CONFRONTING TRANSFORMATION IN THE INVESTMENT INDUSTRY

ADDRESSING INDIVIDUALS’ RETIREMENT NEEDS

GROWING ACCEPTANCE OF THE FACTOR INVESTING AND SMART BETA PARADIGMS

ASSESSING RISK PREMIA IN BOND MARKETS
FROM THE EDITOR

DANGEROUS TIMES FOR ASSET MANAGERS

Transformative threats on several fronts are confronting the investment industry. But threats also offer opportunities that can make winners of industry players who seize them.

Already, four leading houses – Janus, Henderson, Standard Life and Aberdeen – have become just two through mergers ascribed widely to the shift towards passive investment, squeezing mainstream active fund managers. However, the move towards passive management is not that straightforward. The emergence of so-called smart beta products is blurring the lines between active and traditional passive money management based on cap-weighted benchmarks. A three-way fight is underway between market cap-based passive, active and smart beta, with variants in each of these categories. Dynamic management of smart factor exposure is also expected to be a new source of added value.

At the core of active management, setting market prices and carrying out essential arbitraging is indispensable. Smart beta is not always clearly appreciated for what exactly it is because several types of products claim the label. Some are just active quantitative portfolio management tools. Others are genuine attempts to provide investors with well-diversified exposure to long-term rewarded risk factors.

The second problem receiving the most social and political attention concerns retail investors. The fund management industry stands accused of focusing on profit at their expense, causing much distrust. However, the problems cannot be blamed entirely on fund managers. Retailers, investment solutions addressing individuals’ specific needs have not been available on an economic basis.

The third and the most dangerous threat is digital disruption. A leading consultant has stated that there are too many funds. Referring to the previous point, this has arisen from high distribution charges paid for by retail customers allowing their exploitation through a excessive proliferation of fund launches. Digitalisation, by accelerating change, should end this unsatisfactory situation. It will also endanger incumbents and foster new entrants.

Though the digital factor will reduce this exploitation, it does not produce investment solutions specific to each individual, but can facilitate their introduction through investor-centred, as opposed to performance-centred, dialogue. The fast-growing robo-advice sector enabled by digitalisation, already morphing into different forms, does not provide the answer either. The goals-based framework and mass customisation proposed in this edition, in attending to the specific goals of investors, will potentially transform the individual sector by providing tailor-made solutions that are currently not available, except to the wealthiest.

The fixed income sector is vital to the security of anybody expecting retirement benefits from portfolios. Yet, compared with well-developed equity markets, it has more structural weaknesses embracing risk characteristics, indices and trading fragmentation. Particularly, smart beta in fixed income is very much underdeveloped. In this edition, we observe the progress to date and look at what is still required to get on a sound footing in this area as well as in the related sphere of factor investing. We also cover how and why the new and important concept of risk allocation could become established thinking that replaces current asset allocation processes.

Most individuals are unlikely to be seriously interested in concepts such as bonds, shares and funds. Even if they invest their assets in these, many will depend on financial advisers for whom more education is vital.

The ideas of the goals-based framework, mass customisation, smart beta, factor investing and risk allocation have every chance of becoming embedded in individuals’ investment practices. This will then require financial advisers to reach higher levels of sophistication and familiarity with these ideas.

A large proportion of this special edition is devoted to academically-grounded insights on the goals-based framework. Along with the challenges of mass customisation, a new bond retirement index series is also explained, designed to encourage the industry to come up with workable solutions for this framework.

A SNAPSHcOT OF THIS ISSUE

The following five related articles are based on two academic papers that analyse a framework for meeting individuals’ specific retirement goals currently lacking in the industry and how the challenge of mass customisation for the less wealthy can be solved. These will lead to revolutionary changes in the industry, if adopted, rectifying the weaknesses of the investment process available on an economic basis.

A PATH-BREAKING SOLUTION FOR INDIVIDUAL INVESTORS’ PROBLEMS

A non-academic resume of the paper ‘Introducing a Comprehensive Investment Framework for Goals-Based Wealth Management’ is an in-depth review of the goals-based framework aimed at providing a comprehensive understanding for everybody interested in the implementation of practical solutions.

INDIVIDUAL INVESTMENT PROCESSES FOR THE 21ST CENTURY

While the way forward is clearly indicated by the two papers, it is the industry that needs to implement the new ideas in practice. This article points to the industry’s serious difficulties in doing so, though rapidly changing conditions should encourage the radical transformation that is required.

MULTI-ASSET PRODUCTS AND SOLUTIONS

This article puts the need for individual retirement solutions in the context of some of the latest thinking in Modern Portfolio Theory and approaches already used by institutional investors.
FACTOR INVESTING: EFFICIENT HARVESTING OF RISK PREMIA ACROSS AND WITHIN ASSET CLASSES

Asset allocation decisions have for years been based on weightings attached to different asset classes. In a new approach that is increasingly adopted, these decisions are based on exposure to risk factors cutting across asset classes. The theme of this article is the methodology used to implement this approach including the use of efficient factor indices as building blocks for each risk factor in the allocation process.

BOND RISK PREMIA: THE NEW FRONTIER IN FACTOR INVESTING AND SMART BETA

The concepts of factor investing and smart beta are much less developed in bonds compared to equities. In the identification of factors, various difficulties arise. Existing bond indices have serious deficiencies which are partly related to factor exposures being unstable. A broad overview of current first generation smart beta approaches also highlights various weaknesses.

FACTOR-BASED APPROACHES TO THE DESIGN OF SMART BOND PORTFOLIOS

The difficulties of measuring and identifying factors are referred to in this article. A review is carried out of the most consistently identified fixed income factors and it is pointed out that more research is required before bond risk factors can be reliably used in efficiently extracting risk premia.

MEASURING VOLATILITY PUMPING BENEFITS IN EQUITY MARKETS

When portfolios are constructed on the basis of long-term weights, rebalancing is often carried out to restore the initial weights. This article investigates the conjecture that this rebalancing can be a source of extra investment performance. The results show that this is true for suitably selected categories of stocks.

