

Performance Measures in Fixed Income Markets

Research paper

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PERFORMANCE MEASURES IN FIXED INCOME MARKETS

INTRODUCTION

A question often asked by investors is “what is the performance of my portfolio?” and by extension, is my portfolio performing well or not? This is never an easy question, even for traditional fixed income products.

On the one hand, measuring performance can be quite tricky. On the other hand, performance is rarely absolute and is often compared to a reference: a market or a performance objective defined by the asset manager.

Performance is defined over a precise time horizon. The performance over a one year horizon may significantly differ from monthly performance, even if the monthly performance is annualised.

In the first section of this paper, we thus recall the classic definition of performance and its components, and highlight the crucial role of the investment period.

The classic approach is suitable for calculating the total return of liquid fixed income securities which trade in the market, which means that mark-to-market prices can be considered as a fair value. This makes it possible to measure the price return or the change in the intrinsic value of the security over a specified period. The price return over the period captures the performance that would have been achieved by buying the security at its acquisition price and then selling it at the price at the end of the period. In order for the price return component to be meaningful, prices have to be relevant i.e. they have to incorporate all the embedded risks of the security.

In the second section, we describe the difficulties linked to measuring performance on illiquid assets, especially when compared to standard benchmarks, and discuss some paradoxical results.

Finally the performance is linked to the type of investment process. Traditional performance measures are not adapted to managing insurance portfolios, which are generally “buy and maintain”.

In the third section, we focus on the tricky problem of measuring performance in the insurance world and propose solutions which allow us to compare the performance of insurance portfolios against a reference.

1 MEASURING THE PERFORMANCE OF A STANDARD FIXED INCOME PROCESS

In this section, we will discuss the impact of the time horizon on performance before introducing the key components of fixed income performance. We will explain the main differences between absolute and relative performance and finally, we will explain why and how the performance is risk related.

An investor in a classic fixed income process is generally looking for financial returns for a pre-defined investment period. The most common definition of "return" is the variation in value of the fund increased by distributions during the period. The value of the fund is the mark-to-market of the underlying assets.

For a traditional process, the mark-to-market (i.e. the market or transaction price) is the standard valuation method used under international accounting standards; the mark-to-model is used for non-quoted or illiquid assets. In the following section, we will discuss the impact of the time horizon and the need for coherence between the investment and the investment period.

1. THE TIME HORIZON VS THE INVESTMENT PERIOD

The time horizon is an important element in measuring the performance of a financial investment, especially in the fixed income universe. A crucial point is the link between the horizon of the performance measure and the horizon of the investment objective: measuring a performance on a time horizon which is shorter than the investment period is a meaningless exercise and often leads to much head-scratching. Indeed, investors often measure their performance on a yearly basis, between the beginning and the end of the year, whereas processes are often calibrated to offer a pre-defined financial performance for a longer investment period. For instance, open funds are calibrated statistically in order to maximize the probability of achieving a predefined performance for a recommended investment period no matter when the investor invests in the fund.

This recommendation is determined on the basis of the characteristics of the underlying assets: for fixed income instruments (assuming there are no defaults), the longer you hold the instrument, the lower your chances of losing money: time is the investor's friend. The passage of time has two well-known advantages: the "carry" effect, which will be described more precisely in the next section, and the "pull-to-par" effect, which occurs when a bond is bought below par. The carry effect is linked to the interest paid on a bond, whereas the "pull-to-par" is linked to the redemption value at maturity: at maturity, the price of the bond is the redemption value (which is often par).

A direct application of the above principle can be seen in short term funds, where statistically the capital is protected. For example, historically, the chance of losing money on the Barclays Euro Aggregate 1-3 over a period of one year is zero. Assuming that no defaults occur, this probability increases as the investment period decreases, as shown in the chart below:

Figure 1: The impact of shorter time horizons on the probability of the loss of capital

Source: Eulive.barcap.com & Natixis Asset Management

From 06/06/2005 to 06/06/2015				
Investment horizon	12M	9M	6M	3M
Number of negative returns	0	9	110	289

Over a one year period, statistically the gain in carry is always positive and greater than the changes in price. By extension, this is one of the reasons why most fixed income funds have a 3 to 5 year recommended investment period. This illustrates that a year-to-date measurement of performance is not coherent with the specificities of the fixed income market, even if most investors' accounts are yearly.

2. FIXED INCOME PERFORMANCE: AN OVERVIEW

The financial performance of a bond portfolio, as measured by the change in value of the portfolio (including distributions) and assuming that no defaults occur, can be split into 4 main sources: the coupon return, the price return,¹ the paydown return and the currency return.

Figure 2: Return components characteristics

(Source: Eulive.barcap.com & Natixis Asset Management)

Return components	Characteristics
coupon return	Effects of the coupon on the portfolio/index returns
price return	The return due to variations in the portfolio's clean price coming from the roll down / the changes in the basis rates curve and the credit spread
paydown return	The impact when amortized bonds amortize more quickly than the amortizing schedule. An illustration of the impact of prepayment on the performance of illiquid assets will be described in Part 2 of this document
currency return	The impact of changes in the exchange rate between the reference currency of the portfolio and the currency of bonds held in the portfolio

Most of these components are well-known and we will only discuss certain aspects of them below.

For funds that distribute, the coupon often comes directly from the coupons of the underlying assets. However, in this case, the measurement of the performance of the fund should take into account the coupons distributed (i.e. the total return of the portfolio).

a) Coupon return

The coupon return is often defined as the "carry", or the income of a portfolio as a result of the passage of time: for a bond holder, the passage of time results in income. The exact definition of the coupon return is given by the following formula:

$$\text{CouponReturn}_{[t_1, t_2]} = \frac{(AI_{t_2} - AI_{t_1}) + \sum_{t=t_1, t_2} C_t}{P_{t_1}} \quad \text{eq. 1}$$

where AI_t is the accrued interest of the portfolio at time t , C_t is the coupon received in the portfolio at t and P_t is the value of the portfolio at t . It represents the return due to coupon payments and changes in accrued interest between t_1 and t_2 , where $t_2 > t_1$.

b) Price return

The price return is the return which results from variations in the clean price of the portfolio. For a standard bond (i.e. without optionality and/or early redemption), the price return can be split into 3 main components: the roll down, the curve effect and the spread effect.

1. By convention, we call « Price Return » the return of the clean price coming from the change in rate only, even if paydown and currency affect the price of a bond too.

The roll down

The roll down is a very interesting effect, and the asset manager often gives it the same importance as the carry effect: what will happen to a bond with the passage of time, assuming that nothing changes in the market?

A simple way to understand the roll down effect is to consider the price of a bond as the sum of the cash flows, discounted by the yield of the bond and the classic formula for price variation:

$$P_{\text{Bond}} = \sum_i \frac{CF_{t_i}}{(1+y)^{t_i}} \quad \text{eq. 2}$$

$$\Delta P_{\text{Bond}} \approx -D \cdot \Delta y + \frac{1}{2} \cdot C \cdot (\Delta y)^2 \quad \text{eq. 3}$$

where y is the yield of the bond (the Internal Rate of Return), CF is the cash flows of the bond up to maturity, D is the duration of the bond and C is the convexity. The price is the inverse of the yield, i.e. when the yield decreases the price increases.

Let us now consider the zero coupon interest rate curve for a single issuer (irrespective of the issuer). The level of the yield is a function of the maturity of the bond issued by the issuer. If nothing changes in the market except the passage of time, the price of the bond follows the curve until it arrives at the initial price: this impact on the clean price is called the "roll down effect".

