**MONTRÉAL EXCHANGE**

# Understanding 2-5-10 Butterfly Trades in Futures

## Conclusion and Takeaways

Butterfly trades can be interesting to Portfolio Managers that wish to express a pure view on the curvature of the yield curve but investors should be aware of the implied bear steepening bias in these trades. The 2-5-10 butterfly can be transacted entirely in futures now that more liquid markets in CGZ (2-year Government of Canada ("GoC") bond futures) contracts exist, in addition to the more mature CGF and CGB (5-year and 10-year GoC bond futures). With few cash requirements and little trade maintenance required, regression weighted 2-5-10 butterflies may be of interest to managers without a firm view on the level or slope of the Canadian yield curve.
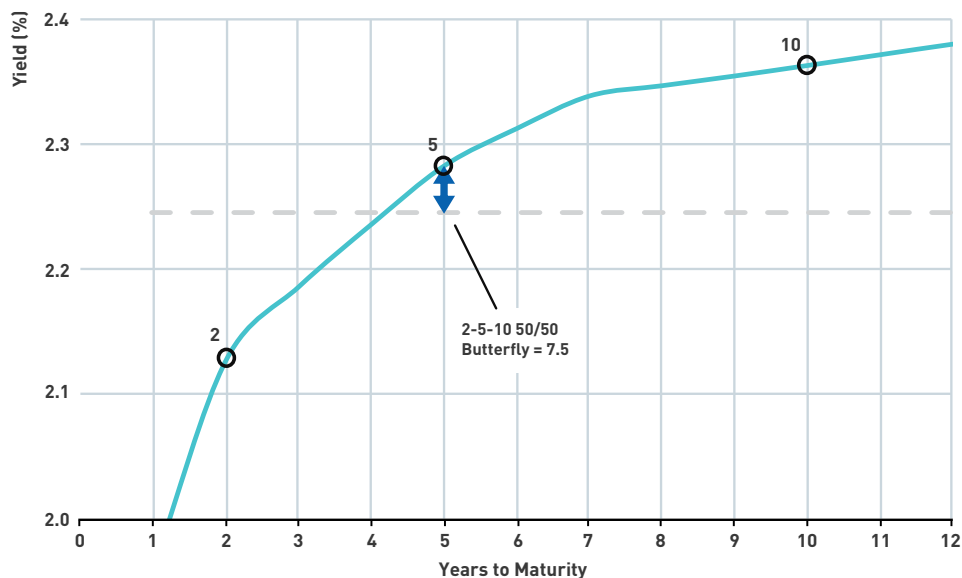
## Curvature/Butterfly Trades

A 2-5-10 butterfly trade is a fixed income trade that is designed to benefit from changes in the curvature of the yield curve, rather than the slope of the curve or level of yields. Although sometimes thought to be complex due to a variety of weighting schemes and industry jargon[1], the general structure of these trades is fairly simple; an investor buys or sells one maturity point on the yield curve (called the "body") and simultaneously does the opposite trade at two other points on the yield curve (called the "wings"). The amount of curvature is quantified as twice the difference between the actual yield level of the middle maturity and the average yield of the two wings. Numerically, the curvature is usually calculated as:

$$\text{Curvature/Butterfly Value} = 2 \times \text{Yield}_{Body} - \text{Yield}_{Wing1} - \text{Yield}_{Wing2}.$$

To demonstrate visually this concept and measurement of the curvature, we present the Canadian yield curve from August 8th, 2018 in Figure 1. The figure shows both the yield curve, the average yield of the two wings (the 2-year and 10-year points) and the difference between the body (the 5-year point) and the average line. The vertical length of the arrowed line is the amount of curvature allowing an investor that buys the body of the butterfly (5-year point) and sells the wings (2-year and 10-year points) to profit if the value of curvature falls.

