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Synthetic Representation of Fixed Income ETFs

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Synthetic Representation of Fixed Income ETFs

With rapidly changing environments, effectively managing risks across diverse portfolios is one of the key demands of Coremont's clients. To meet this need, Coremont is continuously increasing its product coverage to offer a broad range of analytics. This article was written by Alexandre David and Florent Serre, Credit Quantitative Analysts at Coremont. To download this article please click here. To view the official publication, click here

Despite increased interest rates, Investment Grade and High Yield Fixed Income Exchanged Traded Funds (*FI ETFs*) have enjoyed strong inflows in 2023 ([1]). FI ETFs represent a basket of Bonds or Loans (or a mix of both). These funds allow an investor to diversify their risk. The ETFs tend to trade like stocks. Despite, this apparent simplicity, investors should be aware of the risks linked to the underlying instruments. Some long dated treasury bond ETFs have suffered large losses in 2023 due to the rates environment (see [2]). Hence, it is paramount for an investor to understand the underlying risks linked to each FI ETF.

With this in mind, one of our projects in the past year has been the addition of Fixed Income ETFs to *Clarion* – Coremont's portfolio management software. The valuation of such an instrument is straightforward as it is simply Spot times the Quantity. But when it comes to risk representation, one has to consider the underlying constituents and that is where things can get trickier as some ETFs represent more than 3,000 bonds. To overcome this issue, we can think of an ETF as a Synthetic Bond, but the first step is to look at the idiosyncrasies.

Characteristics of Fixed Income ETFs

Exchange-Traded Funds generally represent a basket of equities, commodities, currencies or Fixed Income products. In this blog, we only focus on Fixed Income ETFs and when we use the generic term *ETF*, we will always be referring to a *Fixed Income ETF*. The main providers are Blackrock, Invesco, State Street and Vanguard.

The underlyings of ETFs tend to be Bonds or Loans with different maturities, yields, durations and creditworthiness. With these considerations in mind, there are two options to compute a risk representation on these positions:

1. Load all the underlying constituents and generate risks on each constituent before aggregating the results.
2. Use a synthetic representation to generate risks on this "synthetic bond".

While the first option would appear to be the most accurate, it is not ideal from a practical point of view:

- First, one would need to get static data on all the constituents. As mentioned, some ETFs have more than 3,000 constituents (IEAC LN, IGLB US, IGSB US to name a few). So missing or erroneous data with one of the constituents could lead the whole position to be in error. This means that this solution is harder to maintain.
- In terms of market data, some underlyings might not be traded very often and one would need to be careful about potential staleness.
- Finally, in terms of computing power, it would be time-consuming to process all the underlyings.

These considerations led us to consider a synthetic approach.

What is a synthetic representation of a Fixed Income ETF?

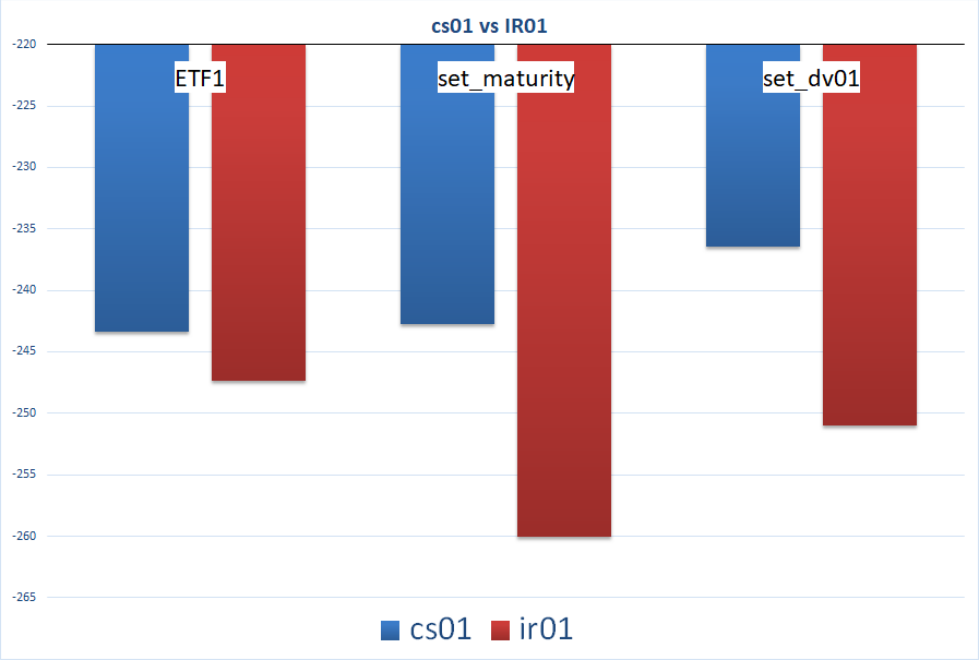
The alternative to loading all the underlying constituents is to represent the ETF as a bond. While representing an ETF as a single bond might seem simplistic, we will demonstrate that, with the right choice of functional, we can generate useful information on the risk profile.