PREDICTING RISK PREMIA FOR TREASURY BONDS: THE EDHEC BOND RISK PREMIUM MONITOR

In general, the variation of bond yields along the yield curve reflects either expected future interest rates or the risk premium. Assessing the risk premium impact on the steepness of the yield curve is, thus, important to bond managers. This article describes the EDHEC Bond Risk Premium Monitor launched by EDHEC Risk Institute as a tool to derive a state-of-the-art estimation of the risk premium using market and monetary policy information.

The following four related articles concern the relatively new and related paradigms of factor investing and smart beta, which are rapidly growing in acceptance and importance. The first two cover bond investing, while the other two pertain to the use of factors across and within asset classes and in equities.

BE SERIOUS WITH EQUITY FACTOR INVESTING

In this article, the problems with equity factor methodologies used by some providers, when they depart from academically accepted practices, are analysed. These include the same provider using different definitions of the value factor at various times. Excessively concentrated bets without adequate diversification are also identified.

EQUITY PORTFOLIOS WITH LIABILITY-HEDGING BENEFITS

Academic research has come up with a remarkable result of considerable interest to pension funds, using liability-driven approaches. Modern Portfolio Theory advocates that pension plans should invest in two portfolios, a liability-hedging portfolio consisting of fixed income securities and a performance-seeking portfolio exposed to riskier assets. However, the finding is that selecting certain types of equity in the risky portfolio can not only enhance the liability hedging benefits, but can also increase the overall performance. Alternatively, a higher allocation to equities becomes possible with commensurate extra performance with the same liability hedging benefits.
The need for new retirement solutions

With the need to supplement retirement savings via voluntary contributions, individuals will increasingly be responsible for their own saving and investment decisions. This global trend poses substantial challenges as individual investors not only suffer from behavioural limitations, but also typically lack the expertise needed to make educated investment decisions.

In response to these concerns, a number of new investment products have been proposed over the past few years by asset management companies. There are reasons to believe, however, that these products known as target date funds short of providing satisfactory solutions to the problems faced by individuals when approaching investment saving decisions.

First of all, target date funds offer a sole focus on the investment horizons without any protection of investors’ minimum retirement needs. In particular, these products are not engineered to deliver a replacement income in retirement, and do not achieve a proper hedging of the main risks related to the retirement investing decisions, namely investment risk, interest rate risk, inflation and longevity risk. Another important restriction is that most existing target date funds do not allow for revisions of the asset allocation as a function of changes in market conditions. This is entirely inconsistent with academic prescriptions, and also common sense, which both suggest that the optimal strategy should also display an element of dependence on the state of the economy.

Towards improved forms of retirement investment solutions

Currently available investment options hardly provide a satisfying answer to the retirement investment challenge, and most individuals are left with an unsatisfying choice between, on the one hand, safe strategies with very limited upside potential, which will not allow them to generate the kind of target replacement income they need in retirement and, on the other hand, risky strategies offering no security with respect to minimum levels of replacement income.

This stands in contrast with a well-designed retirement solution that would allow individual investors to secure the kind of replacement income in retirement needed to meet their essential consumption goals, while generating a relatively high probability of achieving target replacement income levels. As such, the framework builds upon a comprehensive and holistic integration of the three forms of risk management, namely hedging, diversification and insurance. This is in contrast to existing products or approaches used in institutional or individual money management, which are only based on selected risk management principles.

While each of these sources of value added is already used to some extent in different contexts, full integration of these elements within a comprehensive disciplined investment management framework is required for the design of meaningful investment solutions.

EDHEC-Princeton retirement bond and retirement wealth index series

The most natural way to frame an investor’s retirement goal is in terms of how much lifetime guaranteed inflation-linked replacement income they will be able to afford to purchase upon retirement. Given that the biggest risk in retirement is the risk of outliving one’s retirement assets, securing inflation-linked replacement income within the decumulation period can be achieved with inflation-linked annuities, which are the true risk-free assets for individuals preparing for retirement.

Annuity products, however, are cost inefficient, irreversible, and do not contribute to bequest objectives. These elements undoubtedly explain the low demand for annuities (i.e. the “annuitisation puzzle”, when annuitisation is not incentivised or mandatory). A good case can actually be made that annuitisation is a decision that is best taken close to retirement, if ever.

This point was made explicitly in Merton (2015): “Most people would not want to buy an actual life annuity during the accumulation period prior to retirement (…) If the individual buys an annuity on his life, it is reversible only at a high cost, which means if he dies two years from now, he loses everything. If he has life circumstances change - get married, get divorced, start a second family - the lack of flexibility can be costly. The right time for him to determine the detail of post-retirement investment choices (…) is as close to retirement as possible when he has the most information about his health, his responsibilities, his opportunities, and his preferences.”

In the UK, the 2015 Pension Schemes Act, which has nullified the compulsory annuity purchase, creates a tremendous opportunity for asset managers to launch meaningful forms of retirement solutions. A key ingredient in these retirement solutions is a novel form of fixed-income products, where the key focus should be on generating inflation-linked or cost-of-living-adjusted replacement income for a period of time roughly corresponding to the average life expectancy in retirement (say between 20 and 25 years after the retirement date). In parallel, late-life annuities can be purchased in decumulation to obtain protection against tail longevity risk.

In the context of these aforementioned changes in the retirement landscape, EDHEC-Risk Institute has teamed up with Princeton University’s Operations Research and Financial Engineering (ORFE) department to launch a retirement bond index series. This initiative, supported by Merrill Lynch Wealth Management (MLWM) in the context of the “Risk Allocation Framework for Goal-Driven Investing Strategies” research chair at EDHEC-Risk Institute. More specifically, the so-called retirement goal bond index is designed to dynamically hedge interest rate risks and realised or expected inflation risks, thereby forming a dynamic proxy for a forward inflation-linked or cost-of-living-adjusted bond ladder. The introduction of this retirement goal index series is consistent with the prescription of asset pricing theory which has shown that “T-bills investment is a low volatility strategy from an absolute return perspective, but extremely risky for use in a retirement context since it leads to a highly volatile level of purchasing power expressed in terms of inflation-linked replacement income. This paradigm poses substantial challenges to asset managers design and launch a customised dynamic allocation strategy for each investor, the challenge, which we discuss now, is to address the needs of a large number of investors through a limited number of funds.

