

Embedded Options in CGF and CGB Futures

10-year bond yields were 0.96% in early July 2016 but rose over 150 basis points to 2.5% in late October 2018 with a similar move observed at the 5-year point in Canada. After such a significant rise in rates, it may be topical for users of physical delivery futures to review the embedded options inherent in these contracts as well as some of the unique characteristics of Canadian bond futures. Readers familiar with the technical aspects of embedded options inherent in CGF[®] and CGB[®] can skip to the second section where we examine the plausibility of cheapest-to-deliver switches after the recent rise in rates and the ensuing value of the embedded options.

Types of Options ¹

There are four options embedded in physical delivery² bond futures. They all arise due to the creation of the deliverable basket, the attempt to “equate” the bonds in the deliverable basket via conversion factors³, and the ability of the seller of futures to choose when and what to deliver in order to satisfy his/her obligations in the contract.

While the number of bonds in a delivery basket can be quite numerous in markets that have more frequent bond issuance, in Canada the delivery basket for both CGF and CGB futures has remained quite sparse with just two or sometimes three bonds deliverable into the contract.

Since the seller of the futures contract owns all of the options embedded in the contract, the value of these options reduces the price of the futures relative to the cash bond market and, under a no-arbitrage assumption between the two markets, the value of the options is equal to the difference in the forward cash bond price and futures price after adjusting for cost of carry.

Delivery/Quality Option

The quality, or delivery, option is normally the most significant option embedded in both the CGF and CGB futures. This option is closely related to the idea of “switch risk” in physical delivery futures that all hedgers and speculators should be aware of when trading futures contracts.

The quality option exists because the short party in a futures contract can decide which bond in the basket to deliver to the long party. If relative pricing of the bonds in the basket is such that a bond other than the bond that was cheapest-to-deliver (CTD) at the time the contract was sold becomes more favorable for the futures short to deliver into the contract, the CTD has switched and the short will deliver the new CTD into the contract; he/she has essentially exercised the quality option. The buyer of the futures is short the quality option and is obligated to take delivery of the bond chosen by the seller of the contract.

1. Portions of this discussion draw on chapter 14 of Fixed Income Securities, Tuckman, Bruce & Serrat, Angel and Treasury Futures Delivery Options, Basis Spreads, and Delivery Tails, CME Group.

2. Cash settled futures contracts such as BA futures contain no embedded options.

3. Calculation of the conversion factor is not covered here but they are published periodically on the MX website.

Note that changes to the CTD have serious consequences for the characteristics of the futures contract as the DV01 and duration of the futures tend to change drastically as a CTD switch becomes more probable anytime during the life of the contract. This is especially true in Canada since the switch between bonds in the basket would lengthen the duration of the futures contract by a full year in CGB contracts and at least six months in CGF contracts⁴. In comparison, a switch from the current CTD in the US 10-year futures contract to the next most likely deliverable would change the duration of the futures contract by a relatively modest 30 days due to the preponderance of issuance there and the subsequently well-populated delivery basket.

Timing Option

The timing option reflects the right of the short position under the futures contract terms to decide when to deliver a qualified bond into the contract. This option exists only between the first delivery date and the final delivery date for futures and has, therefore, a life of about 30 days, beginning on first notice day and ending on last notice day for each contract.

The decision to deliver early or late is a relatively simple one for parties that are short futures contracts. The primary consideration in this decision is the cost of carry. If it is more profitable to deliver early rather than delaying delivery, the timing option can be “exercised” by delivering the CTD before the last delivery date. However, the Portfolio Manager should also be aware that exercising this option (by providing notice of intent to deliver) eliminates the remaining value of all the embedded options in the contract. Therefore, although a small consideration in many cases, the tradeoff of better carry by delivering early must be weighed against the remaining value of the other options embedded in the futures contract which are eliminated once intent to deliver is declared.

End of Month Option

The end of month option derives its value from the fact that the delivery price of a futures contract is set on the last trading day which is seven business days⁵ prior to the last delivery day (but only 5 business days before the last notice date). After the futures delivery price is set, bond prices will still fluctuate and, should the CTD change, an investor can deliver the new CTD at a lesser cost than the old one. Since the futures price is set and will no longer change to reflect the new CTD, this option can theoretically result in large profits.