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1 Curvature trades go by several different names: curvature, butterfly, and bullet/barbell are common. All these labels are synonyms and are structured as described in this paper.
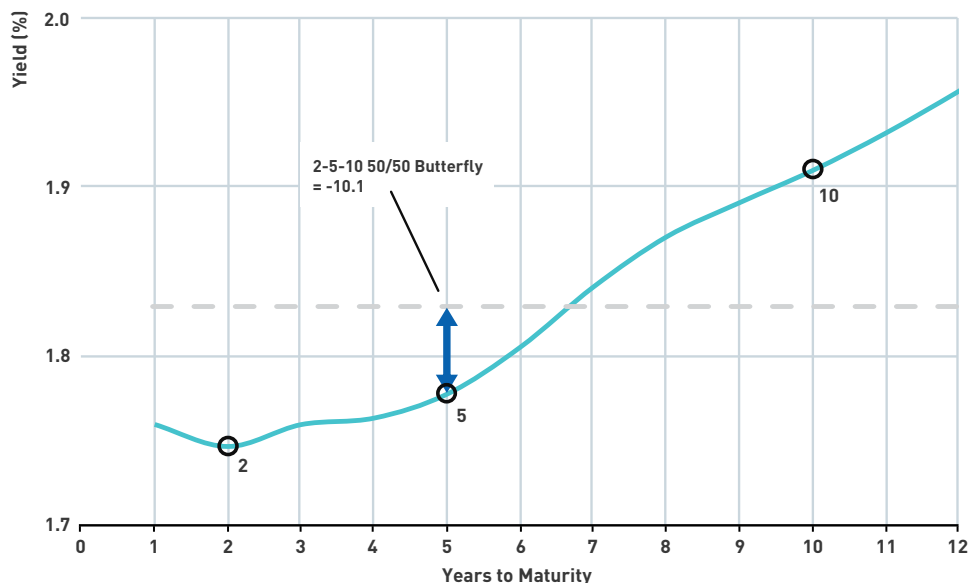
FIGURE 1

## 2-5-10 Butterfly, August 8, 2018



Source: BMO Capital Markets' Fixed Income Sapphire database

Of course, yield curves change and the value of curvature is always in motion, just as the level of yields and slope of the curve is variable. We show another extreme in Figure 2, which is a snapshot of the Canadian yield curve just 8 months after the one shown in Figure 1. In Figure 2, the curvature is now negative as the vertical distance between the average of the wing yields is above the observed yield level of the body. In this historical case, an investor who bought the body and sold the wings 8 months prior would have profited as the level of curvature fell quickly from +7.5 to -10.1.

FIGURE 2

## 2-5-10 Butterfly, March 4, 2019



Source: BMO Capital Markets' Fixed Income Sapphire database

## 2-5-10 and Futures

Many different combinations of bonds can be structured into butterfly trades but one of the most common is designed to profit from changes in the curvature around the 5-year point, often where the yield curve exhibits the most curvature. This structure is the 2-5-10 butterfly and, in Canada, can be transacted directly in bonds, but can also be transacted in futures contracts on the Montréal Exchange. To do so, an investor can buy CGF (5-year) contracts while selling CGZ (2-year) and CGB (10-year) contracts in appropriate quantities. The opposite trade is equally as possible.

Conveniently, this structure can also be transacted as an exchange-traded futures strategy where an investor buys 6 CGZ contracts, sells 4 CGF contracts, and buys 1 CGB contract simultaneously. Although these standardized weights for the body and wings are convenient, an investor can easily use futures contracts to structure any weighting scheme for 2-5-10 butterflies that they desire either by augmenting the standardized 2-5-10 in futures with extra (or fewer) contracts or by transacting the contracts separately.

# Correlation to Factors

Although intended to be neutral to the level of interest rates and the slope of the yield curve, the 2-5-10 structure is often correlated to both.

### Historical Relationships

Historically, the level of the 2-5-10 butterfly has been correlated to the level of interest rates and the slope of the front-end of the yield curve. Figure 3 gives the correlation coefficients between 2-5-10 and the 5-year yield and front-end slope for a full data set encompassing nearly 20 years, a period starting after the Great Financial Crisis, and the short period since August 2020 when Canadian 5-year yields have finally started rising from pandemic lows. From that figure, we can draw a clear conclusion that a 2-5-10 butterfly moves in tandem with the level of yields, in this case the 5-year yield, and the 3m-1-year yield curve slope, which is essentially a medium-term assessment of the likelihood of rate changes by the central bank.