Mass customisation versus mass production in retirement investing

Mass production (in terms of products) happened a long time ago within investment management, through the introduction of mutual funds and, more recently, exchange-traded funds. The new frontier in retirement investing is mass customisation (as in customised solutions), which by definition is a manufacturing and distribution technique that combines the flexibility and personalisation of “custom-made” solutions with the low unit costs associated with mass production. In other words, the true challenge is indeed to find a way to provide a large number of individual investors with meaningful, dedicated investment solutions.

The most natural way to frame an investor’s retirement goal is in terms of how much lifetime guaranteed inflation-linked replacement income they will be able to afford to purchase upon retirement.

In reality, different investors have different goals, as discussed above, and therefore the safe goal-hedging building blocks should be (mass) customised. Besides, the allocation to the safe rather than risky building blocks should also be engineered so as to secure each investor’s essential goals (e.g. minimum levels of replacement income) while generating a relatively high probability of achieving their aspirational goals (e.g. target levels of replacement income).

That mass customisation is the key challenge that our industry is facing has long been recognised, but it is only recently that we have developed the actual capacity to provide such dedicated investment solutions to individuals. There are two main dimensions of scalability, namely scalability with respect to the cross-sectional dimension (designing a dynamic strategy that can approximately accommodate the needs of different investors...
A PATH-BREAKING SOLUTION FOR INDIVIDUAL INVESTORS’ PROBLEMS

1. Introduction

Individual investors have different ambitions concerning their finances. Some of these can be very firm targets while others are more in the category of hopes. There are risks and uncertainties surrounding these definite and less solid aims, which are specific to each individual. Yet, by and large, what they get from financial advisors takes very little account of their individual goals but emphasises much more the risks attached to markets as a whole, an approach that is inadequate.

What is needed is a goals-based investment (GBI) approach that takes account of individuals’ personal goals and preferences and the specific circumstances in relation to their future needs. A paper entitled, "Introducing a Comprehensive Investment Framework for Goals-Based Wealth Management", by Romain Deguest, Lionel Martellini, Vincent Milhau, Anil Suri and Hungjen Wang puts forward an investment framework for catering to these specific needs and hopes. This article is based on the paper.

In some specific cases, goal-based thinking may not be called for. Take a high-flying 30-year-old earning $50,000 per annum and with wealth of just $25,000. This wealth is very small compared with the value of his large income which he expects to receive over many years in the future. In other words, this $25,000 is only a tiny proportion of his overall assets including the human capital represented by his massive earning power. Therefore, he might well invest his $25,000 with a risk of losing it all but also with the possibility of multiplying his investment many times in a few years. He would not have a particular goal in mind such as $100,000 or $1m.

However, take for example three 35-year-old lawyers each with wealth of $200,000 and after-tax income of $60,000. A financial advisor might be tempted to put them in the same market risk category and persuade the clients of this. Though a professional, the client could well be ignorant of finance. However, this would not be a good way of going about it.

The first lawyer might be so concerned about receiving good replacement retirement income at age 65. The second lawyer might have some hopes of retiring early at 50 and then switching to an activity such as running a bookshop with much less income, in line with what he enjoys. The third might be much more focused on paying school fees for his children in the next 25 years and less concerned about his retirement standard of living. Each of these three need different portfolios to suit their separate objectives. Note that, unlike the first and third lawyers, the second has two explicit goals, not just one, namely retiring at 50 and running a bookshop. Firstly, he will need a minimum income of $15,000 per annum at age 50 to survive as an essential goal. Secondly, he will aim to have capital of $100,000 for the bookshop as an important, but not essential goal. This capital would not be essential as he might be able to obtain it through other means, such as a loan.

Let us take another example, this time, of a person with three different goals. A woman at age 45 has $500,000 wealth and a regular income of $40,000 per annum. She might want a minimum retirement income of $20,000 per annum which has to be achieved and therefore, an essential goal. In addition, she would like an extra $10,000 per annum, highly desirable but not vital and hence, this would be classified as an important goal, not essential one. Finally, she might also have vague hopes of having extra $200,000 for going on expensive holidays. She is keen on constructing an investment portfolio that might allow for the possibility of achieving this amount. This would be an example of an aspirational goal in that it cannot be afforded but is hoped for.

The above examples point to individuals’ goals falling under three categories, essential, important and aspirational.

• An essential goal is what the investor has to meet as a sacrosanct target.
• An important goal is what he/she hopes to achieve, but would not be considered as a catastrophe if not attained.

• An aspirational goal is something that is desired, but the investor is realistic enough to understand that there might be a high probability of missing it.

The new GBI approach not only comes up with solutions for constructing the investor’s portfolio, but also forms the basis for an ongoing dialogue between the individual and his/her advisor.

Differing between and allocating priorities for each of the three types of goals (essential, important and aspirational) is a core aspect of this framework. This categorisation makes it stand apart from investment practices in the retail industry to date.

2. The structure of the goals-based investment framework

2.1 Affordability

A key concept is that of affordability. Is the initial wealth sufficient to ensure that the essential goals can be secured with absolute certainty?

If not, the investor has three options. Firstly, he/she can consider adding more money later. Finally, he/she has to be realistic and reduce the essential goal to a lower level. For instance, if an essential goal of $10,000 per annum is unaffordable, it can be reduced to $6,000 per annum which would make the goal certainty achievable.

It is not only essential goals that have to be affordable but also the important goals. The difference between the two types is that the essential goals have to be secured and...
guaranteed while the important ones, though also affordable, are not guaranteed.

Suppose that an individual at age 30 has capital of $450,000 and wants to have a minimum retirement income of $20,000 per annum at age 65. He/she would prefer to have $40,000 per annum at retirement but would not considered it essential. Assuming the necessary investment return from age 30 to age 65, his/her $400,000 capital would allow him/her to achieve not only the essential $20,000 per annum but also the higher $40,000 per annum. If he/she wants the latter to be guaranteed, it is possible that his/her entire wealth of $400,000 has to be tied up for this purpose. However, if he/she only wants the essential $20,000 per annum to be guaranteed, then only half of the wealth is needed for this purpose and the other half can be invested in a riskier way to generate more wealth.

Why would one take this additional risk? Without securing the higher $40,000 income? Suppose also that at age 65 he/she wants to donate $250,000 to an only child or buy a second home in a holiday spot. This would be an aspirational goal that could not be afforded now. If he/she secures the entire $400,000, then this aspirational goal would not be achievable at all. But if he/she secures only the $20,000, the rest can be invested to give him/her a chance of reaching his/her aspirational goal while accepting that the important goal of $40,000 per annum may be at risk.

