, it shows the configuration of these baskets until March 2021 under three possible ranges for the remaining maturities of eligible deliverable issues, that is, a 12- to 22-year range, a 10- to 25-year range, and the actual situation of a 15- to 25-year range.

Table 8 shows that redefining the shortest terms to maturity to 12 years would limit the entrenchment of the $4\frac{1}{2}\%$ of February 2036 issue as the CTD to eight delivery months, namely, from March 2019 to December 2020, instead of 23 months. On the other hand, if the shortest terms to maturity were redefined to 10 years, the $4\frac{1}{2}\%$ of February 2036 T-Bond would be overtaken by shorter-duration bonds until it would lose its delivery eligibility, thus considerably limiting its possibility of becoming the CTD for the upcoming years. Table 8 also shows that under these two possible scenarios, the CTD, which is the issue positioned at the front of the basket, would regularly vary as time progresses, thus keeping the market for trading the T-Bond basis alive. While the cost for delivering a non-CTD bond would still be high, the likelihood of a manipulative short squeeze would be reduced because of the switches in the CTD from one contract to the next (see Figure 4).

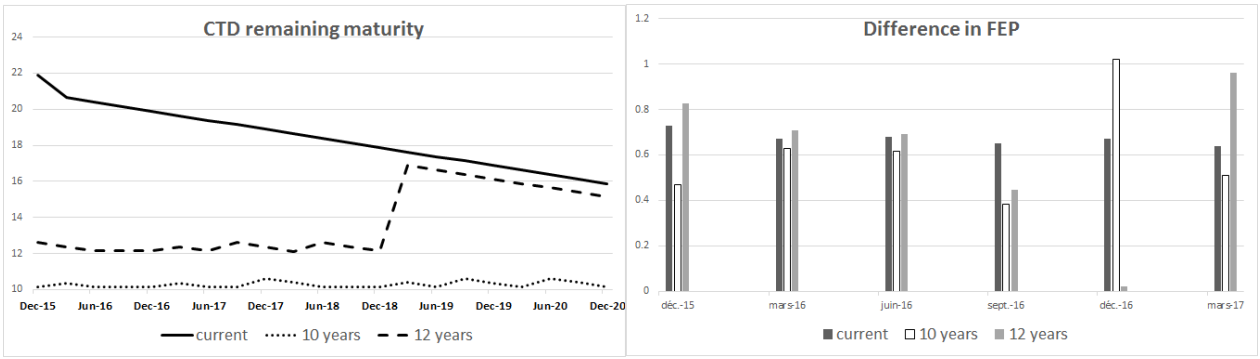


Figure 4: Impact of a shift in the terms to maturity of deliverable grades.

This figure represents the impact of lowering the terms to maturity of grades deliverable into the U.S. T-Bond futures to 10 or 12 years on the remaining CTD maturity from December 2015 to December 2020 and on the difference between the futures equivalent prices of the first and second CTDs from December 2015 to March 2017.

We therefore contend that, while implementing such a solution would have postponed the "five-year-gap issue" to a later date, it would have fared better in the long run by preventing the occurrence of a long CTD dry spell. We also believe that a delay in the five-year-gap issue would probably have attenuated its effects, due to a probable improvement in the performance of the conversion factor system if interest rates were to rise as expected.

Finally, it is interesting to notice that the effective maturity of the futures contract under Option C (either 12 or 10 years, corresponding to the shortest terms to maturity) would have brought the classic T-Bond futures closer to the benchmark 10-Year T-Note futures. This option would have prevented the current 14-year gap between the shortest terms to maturity of the T-Note and T-Bond futures, which forced the CME Group to launch the Ultra 10-Year U.S. Treasury Note futures as of March 2016, in response to customers' demand for a product that makes it possible to hedge the 10-year interest-rate exposure. The Ultra T-Bond futures contract would hence have become the main instrument for hedging the long end of the market.

4.2 Lowering the hypothetical reference coupon rate

We now investigate the potential impacts of an alternative solution consisting of lowering the hypothetical reference coupon rate to levels that better reflect the prevailing long-term rates. Specifically, we examine the impact on the bonds contending for CTD status under two scenarios for the reference coupon rate, namely, 4% and 3%. The rationale behind these suggestions is dual: First, bringing the reference rate closer to the yield curve would make longer-duration bonds more plausible competitors for CTD status, thus shifting the CTD more towards the back of the basket. Second, reducing the discrepancy between the reference and the long-term rates would reduce the conversion-factor-system bias, making deliverable grades more equal for

Table 8: Composition of U.S. T-Bond futures deliverable baskets from March 2015 to March 2021 under Option C.