**FIGURE 3**

## 2-5-10 Correlation Coefficients

| PERIOD | 5-YEAR YIELD | 3M-1Y SLOPE |
|---|---|---|
| 2003-Apr21 | 0.58 | 0.56 |
| 2010-Apr21 | 0.71 | 0.73 |
| Aug20-Apr21 | 0.88 | 0.65 |

Source: BMO Capital Markets[i] Fixed Income Sapphire database
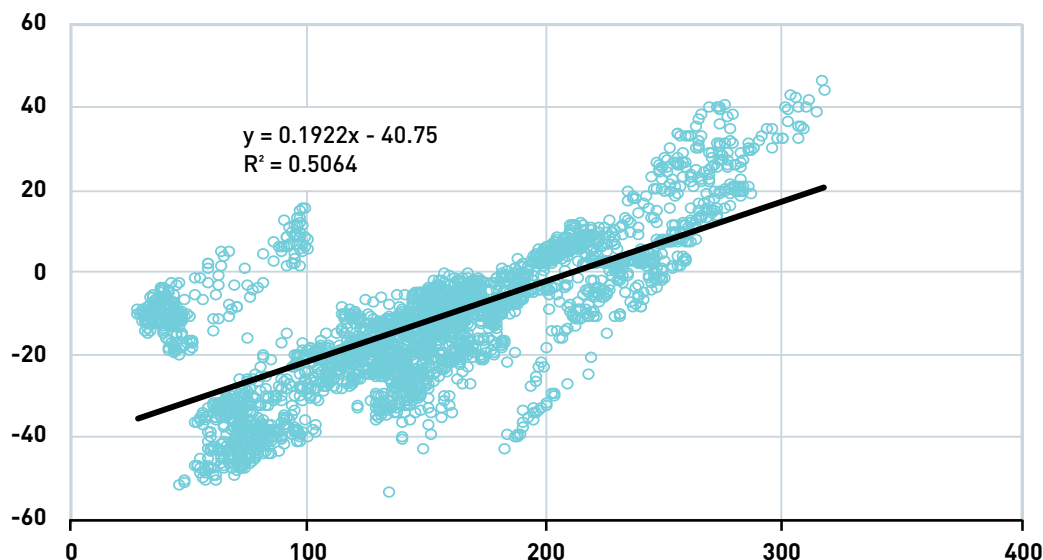
### Yields

Correlation to yields, especially the 5-year yield, makes intrinsic sense given that yield curves have tended to be very flat at low levels of yield, especially after 2008. Higher yields are associated with a more typical looking yield curve that is upward sloping and concave to the origin (humped). Low for long and zero interest rate policies have tended to create very flat yield curves with little curvature at low-yield levels.

Figure 4 shows a regression of the traditional 50/50 weighted 2-5-10 butterfly versus the level of 5-year interest rates since 2010. The figure clearly shows the tendency for 2-5-10 to rise to higher levels when 5-year yields are higher.

