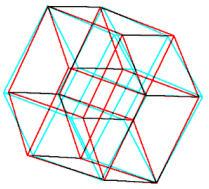


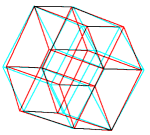
Adding Alpha with Eris Swap Futures

- Eris Futures track the total return of a complete set of interest rate swap maturities.
- They provide higher duration exposure than other fixed income futures, with convexity, and are therefore a more natural fit for traditional longer dated fixed income trading.
- Relative value trading ratios are more accurate using Eris Swap Futures, as the embedded total return tracking inherent in the construction of Eris contracts captures all carry and roll down.
- IMM dates, and preset coupons, ensure maximum concentration of liquidity, and efficient unwind ability.
- Margin costs can be reduced due to offsetting versus other CME Group interest rate futures (Eurodollar futures and US Treasury futures).
- Eris allows non-ISDA users access to the IRS market.

CME Eurodollar Futures, which offer a linear payout based on the movement of 3 month LIBOR, are perhaps one of the world's most successful listed interest rate futures products. The success of interest rate futures in general, and Eurodollars in particular, comes from three sources:

a) Simplicity: The implied rate is exactly 100-(futures price). No exponentiation involved as when calculating NPVs. No division by non-linear terms. Very easy to reason about.
b) Concentrated liquidity. Unlike OTC LIBOR derivatives, issue dates and maturities are fixed to four "IMM" dates per year, thereby consolidating open interest to a small number of points on the curve, vastly increasing the number of buyers and sellers who can meet each other.
c) High granularity. Three-month spacing allows for very high-resolution relative value trading possibilities, especially for the first 8 contracts (2 years) of the curve.

These design choices have made Eurodollars some of the most successful financial products in history, but as with all choices, there are tradeoffs. Calculating yield is made more difficult because a *convexity adjustment* is necessary (yield does not, in reality move as a linear function of price). On point c), high granularity, while excellent for short-term interest rate traders, is more cumbersome when one wishes to hedge a larger swap book, or compare



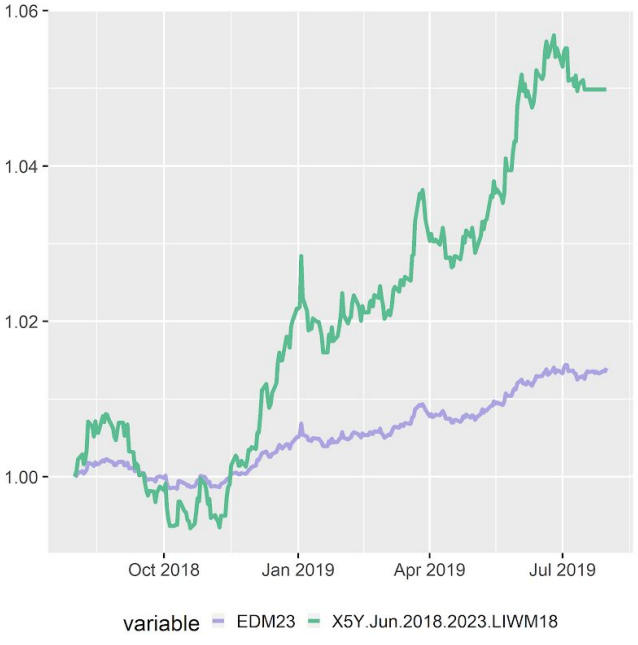
futures to bonds. In this respect it could be argued that Eurodollar futures are optimal for short term interest rate traders, especially in banks, where very accurate money market term structure evolution needs to hedged. On the other hand, the vast majority of fixed income *investment* occurs in coupon-bearing instruments, including interest rate swaps (IRS), for reasons that the ultimate end users typically require coupons for income.

Enter Eris Futures

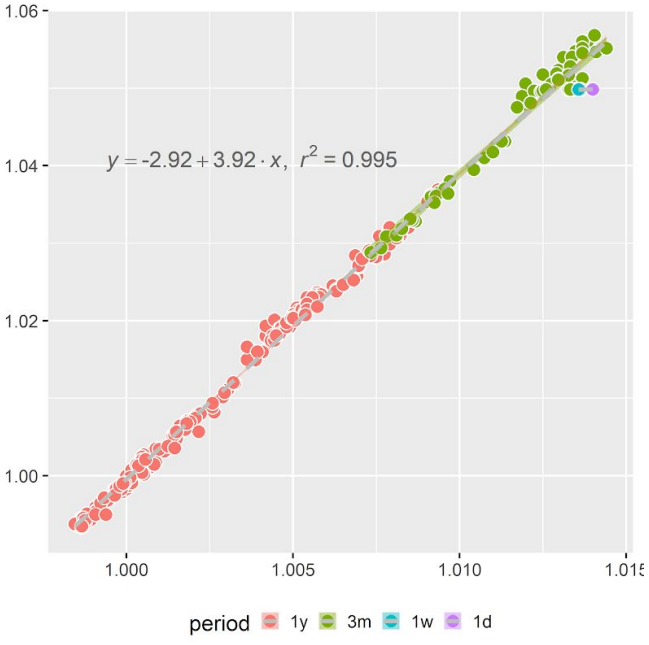
The Eris Futures product is an exact replica of an OTC interest rate swap, except that it trades on an exchange (the CBOT), has preset close-to-market coupons, set to match the Sifma MAC rate 9 months in advance of the swap's IMM effective (start) date. As such, compared with Eurodollars:

a) Eris contracts trade natively on price. The P&L from an Eris position is an NPV-accurate function of the yield, including convexity.
b) Eris includes all the coupons (and the NPV) of an interest rate swap, just like a fixed income investment. Indeed the Eris price also includes Price Alignment Interest, or the inherent daily funding on the MTM collateral that would be posted for collateralized IRS, and as such the Eris price represents an exact total return index of an equivalent IRS.
c) Contracts past the swap start date continue to be listed until the final maturity date of the equivalent IRS.
d) Longer maturities with much longer duration and greater DV01 (see charts 1 and 2).