CUSIP	Coupon	Issue Date	Maturity	Mar-15	Jun-15	Sep-15	Dec-15	Mar-16	Jun-16	Sep-16	Dec-16	Mar-17	Jun-17	Sep-17	Dec-17	Mar-18	Jun-18	Sep-18	Dec-18	Mar-19	Jun-19	Sep-19	Dec-19	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21
912810EV6	6 7/8	08/15/95	08/15/25	10.47	10.21																							
912810EW4	6	02/15/96	02/15/26	10.97	10.72	10.47	10.22																					
912810EX2	6 3/4	08/15/96	08/15/26	11.47	11.21	10.96	10.71	10.46	10.21																			
912810EY0	6 1/2	11/15/96	11/15/26	11.72	11.47	11.21	10.96	10.72	10.46	10.21																		
912810EZ7	6 5/8	02/18/97	02/15/27	11.97	11.72	11.47	11.22	10.97	10.72	10.46	10.21																	
912810FA1	6 3/8	08/15/97	08/15/27	12.47	12.21	11.96	11.71	11.46	11.21	10.96	10.71	10.46	10.21															
912810FB9	6 1/8	11/17/97	11/15/27	12.72	12.47	12.21	11.96	11.72	11.46	11.21	10.96	10.72	10.46	10.21														
912810FE3	5 1/2	08/17/98	08/15/28	13.47	13.22	12.96	12.72	12.47	12.21	11.96	11.71	11.47	11.21	10.96	10.71	10.47	10.21											
912810FF0	5 1/4	11/16/98	11/15/28	13.72	13.47	13.22	12.97	12.72	12.47	12.21	11.96	11.72	11.47	11.21	10.96	10.72	10.47	10.21										
912810FG8	5 1/4	02/16/99	02/15/29	13.97	13.72	13.47	13.22	12.97	12.72	12.47	12.22	11.97	11.72	11.47	11.22	10.97	10.72	10.47	10.22									
912810FJ2	6 1/8	08/16/99	08/15/29	14.47	14.22	13.96	13.72	13.47	13.21	12.96	12.71	12.47	12.21	11.96	11.71	11.47	11.21	10.96	10.71	10.47	10.21							
912810FM5	6 1/4	02/15/00	05/15/30	15.22	14.96	14.71	14.46	14.21	13.96	13.71	13.46	13.21	12.96	12.71	12.46	12.21	11.96	11.71	11.46	11.21	10.96	10.71	10.46	10.21				
912810FP8	5 3/8	02/15/01	02/15/31	15.97	15.72	15.47	15.22	14.97	14.72	14.47	14.22	13.97	13.72	13.47	13.22	12.97	12.72	12.47	12.22	11.97	11.72	11.47	11.22	10.97	10.72	10.46	10.21	
912810FT0	4 1/2	02/15/06	02/15/36	20.98	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97	15.72	15.47	15.22	
912810PT9	4 3/4	02/15/07	02/15/37	21.98	21.73	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.98	18.72	18.47	18.22	17.98	17.72	17.47	17.22	16.97	16.72	16.47	16.22	15.97
912810PU6	5	08/15/07	05/15/37	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.96	16.71	16.46	16.22
912810PW2	4 3/8	02/15/08	02/15/38	22.98	22.73	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.98	18.72	18.47	18.22	17.97	17.72	17.47	17.22	16.97
912810PX0	4 1/2	08/15/08	05/15/38	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.96	17.71	17.46	17.22
912810QA9	3 1/2	02/17/09	02/15/39	23.98	23.73	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.98	19.72	19.47	19.22	18.97	18.72	18.47	18.22	17.97
912810QB7	4 1/4	05/15/09	05/15/39	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.96	18.71	18.46	18.22
912810QC5	4 1/2	08/17/09	08/15/39	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.96	18.72	18.47