**FIGURE 4**

## 2-5-10 versus 5y
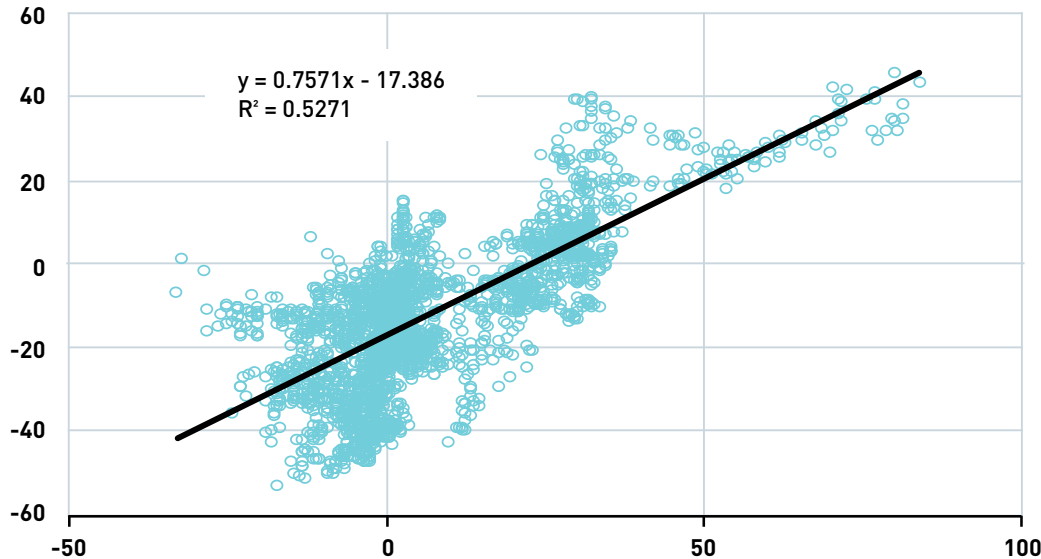


$y = 0.1922x - 40.75$
$R^2 = 0.5064$

Source: BMO Capital Markets[i] Fixed Income Sapphire database

## Front End

The slope of the front end of the yield curve, a proxy for Bank of Canada rate hike expectations in the market, is also important to the level of a 50/50 2-5-10 butterfly as shown by the regression chart of the butterfly versus the 3-month-1-year slope in Figure 5. When the Bank is expected to raise rates within a year, presumably to slow inflation, 5-year bonds are higher yielding versus the 2-year and 10-year bonds than otherwise. This is consistent with a Bank that has been successful at managing inflation over the long term since any rise in expected inflation would be reflected in the belly of the curve but not in longer bonds, since a successful central bank will quell inflation tendencies over longer periods as it manages aggregate demand in the economy.

**FIGURE 5**
## 2-5-10 versus 3m1y



$y = 0.7571x - 17.386$
$R^2 = 0.5271$

Source: BMO Capital Markets[i] Fixed Income Sapphire database

## Bearish Front-End Steepener

A 2-5-10 curvature trade, when constructed traditionally, can best be thought of as a bearish trade with a bias toward a steepening of the front-end of the yield curve or, essentially, a prediction that the market will imply more (be short the body for more curvature) aggressively hawkish talk/moves by the central bank, or less (be long the body for less or negative curvature).

# Weighting Schemes

Multiple methods for weighting a 2-5-10 butterfly exist and we are only going to discuss four of the most commonly traded weighting schemes here. While each has its merits, clients will probably be most comfortable with the traditional 50/50 weight or a regression-weighted 2-5-10 butterfly.

## Cash & DV01 Neutral

In bonds, many clients prefer to structure a 2-5-10 butterfly to be both cash neutral and DV01 neutral since doing so results in a zero cash flow and no (initial) deviation in the total market value of bond positions. Investors should note though that this version of the trade is not normally neutral to the slope of the yield curve. To create this structure, an investor calculates the weights for the wings that simultaneously satisfy the two equations:

$$\text{Notional}_{Body} \times \text{DV01}_{Body} = \text{Notional}_{Wing1} \times \text{DV01}_{Wing1} + \text{Notional}_{Wing2} \times \text{DV01}_{Wing2}$$

$$\text{Notional}_{Body} \times \text{Price}_{Body} = \text{Notional}_{Wing1} \times \text{Price}_{Wing1} + \text{Notional}_{Wing2} \times \text{Price}_{Wing2}$$

Where prices are full (dirty) prices, including accrued interest.