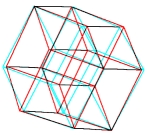
TRI performance EDM23 vs Eris 5Y Jun 2018-202:
Chart 1



Eris 5y high beta against EDM23
Chart 2



Eris Futures track interest rate swaps, and therefore have higher beta to the market than eurodollar futures. Where Eurodollars provide highly granular and accurate access to term structure evolution,



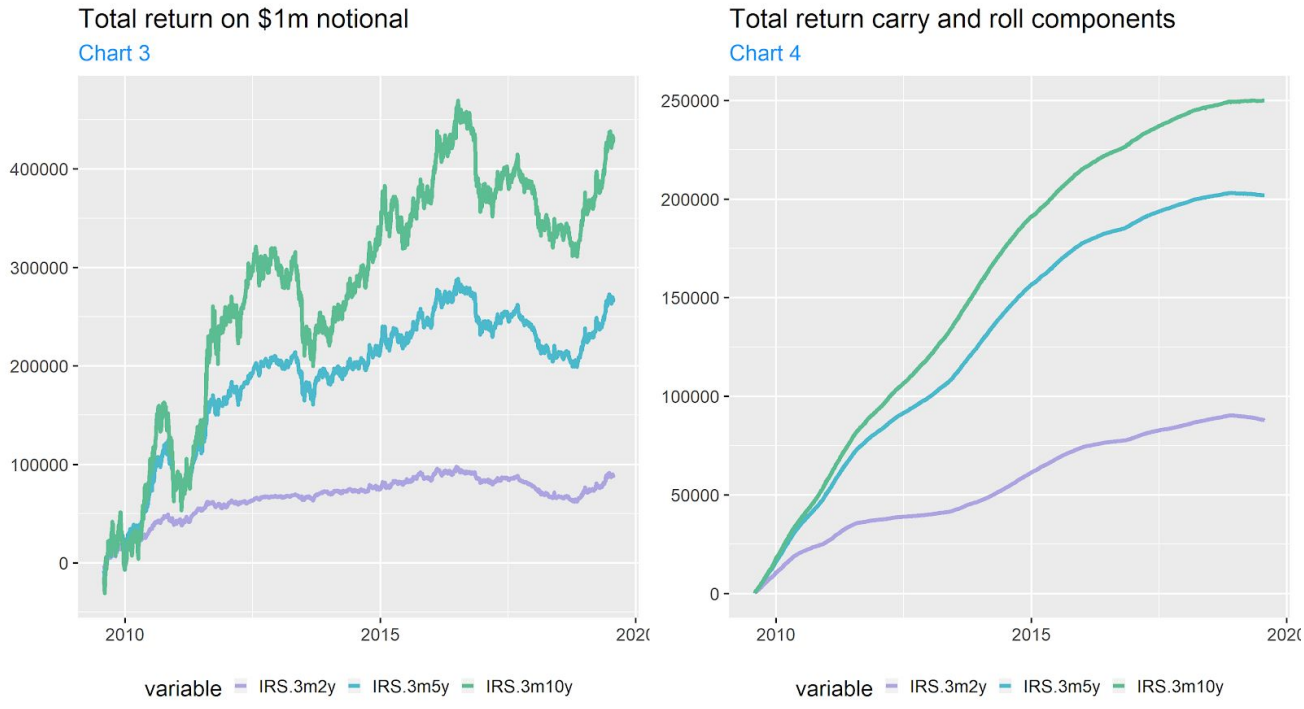
Eris Futures track longer dated instruments. In the charts above we show the total return and beta of Eris Futures versus a single comparable Eurodollar future, in order to highlight this difference.

Compared with IRS, benefits include:

a) Liquidity. This is an IMM-date product with concentrated liquidity on IMM dates.
b) Central clearing counterparty maintenance margins of 25-60% of the equivalent cleared IRS.
c) Central limit order book allows easier electronic trading.
d) Automatic margin offset versus CBOT Treasury and CME Eurodollar futures.
e) Avoid added funding costs often charged on initial margin for cleared IRS.
f) No expensive “broken dates” unwind costs, before and even after the swap effective date.
g) Easy NPV calculation for risk management and historic backtesting.
h) Ease of access to IRS economics for entities which do not have ISDAs with banks.
i) Listed product therefore avoids cross-bank credit risk and unwind charges.
j) Line item cost optimization for active users of swaps and large swap books (avoidance of per-entry book costs for offsetting instruments).

Why IRS?