912810QD3	4 3/8	11/16/09	11/15/39	24.73	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97	18.72
912810QE1	4 5/8	02/16/10	02/15/40	24.98	24.73	24.47	24.22	23.98	23.72	23.47	23.22	22.98	22.72	22.47	22.22	21.98	21.72	21.47	21.22	20.98	20.72	20.47	20.22	19.97	19.72	19.47	19.22	18.97
912810QH4	4 3/8	05/17/10	05/15/40		24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47	19.22
912810QK7	3 7/8	08/16/10	08/15/40			24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72	19.47
912810QL5	4 1/4	11/15/10	11/15/40				24.98	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.73	22.47	22.22	21.97	21.73	21.47	21.22	20.97	20.72	20.47	20.22	19.97	19.72
912810QN1	4 3/4	02/15/11	02/15/41					24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.73	22.47	22.22	21.98	21.73	21.47	21.22	20.98	20.72	20.47	20.22	19.98
912810QQ4	4 3/8	05/16/11	05/15/41						24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47	20.22
912810QS0	3 3/4	08/15/11	08/15/41							24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72	20.47
912810QT8	3 1/8	11/15/11	11/15/41								24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.73	22.47	22.22	21.97	21.72	21.47	21.22	20.97	20.72
912810QU5	3 1/8	02/15/12	02/15/42									24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.73	22.47	22.22	21.98	21.72	21.47	21.22	20.98
912810QW1	3	05/15/12	05/15/42										24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47	21.22
912810QX9	2 3/4	08/15/12	08/15/42											24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72	21.47
912810QY7	2 3/4	11/15/12	11/15/42												24.97	24.73	24.47	24.22	23.97	23.73	23.47	23.22	22.97	22.72	22.47	22.22	21.97	21.72
912810QZ4	3 1/8	02/15/13	02/15/43													24.98	24.73	24.47	24.22	23.98	23.73	23.47	23.22	22.98	22.72	22.47	22.22	21.98
912810RB6	2 7/8	05/15/13	05/15/43														24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47	22.22
912810RC4	3 5/8	08/15/13	08/15/43															24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72	22.47
912810RD2	3 3/4	11/15/13	11/15/43																24.97	24.73	24.47	24.22	23.97	23.72	23.47	23.22	22.97	22.72
912810RE0	3 5/8	02/18/14	02/15/44																	24.98	24.73	24.47	24.22	23.98	23.72	23.47	23.22	22.98
912810RG5	3 3/8	05/15/14	05/15/44																		24.97	24.72	24.47	24.22	23.97	23.72	23.47	23.22
912810RH3	3 1/8	08/15/14	08/15/44																			24.97	24.72	24.47	24.22	23.97	23.72	23.47
912810RJ9	3	11/17/14	11/15/44																				24.98	24.73	24.47	24.22	23.97	23.73
912810RK6	2 1/2	02/17/15	02/15/45																					24.98	24.73	24.47	24.22	23.98
912810RM2	3	05/15/15	05/15/45																						24.97	24.72	24.47	24.22
912810RN0	2 7/8	08/17/15	08/15/45																							24.97	24.72	24.47
912810RP5	3	11/16/15	11/15/45																								24.97	24.73