In general, therefore, some risk is taken with important goals in order to increase the probability of achieving the aspirational ones. So, both the important and aspirational goals, while achievable, are exposed to risk.

2.2 Wealth and consumption

At a specific date in the future consider an individual aiming to withdraw money from his/her investment assets in order to finance specific consumption targets such as renovating a home, buying a yacht or an expensive car. These targets are consumption-based goals.

In contrast, wealth-based goals require the individual’s wealth to reach particular levels at specific future dates.

In the end, all wealth is used for consumption including bequests. However, in a wealth-based goal the individual has no specific consumption usage in mind as is aiming for. This analysis in this article differs according to whether goals are wealth-based, consumption-based or both.

2.3 Three investment buckets

The investor’s wealth and any future non-portfolio income are allocated among the following three buckets.

• The personal bucket
• The market risk bucket
• The aspirational bucket

2.3.1 The personal bucket

The personal bucket would correspond to essential goals and three goals do not need to be precisely quantified in every case. For instance, a person might be living in an expensive home worth $1m and is determined to live in this home until death. This $1m would be a part of his/her wealth but his/her goal of staying in the home will be achieved by ringfencing this part as un-touchable and the value of the home becomes irrelevant. Similar consideration could be applied to art collections or comparable assets.

At the other end of the economic spectrum, there may be a strong desire to avoid poverty or survive a possible stretch of unemployment, for which some cash cushion is put aside.

The essential goals that are quantifiable need to be catered for by the allocation of legal assets to meet them. These assets have to comprise a separate portfolio that ensures that the essential goal is met. For instance, consider the above the 45-year-old woman from section 1 with the essential goal of $20,000 at retirement. Her initial wealth should be more than sufficient to create enough assets at age 60 to assure this retirement income.

Assume that $300,000 is needed for this purpose. Then this $300,000 can be set aside in a portfolio of bonds that will provide the required income with certainty. This is referred to as the goal-hedging portfolio (GHP).

In general, the essential goals are made certain by allocating enough assets to the GHP.

2.3.2 The market risk bucket

In the case of GBI, the assets assigned to the safe GHP fully secure essential goals, and therefore present no risk at all. As outlined in 2.1 above, the rest of the investor’s assets are invested in risky ways to aim for important precisely quantifiable goals. A performance-seeking portfolio (PSP) is established for this purpose. Such PSPs are not specific to any individual and can be used by anybody who is seeking to maximise their wealth by taking on risk. Modern Portfolio Theory (MPT) suggests choices that are discussed in a later section.

2.3.3 The aspirational bucket

Many aspire to a higher level of wealth and lifestyle standards in society. This aspiration is described as a desire for wealth mobility. In the context of GBI, many investors aim for their aspirational goals through what is referred to as the wealth mobility portfolio (WMP) which falls within the aspirational bucket. However, this does not mean that all aspirational goals target wealth mobility. For instance, consider again the 45-year-old woman. She might decide to spend all the $300,000 luxury expenditure in five years without gaining any mobility in her affluence status in society. It is not essential that the aspirational bucket contains specific assets for aspirational goals. These can be targeted, in theory, through

a leveraged allocation to the PSP, but in practice, many individuals are constrained from borrowing. Hence, the contents of an aspirational bucket often consist of the investor’s personal choice of investments.

2.3 Three investment buckets based or both.

2.3.3 The aspirational bucket

Though the initial wealth can be above the minimum floor level as indicated earlier, what happens if more than the floor level of the essential wealth is invested in the GHP? In this case, less becomes available for the PSP reducing the chances of overall wealth increasing. Only by investing the minimum possible amount of the initial wealth in the GHP subject to the floor being safeguarded, will the PSP performance prospects be maximised. This implies that the amount invested in the GHP should be exactly the floor value, no more no less, as far as practicable.

For instance, assume a man with $350,000 of initial wealth at age 55 wanting a retirement income of $10,000 per annum at age 65. To achieve this retirement income let us suppose that the minimum initial wealth has to be $180,000 for the GHP. In this case, this goal will be attained and $200,000 will be left over for the PSP allowing him to aim for other important goals. If he decides to invest, say $300,000 in the GHP then only $50,000 will be available for the PSP reducing the prospects of his overall wealth increasing.

4. The goal-hedging portfolio in the absence of non-portfolio income

The various concepts defined and explained in the foregoing sections form the essential background to the central task in the GBI of constructing the three GHP, PSP and WMP building blocks, and the all-important process of allocating the investor’s assets to each of these blocks.

Three types of cashflows are relevant to the investment framework:

• The initial wealth available for investment
• A possible consumption stream which the investor aims to withdraw
• A possible non-portfolio income stream which will add to the wealth

The non-portfolio income represents additional contributions from the investor as opposed to portfolio income (coupons, interests, etc. generated by the investments). In this section, it is assumed to be absent while the next section covers the presence of such income.

Take the example of two 40-year-old women, $100,000, requiring her wealth at age 60 to be $11,000 with adjustments for inflation in the 20 intervening years. To be certain of achieving this, she has to have access to a bond, the value of which increases with inflation over the years. However, not all markets have inflation-linked bonds of the precise maturity of 20 years. In such cases the goal would not be affordable as there is the danger that high inflation will allow expected returns to be lower than expected.

Several different circumstances are:

• Wealth-based goal with a single horizon
• Wealth-based goal with multiple horizons
• Consumption-based goal
• Multiple consumption-based goals
• Wealth-based and consumption-based goals

In this section and section 5, we focus on the wealth-based goal and the WMP are explained in section 6.

4.1 The minimum wealth condition for affordability

The minimum wealth required for constructing the GHPs is derived using elementary financial theory (the principles of compound interest and related discount rates) as well as advanced probability techniques (involving stochastic calculus used in the celebrated Black-Scholes formula for option pricing). Important results and observations are presented here with minimal mathematics and the interested reader should read the original paper for the technical detail.

Under the goals-based framework, investors introduce initial wealth at inception and possibly more infusions of cash later, which are allocated to the GHP and other buckets. What is put into the GHP requires particular attention as these cashflows are aimed at meeting the essential goals.