Using equations (3) and (2), the roll down effect can be approximated by:

$$Rolldown'_{[T_1, T_2]} = \sum_i \frac{CF_{t_i}}{(1+r_{T_2})^{t_i}} - \sum_j \frac{CF_{t_j}}{(1+r_{T_1})^{t_j}} \quad \text{eq. 4}$$

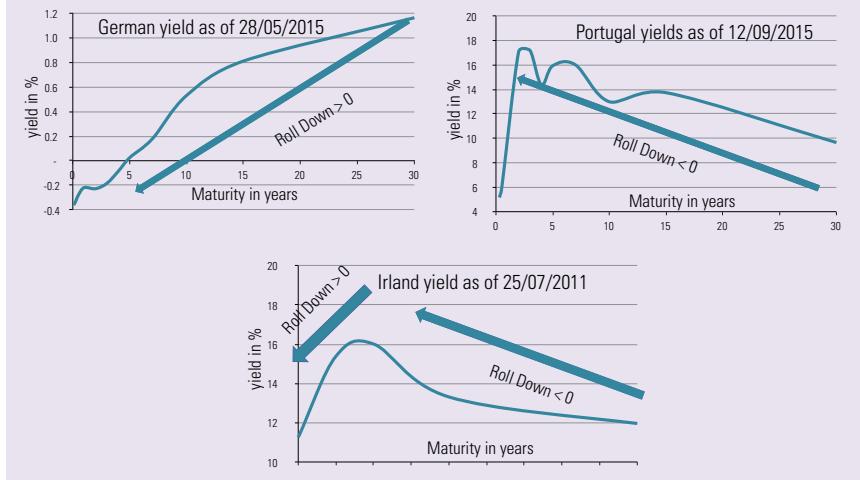
$$Rolldown_{[T_1, T_2]} \approx - \left(\frac{D_{T_2} + D_{T_1}}{2} \right) \cdot (y_{T_2} - y_{T_1}) + \frac{1}{2} \left(\frac{C_{T_2} + C_{T_1}}{2} \right) \cdot (y_{T_2} - y_{T_1})^2 \quad \text{eq. 5}$$

where $r_{T_i}^t$ is the zero coupon rate at time t for the maturity T_i , y_{T_i} is the yield to maturity at time T_i and D_{T_i} is the duration of the bond with a maturity T_i .

This effect can be positive or negative, depending on the form of the yield term structure for the issuer, as described in *Figure 3* below. If the term structure increases, the effect is positive. The impact depends on the steepening of the curve: the steeper the curve, the greater the impact.

Figure 3: Different interest rate term structures

Source Bloomberg & Natixis Asset Management



The curve effect

The impact of changes in the curve is called the “curve effect”. As the price of a bond is a function of the interest rate curve, any changes in the curve will affect the clean price of the bond.

The price of a bond can be calculated by discounting its cash flows with the entire interest rate curve of the issuer. The curve effect between tA and tB can be calculated as follows:

$$\text{Curve effect}_{[tA, tB]} = \sum_i \frac{CF_{t_i}}{(1+r_{i,t}^{tB})^{t_i}} - \sum_j \frac{CF_{t_j}}{(1+r_{j,t}^{tA})^{t_j}} \quad \text{eq. 6}$$

where $r_{i,t}^{tB}$ is the zero coupon interest rate curve in t_i

The spread effect

The final effect which impacts the price return is the impact of changes in the issuer spread. A simple way to analyse the impact is to consider that the price of the bond is the net present value of the cash flows, discounted using the issuer curve. The issuer curve can be split into the basis curve and the spread curve that is specific to the issuer.

For instance, corporate bonds are often valued using the swap curve as a reference, plus a spread curve. The valuation of a standard corporate bond becomes:

$$P_{\text{Bond}} = \sum_i \frac{CF_{t_i}}{(1+r_{i,t} + s_{i,t})^{t_i}} \quad \text{eq. 7}$$

where $r_{i,t}$ represents the zero coupon swap rate curve and $s_{i,t}$ represents the spread of the issuer for the maturity t_i .

If the spread increases, the price decreases. The impact of the change in price due to the spread is often called the “duration spread” or the “duration time spread”. Taking into account the overall spread curve, the spread effect between tA and tB where $tB > tA$

$$\text{Spread effect}_{[tA, tB]} = \sum_i \frac{CF_{t_i}}{(1+r_{i,t}^{tA} + s_{i,t}^{tB})^{t_i}} - \sum_j \frac{CF_{t_j}}{(1+r_{j,t}^{tA} + s_{j,t}^{tB})^{t_j}} \quad \text{eq. 8}$$

where r^{tA} is the zero coupon swap curve at tA and s^{tA} and s^{tB} are the spread curves over the reference interest rate curve (generally the swap treasury curve) respectively at tA and tB .²

3. ABSOLUTE VERSUS RELATIVE PERFORMANCE

Generally, there are two types of process: total return and benchmarked. In both cases, for standard fixed income instruments, and even if the performance is measured by the change of mark-to-market value of the portfolio, the fundamental difference between the two processes lies in the reference. Indeed, a reference is needed to quantify the effectiveness of the management process:

- Total-return processes aim to out-perform money market investments, for instance the capitalized Eonia for European funds, or to achieve the best possible absolute performance (total return versus absolute return approach). The estimation of the “total return” is used to measure the financial performance

2. In this example, the reference rate curve is the swap curve, but the choice of the reference depends mainly on the philosophy of the process. For instance, in a pure treasury process or in an aggregate process, the reference is the least risky government curve. For a Euro treasury process, the German curve is often used as the reference.

- Benchmarked processes aim to out-perform certain predefined indices, which may be market-weighted or weighted using smart beta concepts.³

$$\text{Excess Return}_{[t1,t2]} = \text{Total Return}_{[t1,t2]}^{\text{fund}} - \text{Total Return}_{[t1,t2]}^{\text{index}}$$
eq. 9

$$\text{Total Return}_{[t1,t2]}^{\text{fund}} = \text{Carry Return}_{[t1,t2]}^{\text{fund}} + \text{Price Return}_{[t1,t2]}^{\text{fund}} + \text{Paydown Return}_{[t1,t2]}^{\text{fund}} + \text{Currency Return}_{[t1,t2]}^{\text{fund}}$$

$$\text{Total Return}_{[t1,t2]}^{\text{index}} = \text{Carry Return}_{[t1,t2]}^{\text{index}} + \text{Price Return}_{[t1,t2]}^{\text{index}} + \text{Paydown Return}_{[t1,t2]}^{\text{index}} + \text{Currency Return}_{[t1,t2]}^{\text{index}}$$

The Excess Return, used to estimate the financial performance of the fund, is simply defined as the difference between the total return of the fund and the total return the reference index:

Even in the case of relative performance, such as the calculation of the excess return, the previous decomposition is still accurate and can be used to measure, to explain and to qualify the performance of a financial process. This is the foundation of performance attribution, and widely used in the fixed income world.⁴

We will see in the next section that this type of analysis can be much more difficult when measuring the performance of illiquid assets, especially when the performance is being compared to a benchmark.

2 THE PERFORMANCE MEASURE OF ILLIQUID ASSETS AND THE IMPACT OF THE PRICING MODEL ON RETURNS: THE BENCHMARK PUZZLES

Illiquid instruments, by definition, do not trade in the market. It is thus quite difficult to unambiguously determine their value and price return. Such securities may be attractive for longer term investors interested in capturing the embedded illiquidity premium by holding the security up to maturity. In this case, it would be useful for investors to isolate the illiquidity premium from the expected total return, estimated by the par yield at acquisition. This issue will be addressed in section 1.

More generally, comparing the performance of an illiquid instrument to a traditional benchmark using standard measures is not straightforward. In addition to the investment horizon mismatch, the discrepancy in performance drivers makes it difficult to make direct comparisons as we will see in section 2. Although these distortions are observed for traditional assets held till maturity, they are amplified in the case of illiquid securities due to a specific bias induced by the mark-to-model. In fact, although using mark-to-model prices may be appealing at first sight, one should bear in mind that the price return calculated using a model may not necessarily reflect the fair value. Changes in prices may artificially exaggerate or underestimate returns. We highlight this issue in section 3.