The interest rate swap market grew out of the need for banks, but especially corporate bond issuers, to hedge their longer dated interest rate exposures. In a typical primary market, a corporation or a bank wishes to borrow money at the cheapest rate possible, but also wishes not to have to repay funds for as long as is necessary to match the needs of the funds. It is typical for companies to borrow for maturities of 5 years or 10 years, because these are the timeframes over which they expect their investments to have made a good return. However in addition to borrowing for long periods of time, issuers also wish to pay as little interest as possible. Yield curves are typically upward sloping, meaning that the lowest borrowing rates are to be found in the short end. How do they reconcile these apparently conflicting objectives? They use the interest rate swap market. IRS allows issuers to swap their long dated interest rate exposure, to a front-end rolling short interest rate exposure. Thus they are able to obtain the best of both worlds - issuing into investor demand for longer dates, while paying the lower rates in the front end. Of course there is no free lunch -- by swapping to the front end they are exposing themselves to the risk that the path of short dated rates will rise *more than implied by the yield curve*. Nevertheless, despite this risk, history has demonstrated that typically, long dated exposure is much more expensive for the borrower than short dated exposure, as shown in the following charts:

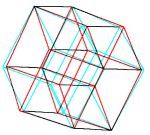


Longer dated interest rate swaps tend to pay more than shorter dated ones, but this is not only because of higher beta through duration. The chart on the left shows the entire total return on three IRS instruments (all 3m forward starting), and on the right, the same but with the capital gain/loss associated with DV01 stripped out. It is clear that carry and rolldown still have a significant effect, and that the effect is greater for longer maturities. In the above case the "carry" has been priced into the roll, since these are forward starting instruments. Nevertheless the economics are equivalent.

It is clear that the swap market tends to function as it is supposed to: it provides the very useful service of meeting the objectives of both classes of actors in the financial markets: borrowers and lenders. It is for this reason that it has been so successful, and it is arguably surprising that futures which properly track such a fundamental market have not already been created. Eris Futures fill this market need, and allow investors to track the crucial dynamics between front end and long end markets. Given that they provide efficient long term exposure, they can be viewed as an important new futures tool uniquely suited for fixed income traders of the longer end.

How exactly do Eris Swap Futures work?

Eris Futures contracts are listed on the Chicago Board of Trade (CBOT, a CME Group company), in maturities of 2y, 3y, 4y, 5y, 7y, 10y, 12y, 15y, 20y and 30y. The underlying swap terms are set as the MAC swap terms when initially published 9 months in advance of the swap start date, and CME currently lists 3 forward starting IMM dates. Similar to US Treasury futures, the nearest quarterly IMM effective dated contract is the actively traded contract, but all listed contracts may be traded by request for quote (RFQ), which facilitates and encourages electronic liquidity in old Eris contracts. MAC interest rate swaps are standardized IRS contracts, starting on quarterly IMM dates (third Wednesday of each of March, June, September, and December), and maturing on the equivalent day X years later,



where X is the maturity of the underlying MAC swap. The coupons are set to the Sifma MAC (market agreed coupon), which Sifma has CME administer on their behalf. The MAC rate is then assigned to cleared OTC swaps and to Eris Swap Futures. MAC swaps coupons are rounded to the nearest 25bps to the prevailing par market coupon at the time.

Eris Futures trade in notional increments of 100k USD, and exactly track the cash flows and thus the P&L of the underlying MAC swap, including all the components of returns, including directional movements, coupon carry, slide, and rolldown, and margin capital return (PAI). As such, they provide identical cash flow exposure as would entering into an equivalent OTC interest rate swap.

Importantly, Eris Futures do not actually mature until the underlying swap matures. The date assigned to Eris contracts represents the IMM effective date, not the maturity date. So LITZ19 represents the Eris 2yr (LIT), with a 2 year swap commencing on the December 2019 IMM date. After the IMM date, the contracts remain listed until the maturity date of the underlying swap, with all cash flows settling in the Eris price, which is the sum of 100 + NPV of future cash flows + past cash flows - PAI (Price Alignment Interest, equivalent to the accumulated Fed Funds interest on the daily swap NPV, analogous to the accumulated daily interest received on collateral posted, as if it were a collateralized IRS).