What are the possible approaches?

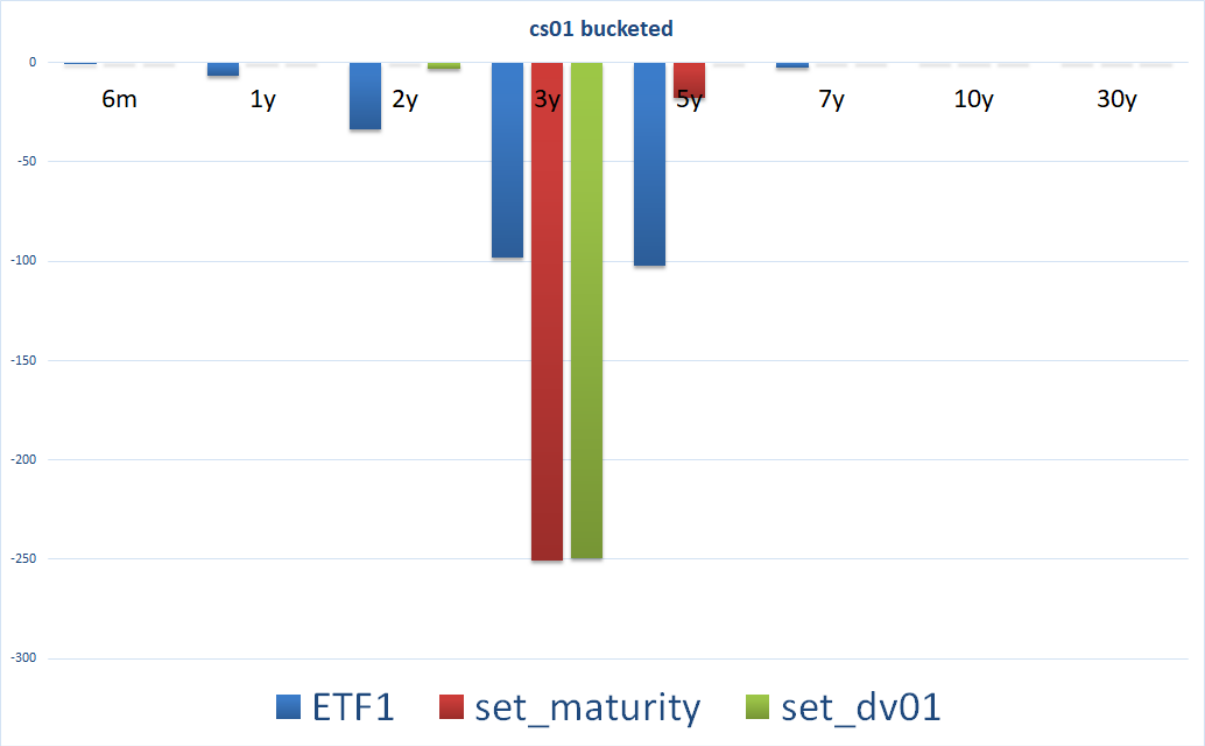
ETF providers generally display information regarding the yield, duration, weighted coupon and weighted maturity of the ETF. Starting from here, we could consider to represent the ETF as a:

1. Single Bond with a matching yield, a matching coupon and a maturity matching the weighted maturity.
2. Single Bond with a matching yield, a matching coupon and a matching duration.