As with all 2-5-10 butterfly strategies, this one could be constructed in futures contracts to minimize portfolio disruptions and trade maintenance. We show an example construction of a cash & DV01 neutral 2-5-10 butterfly in futures contracts[2] in Figure 6.
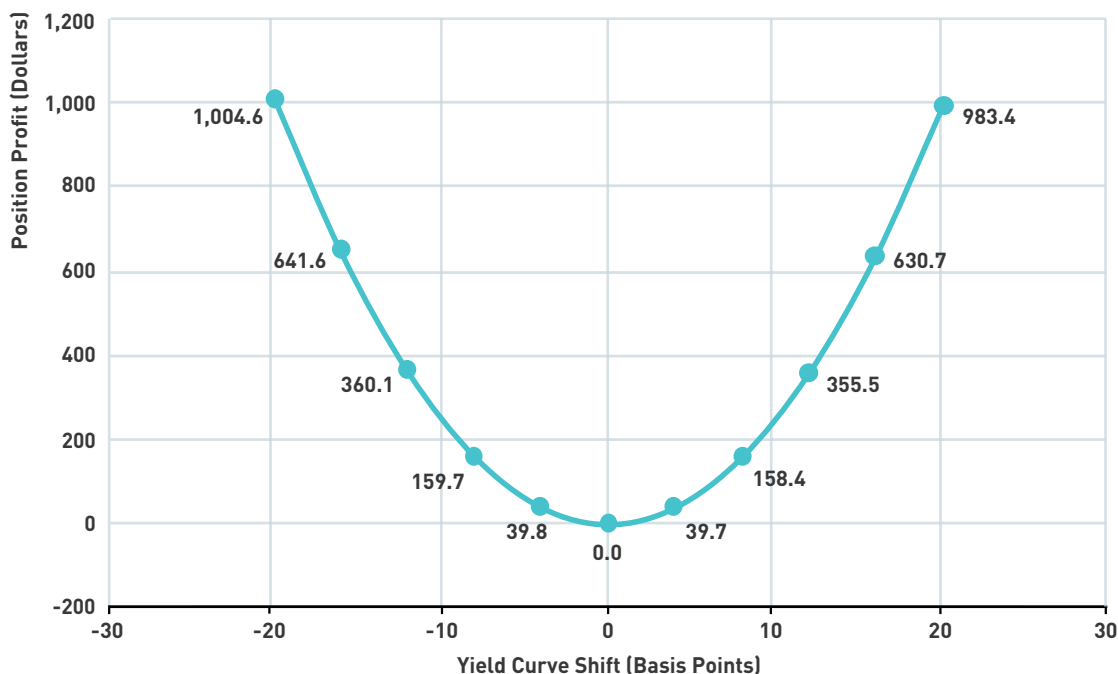
**FIGURE 6**

|  | WING1 | BODY | WING2 | TOTAL |
|---|---|---|---|---|
| Security | CGZM21 | CGFM21 | CGBM21 | 2-5-10 Bfly |
| Position | 219 | -414 | 200 |  |
| Position DV01 | 4,188 | -25,001 | 20,796 | -17 |
| ConvV01 | 9 | -132 | 172 | 50 |

Source: Montréal Exchange

This 2-5-10 construction has positive convexity, a trait shared by many butterfly trades that are short the body, as shown below in Figure 7 where we chart the instantaneous gain/loss in the butterfly incurred by parallel shifts in the yield curve. Since the trade is DV01 neutral, the only gain/loss incurred is via the positive convexity of the butterfly.

**FIGURE 7**

# Cash & DV01 Neutral Butterfly Profit, Parallel Shifts



## 50/50

Another traditional weighting of a butterfly trade is for the investor to buy (sell) 1 unit of risk in the body and sell (buy) 0.5 units of risk in each of the wing bonds, or futures contracts in this case. This is the structure examined in the correlation sections above and, despite being both interest rate and slope neutral, exhibits a steepening bearish bias in almost all economic environments as we showed above in Figure 4 and Figure 5.

In cash bonds, this structure is not cash-neutral like the cash & DV01 neutral structure described above, and can create cash management issues for some clients. Transacting the butterfly in futures solves those potential issues for many portfolios as the cash used for margining futures positions is usually negligible.

An example of the 50/50 butterfly constructed in futures contracts, once again for a position of short $25,000 DV01 in the body of the butterfly, is shown in Figure 8.