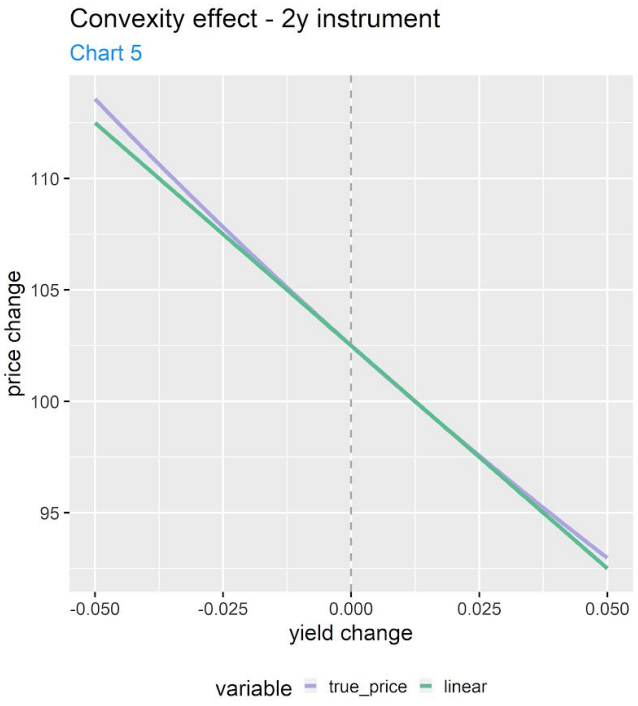
Let's talk about convexity

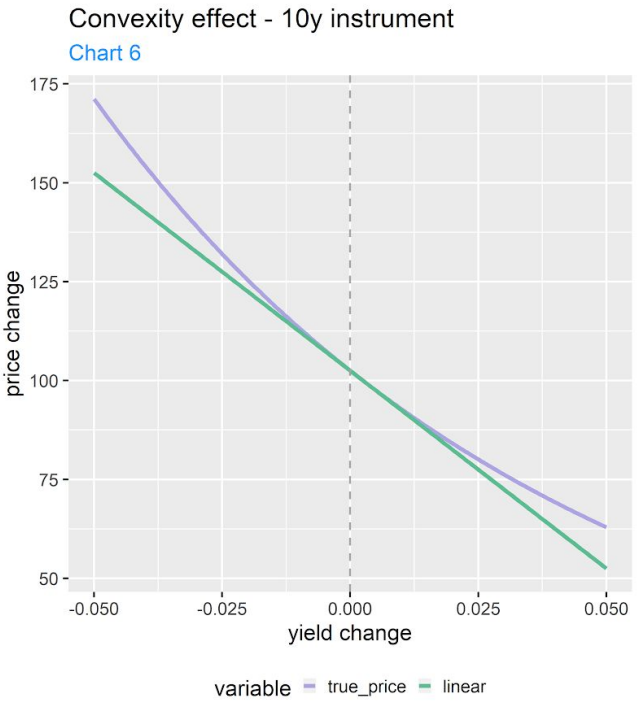
The term convexity refers to the fact that there is a *non-linear* relationship between the price of a fixed income instrument, and its yield. Let's take the simplest example, a zero coupon instrument. These typically trade in yield, and the price is determined by the following formula:

$$p = \frac{100}{(1+r)^y}$$

Where p is the price, r is the rate, and y is the number of years.

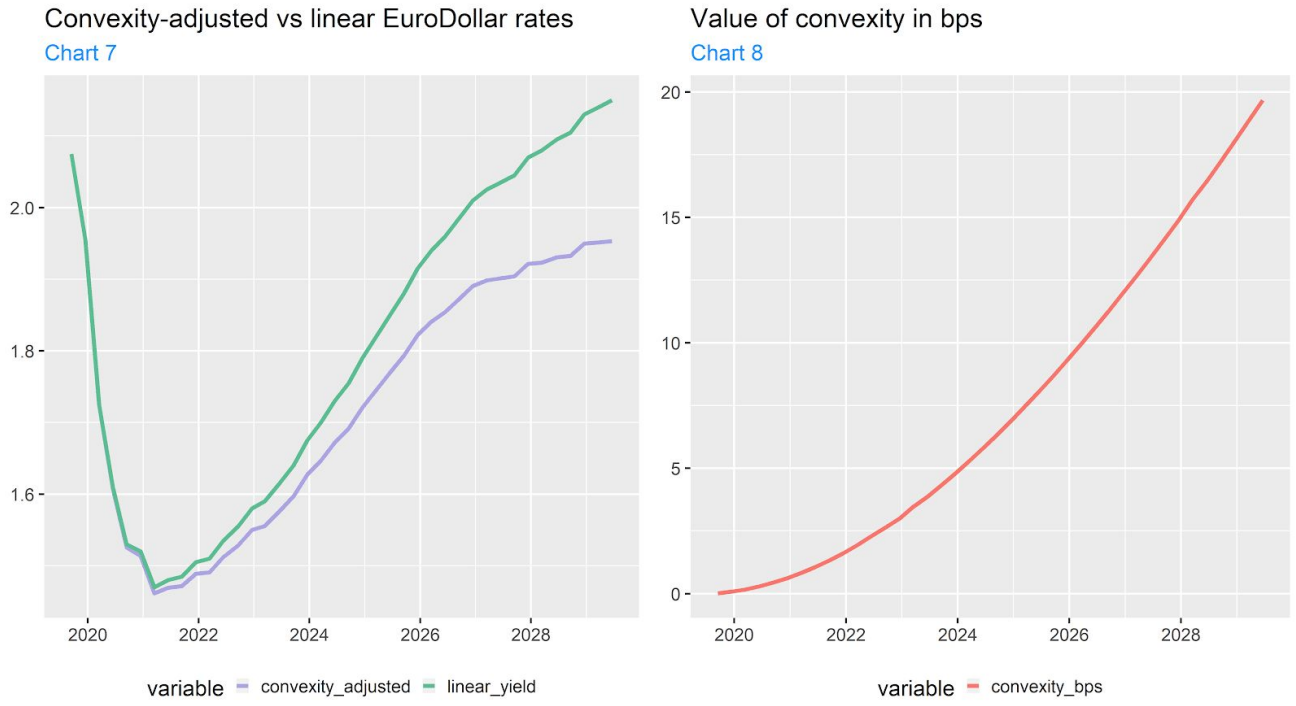
This is a nonlinear equation in r due to the division of a constant by a moving term in the denominator, such that there is a convex relationship between it and p. Non-linearity can be seen in charts 5 and 6 below. As is clear, convexity favours the (long) investor: no matter which direction rates move, the investor who is long is always better off than the investor who owns an instrument that is linear in r.





During big market moves, investors are always better off with a convex instrument, than with a linear one, since the convex line is at all times above the linear one, no matter in which direction rates move. The effect is greater for longer dated instruments.