The natural question that arises is, how would this representation fare? We have run some IR01 (which represents the impact of a 1bp parallel shift of the Zero curve) and CS01 (which represents the impact of a 1bp parallel shift of the Credit curve) tests in both cases for an ETF we called ETF 1*:



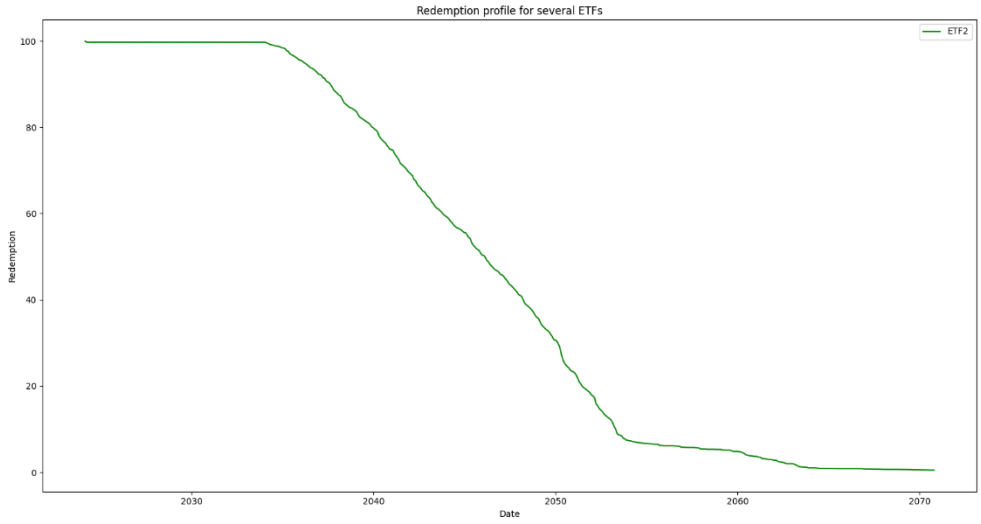
On the left is the actual ETF (the risks were generated using all the underlying constituents of this ETF). In the middle, we match the maturity and on the right, we match the duration. Considering how simplistic this approach is, the risk profile is not too far from the actual ETF. The set dv01 gives better results in terms of IR01. Now let us have a look at the bucketed cs01, which shows the cs01 impact per maturity bucket:



As expected, the result is less satisfying. Most of the risks are on a specific tenor, which is not surprising as we have represented our ETF as a bullet bond. We need to consider the amortization profile.

What is a classic redemption profile for an ETF?

We started with a notional of 100 and we checked all the constituents of a number of ETFs. Every time a constituent reached its maturity, we reduced the total redemption by its weight. We plot below some examples of redemption profiles:



Redemption profiles can have different shapes but we tend to observe an inflection point. Based on those observations, we decided to model the redemption profile using a tangent hyperbolic function:

$$f: x \to A - B\ \tanh((x - \mu) * C)$$

With the following boundary conditions

$$\begin{cases} f(0) = 100 \\ f(M) = 0 \end{cases}$$

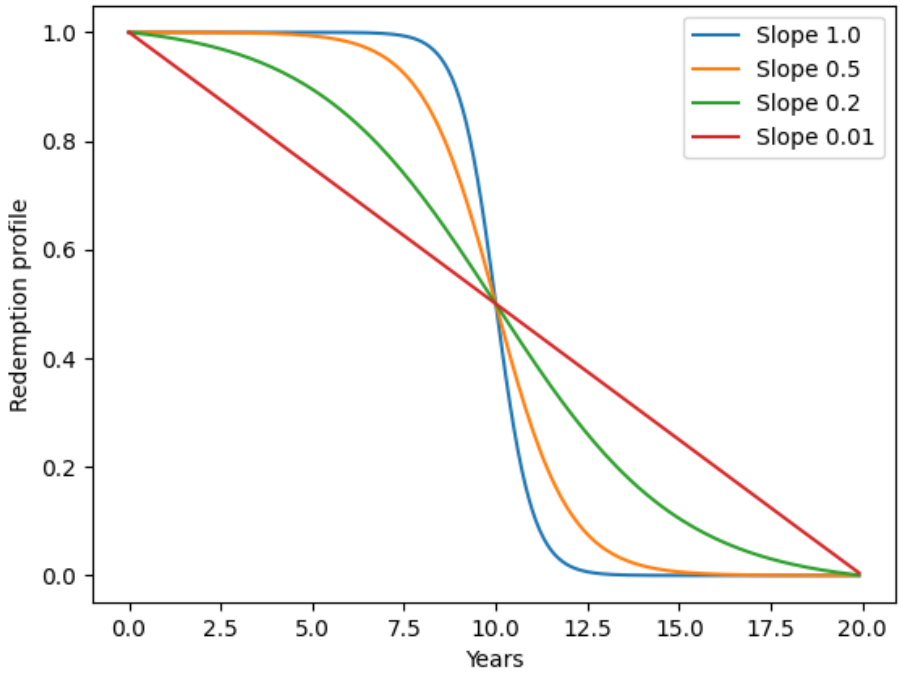
This choice has a number of desirable properties:

- It starts at 100 and finishes at 0.
- We can play with the speed of the amortization profile by changing the coefficient C
- If an ETF targets a specific maturity bucket (e.g. 5 to 10Y), it is easy to keep the redemption profile at 100 by *moving* the functional *to the right*. A Gaussian or inverse exponential amortization profile would not give us such freedom.

Solving the boundary conditions gives us:

$$f: x \to 100\ \frac{\tanh\big(C(M - \mu)\big) - \tanh(C(x - \mu))}{\tanh\big(C(M - \mu)\big) + \tanh(\mu C))}$$

These are the different profiles we can get for different values of C:



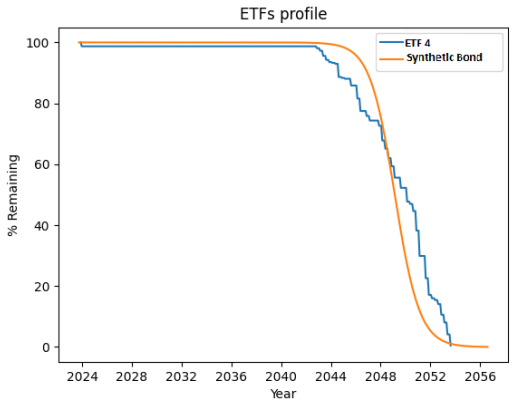
M is set to 20Y and μ to 10Y. A few observations:

- As the *Slope* C tends to 0, we get a linear amortization profile
- By switching μ, we will be able to move the redemption profile *to the right* to fit ETFs targeting a specific maturity bucket. For example, this would be useful for ETFs not amortizing before 5 years.

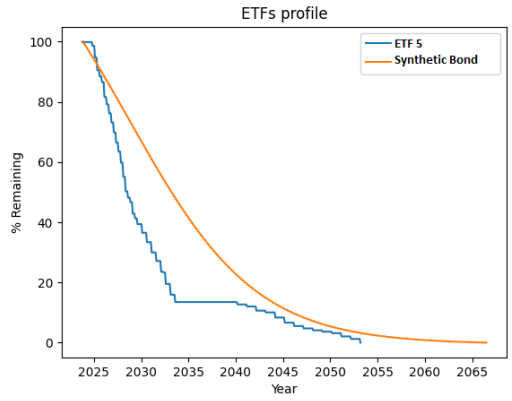
How to set μ?