The end of month option has a brief life of just a handful of days which limits its value in practice. In addition, cheapening of the non-CTD bonds in the basket is probably limited during the end of month option’s short life by other investors actively bidding up the relative price of non-CTD bonds in the basket as they approach CTD status in order to exercise the end of month option, thus constraining the potential profits shorts could derive from this option. It should be noted though that at certain yield levels, multiple CTD switches are theoretically possible during the life of the end of month option and that, by adjusting the bond hedge to a short futures position, this option can be “exercised” multiple times⁶.

Wildcard Option

The wildcard option occurs solely because futures exchanges close before the time that delivery notice must be made while it is still possible to trade bonds over-the-counter during this time. If an event occurs late in the day anytime during the delivery period which changes the relative value of bonds in the basket, the futures contract settlement price can be high enough to justify giving notice to deliver at the day’s settle price which was set some hours ago. As with the other timing option, investors must balance the value derived by exercising the wildcard option with the fact that exercising this option causes it to expire.

For both CGF and CGB the wildcard option exists every day during the delivery period (i.e. for about 22 business days) between 3PM and 5:30PM. In practice, a futures short position would have to be quite nimble for the investor to recognize favorable conditions to exercise this option, notify his/her settlements and clearing department, and provide notice of intent to deliver to the exchange within the short life of the wildcard option in Canada⁷.

4. Under current issuance intentions published by the Government of Canada.

5. Note that CGF is markedly different from the 5-year contract traded on the CME. Last trading day for CGF is the same day as CGB, NOT later in the month as with the US 5-year contract. Thus the CGF end-of-month option would have considerably more value, all else equal, than its counterpart in the US when a potential switch is in play.

6. Declaring intent to deliver is not necessary to benefit from the optionality here.

7. Canadian futures are, again, slightly different from Treasury futures. In the US, the wildcard option exists between the time the futures settlement price is established at 2PM and 6PM when delivery notification must be received from the short (4 hours). In contrast, Canadian bond futures establish a settlement price at 3PM and notice must be received by 5:30PM (2.5 hours).

Value of Embedded Options in Z18 Contracts

Quality Option

While yields at both the 5-year and 10-year point have risen considerably from their low levels of last year, that rise has been accompanied by a flattening of the yield curve. Since a flattening curve is the cheapening of shorter maturity bonds relative to longer maturity bonds, the net result is that the quality option embedded in the CGF and CGB contracts is still extremely unlikely to become a factor in active CGF and CGB contracts.

Figure 1 and Figure 2 show the cheapest-to-deliver bond for each of CGFZ18 and CGBZ18 respectively at the final delivery date for a range of yield and slope changes. In those figures, the current yield/slope is shown in bold and the current CTD bond is shown in green. While combinations of yield and slope that would result in CGF and/or CGB switching to a different CTD exist, it would require a very drastic steepening selloff. We discuss that possibility in the Scenarios & Simulation section below.

FIGURE 1

CGF Matrix

Slope	Canada Mar 23 Yield															
	0.44%	0.94%	1.44%	1.94%	2.44%	2.94%	3.44%	3.94%	4.44%	4.94%	5.44%	5.94%	6.44%	6.94%	7.44%	7.94%
-4.0	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
-3.0	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
-2.1	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
-1.1	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
-0.1	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
0.9	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23
5.7	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23
10.5	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23
15.3	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23
20.2	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23
25.0	Mar23	Mar23	Mar23	Mar23	Mar23	Mar23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23	Sep23

Source: Montreal Exchange, CanDeal

FIGURE 2

CGB Matrix

Slope	Canada Jun 27 Yield															
	0.53%	1.03%	1.53%	2.03%	2.53%	3.03%	3.53%	4.03%	4.53%	5.03%	5.53%	6.03%	6.53%	7.03%	7.53%	8.03%
-5.0	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28
-3.9	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28
-2.7	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28
-1.6	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28
-0.4	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28
0.7	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28
5.6	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28
10.4	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28
15.3	Jun27	Jun27	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28
20.1	Jun27	Jun27	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28
25.0	Jun27	Jun27	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28	Jun28

Source: Montreal Exchange, CanDeal

Timing Option

The timing option is in play for Z18 contracts, especially for CGBZ18 as of the date of writing. Given the extreme distance from any switch potential, and therefore the lack of any significant value to the other embedded options, the decision to deliver early becomes a simple carry calculation. For CGB, the cost of carry for a position that is long cash bonds to deliver into the futures contract is currently quite negative. Portfolio Managers that are long the basis⁸ should be inclined to deliver early and thus exercise their timing option.