3. For further information about smart beta indexation, please see our Research Paper #5 « From Smart Beta to Enhanced Beta in the Fixed Income World », March 2015.

4. Another angle which is commonly taken in the fixed income market (among others) is to assess whether the actual performance has adequately remunerated the risk taken. The idea is to estimate the performance by unit of risk. If one wants to know if the risk taken is in line with the realized performance, the best approach would be to define a good estimator of risk and then to calculate the realized performance by unit of risk taken. As many well-known researchers have written extensively on this topic, we do not intend to address the issues more in detail: generally, the higher the ratio, the better the performance by unit of risk...

1. HOW TO MEASURE THE PERFORMANCE OF ILLIQUID FIXED INCOME SECURITIES? CAPTURING THE ILLIQUIDITY PREMIUM IN A HOLD-TO-MATURITY STRATEGY

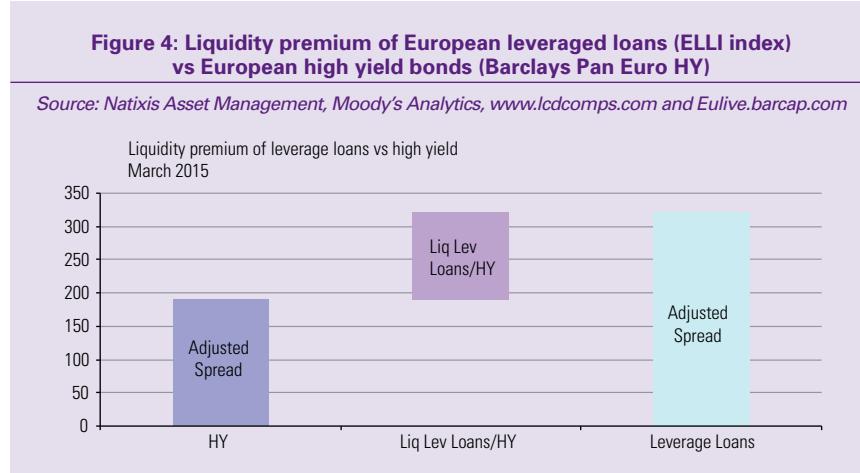
When investing in illiquid securities, an investor expects to be paid a higher return in order to compensate for the liquidity risk.⁵ This is typically the case for private placement securities bought at issuance and held to maturity with the objective of capturing an attractive carry over the investment period.

It is difficult to identify the liquidity premium of an illiquid security compared to a more liquid security. However, it is possible to infer the liquidity premium by making certain assumptions regarding the similarities in the fundamental characteristics of the securities. Assuming that spreads compensate for expected loss, we define the liquidity premium of a security relative to another security as the difference between their adjusted spreads. By "adjusted spread", we mean the nominal spread minus the annualised expected loss. The adjusted spread is determined by using the following equation:

$$\text{AdjustedSpread} = \text{Spread} - \frac{\text{CumulativeDefaultProbability} \times (1 - \text{Recovery})}{\text{Maturity}} \quad \text{eq. 10}$$

Such an approach relies on the assumption that the excess adjusted spread of an illiquid asset vs. a liquid asset is mainly due to the liquidity risk.

For instance, we reproduce in *Figure 4* the liquidity premium of leveraged loans vs. high yield bonds as of March 2015.

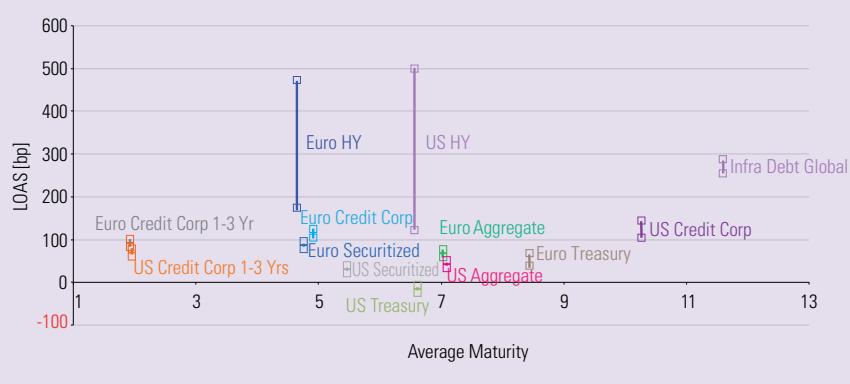


In a hold-to-maturity strategy, the main risk is default. A proxy of the expected performance can be the spread or the yield to maturity. The latter may be adjusted for expected losses (EL) stemming from potential defaults. In *Figure 5*, we plot the average spread and the spread adjusted for EL for various fixed income asset classes, including the less liquid infrastructure debt.

5. The relationship between illiquidity and return was addressed in our Research Paper #3, Liquidity risk in fixed income markets.

Figure 5: LOAS (top of the stick) and default adjusted LOAS (bottom of the stick)

Source: Natixis Asset Management, Natixis, Moody's Analytics, Eulive.barcap.com



Taking into account EL would reduce US corporate yields by roughly 40bp and those of infrastructure debt by 20bp. This lower cost of default stems from the higher recovery rates for infrastructure debt. The pick-up of infrastructure debt relative to US corporate credit is thus above 100bp.

The adjusted YTM is a suitable proxy of the expected return at maturity of illiquid securities. It combines two advantages: it is easy to calculate and it is easy to make comparisons between securities and asset classes. But how can the performance of illiquid securities at intermediate dates relatively to a liquid benchmark be assessed? This issue is typically raised when the investment in illiquid securities is part of the diversification strategy of a core liquid portfolio, such as a private debt bucket in a traditional benchmarked credit process. The portfolio then comprises two buckets, one which is liquid and the other which is illiquid. The daily performance of the overall portfolio has to be compared to that of the underlying benchmark in order to calculate excess returns and other useful metrics.

2. THE DISCREPANCY BETWEEN THE LIQUID BENCHMARK AND THE ILLIQUID SECURITY PERFORMANCE DRIVERS

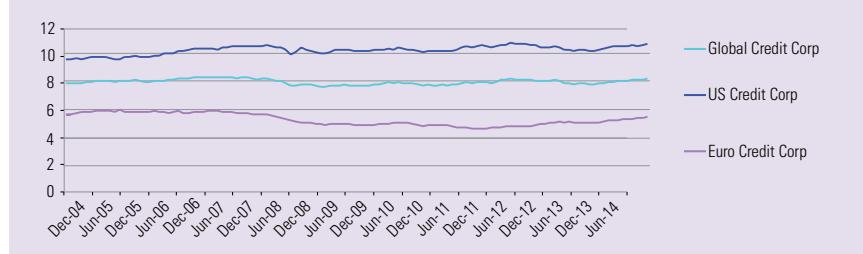
Comparing the performance of an illiquid security to traditional benchmarks using standard measures is not easy, for at least two reasons.

- a) The investment horizon: monthly rebalanced benchmark vs. a hold to maturity investment

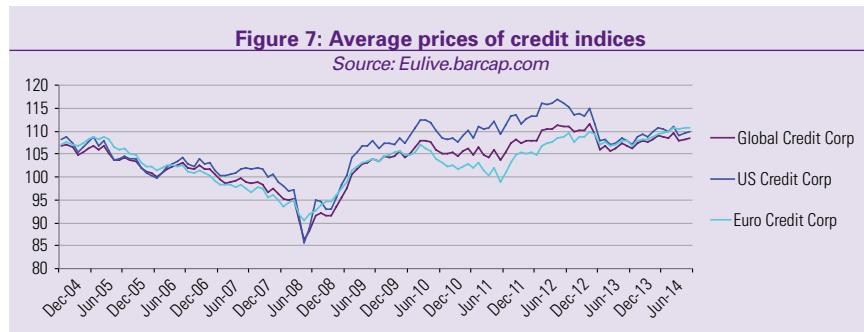
Indices such as the Barclays credit index are rebalanced on a monthly basis. Certain securities are removed from the index (mainly those with a residual maturity of less than a year) and new securities are added. However, the maturity of the index varies within a certain interval, according to the market structure and the dynamics of primary issuance. *Figure 6* highlights this. For instance, the average maturity of the US Credit Corporate index varies little from its average maturity of between 9.5 and 10.7 years. This also holds for the Euro and the global credit markets.