Inflection point

One method is to set μ so that it matches the weighted maturity of the ETF. This is very tractable and easy to compute. This means that the inflection point will be at the weighted maturity of the ETF. Below, we plot an example of a redemption profile using this methodology:

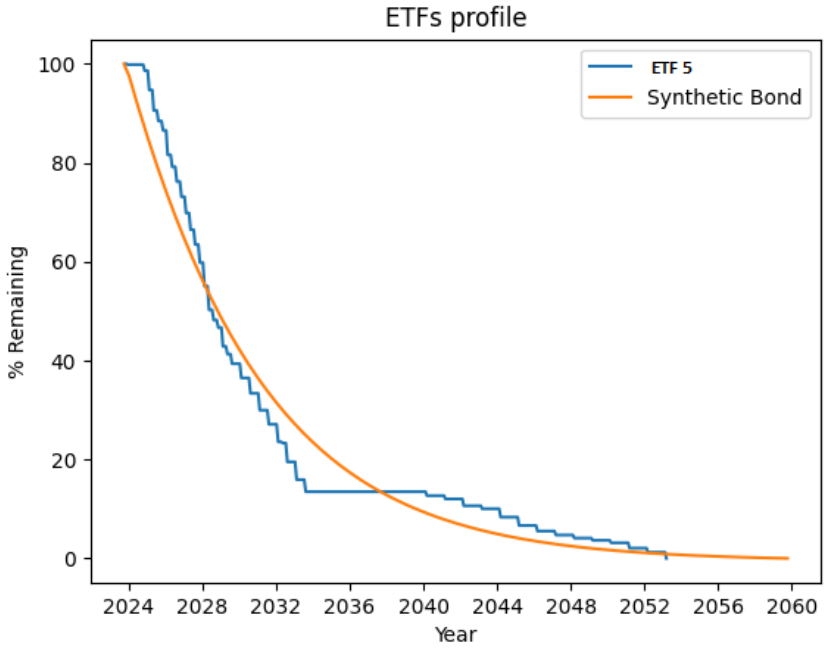


One caveat is that even though this method generalizes well, we can end up with some cases where we have a lot of bonds with a short maturity (let us say < 2Y) but also a large number of bonds with a maturity greater than 10Y. In this specific instance, we get an amortization profile that is relatively *flat* in the middle of the redemption profile and the constraints set for μ might be too restrictive as one can see below



Additional constraints

When dealing with these specific cases, we came up at *Coremont* with a set of additional constraints that allows us to shift μ so that we accurately match the redemption profile.