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2 We present this weighting scheme here for completeness and since some clients may have experience with it. Since a cash & DV01 neutral trade is usually favored by portfolios which need to avoid holding negative or positive cash balances and transacting 2-5-10 in futures already solves this problem for many portfolios, the likely reason a manager would favor this weighting scheme would be if they intended to make and receive delivery on the entire trade.
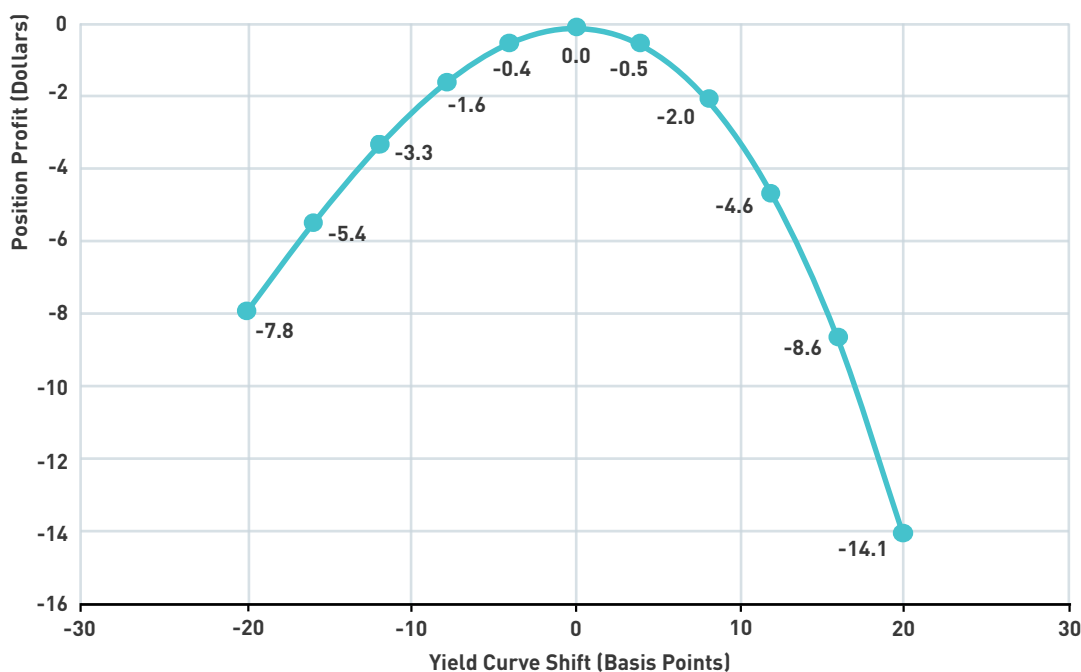
**FIGURE 8**

| | WING1 | BODY | WING2 | TOTAL |
|---|---|---|---|---|
| Security | CGZM21 | CGFM21 | CGBM21 | 2-5-10 Bfly |
| Position | 654 | -414 | 120 | |
| Position DV01 | 12,505 | -25,001 | 12,478 | -18 |
| ConvV01 | 28 | -132 | 103 | -1 |

Source: Montréal Exchange

Unusually for a butterfly, the 50/50 weighted 2-5-10 is currently very slightly negative convexity due to the high coupon of the CGBM21 cheapest-to-deliver bond relative to the other contracts. At less than a dollar per one basis point shift in the yield curve, this does not appear relevant for any institutional client.

**FIGURE 9**
## 50/50 Butterfly Profit, Parallel Shifts



### Inter-Group Strategy Weights (6CGZ-4CGF+1CGB)

An easy way to trade 2-5-10 butterflies is via the 6CGZ-4CGF+1CGB listed inter-group strategy on Montréal Exchange. By buying 1 unit of the strategy, an investor buys 6 contracts of the active CGZ 2-year contract, sells 4 contracts of the CGF 5-year contract, and buys 1 contract of the CGB 10-year contract. The strategy resembles the weights of a 50/50 weighted butterfly but, since the contract ratios are fixed while the relative DV01 of each contract is variable, investors may want to incrementally adjust the number of contracts to adjust the risk profile of the trade and ensure it reflects their view.