Figure 6: Average maturities of certain credit indices

Source: Eulive.barcap.com

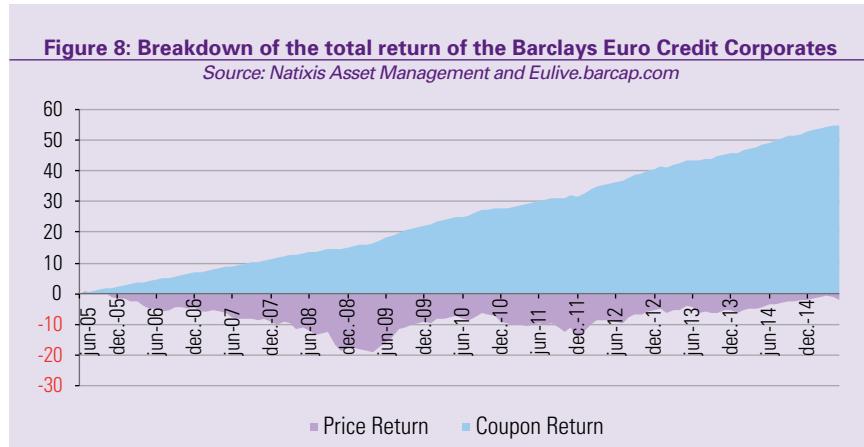


The price of the US index is influenced by market risk factors such as rate, spread and volatility, with no convergence or mean reverting force pushing the price towards par. *Figure 7* shows how prices of credit indices dropped from 110 to 85 before increasing to 115.



Decomposition of the Euro Credit Corporates Index into its two main components, price and coupon.
The sum of the blue and purple areas gives the cumulative total return for an inception date in June 2005.

This volatility in prices exaggerates the price return component of the indices whose amplitude may be offset by the coupon return component. In *Figure 8* below, we represent the total return decomposition of the Barclays Euro Credit Corporate between its two components: price and coupon. We notice that even if the coupon dominates⁶ over long periods, it does not offset the negative price return in stressed markets.

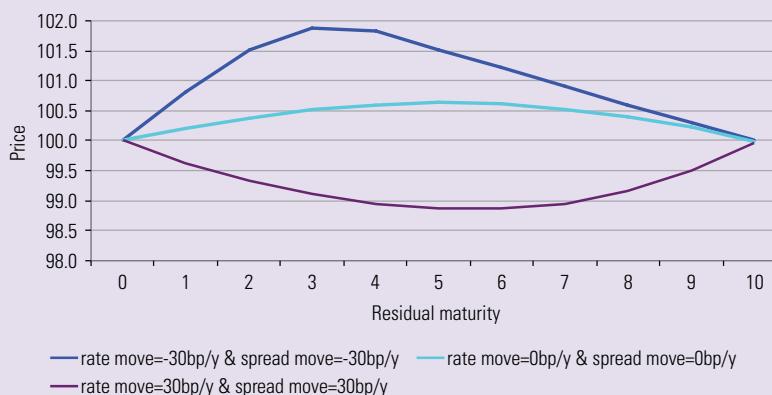


A fixed rate bond held to maturity without defaulting will deliver a return close to its yield to maturity. Its return at maturity is not subject to price fluctuations during its life cycle but is determined by the acquisition price and intermediate payments. At maturity, the price will converge to par irrespective of price fluctuations during its life cycle. If the price goes up over a certain period, boosting price returns over this period, convergence to par would then pull the price down, yielding negative price returns. Over the whole period until maturity, positive price returns are completely offset by negative returns. The overall return thus depends on the entry and exit prices and on intermediate coupons. When no capital gain is achieved, e.g. when securities are bought at par, coupons are the main source of performance. On *Figure 9*, we plot the price of a generic fixed rate security from issuance until maturity under three different rate and spread scenarios.

6. This stylized fact was highlighted in our Research Paper #1, Managing fixed income portfolios in a rising rate environment.

Figure 9: Price simulation of a 10 year security under various rate and spread scenarios

Source: Natixis Asset Management



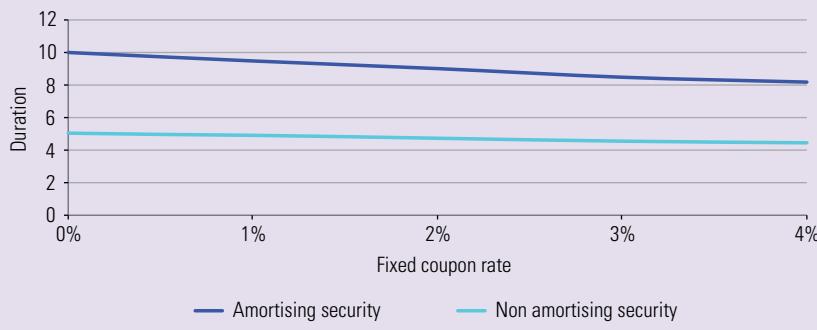
Prices may diverge according to rates and spreads dynamics. However, the price will always converge to par at maturity.

- b) The impact of prepayments: lower duration and potentially lower return

Project finance instruments, private debt, real estate loans etc. are often subject to capital prepayments (both anticipated and unanticipated). Prepayments may affect the return on a loan but have a marginal impact on the return of the corresponding index. According to Barclays default methodology, which is used to calculate returns on its indices, when prices are above par, reinvested prepayments contribute negatively to return. Moreover, prepayments reduce the duration: in *Figure 10* below, we have charted the duration at issuance of a ten year security with and without prepayment for different coupon rates. The duration for a straight-line amortising security would be half that of a non-amortising security with the same characteristics. This would reduce the sensitivity of return to rate movements, whether up or down. The return of our amortising security would be $5 \times 10 = 50\text{bp}$ if rates tightened by 10bp just after issuance; for a non-amortising security, the return would be doubled: $10 \times 10 = 100\text{bp}$.

Figure 10: Duration of a 10 year bond, subject or not to a linear amortisation, for various fixed coupon rates

Source: Natixis Asset Management



Moreover, if prepayments are distributed and not reinvested in the security as assumed in the prepayment return component, the return would be far below the coupon rate. Consider for instance a non-amortising security which pays an annual fixed coupon of 5% of the residual capital normalised at €100 at issuance. At redemption, we would have received $10 * €5 = €50$. The rate of return with respect to the initial investment of €100 is thus 5% per year. If the security was subject to a linear amortisation, the sum of coupons received at maturity would have been equal to €27.50 and the rate of return with respect to the initial investment would have been 2.75% per year e.g. approximately half the rate of return of the non-amortising security. The coupon schedule of both securities is reproduced in the chart below.



To resume, although illiquid amortising debts may outperform a traditional benchmark at the time of acquisition, their relative attractiveness fades as the residual maturity decreases, pulling its price to par. This effect can be mitigated by keeping the maturity of the debt portfolio close to that of the benchmark. This can be achieved by continuously investing in new debts, either by reinvesting prepayments or by injecting more cash. If illiquid assets are expected to yield a higher return, the pick-up they offer over liquid assets with the same characteristics raises the problem of their valuation. How can such assets be valued, in the absence of a sound market for defining their fair value? In fact, the illiquidity of such a security and the paucity of available data imply that only limited information can be gleaned from the market price, if it exists. Daily pricing is required in order to compare the performance of illiquid securities to the reference benchmark.