The general approach followed through this section is best introduced and explained by a simple example of an initial life goal.

Consider somebody starting with an initial wealth of $10,000 at inception. In the general case, this initial wealth will be referred to as $G_0$. The aim is to generate the $20,000 ($10,000 at year 10. In the general case, year 10 becomes year T, the time horizon of the goal and the goal of $20,000 becomes G_T$. The central problem is to check affordability. In other words, whether $A_t$, the initial wealth ($10,000) is greater than or equal to $G_T$, the essential goal ($20,000$) in this example at year 10. For this purpose, $G_T$ is discounted back to its present value $G_0$ at inception. This discounting is based not only on elementary compound interest techniques but also on an advanced theoretical standpoint, given that investment returns and market conditions which might enable G to increase to $G_T$ in ten years are uncertain. Hence, $G_T$ is the minimum amount that has to be available at inception to reach $G_T$ at year 10.

The test is then whether $A_t$, the initial wealth ($10,000$) is greater than or equal to the minimum amount needed, $G_T$. If it is, the goal is affordable with the initial wealth. Otherwise, it is not.

The simple example above was based on just a single goal at year 10. In general, there may be more than one goal (multiple goals) at times T1, T2...Tn which could be wealth-
3.4 Consumption-based goal with multiple horizons

A wealth-based goal at a particular time horizon \( T \) requires that the initial investor at that time to be equal to or above the minimum wealth required for the goal, \( G_0 \) at the horizon after starting with initial wealth, \( A_0 \) at inception.

This simple case exactly corresponds to the example outlined in section 4.1 above and hence, the affordability criterion derived there is repeated here.

The present value of \( G_0 \), the terminal wealth at time \( T \), is \( G_0 \). The test is then whether \( A_0 \), the initial wealth is greater than or equal to the minimum amount needed, \( G_0 \), the floor value. If it is, the goal is affordable with the initial wealth. Otherwise, it is not.

Remember that the test of affordability also requires the existence of a replicable set of assets that can achieve the goal starting with \( G_0 \). As mentioned in section 3.3 above, all the goals in sections 4.1 and above are assumed to be replicable. If there is no such set, then the goal is not affordable even if the initial wealth is above the floor.

3.5 Multiple goals and joint affordability

While the foregoing referred to just one goal, either wealth-based or consumption-based, in reality many individuals have more than one goal of each type.

Then the question of joint affordability arises. Whereas previously the criteria for the affordability of a goal on its own were established, in the multiple case conditions for the different goals to be jointly affordable need to be identified.

4.1 Multiple wealth-based goals

The general case of several single wealth-based goals each with multiple horizons is considered and analyzed here for their joint affordability. One facet of it, multiple goals might seem to produce additional complications.

Consider that there are three goals, \( A \) and \( B \) and \( C \).

Three goals are equivalent to a single goal \( D \) with the horizons combining the separate horizons.

A numerical example will make this clear. Suppose goal \( A \) - \$200 at year 2, \$300 at year 4, \$500 at year 6, \$600 at year 7, \$800 at year 9.

Goal \( B \) - \$150 at year 1, \$500 at year 4, \$700 at year 8.

Goal \( C \) - \$60 at year 2, \$80 at year 4, \$120 at year 9.

These three separate goals, \( A \), \( B \) and \( C \) become equivalent to a single goal \( D \). Similarly, multiple wealth-based goals can be treated as a single wealth-based goal with multiple horizons.

4.2 Multiple consumption-based goals

They are treated in the same way as multiple wealth-based goals and are equivalent to a single goal with the separate goal’s consumption payments at different horizons. A major difference is that evaluating the minimum wealth required at all the time horizons \( T \), is \( G_0 \).

The consumer, \( G_0 \), is the minimum required at each point in time. The floor value, which is the initial wealth of the combined goal has to be equal or exceed consumption payment at the horizon of the individual floor values of each of the separate goals.

This is simpler than computing the minimum required for multiple wealth-based goals.

4.3 Wealth-based goal with multiple horizons

This is a simple extension of the logic applying to multiple wealth-based goals in section 4.1 and multiple consumption-based goals in section 4.2 above. These goals can be all treated as a single wealth-based goal and a single consumption-based goal.

Following the principles in the sections above, the joint affordability of these goals is again based on a series of specially defined present values that identifies the floor value for the GHP.

5. The goal-hedging portfolio in the presence of non-portfolio income

The analysis in section 4 was based on a single inflation of capital, the initial wealth at inception with no other cashflows being brought in by the investor. There is an additional complexity in the presence of incoming cashflows (referred to as non-portfolio income or income from portfolio income such as dividends and interest received), though the general principles in section 4 remain applicable.

There are alternative ways of financing the GHP differing in how much credit is taken for the later income flows and how much of the initial wealth is assigned to the GHP with the rest being allocated to the PSP.

Clearly, as explained in section 3 above, the lower the amount of the initial wealth that is invested in the GHP to secure the essential goals, the more money is available for the PSP to increase the investor’s wealth. It is, therefore, in the investor’s interest to use the method that allocates the lowest amount of the initial wealth to the GHP.

This lowest possible initial wealth is referred to as the ‘cheapest’ GHP. Selecting the cheapest GHP leads to a cheaper GHP than the one via the LIQ method, with only about $60 of the initial wealth being used and leaving the rest for the PSP. But it assumes that the $40 at year 1 earns interest year to year up to 2.

With INC-ZER a little less than $60 of the initial wealth is allocated to the GHP relying on the $40 of income at the end of year 1 to make the required $100 consumption pay-off at year 2. Hence, the amount available to the PSP at year 0 is a little over $40, about ten times what is produced by the LIQ method.

5.3 INC-CMP technique

In the INC-ZER method, no allowance is made for the income of $40 at year 1 to earn interest. In another method, INC-CMP, this allowance is made. As a result, there is a reduction in the proportion of the $100 payment that needs to be financed from the initial wealth. So, INC-CMP leads to a cheaper GHP than when INC-ZER produces.

5.4 INC-FWD technique

Forward contracts do not always exist in a market but if they do, investing in such contracts can represent an even cheaper method of establishing the GHP, referred to as INC-FWD.