Eurodollar futures do not have convexity - they move linearly with price. One might assume that investors should therefore sell Eurodollar futures and buy an equivalent instrument that displays convexity, thereby potentially earning alpha if yields move significantly. While it is true that Eurodollars will underperform in large moves, they compensate for this with a higher effective interest rate than the equivalent yield based instrument, a Forward Rate Agreement (FRA). This can be seen in charts 7 and 8 below:



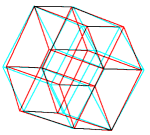
Convexity benefits the investor, but has a cost. The higher the convexity of the instrument (usually with longer maturity comes higher convexity), the less it yields compared with a linear instrument.

As is clear, the further out the maturity spectrum one goes, and therefore the higher the value of convexity, the higher the Eurodollar futures rate will be over the yield of the equivalent FRA.

Nevertheless, this difference in performance means Eurodollars behave much more like money market instruments, and Eris Futures, which keep convexity intact, behave more like IRS. In this respect, Eris Futures represent a canonical fixed income instrument for investors who wish to hedge fixed coupon instruments generally, such as a swap book, or indeed, a relative value trader against cash bonds.

Simplifying the hedge unwind process

A big disadvantage of OTC swaps is the asymmetry between entry and exit costs. It is easy and cheap to enter into a vanilla OTC interest rate swap, but a few days, weeks, or months later, a book may have built up with multiple offsetting legs which do not exactly match. Although unwinding these is made easier now that IRS is (usually) centrally cleared, there are still large potential line-item charges for unwinding instruments that are not standardized. Eris Futures solve this problem, as they are always traded against the CBOT, and are always traded on IMM dates with standardized terms resulting in automatic netting-down of offsetting trades. This concentration of liquidity around four dates per year, and around standardized MAC swap instruments, mean vastly more buyers and sellers can meet efficiently, thereby lowering transaction costs and slippage. This also means that large books of offsetting swaps can be avoided. These advantages should persist even if an investor



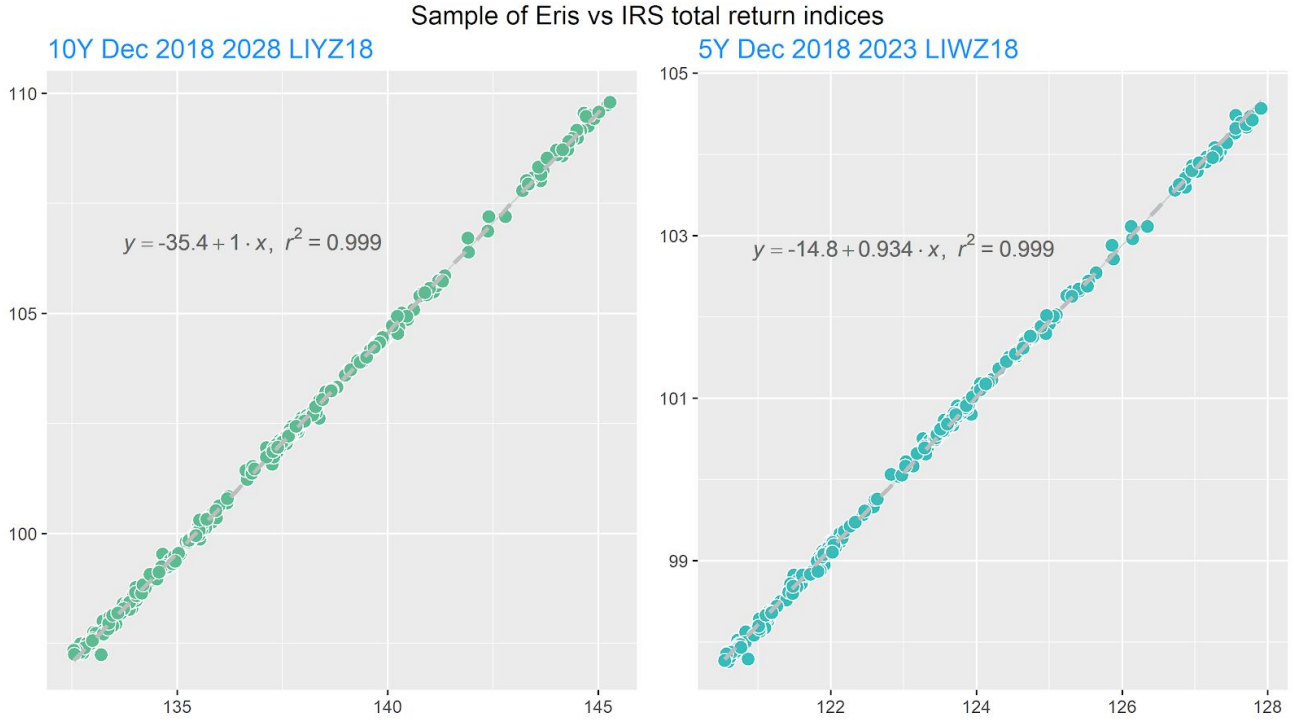
chooses to “take delivery” of the futures contract, since Eris Futures do not disappear in the traditional sense of futures.

When is Eris not the right product?

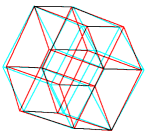
Eris tracks standardized IRS with quarterly IMM effective dates, predetermined fixed coupons, and 10 underlying tenors available to trade. Standardization brings many benefits, but custom (par or other) coupons, or exact matching a set of cashflows, is not possible. Moreover, given that Eris Futures must set their coupon at listing time of the contract (nine months prior to the swap effective date), there can be some “drift” between market-prevalent coupons and Eris Futures coupons, on top of the 25bps rounding difference. Investors can choose to adjust the notional traded by a small amount to match the duration of an underlying instrument to hedge, with minimal tracking error versus exact cashflow matching.