This table presents the composition of the baskets deliverable into the U.S. T-Bond futures contracts from March 2015 to March 2021 if Option C were implemented. For each grade eligible for delivery, this table reports the CUSIP, the coupon rate, the issue date as well as the maturity date. We also report the remaining maturity of each bond, defining its delivery eligibility. The actual composition of deliverable baskets is delimited by the bold line. The values highlighted in gray correspond to baskets resulting from redefining the shortest terms to maturity to a range between 12 and 22 years. The values that are not highlighted correspond to baskets resulting from redefining the shortest terms to maturity to a range between 10 and 25 years. Data is obtained from the CBOT.

delivery, and thus limiting the incentives to short-squeeze the market and the negative impacts of a short supply in the CTD.

We report in Tables 9 and 10 the ranking of deliverable grades, from December 2015 to March 2017, based on their futures equivalent prices under the scenarios of a reference coupon rate of 3% and 4%, respectively. The impact of these two possible scenarios on the CTD remaining maturity and on the squeeze propensity is illustrated in Figure 5.

Table 9: Futures equivalent prices and ranking of deliverable T-Bonds from December 2015 to March 2017 under the scenario of a reference coupon rate of 3%.

	Dec-15		Mar-16		Jun-16		Sep-16		Dec-16		Mar-17	
T-Bond	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#
$4\frac{1}{2}$ 02/36	105.27	13	103.15	14	101.31	15	99.93	16	98.53	17	96.91	18
$4\frac{3}{4}$ 02/37	105.08	11	102.95	12	101.08	13	99.68	14	98.24	15	96.63	16
5 05/37	105.11	12	102.96	13	101.10	14	99.69	15	98.28	16	96.64	17
$4\frac{3}{8}$ 02/38	104.80	9	102.60	11	100.67	12	99.23	13	97.73	14	96.10	15
$4\frac{1}{2}$ 05/38	104.800	10	102.58	10	100.66	11	99.21	12	97.73	13	96.07	14
$3\frac{1}{2}$ 02/39	104.36	CTD3	102.05	4	100.03	5	98.51	6	96.93	7	95.26	8
$4\frac{1}{4}$ 05/39	104.54	8	102.27	8	100.29	9	98.80	10	97.27	11	95.60	12
$4\frac{1}{2}$ 08/39	104.53	7	102.29	9	100.32	10	98.84	11	97.28	12	95.64	13
$4\frac{3}{8}$ 11/39	104.46	6	102.18	6	100.19	7	98.69	8	97.15	9	95.48	10
$4\frac{3}{8}$ 02/40	104.45	5	102.20	7	100.22	8	98.73	9	97.16	10	95.52	11
$4\frac{3}{8}$ 05/40	104.36	4	102.06	5	100.06	6	98.55	7	96.99	8	95.31	9
$3\frac{7}{8}$ 08/40	104.15	CTD1	101.84	CTD1	99.78	CTD1	98.25	CTD2	96.62	CTD3	94.96	4
$4\frac{1}{4}$ 11/40	104.22	CTD2	101.89	CTD2	99.87	CTD3	98.33	4	96.75	5	95.07	6
$4\frac{3}{4}$ 02/41			102.01	CTD3	100.00	4	98.49	5	96.89	6	95.25	7
$4\frac{3}{8}$ 05/41					99.80	CTD2	98.26	CTD3	96.66	4	94.99	5
$3\frac{3}{4}$ 08/41							97.89	CTD1	96.21	CTD2	94.55	CTD3
$3\frac{1}{8}$ 11/41									95.71	CTD1	94.00	CTD2
$3\frac{1}{8}$ 02/42											93.92	CTD1
Difference (CTD2-CTD1)	0.07		0.05		0.02		0.36		0.50		0.08	

This table reports the theoretical futures equivalent prices (FEP) and the ranking (#) of T-Bonds composing the deliverable baskets of U.S. T-Bond futures from December 2015 to March 2017 under the scenario of a reference coupon rate of 3%. The futures equivalent prices are obtained by dividing bond cash prices by their conversion factors. Theoretical conversion factors are computed using the CBOT methodology. Bond cash prices are computed on the last day of the delivery month as the theoretical intrinsic value of the bond obtained by discounting its future cashflows using the Svensson Nelson and Siegel estimation of the yield curve forecasted by the Bloomberg consensus, and adjusted for accrued interests. The CTD is identified as the bond with the lowest futures equivalent price.

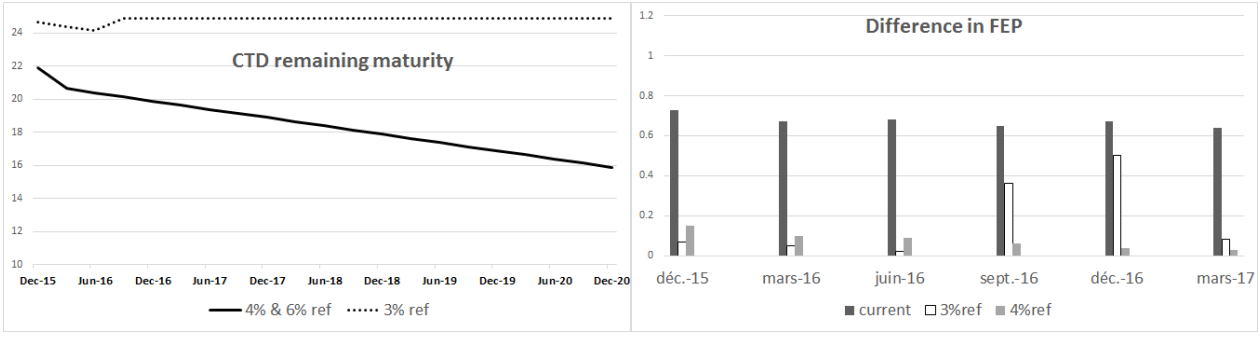


Figure 5: Impact of lowering of the reference coupon rate.