5.5 Other situations

Another case involves multiple income flows interfaced with consumption outflows. The approaches selecting the cheapest portfolio remains the same, although the process is a bit more complicated. At any particular date of a consumption pay-out, all the unused income up to that date should be allocated before calculating how much of the initial wealth will be used to contribute to this pay-out. The overall goal of the investor should be preferred to current wealth in securing the essential goals still applies. Hence, the minimum wealth required for the PSPs made available for the PSPs aimed at increasing the investor’s wealth and helping to achieve non-essential goals.

The principle of preferring income to wealth is false in the first place but true in the second. If the income flows are uncertain, it might be better to use liquid wealth rather than the uncertain income to achieve the final goals with certainty.

In the general case, a formula is derived for the floor of the GHP, the minimum initial wealth for the goal to be affordable. The securing of this goal involves the use of exchange options. Based on this general solution, specific formular are also derived for each of the above methods: LIQ, INC-ZER and INC-CMP. In some cases, bonds (including zero-coupon bonds) can be used instead of exchange options. A special case involves retirement where there is a series of income flows before retirement (accumulation phase) and consumption outflows after retirement (deaccumulation phase).

This case is examined in detail in the paper.

6. Performance-seeking portfolio and wealth-mobility portfolio

In the two previous sections, the construction of the GHP corresponding to the personal budget and the portfolio, the two other building blocks are covered. PSPs corresponding to the market risk bucket and WMP corresponding to the aspiration bucket.

6.1 Performance-seeking portfolio

While the set of GHPs corresponds to the essential goals that are personal to every investor, the PSP seeks to maximise performance through a well diversified portfolio investing in assets that are tradable in financial markets. From this perspective, even hedge funds and private equity can be considered as they are relatively diversified attempts to exploit market opportunities. MPT points to a type of portfolio known as the maximum Sharpe ratio (MSR) portfolio, which all investors should use to achieve optimal performance and risk-reward ratio. Typical investment practice is to identify investments in various asset classes and then to allocate the portfolio among these.

In MPT terms, the procedure involves the first step of generating investible proxies for MSR at each asset class which are usually taken to be market indices. In equities particularly there is a growing belief that market cap weighted indices are not suitable and techniques such as smart beta are being
increasingly adopted. Then the second step is to allocate the PSP assets to each of these separate wealth classes in order to establish a multi-class PSP.

This second step is known in the industry as the asset allocation process but is usually referred to as the allocation of funds to meet the essential goals.

For the purpose of prioritisation, all essential goals need to be made sure and have to be affordable. If the essential goal is not affordable but each goal within the set is individually affordable then the investor has to decide which goals are affordable or make some of the lower priority essential goals merely important.

Within the set of important goals, as well as in the set of aspirational ones, there has to be a degree of priority in terms of investor’s preference. To avoid conflicts of priorities, an explicit hierarchy within and across type to weight the minimum wealth required in it and to allocate the rest to the PSP. Therefore, the amount invested in the PSP is equal to the GHP. Consequently, this simplification is important because in the absence of additional income it remains unaltered. If the investor reappraises with the PSP falling in value, the gap between the total wealth and the GHP goes down close to zero. In fact, it is the same option for the two goals that builds on zero and in the extreme, the wealth is invested entirely in the GHP. This strategy is akin to the constant proportion portfolio insurance (CPP) strategy where the risk disappears when the portfolio hits the floor.

8.2 The simple approach: Buy and hold

The simplest and most natural strategy is to secure each of the classes of minimum wealth required in it and to allocate the rest to the PSP. Therefore, the amount invested in the GHP is equal to F. But since G is always equal to zero, this might appear that the floor value is no longer secure because the new GHP value, G, is below that value.

But this is not so. If the total wealth falls to the floor value, F, then G becomes zero, G becomes T. Thus it is equal to F and thus G becomes equal to F. The P value reaches the floor value again.

This explains why the appearance of the floor value being insecure is not a real danger. As long as the total wealth stays above the floor value, it is always possible to secure it. The total wealth value in the floor value as but mentioned above, G, automatically achieves the floor value, thus removing any danger and securing the essential goal.

When in is taken as 1, the formula becomes the same as in the buy and hold strategy. Generally, in vary over time but the GHP framework is fixed at a particular value.

8.3 The optimal approach

This buy and hold strategy, however, is not the most optimal. A detailed analysis of the optimal strategy, based on MPT principles, leads to more complex formulae which are simplified with the use of a multiplier m. Intuition also suggests that the use of this multiplier through the extension of the buy and hold strategy. This strategy then becomes just a special case with m equal to 1.

In the light of the above, the amount invested in the PSP initially is not the difference between the total wealth and the GHP. Consequently, the difference and what is invested in the GHP is securely invested in the GHP. Conversely, if the GHP goes down close to zero. In fact, it is the same option for the two goals that builds on zero and in the extreme, the wealth is invested entirely in the GHP. This strategy is akin to the constant proportion portfolio insurance (CPP) strategy where the risk disappears when the portfolio hits the floor.

8.4 The different situations and rebalancing

The various cases (wealth-based goals, consumption-based goals and multiple goals) correspond to different situations in terms of the structure where the CPPPI principle holds. As the total wealth approaches the floor value, the GHP moves outwards and inwards and when the total wealth reaches the floor value, the entire wealth is invested in the GHP. In the event of the total wealth increases, the allocation to the PSP rises with the probability of achieving more performance.

It was shown above that the introduction of the multiplier (greater than 1) poses no risk to the security of the floor. However, this assumes that rebalancing is continuous as the PSP drops in value. In reality, rebalancing and associated trading take place at discrete time intervals. If the PSP falls by a large amount between rebalancing dates, the floor itself might be breached before the next rebalancing takes place. This risk becomes more serious if the exposure to the PSP is a large as a consequence of a high value for m.

8.5 Multiple goals

Multiple essential goals introduce another diagram taking place at discrete time intervals. If two multiple goals the floor is the higher of the two different floors. The GHP then as a safe asset corresponding to the minimum wealth required and the investor is more likely to be breached as the wealth falls. If the floors are reasonably close to each other, it is unlikely that one floor will be switched to the new higher floor if necessary.

The case of more than two multiple goals is a clear extension of this two-goal process.