For CGF in early November, it is still slightly preferable for PMs that own bonds and have short futures positions to deliver at or near the final delivery date of the contract.

End of Month Option

Given that the chance of a switch from the current CTD for both contracts to a new CTD is so minimal and the crossover points to achieve this are so far from current yield levels, the end of month option, which requires the switch to occur specifically during the last week of delivery period, is equally unlikely and worthless.

Wildcard Option

Similar to the end of month option, the wildcard option would take value if a switch between CTDs were likely to occur between 3PM and 5:30PM during the delivery period. Since no switch seems likely at any juncture, this option should be considered worthless at this time as well.

Scenarios & Simulation

Using the historical experience of interest rates in Canada, we can estimate for the reader the likelihood of a switch occurring in two different ways.

Worst Selloff Scenario

The first method to gauge whether a switch is plausible is to examine the largest selloff in the historical dataset⁹. For the last 15 years, which encompasses at least an entire monetary policy cycle, the largest selloff in a three month period occurred in 2004 (+113 basis points) for the 5y yield and in 2016 (+90 basis points) for the 10y yield. Neither of these worst case scenarios for bonds would result in a switch for the active contract. In fact, CGF would still be more than 230 basis points from a switch of CTD and CGB would still be more than 250 basis points from a switch. Each of these selloffs was accompanied by a flattening of the yield curve, as is normal in low inflation environments, so the contract would probably end up even further from a switch point than stated above.

Simulation Model

Using a historical data set is good, but can't test for possibilities that didn't happen in the past. To test theoretical possibilities, given the current level of rates and shape of the curve, we constructed a 10,000 iteration Monte Carlo simulation to model the yield curve over time. Rather than utilize a yield curve model, we evolved the current yield and slope using random draws from the realized sample of 15 years of daily history in Canadian yields. Rates could therefore evolve upwards or downward from current levels but must "fit" the sample distribution from the prior cycle, including the correlation between 5-year rates, 10-year rates, and slope.

In the case of the simulation results, the largest selloff in 10,000 trials was +145 basis points for the 5-year yield and +137 basis points for the 10-year yield. Again, in both cases, no CTD switch was observed and the level of rates and slope of the curve, even in the most extreme trials, left the 5-year and 10-year yields hundreds of basis points from a level that would result in any CTD switch potential.

8. Long the basis is a relative value position where the PM holds cash bonds and is short futures contracts.

9. Dataset provided by BMO Capital Markets Fixed Income Sapphire database. BMO Capital Markets is a trade name used by BMO Financial Group for the wholesale banking business of Bank of Montreal, BMO Harris Bank N.A. (member FDIC), Bank of Montreal Ireland plc., and Bank of Montreal (China) Co. Ltd and the institutional broker dealer businesses of BMO Capital Markets Corp. (Member SIPC) in the U.S., BMO Nesbitt Burns Inc. (Member Canadian Investor Protection Fund) in Canada and Asia and BMO Capital Markets Limited (authorized and regulated by the Financial Conduct Authority) in Europe and Australia. "BMO Capital Markets" is a trademark of Bank of Montreal, used under license.

Conclusions

We find that only the timing option has any value at current yield levels, despite the significant selloff since the low point in yields in 2016. This is in part because the curve has flattened significantly during the same time period, thus richening (relatively) the longer maturity bonds in each basket and putting a potential switch even farther from realization. No plausible interest rate scenario over the life of a futures contract would result in a CTD switch for either the CGF or CGB contracts at this time.

The implications for Portfolio Managers are:

- For long positions, which are short the embedded options, there is no reason to fear a potential switch which changes the characteristics of the contract or the potential for a different bond to be delivered to your portfolio other than the current CTD. The futures contracts make an excellent proxy for the CTD in an environment with no switch potential. Note that early delivery, when the short futures position is negative carry, should be expected.
- For short positions, which are long the embedded options, it is important to ensure that the futures price at which you sell reflects the near-valueless nature of these options. Built into the futures price is the value of the options and, given that those options provide no plausible path to exercise, one must be careful not to overpay¹⁰.

10. i.e. Sell at too low of a price.



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