This figure represents the impact of lowering the reference coupon rate to 3% or 4% on the remaining CTD maturity from December 2015 to December 2020 and on the difference between the futures equivalent prices of the first and second CTDs from December 2015 to March 2017.

Table 10: Futures equivalent prices and ranking of deliverable T-Bonds from December 2015 to March 2017 under the scenario of a reference coupon rate of 4%.

	Dec-15		Mar-16		Jun-16		Sep-16		Dec-16		Mar-17	
T-Bond	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#	FEP	#
$4\frac{1}{2}$ 02/36	120.63	CTD1	118.08	CTD1	115.83	CTD1	114.13	CTD1	112.39	CTD1	110.41	CTD1
$4\frac{3}{4}$ 02/37	120.79	CTD3	118.21	CTD3	115.93	CTD3	114.21	CTD3	112.43	CTD2	110.45	CTD3
5 05/37	120.78	CTD2	118.18	CTD2	115.92	CTD2	114.19	CTD2	112.45	CTD3	110.44	CTD2
$4\frac{3}{8}$ 02/38	121.27	4	118.60	4	116.24	4	114.45	4	112.60	4	110.59	4
$4\frac{1}{2}$ 05/38	121.31	5	118.61	5	116.26	5	114.46	5	112.64	5	110.60	5
$3\frac{1}{2}$ 02/39	122.10	12	119.28	13	116.78	13	114.88	13	112.90	13	110.83	13
$4\frac{1}{4}$ 05/39	121.72	8	118.95	8	116.53	8	114.67	8	112.78	9	110.72	8
$4\frac{1}{2}$ 08/39	121.62	6	118.90	6	116.48	6	114.65	6	112.72	6	110.70	6
$4\frac{3}{8}$ 11/39	121.77	9	118.99	9	116.56	9	114.69	9	112.78	10	110.72	9
$4\frac{5}{8}$ 02/40	121.67	7	118.94	7	116.51	7	114.66	7	112.73	7	110.71	7
$4\frac{3}{8}$ 05/40	121.91	10	119.10	11	116.65	11	114.76	11	112.83	11	110.77	11
$3\frac{7}{8}$ 08/40	122.26	13	119.42	14	116.89	15	114.97	15	112.94	15	110.88	15
$4\frac{1}{4}$ 11/40	122.09	11	119.25	12	116.77	12	114.85	12	112.88	12	110.81	12
$4\frac{3}{4}$ 02/41			119.09	10	116.63	10	114.75	10	112.78	8	110.76	10
$4\frac{3}{8}$ 05/41					116.82	14	114.90	14	112.91	14	110.84	14
$3\frac{3}{4}$ 08/41							115.15	16	113.06	16	110.99	16
$3\frac{1}{8}$ 11/41									113.27	17	111.12	17
$3\frac{1}{8}$ 02/42											111.15	18
Difference (CTD2-CTD1)	0.15		0.10		0.09		0.06		0.04		0.03	

This table reports the theoretical futures equivalent prices (FEP) and the ranking (#) of T-Bonds composing the deliverable baskets of U.S. T-Bond futures from December 2015 to March 2017 under the scenario of a reference coupon rate of 4%. The futures equivalent prices are obtained by dividing bond cash prices by their conversion factors. Theoretical conversion factors are computed using the CBOT methodology. Bond cash prices are computed on the last day of the delivery month as the theoretical intrinsic value of the bond obtained by discounting its future cashflows using the Svensson Nelson and Siegel estimation of the yield curve forecasted by the Bloomberg consensus, and adjusted for accrued interests. The CTD is identified as the bond with the lowest futures equivalent price.