3. THE MARK-TO-MODEL AND THE RETURN PUZZLE: HIGHER YIELD BUT LOWER PERFORMANCE

As there is no active secondary market, where illiquid securities can be bought and sold without any particular friction, no mark-to-market prices are available for valuing this type of asset.

A mark-to-model approach, in which illiquid assets are valued with respect to other liquid instruments with similar attributes, offers a suitable alternative. However, such an approach suffers from a couple of pitfalls:

- the mark-to-model is not an execution price; and
- using a mark-to-model has a direct impact on the measurement of the performance.

The performance bias created by the mark-to-model could amplify distortions highlighted in the previous section.

a) The Mark-to-Model Valuation

In general, the value of any fixed income security can be determined by discounting expected cash flows by the corresponding risky rates.

$$P_t = \sum_i \frac{E_t[CF_{t_i}]}{(1+r_{t,t_i}+s_{t,T-t})^{t-t_i}} \quad \text{eq. 11}$$

where P_t denotes the price at time t , CF_i denotes the cash flow at time t_i and E denotes the expectation operator. r_{t,t_i} corresponds to the risk free rate as observed at time t for maturity t_i and $s_{t,T-t}$ is the discounting spread of maturity $T-t$ as of time t .

Although the modelling of future cash flows is not complicated, the choice of suitable discounting rates is less obvious. Typically, the spread should be that of equivalent quoted instruments issued on the primary market. Unfortunately, such a spread cannot be observed for all instruments at all times and does not allow for backtesting. One has to infer the unobserved discounting spread $s_{t,T-t}$ from observable figures, given a set of assumptions.

The cornerstone of such an approach consists in valuing illiquid instruments relative to their chosen benchmark i.e. by determining unobservable spreads from observable spreads. We assume an affine relationship between observable and unobservable spreads. The model's spread dynamics are thus driven by the corresponding observable spreads according to the following equation:

$$S_{t,T-t} = \frac{S_{0,T}}{a+bS_{0,T}} (a+bS_{t,T-t}) = \underbrace{\frac{as_{0,T}}{a+bS_{0,T}}}_{\text{constant } t} + \frac{bs_{0,T}}{a+bS_{0,T}} S_{t,T-t} \quad \text{eq. 12}$$

The intercept term accounts for that part of the spread of the illiquid instrument which is not explained by the index e.g. liquidity, implicit options, etc. Note that the higher the pick-up ($s_{0,T}$ vs $S_{0,T}$), the higher the sensitivity of the modelled spreads to the benchmark's spreads.

Ultimately, the dynamics of the model's spreads are driven by the ratio $\frac{bs_{0,T}}{a+bS_{0,T}}$ that defines their sensitivity to the benchmark spreads. The values of a and b have a direct impact on the volatility and performance of the illiquid security.

b) An example of the impact of the pricing model on performance

Over the life of an illiquid security, the price return (and therefore the parameters a and b) do not have a major impact on the absolute performance of the debt, since the price starts from 100 and finishes at 100. However, on intermediate dates, the higher b is, the higher the volatility of the debt; the higher a is, the lower the volatility of the debt. Moreover, although the coupon margin has a positive effect on the outperformance relative to the corresponding benchmark, it affects the sensitivity of the model's spreads relative to the benchmark's spreads. This may have a negative impact on return.

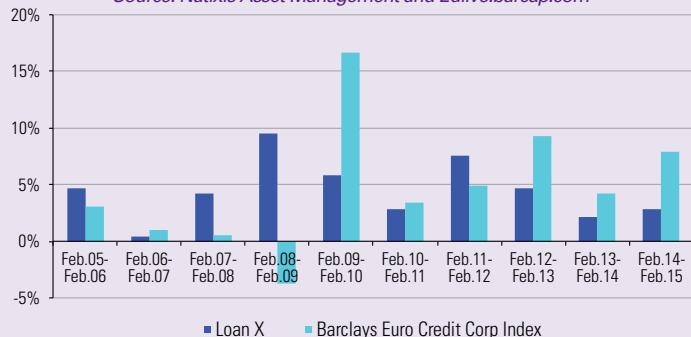
Let's consider a generic loan, Loan X, which is denominated in Euros, rated BBB, has a fixed coupon of 4.0% and a maturity of 17.2 years. The loan is bought at par on 22 February 2005, and is subject to a linear amortisation. The YTM of the Barclays Credit Corporate index at that date was about 3.4%. The excess yield of our generic loan is therefore 60bp at issuance.

Performance Measures in Fixed Income Markets

The following chart shows the annual total return for both the generic loan and the benchmark. The excess return over the first 4 years is offset by the outperformance of the benchmark after 2009.

Figure 12: The annual total return of a generic illiquid loan marked-to-model vs the total return of the Barclays Euro Credit Corporates index

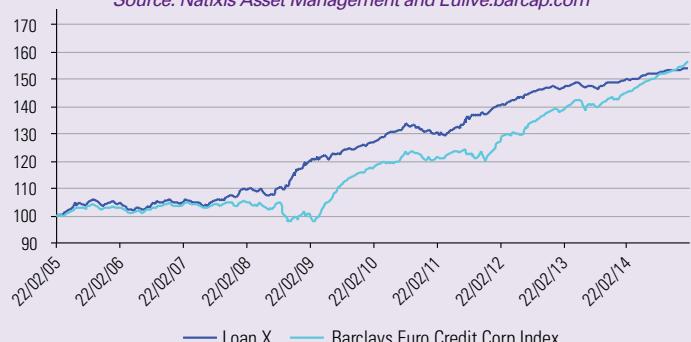
Source: Natixis Asset Management and Eulive.barcap.com



The total performance of Loan X since issuance is therefore slightly below that of the benchmark, as highlighted in Chart 13 below.

Figure 13: The evolution of a €100 investment in both the Barclays Euro Credit Corporate index and a generic loan

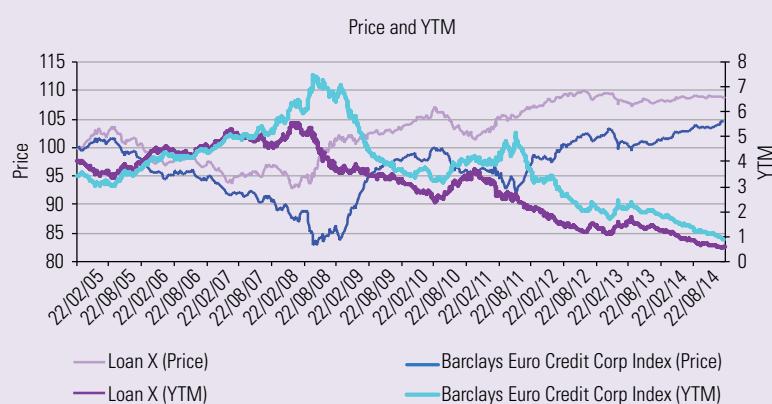
Source: Natixis Asset Management and Eulive.barcap.com



Prices and YTM for both our generic debt and the Barclays Euro Credit Corp benchmark are plotted in the chart below.