Tracking errors

Eris products have very low tracking error compared with a total return IRS. In the following charts we have produced our own interest rate swap indices from first principles, and regressed them against their matching Eris Futures. It is clear that the tracking error is extremely low, and any jitter in the charts below can be attributed to timezone differences between the input data to our calculations (London), and the Eris Futures closing time (New York).



A full set of these across different periods for both the 5y and 10y is included in Appendix A.

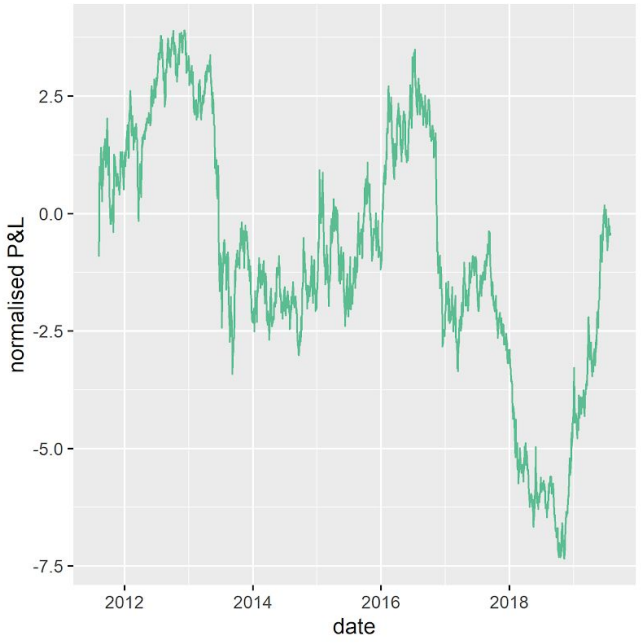


A sprinkling of Alpha

Interest rate swaps are enormously successful products, and Eris Futures track them very well. However it is worth remembering exactly what Eris tracks. It does not track interest rate swap yields, instead it tracks the interest rate swap *total return*, as can be seen in the chart below:

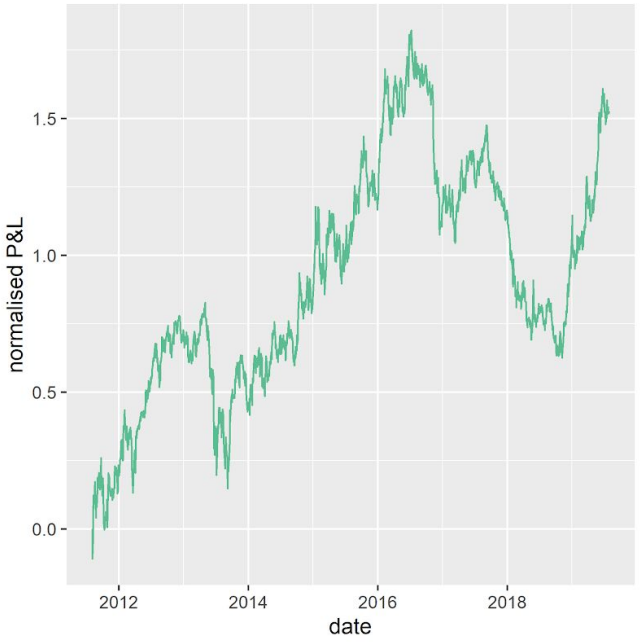
5y rolling P&L due only to rates moves

Chart 10



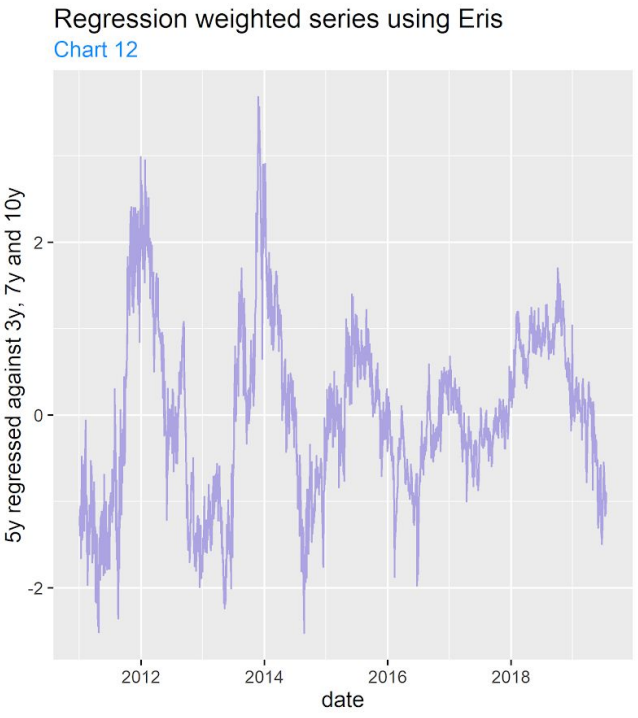
5y rolling P&L including carry

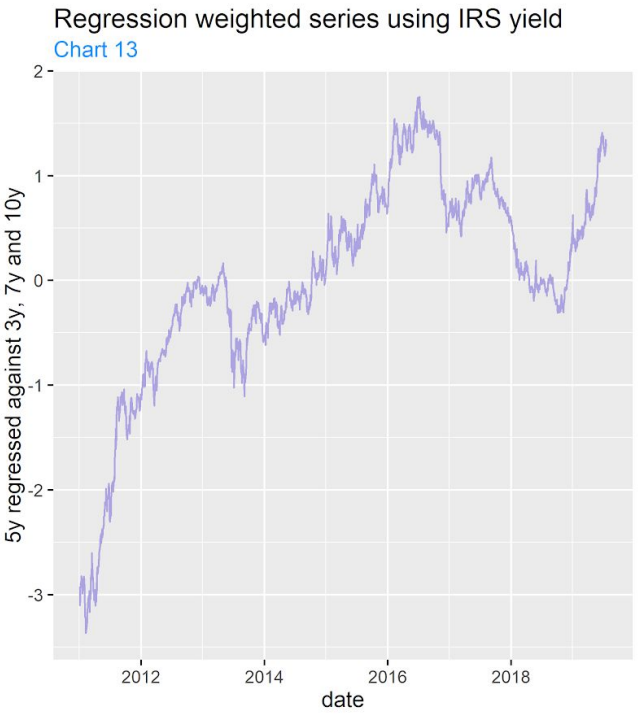
Chart 11



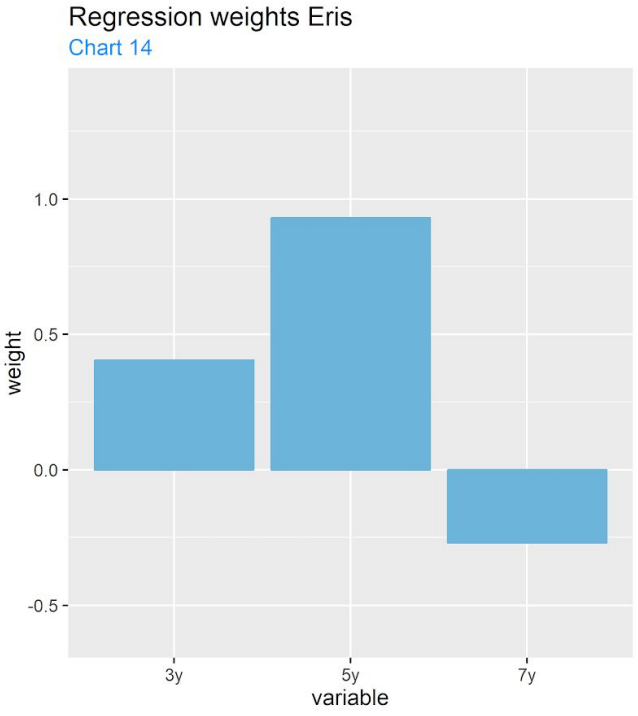
Over long periods, looking only at the interest rate of an IRS is misleading. Including the carry, the series looks markedly different.

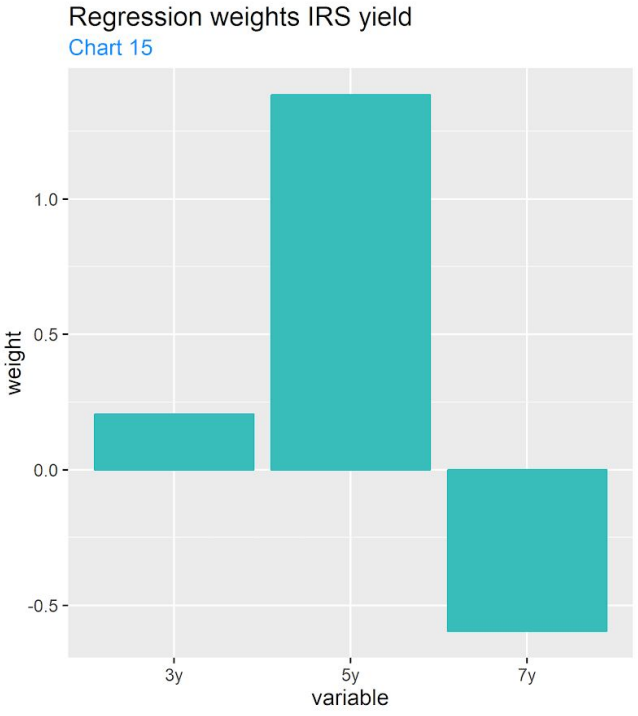
This is important because interest rate swap total returns are notoriously difficult to produce without bootstrapping zero curves for each “roll date” and thereafter repricing an original swap against that zero curve every day. With Eris Futures, all this hard work, which would usually require a quantitative analyst armed with appropriate (and expensive) financial software, is done for you. It is important to note that carry must be taken into account when analyzing potential trade ideas. Here is a good example of how using outright IRS yield can be misleading:



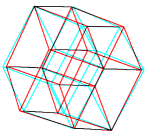


If one were looking for a mean reverting trade over long periods of time, as per chart 12 above, one must take into account carry. If weights are calculated only using yields, then a mishedge might occur (chart 13 is clearly no longer stationary).





The charts show that using Eris, stationary weights are similar but not exactly the same as using the swap yield. Chart 14 is more accurate than chart 15, as return has been taken into account.