Aside from the bundled nature of this transaction, trading a 2-5-10 butterfly entirely in futures opens curvature strategies to managers that cannot trade cash bonds or who choose to avoid the uncertainty and additional costs of financing positions in the funding markets. Additionally, some weighted butterflies consume (or generate) cash in quite large amounts, which can introduce additional management problems in some portfolio structures.

We show this trade construction below in Figure 10. Note that the advantage of standardized weights and single-step execution can have a cost, as illustrated here by the fact that this construction is not DV01 neutral at this time and is negatively convex[3], although not disturbingly so. As mentioned above, clients can execute most of their trade construction via the inter-group strategy, and then augment with incremental contracts to create whatever weighting scheme is optimal for them.

3 Since a parallel curve shift results in gains/losses unrelated to the convexity position, the convexity chart is less relevant here and is not shown.

FIGURE 10

| | WING1 | BODY | WING2 | BUTTERFLY |
|---|---|---|---|---|
| Security | CGZM21 | CGFM21 | CGBM21 | 2-5-10 Bfly |
| Position | 621 | -414 | 104 | |
| Position DV01 | 11,874 | -25,001 | 10,762 | -2,365 |
| ConvV01 | 27 | -132 | 89 | -16 |

Source: Montréal Exchange

## Regression Weighted

A regression-weighted butterfly attempts to account for the fact that the slope between the front wing yield and the body is normally more volatile than the slope between the body and the far wing. By calculating the weights of the wing bonds based on the historical (and hopefully future) sensitivity of the 5-10 slope to the 2-5 slope, structure is improved, assuming the historical correlation holds for the trade horizon. Regression-weighted butterflies are not cash neutral, like 50/50 structures and many clients can benefit from reduced portfolio management issues and costs by constructing these trades in futures.

A regression-weighted butterfly is constructed by solving the system of linear equations:

$$\text{Notional}_{Body} \times \text{DV01}_{Body} = \text{Notional}_{Wing1} \times \text{DV01}_{Wing1} + \text{Notional}_{Wing2} \times \text{DV01}_{Wing2}$$

$$\text{Notional}_{Body} \times \text{DV01}_{Body} = \text{Notional}_{Wing1} \times \text{DV01}_{Wing1} - \beta \times \text{Notional}_{Wing1} \times \text{DV01}_{Wing1}$$

Where β is the regression coefficient between $\text{Yield}_{Body}$-$\text{Yield}_{Wing1}$ and $\text{Yield}_{Wing2}$-$\text{Yield}_{Body}$.

We found the regression coefficient between 2-5 and 5-10 to be in the range of 0.25 to 0.36 over various timeframes as shown in Figure 11. Normally, a recent period is chosen to create a regression-weighted butterfly so we chose the coefficient 0.36 from the most recent period of rising rates since August 2020 to structure the trade shown in Figure 12. Unfortunately, this structure is never[4] cash-neutral when transacted in bonds; a fact that makes the structure in futures advantageous for some.

**FIGURE 11**
## Regression Coefficients, 2-5 versus 5-10

| PERIOD | β |
|---|---|
| 2003-Apr21 | 0.30 |
| 2010-Apr21 | 0.26 |
| Aug20-Apr21 | 0.36 |