Figure 14: The evolution of the price and the YTM of the generic loan and the Barclays Euro Credit Corporate index

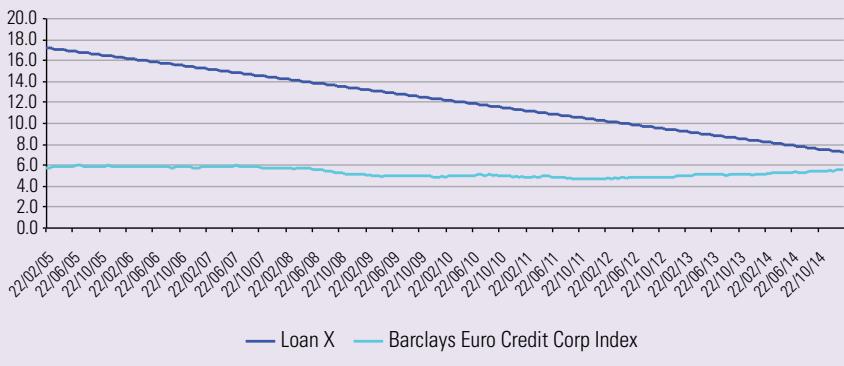
Source: Natixis Asset Management and Eulive.barcap.com



The relative resistance of the price of Loan X during the 2008 crisis can be explained by the low volatility of its spread dynamic and thus its YTM. We notice that the YTM of our generic debt widened gently up to 5.5%, while the YTM of the benchmark reached a maximum level of 7.5% in Q3 2008, that is to say 2.0% above the YTM of our generic debt. It follows that the prices of our generic loan dropped less than the price of the benchmark. In addition, although the maturity of the loan is greater than that of the benchmark, their durations are comparable due to the amortisation schedule of the debt, as shown on *Figure 15* and *Figure 16* below.

Figure 15: The evolution of maturity for the generic loan and the Barclays Euro Credit Corporate index

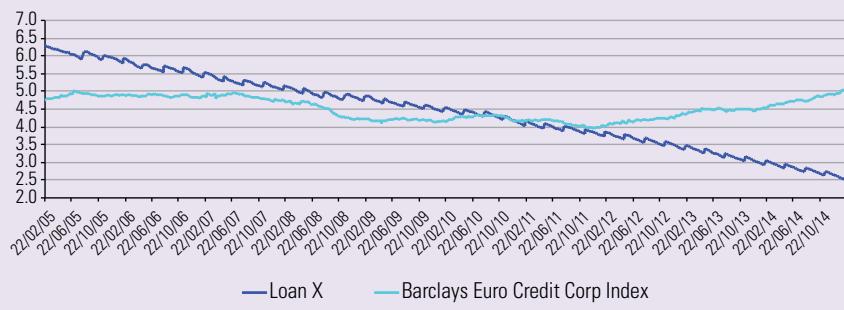
Source: Natixis Asset Management and Eulive.barcap.com



From February 2005 to October 2008, the benchmark's YTM widened by 4%, mainly because of an increase in spreads of roughly 3.9%. For the loan, the mark-to-model spreads increased much less. Since their durations are similar, it follows that the price of the loan will decrease less. Moreover, the carry component mitigates the negative price return of the loan but does not offset the sharp drop in the corporates' prices. The tightening of market spreads in the aftermath of the crisis boosted the benchmark return while slightly enhancing Loan X's return. The corollary of such a spread dynamic is a low volatility in prices.

Figure 16: The evolution of duration for the generic loan and the Barclays Euro Credit Corporate index

Source: Natixis Asset Management and Eulive.barcap.com



Over the selected time period, an investor would have been better off investing in the generic loan than in the euro credit corporate index: for the index, the sum of coupons received would have been offset by the drop in the prices for the corporates. The global outcome of an investment in the loan would have been positive as the cumulated coupons were higher than the drop in the model price.

Our conclusion in relation to this section is that classic measures of performance can be misleading if the asset class is not "classic" and is intended to be held to maturity. The crucial question then becomes: how can we measure performance on "buy and hold" portfolios, typical of insurance companies?

3 FIXED INCOME PORTFOLIO FOR INSURERS: THE REFERENCE AND HORIZON PUZZLES

Fixed income portfolios of insurers cannot be managed in the same way as standard pooled funds. Every sale has a potential impact on its balance sheet and / or income. These portfolios are usually carefully built for a medium to long term horizon in order to meet asset and liability management objectives. Turnover is lower, most of the bonds are hold-to-maturity and the performance measurement is focused on accounting and amortized cost; thus, the main performance driver is the book yield⁷ rather than the price return, the coupon return or the paydown return. The book yield measures the exact income of a bond on an accounting basis. As we will see, there is equivalence between this measure and the usual marked to market performance, but only when **the whole horizon until maturity** is considered.

As most of the bonds are held to maturity, the whole portfolio can be considered as an illiquid placement. In addition, as the portfolio is accounted for on an amortizing basis, the accounting value can be seen as the mark to model. As seen in the second section, this makes the comparison between the portfolio and a market benchmark difficult, and not always accurate.

In this last section, we will first try to reconcile the long term accounting performance and the market performance; we will then zoom in on the buy and maintain management approach and propose a method to build a reference and performance indicators both on annual and a multiannual basis.

Each insurer's portfolio is absolutely unique. Unlike two pooled funds with the same benchmark, which can easily be compared, each insurer's portfolio is the result of a unique combination of Strategic Asset Allocation, history (portfolio age, inflows and outflows, maturity and duration objectives derived from the liabilities), risk appetite (risk budgets, credit limits) etc. As a consequence, two portfolios may be as similar as two pooled funds with the same benchmark on a mark to market basis, but still have a very different accounting behavior and performance.

Classic performance measures as described in the first section of this paper may not be well adapted to insurers from an accounting perspective; we have to find indicators that are better adapted.

1. MARKED TO MARKET VS ACCOUNTING

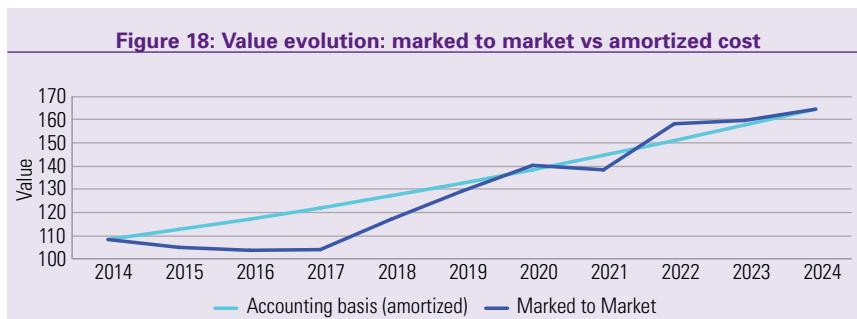
On the date on which a security is purchased, the security is accounted for at the purchase price which is by construction the market price. At maturity, the marked to market price and the accounting value are also the same: par. Between the two dates (the purchase date and the maturity date), both values will evolve independently, see *Figure 17*.

Figure 17: Example, Bond Price, Marked to Market vs Amortized Cost



7. Book yield : Yield to Maturity on purchase, this rate is used for calculating the accounting price of the bond.

The same convergence occurs for the value of the bonds plus reinvested coupons, if we suppose the coupons are reinvested at any time up to the date of maturity of the fund:



Over a medium to long term horizon, both performances can be compared: for shorter periods we will have to focus on accounting based measures.

2. BUY AND MAINTAIN

Figure 19: Comparison between benchmarked and Insurer approach

	Benchmark	FI Insurer Portfolio
Philosophy	Each position is relative to the benchmark and can be offset at will	Long term building ; each sale has accounting consequences
Allocation	Debt weighted	Liability driven
Evolution	Downgraded securities and maturities shorter than a year are sold	Usually hold to maturity
	New bonds to enter the benchmark on a monthly basis	New bonds often bought on primary issuance
Rebalancing	Systematic, monthly	Not applicable

Fixed income portfolios of insurers are usually relatively stable. Their objective is to generate long term, stable returns while globally matching their liabilities, (so called liability driven strategy). The meaning of "return" in this context is "accounting return"; fixed income is accounted for at amortized cost. Historically, these portfolios were often managed on a hold-to-maturity basis. However, there is now an evolution towards more active management, known as the "buy and maintain approach".