8.6 Cap on wealth

An interesting situation arises when a cap is introduced on the minimum wealth set aside. In this event the probability of reaching high wealth levels, though below the cap-imposed maximum level, can be enhanced.

8.7 The presence of non-portfolio income

The presence of income from non-portfolio income requires decisions at each income date as to what income is ringfenced with the general principle remains valid that consumption expenses should be primarily financed with income and that liquid wealth is used only when income on its own cannot meet consumption needs.

Note that under the general principle the GHP floor takes into account the expected incoming income flows. So, as each income flow comes in, some of it is allocated to the GHP and the rest to the PSP. Thus, the GHP continues to secure essential consumption-based goals.

9. Case Studies

Individual investors are typically classified by life stage and function.

Three life stage clusters are:

• LS1: Accumulation (age less than 55 years)
• LS2: Transition (age between 55 and 65 years)
• LS3: Decumulation (age higher than 65 years)

The affiliation dimension is usually grouped under:

• A1: Mass affluent ($20K to $1m)
• A2: High net worth ($1m to $5m)
• A3: Ultra high net worth ($5m+)

These three clusters can be further grouped under three overall clusters:

• C1: Accumulation/transition
• C2: Decumulation/transit
• C3: Retirement/transit

Each cluster corresponds to the higher of the two above, each can replace the other as the higher performance.

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The simplified forms of the GBI analysed in the paper are not subject to the risk of using an inappropriate model. Essential goals are secured in any event and so is the substantial access to upside potential, though not quantified, of PSP assets. What is subject to models and not robust are the actual quantitative assessments relating to important and inspirational goals.

11.2 Outputs

Outputs are needed for both monitoring and adjusting the GBI strategy and also generating important information for a vital dialogue at regular intervals between the financial advisor and the investor. As with inputs, there are subjectives as well as objective outputs relating to the probabilities of reaching goals, any expected shortfalls and asset allocation recommendations.

Various measures of success are available for the assessment of strategies whether GBI or others such as the investor's existing approach. Examples are:

- Probability of success of the goal
- The expected maximum shortfall and variations on this theme – the worst possible shortfall at any time, not just the average expected

These measures relate to the different types of goals such as wealth-based and consumption-based and all the relevant horizons. They are computed by simulating future portfolio performances, which depend on assumptions regarding the specific returns on various assets and the evaluation of relevant risk factors such as interest rates and inflation. These returns and risk parameters can be re-estimated on every occasion when the portfolio is reviewed.

An important output relates to the opportunity cost of paying out any given essential goal. If this goal was not essential, additional assets would be available for the market risk bucket leading to a higher probability of more wealth. This extra wealth is foregone if the goal remains essential and represents the opportunity cost of securing the essential goal, a measure that the investor could find useful in his/her allocation to various risk buckets. This process could be widened to allow the investor to estimate the opportunity cost of staying with the current strategy rather than going for the more optimal GBI strategy.

11.3 Allocation advice

It is emphasised that essential goals must have a 100% probability of achievement irrespective of models and parameter values chosen. An essential goal is any goal the investor desires to be met in an equity allocation. If a stock index is assumed to generate a sufficiently high return, future taxes already suggested, then a strategy based on a very high weighting in the stock index can suggest that an essential goal is certain to be achieved. But this forecast return is highly unreliable and in truth, the essential goal will not be achieved.

In contrast, as explained in section 8, referring to the allocation process between the GHP and the PSP when the total wealth falls to the GHP level, the wealth becomes invested entirely in the GHP, thus securing the essential goal. This result is independent of models.

11.4 Mass customisation

A substantial problem arises in real life in the implementation of a GBI solution. Investors, in general, share a financial advisor with many others. This severely limits the time that the advisor can give any particular client unless they are very wealthy. Thus, it is difficult for the advisor to offer a high degree of customisation needed for the GBI solution. It is, therefore, necessary to group individual investors into clusters according to their characteristics. The question then is which tailored benefits of the framework remain available with such groupings.

This paper depends on which of the three building blocks – the GHP, the PSP and the WMP – are being considered as well as on the final process of allocating between these three.

11.4.1 The goal-hedging portfolio

These are specific to every investor and demand a high degree of customisation. In the case of consumption flows, a solution is to invest in bonds, the maturities of which match consumption cashflows such as pension payments. The reinvestment of coupons issued by these bonds also presents a problem. It is suggested that if this exact cashflow matching of bond maturities with consumption payment dates is difficult, advanced techniques referred to as immunisation or convexity adjustments and various interest rate management tools can be used. Thus, it might be possible for financial advisors to achieve a reasonably acceptable implementation of GBI strategies if there is available a section of bond portfolios and nominal, which can be used as proxies for GHPs.

There is a trade-off between the range of portfolios the advisors can use and the probabilities of achieving the essential goals. If this range is too narrow, these probabilities can fall unacceptably below 100%.

11.4.2 The performance-seeking portfolio

The PSP represents the easiest. In theory, all investors can have the same PSP with their different expected performance targets by varying the proportions allocated to the optimal minimum MSR portfolio and cash. Leverage can be used in attempting to exceed the return available on the MSR portfolio.

In practice, however, there are some obstacles such as constraints on leverage, short sales and foreign investments as well as exclusion of affordable and illiquid asset types. This would mean that different investors might need different PSPs, but even this is manageable with a relatively small number of PSPs.

11.4.3 Allocation between building blocks

The biggest obstacle to mass customisation is the all-important process of allocating the investor's wealth between the building blocks, particularly between the GHP and the PSP as set out in section 8 (and ignoring the WMP for the reasons given there). It is, for the most part, impossible to offer the same allocation strategy to several investors even if their goals are similar to each other. The allocation to the various blocks depends on the specific situation of each investor including current wealth levels and the extent of progress towards each goal. The big question still remains as to whether a limited number of portfolios (encompassing the different proportions in the GHP and the PSP) can do the job of mass customisation.

It is suggested that model portfolios built by financial advisors with equity allocations of 20%, 40%, 60%, 70% and 80% and the rest of each allocation in bonds and cash can be interpreted as crude approximations for GBI strategies. The idea is that equities represent risks, bonds represent long-term consumption needs and cash provides the protection required by GHPs against losses. However, proper mass-scale customisation needs a dedication allocating a limited number of building blocks requiring a satisfactory information technology system.
The construction of the GHP takes account of various types of multiple goals that reflect the real-life behaviour of many investors, thus enhancing the practical value of the investment solution prescribed. The PSP is based on Modern Portfolio Theory principles and common to all investors. Setting up the WMP does not arise as it is already preselected.