Redemption profile with additional constraints for μ

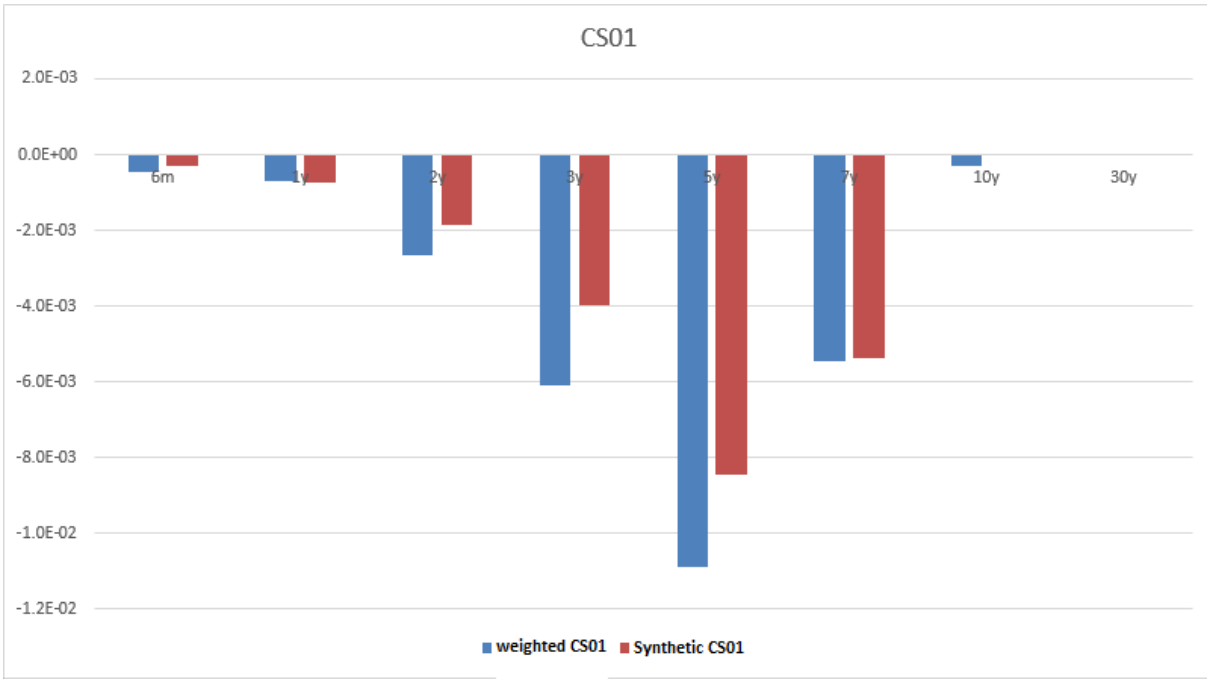
Calibration Process

We have defined the redemption profile of a synthetic bond. The next step is to calibrate a synthetic bond for a given ETF. We create a *set* of candidates with maturities 3M, 6M… all the way to 50 Years. We call B_i the bond with maturity i and an amortization profile that follows the profile explained earlier. Each bond will have a different DV01 that will depend on its maturity. Knowing the Duration (D) of the ETF and the yield y of the ETF, we are trying to minimize

$$\min_i (D - DV01(B_i, y))^2,$$

Penalties are added to the objective function to avoid noisy behaviours (e.g. very long maturities with small weights) but this is out of the scope of this blog. The extra penalties do not have any major impact on the synthetic representation of the ETF.

We now plot the cs01 bucketed of an ETF containing hundreds of bonds versus its synthetic representation using the methodology described above.



Using a single bond, we managed to closely match the risk profile of the ETF.

The results are displayed in *Clarion* under the *Risk* Section. Below is an example of CS01 bucketed and IR01 for 1M position in LQD US:

TRADE DETAILS					VALUE		RISK										
Issuer	Trade Type	Description	Notional	ISIN	Local PV	PV	CS 01	6M	1Y	2Y	3Y	4Y	5Y	7Y	10Y	30Y	Rates Delta
LQD US		LQD US	1m +1m	US4642872422	105,040.0k	105,040.0k	-77.6k	-0.1k	-0.3k	-0.8k	-1.3k	-1.8k	-3.3k	-7.3k	-26.1k	-36.6k	-77.4k
LQD US	ETF	LQD US	1m +1m	US4642872422	105,040.0k	105,040.0k	-77.6k	-0.1k	-0.3k	-0.8k	-1.3k	-1.8k	-3.3k	-7.3k	-26.1k	-36.6k	-77.4k
LQD US	ETF	LQD US	1m +1m	US4642872422	105,040.0k	105,040.0k	-77.6k	-0.1k	-0.3k	-0.8k	-1.3k	-1.8k	-3.3k	-7.3k	-26.1k	-36.6k	-77.4k

Conclusion

We have highlighted the main approach behind our methodology to represent Fixed Income ETFs in *Clarion*. By choosing a specific functional (*tanh*) for the amortization profile, we were able to closely match the redemption profile of ETFs containing hundreds of constituents. As a result, we can produce fast, accurate and stable risk metrics based on this synthetic representation. If you are keen to see more details on the synthetic representation and the calibration method, you can find the full article here.

If you'd like to discuss Coremont's product coverage and broad range of analytics, please contact us for more information.

References

[1] *High-yield bond ETFs attract highest flows on record in November*, Financial Times, December 2023

[2] *Investors snap up fixed income ETFs despite bond rout,* Financial Times, October 2023

[3] *Synthetic Representation of Credit ETFs*, Coremont, 2024

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*The analysis was run on actual ETFs but the data has been anonymized and slightly modified for publication purposes.

About Coremont

Coremont provides market-leading portfolio management technology and data across all investment management and trading functions, including risk and quantitative analysis, operations, treasury, accounting and regulatory reporting. Clients include hedge fund managers and institutional asset managers, spanning four continents.

The cornerstone of Coremont's offering is Clarion, cloud-based portfolio management technology, which is powered by Coremont's proprietary pricing models and analytics. Available through UI or API, Clarion helps clients navigate the daily demands of trading and risk management, with advanced capabilities in derivatives.

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