Where "Buy and Hold⁸" consisted on buying bonds and holding them until maturity, "Buy and maintain" add some selling flexibility: most of the bonds will be held to maturity, some of them will be sold before on opportunities.

"Buy and maintain" has the following advantages over standard benchmarked portfolio management:

- It captures the highest book yield within a maturity and credit risk budget;
- It captures the illiquidity premium: liquidity is not important if the cash flows match liabilities;
- It avoids automatic sales, caused either by downgrades, or maturity lowering under 1 year. Insurers generally seek to avoid realizing unanticipated gains or losses. Realizing a gain can result in tax losses and usually means reinvesting at a lower book yield. A low turnover helps to reduce transaction costs;

8. Buy and Hold : a passive investment strategy in which an investor buys bonds and holds them until maturity.

- Credit limits (maturity, sectors...) can be customised, avoiding a debt-weighted allocation. A more flexible selling policy can avoid unnecessary losses while allowing sales if the opportunity arises.

In the “buy and maintain” approach, as set out above, the main risk is default risk, as a decrease in the market value of the portfolio would generally be absorbed by a fall in the value of the liabilities. The performance, from an investor’s perspective, is the accounting profit generated by the portfolio on a Year on Year (YoY) basis. An obvious “performance” measurement is obtained by dividing accounting revenues by the average accounting book value.⁹ This figure gives an idea of the absolute portfolio performance, but it has two main weaknesses.

Firstly, it is a spot measure, whereas the accounting revenues are mostly determined on historical book yields. The revenues of the relevant year are determined by the purchase yields of past years; measuring the performance on a YoY basis tends to ignore that this performance is mainly determined by investments in previous years, according to the relevant accounting standard (LIFO,¹⁰ FIFO,¹¹ ...). A multi-year horizon would be more pertinent in measuring the performance of the portfolio.

Secondly, it is an absolute measure; it does not allow for any relative judgment and does not help in deciding how good the performance is. The consequences of the historical accounting principles are that book yields are mainly driven by the insurer’s asset allocation and the historical portfolio ramp-up. Two portfolios that are identical from a mark-to-market perspective can generate very different accounting performances, depending on when the securities were bought and the level at which the book yield was locked.

3. BUILDING THE CUSTOMISED BENCHMARK

When the question is : “is the fixed income portfolio well managed ?”, the absolute accounting measure will not help us to answer. As we wrote in the first section of this paper, a reference is needed to quantify the effectiveness of the management process. Thus, a customised fair reference must be built.

This reference must deal with all the insurer’s specific requirements: the reference portfolio must be invested at the same time and for the same amount as the real portfolio, for the same maturity and with the same risk budget constraints. Both the reference portfolio and the real portfolio must have the same inflows and contingencies (outflows, sells realising gains/losses for accounting adjustment...).

To avoid a back trading construction of the reference portfolio, it should be set up as a clone of the real portfolio at the beginning of the period under review. This allows a direct comparison between both portfolios by ignoring the consequences of past investments: investments made before the period under review will have the same impact on the real and the reference portfolio.

When done so, a critical point is: what would a “portfolio-manager neutral” investment policy be.

Could we build a “robot” manager which would invest the portfolio completely independently of the market ? This is key to constructing a credible reference. Assuming the existence of such a “robot”, the algorithm can be easily described as in *Figure 20*.

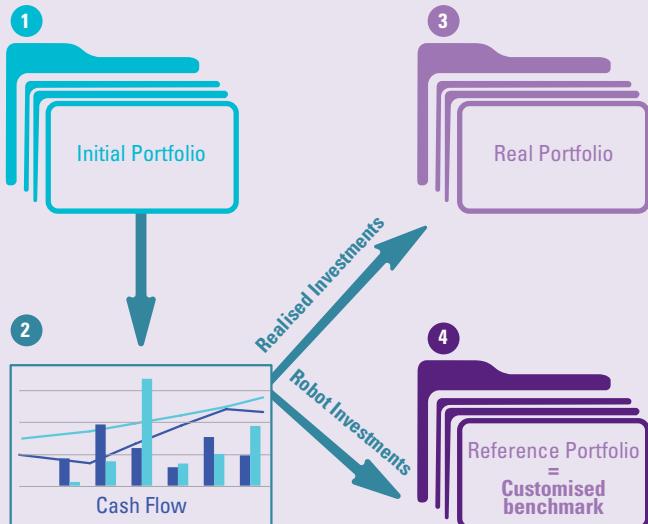


A classic market benchmark cannot represent the management of a fixed income portfolio within an Insurer’s balance sheet... A “Buy and Maintain” approach is more suitable.

9. Book value : accounting value of the portfolio.

10. LIFO: Last In First Out, an valuation method that assume that assets acquired last are the ones that are sold first.

11. FIFO: First In First Out, an valuation method that assume that assets acquired first are the ones that are sold first.

Figure 20: Benchmark construction

Initial portfolio by construction is used as is

Performance measurement algorithm :

1. Future cash flow is determined from the Initial Portfolio projection, production hypothesis (other inflows) can be added at this stage
2. Flows are invested
By the portfolio manager implementing its market views
By the « robot » determined ex ante without any market anticipation
3. Performances of both the Real Portfolio and the Custom Benchmark are measured
4. The portfolio manager's performance is the difference between the two

For the Reference Portfolio to be a “fair” reference for comparison, the investments must have the same guidelines and constraints as investments in the real portfolio. This “neutral” algorithm must be adjusted to the insurer specifics as mentioned above: Asset Allocation, limits and constraints. The algorithm must include issues on the primary market as they are usually a major part of real investments.

4. TEMPORALITY

An insurer’s fixed income portfolio is invested in order to meet a medium to long term objective. The objective is to build a robust portfolio which is able to generate accounting revenues for the following years.

The duration of the portfolio is determined by the duration of the liabilities. A photo of the performance at a single point of time cannot encompass the whole process. A manager will decide to invest for periods which are longer or shorter than the target duration on the basis of his or her medium term market view, as investments are usually hold-to-maturity.

A YoY indicator will give an idea of how well the previous year’s cash flows were invested but a multiyear indicator will be more meaningful in judging the portfolio management over a time period that is in line with the portfolio’s objectives.

a) Year on Year

Two indicators are obvious candidates:

→ ABY_n : weighted Average Book Yield at the end of the year n :

$$\text{ABY}_n = \frac{\sum_i PB_{i,n} \cdot Y_i}{\text{Book_Value}_n} \quad \text{eq. 13}$$

Where • $PB_{i,n}$ is the book price i.e. the amortized value of the bond on 31/12/n

- Y_i is the book yield i.e. the actuarial yield calculated on purchase
- $\text{Book_Value}_n = \sum_i PB_{i,n}$ is the value of the whole portfolio

→ ARR_n : Accounting Rate of Return (accounting revenues / average book value) for the year n

The ABY is the more instantaneous measure, giving a good approximation of the earnings to come in the following period, whereas the ARR is the exact return for the period under review. While the ABY is an indicator of the underlying wealth of the portfolio, the ARR estimates returns for the following period. Both indicators are necessary to follow the realized performance and the underlying expected performance.

b) Multiyear

On a multiyear basis, the ARR is still a good indicator of past performance, but the ABY is not precise enough to estimate the underlying wealth for longer future periods. Bonds in the portfolio will provide accounting revenues until maturity, projected revenues can be calculated until the maturity of the portfolio, ABY will provide a good estimate before the bonds in the portfolio start to mature.