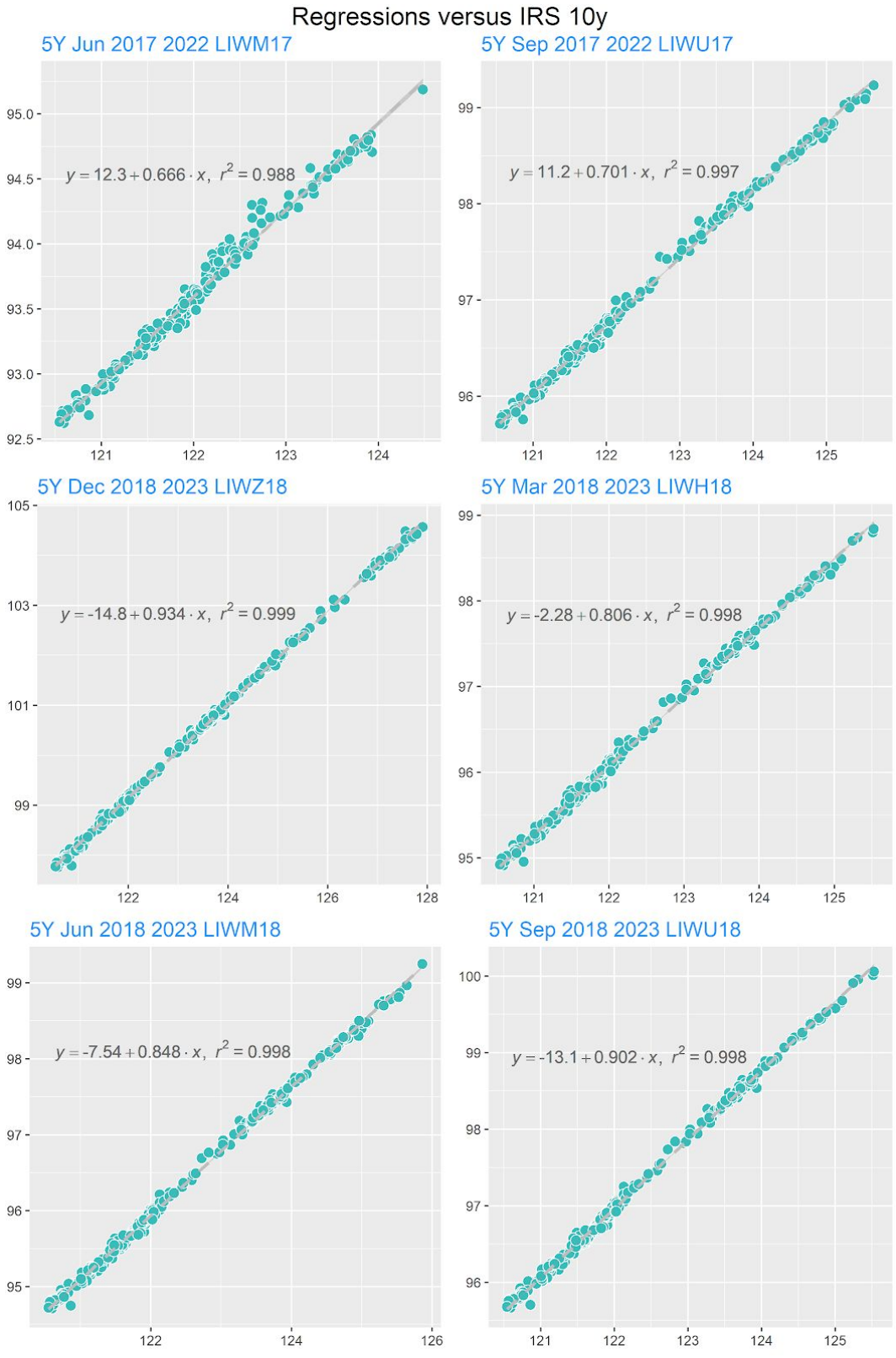
In the charts above, we selected a mean reverting strategy by regressing every maturity offered by Eris against two or three other Eris Futures, chosen optimally using the Leaps R software library's "regsubsets" function (which automatically finds the best independent variables to describe a dependent variable). We then did the same using outright IRS yields, in order to show the difference in weights obtained each time (charts 14 and 15). We show how the carry would "drift" if IRS yield-based regressions were used to calculate weights, instead of the more accurate Eris regressions (chart 13 vs chart 12).

It is clear that while IRS is a good proxy for short term regressions, any long term strategy must take into account the total return of a swap.

It is also clear that there are interesting mean reverting strategies in IRS, many of which do not require dynamic hedging. This will be explored in the next installment of this series.

For further information on the construction of ERIS swap futures, please visit
https://www.cmegroup.com/education/files/eris-methodology-overview.pdf

APPENDIX A: 5y and 10y Eris Futures regressed against constructed IRS total return indices for same maturity, selection of periods




Regressions versus IRS 10y
10Y Jun 2017 2027 LIYM17
y = -26.7 + 0.851 · x, r² = 0.996
10Y Sep 2017 2027 LIYU17
y = -25.2 + 0.902 · x, r² = 0.996
10Y Dec 2018 2028 LIYZ18
y = -35.4 + 1 · x, r² = 0.999
10Y Mar 2018 2028 LIYH18
y = -31.2 + 0.924 · x, r² = 0.997
10Y Jun 2018 2028 LIYM18
y = -33.5 + 0.94 · x, r² = 0.997
10Y Sep 2018 2028 LIYU18
y = -34.7 + 0.964 · x, r² = 0.997