Source: BMO Capital Markets' Fixed Income Sapphire database

This version of the 2-5-10 butterfly is DV01 neutral and compensates for the fact that front-end yields are more volatile than long-term yields.
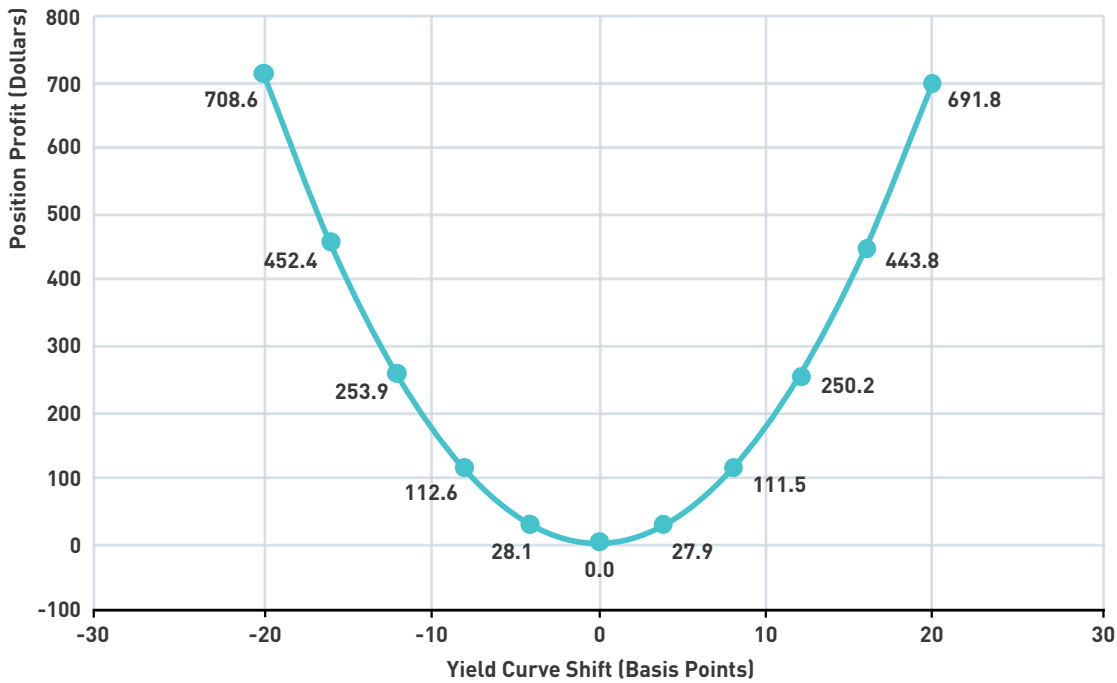
**FIGURE 12**

| | WING1 | BODY | WING2 | TOTAL |
|---|---|---|---|---|
| Security | CGZM21 | CGFM21 | CGBM21 | 2-5-10 Bfly |
| Position | 346 | -414 | 177 | |
| Position DV01 | 6,616 | -25,001 | 18,405 | 20 |
| ConvV01 | 15 | -132 | 152 | 35 |

Source: Montréal Exchange

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4 Except by random chance.

Additionally, the regression-weighted version is positive convexity, as shown in Figure 13. For clients that can transact 2-5-10 in futures, the regression-weighted version is a purer version of the curvature trade while remaining easy to manage even in portfolios that tend to avoid generating positive or negative cash balances.

**FIGURE 13**

## Regression Butterfly Profit, Parallel Shifts



# Current Situation

As many readers will have guessed, the 2-5-10 butterfly has risen rapidly as the selloff in 5-year bonds has progressed since the beginning of 2021. In Figure 14, one can observe that the trade reached a point of about +15 basis points after trading as low as -20 at the end of 2020. As of early May 2021, it had retraced to around +5 basis points, still quite elevated versus most periods in recent years.

**FIGURE 14**

## CAD Constant Maturity 2-5-10 (2x body), 2010 to 2021



Source: BMO Capital Markets' Fixed Income Sapphire database

The rise in 2-5-10, coincident with a rise in 5-year yields and the level of 2-5 slope, is shown for the most recent period in Figure 15. Interestingly, market participants seem to have concluded that the Bank of Canada may indeed allow inflation to be sustained for longer than once thought before stepping in to cool growth. Evidence of this is the fall in 2-5-10 while 2-5 has remained steady for about 2 months; falling 2-5-10 but steady 2-5 means 5-10 must have been steepening.

If the Bank of Canada does allow additional inflation to assure themselves that the post pandemic recovery has truly taken hold, 2-5-10 could fall in an inflation anticipating environment rather than rise. 2-year yields would reflect the Bank's low yield stance while both 5-year bonds and 10-year bonds would reflect higher inflation expectations, in this way, 2-5-10 may behave differently during this recovery and period of rising rates than it has in the past.

**FIGURE 15**

## CAD Constant Maturity 50/50 2-5-10 (2x body), Since Low Yields of 2020



Source: BMO Capital Markets[i] Fixed Income Sapphire database

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