Building an indicator embedding both realised and expected revenues leads to the following equation:

$$\text{Performance indicator} = \left\{ \prod_1^{np} (1 + \text{past}_i) \times \prod_1^{nf} (1 + \widetilde{\text{future}}_i) \right\}^{\frac{1}{np+nf}} - 1 \quad \text{eq. 14}$$

Where • np and nf are the considered number of years in the past and in the future respectively

- past_i and $\widetilde{\text{future}}_i$ are the performance indicators for past and future years (past realized, future expected).

For past periods, the ARR_n can be used. For future periods, different indicators may be relevant.

→ \widetilde{IRR} : Internal Rate of Return of the projected portfolio, the rate that solves the following equation:

$$\text{Book_Value}_n = \sum_{i=1}^n \frac{\widetilde{CF}_i}{(1 + \widetilde{IRR})^i} \quad \text{eq. 15}$$

Where • \widetilde{CF}_i are the expected portfolio outflows (coupons and principal, eventually adjusted by the expected default)

• t_i are the respective date of the outflows

in this case : $\prod_i^{nf} (1+\widetilde{future}_i) = (1+IRR)^{nf}$

→ \widetilde{ARR}_i : estimated Accounting Rate of Return, eventually adjusted by the expected default, in this case : $\prod_i^{nf} (1+\widetilde{future}_i) = \prod_i^{nf} (1+\widetilde{ARR}_i)$

Comparison of these indicators:

Figure 21: \widetilde{IRR} and \widetilde{ARR}_i comparison

	\widetilde{IRR}	\widetilde{ARR}_i
Composition: perf=	$\text{eq. 16} \left\{ \prod_i^{np} (1+\widetilde{ARR}_i) \times (1+\widetilde{IRR})^n \right\}^{\frac{1}{np+n}} - 1$	$\text{eq. 17} \left\{ \prod_i^{np} (1+\widetilde{ARR}_i) \times \prod_i^{nf} (1+\widetilde{ARR}_i) \right\}^{\frac{1}{np+nf}} - 1$
Pros	No need for an exogenous hypothesis n = portfolio maturity	Homogeneity between past measures and future expectations
Cons	Implicit re-investment hypothesis at \widetilde{IRR} rate	How to choose nf and replacement rate
Remarks	\widetilde{IRR} is a spot measure of the underlying wealth, to use in priority in dashboards or when the communication in relation to the past and the future is independent	When only one figure is wanted this indicator is the most likely to be retained

In a very simple portfolio simulation of:

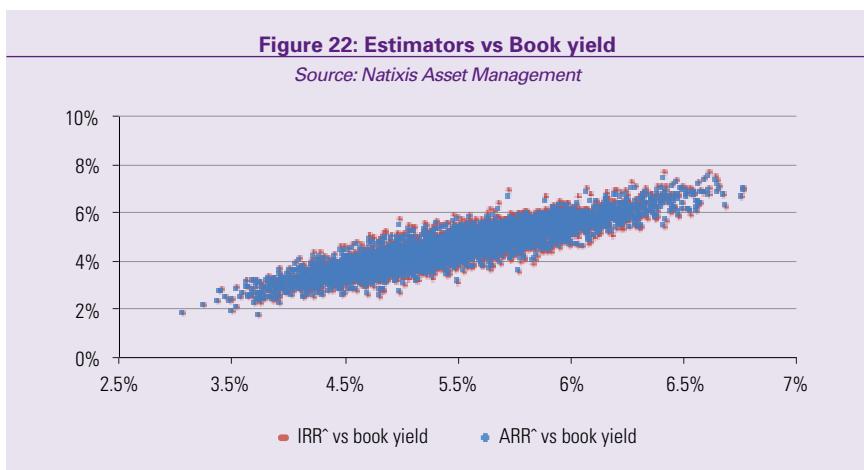
- 20 bonds
- random book yields (0% to 10%), random coupon (0% to 10%)
- random maturities (1 to 15 years)
- 10 000 simulations

we calculate the initial portfolio book yield, and both \widetilde{IRR} and $\widetilde{ARR} = \prod_i^{nf} (1+\widetilde{ARR}_i)^{\frac{1}{nf}}$ with $nf = n$ = portfolio maturity.

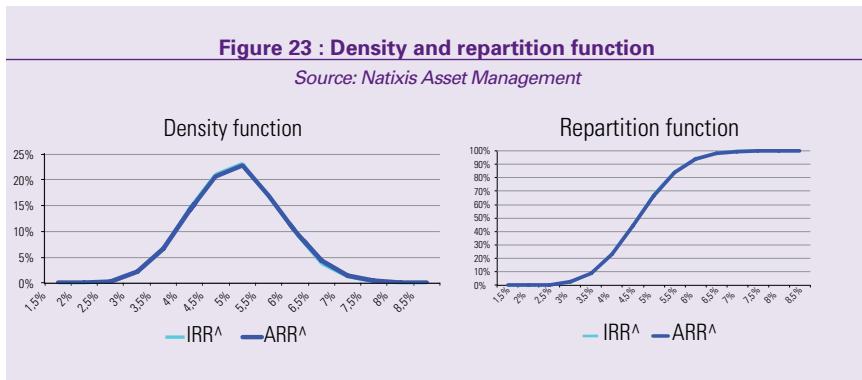
We first graph both indicators versus the initial book yield:

Figure 22: Estimators vs Book yield

Source: Natixis Asset Management



Both indicators move in the same direction as the book yield and they look quite similar.



The distribution of both indicators is quite close; from a statistical point of view, they are identical. If a choice has to be made between them (both can be used simultaneously in dashboards), the choice must be made on the basis of qualitative arguments set out in *Figure 21*.

c) Performance measurement, next steps

Achieving the performance measurement is the last step of our algorithm (see *Figure 20*). Once the portfolio has been in existence for a few years ($np \geq 1$ in Eq 14), a starting date can be defined. The assets in the portfolio on the starting date will constitute both the real portfolio and the initial reference portfolio. From that point, two portfolios will be considered: the portfolio which is actually managed by the portfolio manager, where cash flows are really invested, and the reference portfolio where the "robot" simulates the investment of cash flows.

The portfolio asset management performance is then:

$$perf_{AM} = perf_{real} - perf_{reference}$$

Once the accounting based performance measure has been implemented, a view on risk should be added. To be homogeneous it should be based on accounting figures: a risk can be defined as an event that triggers an accounting impact: impairment, forced sales due to migration below a certain level of rating, migration that leads to the breach of a risk limit, a double notch downgrade...

A proper holistic framework from portfolio management to performance assessment would require a rich dashboard that follows both the MtM and the accounting-based performance, for shorter and longer horizons. All market relative analysis should be included: attribution factors such as KRD (key rate duration), duration and curve positioning, currency... The scorecard must be customized relative to the insurer's specificities, for example:

- the considered horizons will not be the same depending on the horizon of the liabilities,
- the existence of regulatory limits to investment will impact WARF and credit segmentation

With the evolving prudential regulatory framework (Solvency II in Europe), the scorecard could also be enriched by regulatory risk indicators (market SCR spread, interest rates, currencies...).

CONCLUSION

TO EACH CONTEXT ITS PERFORMANCE MEASURE

We have argued in this document that using traditional performance measures can be very misleading in certain specific contexts. We examined two different types of portfolios: portfolios of illiquid assets and portfolios of insurance companies. For illiquid assets, we conclude that the Mark to Model approach has its virtues. When it comes to portfolios of insurance companies, due to the accounting stress on asset management, performance measures should be constructed on the basis of the accounting treatment of the assets.

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OPENING UP NEW INVESTMENT PROSPECTS

In order to face the new challenges in financial markets, Natixis Asset Management places research and innovation at the core of its strategy. Natixis Asset Management designs optimised investment solutions for its clients in six areas of expertise: Fixed income, European equities, Investment and Client Solutions, Structured and Volatility, Global emerging equities and Responsible investing.



With €328,6 billion in assets under management at 30 June 2015, Natixis Asset Management brings its clients new solutions to create value.