Under the 3% scenario, examination of Table 9 shows a completely different ranking of deliverable grades with respect to the current scenario. Note that a situation where the reference coupon rate is lower than the long-term yield favors delivery of the highest-duration grades (lowest coupon rate combined with the longest maturity). Table 9 shows a shift in the contenders for CTD towards the bottom of the baskets, where bonds with lower coupons and a highest duration, auctioned in the aftermath of the last global financial crisis, are positioned. We observe that not only would the entrenchment of a single CTD be prevented, allowing for an optionality value in the futures contract, but also that squeeze incentives would be relatively low. It is also worth noting that lowering the reference coupon rate to 3% would entail a one-time calendar spread jump when the new rate is applied, while the most plausible candidates for CTD under this scenario would always be far from those concerned by the five-year-maturity gap. However, it is important to notice that the shift of the CTD towards the back of the baskets observed under the 3% scenario would bring the effective maturities of the classic T-Bond futures to approximately 25 years (close to the current maturities of the Ultra T-Bond futures), while the effective maturities of the Ultra contract would be brought to 30 years. As a result, under the 3% scenario, the classic and Ultra T-Bond futures would be associated with new maturity sectors.

On the other hand, under the 4% scenario, although the $4\frac{1}{2}$% of February 2036 T-Bond would remain the CTD for the upcoming six contracts, the difference in futures equivalent prices would be substantially reduced between any two successive bonds in the new ranking, showing grades that are more equal for delivery. This can be explained by the fact that the forecasted yield curves provided by the Bloomberg consensus and used to estimate the futures equivalent prices are showing long-term rates that are gradually rising towards the level of 4%—the assumed reference coupon rate. The conversion factor system would thus reach its best performance for the March 2017 futures contract, where only \$0.03 would separate the FEP of the two cheapest-to-deliver bonds, and only \$0.74 would separate the FEP of the CTD and the T-Bond

ranked last (18th) among deliverable grades (these differences are to be compared with the current situation, that is, respectively \$0.64 and \$10.58). We conclude that, under the 4% scenario, the $4\frac{1}{2}$% of February 2036 issue would remain the CTD over the period under study, but the incentive to manipulate its market would be substantially reduced, as the cost of delivering alternative bonds would be relatively insignificant. This scenario, which puts bonds on a roughly equal footing, would probably be the most sustainable scenario in the long run.

Recall that a similar action was taken by the CBOT in March 2000, when the hypothetical reference coupon rate was reduced from 8% to 6%. It is interesting to point out that the aim of this measure was not to put an end to the dry spell of 1994–1999, since the $11\frac{1}{4}$% of February 2015 issue was no longer eligible for delivery as of March 2000, but rather to better reflect the level of long-term rates prevailing at the time, and hence, make deliverable grades more similar for delivery and make the CTD issue less predictable. Indeed, during the five years following this rate correction, the conversion factor system was working relatively well. This fact is corroborated by an examination of the history of the most-delivered issue into the U.S. T-Bond futures, which shows that a wide variety of bonds in terms of coupons and maturities were delivered over the period from March 2000 to December 2004, sometimes even on the same day.

5 Concluding remarks

We showed that a rare combination of conditions, in association with two exceptional events, triggered a situation allowing the identification of a single issue as the cheapest-to-deliver for a long period of time and fostering the occurrence of market squeezes. The first event was the elimination of the callable feature of T-Bonds after 1985, which caused a maturity gap in the deliverable basket and triggered a dry spell episode ten years later. The second event was the suspension of the issuance of 30-year T-Bonds between 2001 and 2006, also producing a maturity gap in the deliverable basket, with repercussions that will be experienced during the next five years.

Rephrasing a famous quote from George Santayana (1863–1952), those who *can* remember the past are *not* condemned to repeat it. By anticipating the adverse consequences of the present rare alignment of conditions, it is possible to take steps to avoid the entrenchment and predictability of the CTD during the next five years. In this paper, we suggest and analyze two avenues that could be taken towards those ends, and we show that these measures could alleviate the demand for a single issue, reduce the incentive to manipulate the bond and futures markets, and/or make the bonds composing the deliverable basket more equal for delivery.

It is interesting to conclude our historical reminiscence by recalling the situation in 1995–1999, when market analysts thought that the record low levels of long-term yields—around 5% to 6%—were abnormal and expected them to return to "normal" levels around 8%, and when all market participants were anticipating the announcement of a hike in the short rate by the Federal Reserve.

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