In the face of multiple goals it is important that the investor ranks them in a clear hierarchy even within the essential, important and aspirational classes, so that implementation of the framework does not violate the hierarchy of preferences.

Taxes present a problem. Income taxes are less of a difficulty but capital gains taxes are unpredictable, depending on the level of transactions and are a source of friction that detracts a little from the smooth workings of the GHP approach. However, the effect is not too serious.

Finally, it is important to keep this investment approach under continual review in terms of progress towards goals. Various inputs and outputs, part of the monitoring process, need to be incorporated into an ongoing dialogue between investors and their advisors. Such a dialogue takes the interaction between these two parties in a new more sophisticated level.

A major concern is that, by and large, financial advisors might find the advocated solution that needs to be tailored for each client uneconomic. Hence, the question of whether mass customisation is possible comes up. But overall, widespread adoption of the new process will enable the individual sector to access and reach the level of professional thinking that is taken for granted by leading institutional investors.

This is the second of a group of related articles on retirement investing. Please see the previous one on “Retirement Goal-Based Investing” and the next three on “Tailor-Made Funds with Economies of Scale”, “Individual Investment Processes for the 21st Century” and “Multi-Asset Products and Solutions”.

References

The most pressing problem lies in the growing shift from defined benefit to defined contribution pension schemes, wherein individual beneficiaries are landed with responsibility for investment management: Addressing a tough engineering problem and the challenge was how to solve it.

1. Introduction

The asset management industry has to change radically in the next decade or so. How it will change is uncertain but change it must given the wall of problems it faces, particularly in the retail sector where its offerings are widely not considered fit for purpose.

A new academic paper ‘Mass customisation versus mass production in retirement investment management: Addressing a tough engineering problem’ by Lionel Martellini and Vincent Milhau points a way forward for the retail industry, a road that should revolutionise the industry for the better. This article is based on the paper.

What is wrong in retail? The most pressing problem lies in the growing shift from defined benefit to defined contribution pension schemes, wherein individual beneficiaries are landed with responsibility for investment decision-making which they are not equipped for, given widespread illiteracy. The imperative for the solution to a potentially serious crisis on this front becomes ever more pressing year by year with fast-growing ranks of individuals under the threat of poor retirement living standards.

A brief review of what is available for more customised solutions. He saw mass customisation that combines the economies of scale and low costs attached to mass production with the flexibility of solutions tailored for individuals as a tough engineering problem and the challenge was how to solve it.

2. An individual’s goals

The results in the paper are derived using elementary financial theory (the principles of compound interest and related discount rates) as well as advanced probability techniques (involving stochastic calculus...
2.1 The two stages of mass customisation

Individuals, in general, have an idea of the minimum standards of living they want in retirement before which they would be unhappy. In addition, they might aspire to a much higher standard that would be desirable, but not necessarily attainable. In terms of retirement income, these two standards are referred to as essential and aspirational goals respectively. The challenge of mass customisation is met with a solution that encompasses two stages. The challenge of mass customisation is met by the contributions coming in.

2.2 Portfolio: Goal-hedging and performance-seeking

The first task is to determine the maximum possible retirement income. The second is to determine the optimal allocation between the building blocks is complicated by the tough engineering problem mentioned by Merton. This second stage is covered from Section 5 onwards.

1. The wealth, \( W \), at time 0 is referred to as the funded ratio, \( R \).

2. The minimum wealth, \( G \), for the essential goal can be expressed as

\[
G = \max_{t \in \{0, \ldots, T\}} \left\{ \sum_{i=1}^{T} r_i \right\}
\]

3. The essential goal, \( \delta_{ess} \), has to be secured by retirement date, \( T \). The minimum wealth that is required at age \( T \) to achieve the essential goal is referred to as \( G \). So, the optimal investment policy involves making sure that

\[
\text{the wealth at time } T \text{ equals or exceeds } G.
\]

4. Building blocks and allocation

- Allocation between the building blocks

To make sure that essential goals are achieved, not only does the investor’s wealth have to be sufficient at the retirement date, \( T \), but also in the event of exiting the fund any time before that date, his/her wealth at that time needs to be sufficient to secure his/her essential retirement income. This requires his/her wealth at any time \( t \) before the start date and \( T \) to be above a floor value, \( G \). Since this applies to all individuals, it means that the value of the entire fund, \( X \), has to exceed a floor value, \( F \). This floor value is computed by using a formula that differs according to how the fund is made scalable and less customised, as explained in later sections. For the purpose of this section, it is sufficient to note that there is a well-defined floor value above which the total wealth must stay at all times.

It was explained in section 3 that the optimal investment policy consists of investing in a combination of a guaranteed income portfolio (GIP), a performance-seeking portfolio (PSP) and a hedge portfolio (GHP). A feature of this strategy is that the allocation to the PSP falls to zero when the total wealth falls below a certain floor value, \( F \). Nevertheless, this strategy has the weaknesses listed earlier and is not implementable. The same feature of the PSP falling to zero is captured by making the allocation to the PSP a multiple of the difference between the floor value of the GHP, \( F \), and the total wealth. Thus, financial theory shows that the amount invested in the PSP, \( A \), is

\[
A = 0 \text{ if } F - X < 0, \quad A = F - X \text{ if } F - X \geq 0
\]

where \( X \) is the value of the outstanding contributions and \( F \) is also the value of the accumulation bond.

Finally, the amount in the accumulation bond, \( A_{acc} \), is

\[
A_{acc} = X - V \times \text{sgn}(R - 1)
\]

where \( V \) is the value of the accumulation bond, \( R = \text{sgn}(R - 1) \) is a negative position (a short position) in the accumulation bond which is being paid off with these funds. While at the beginning of the period the value of the accumulation bond is the present value of the remaining coupons, \( C_{t+1} \), at any later time, \( t \), its value decreases to become the present value of the contributions still outstanding and outstanding contributions due for payment at date \( T \). When the retirement date is reached, no further contributions will be paid and therefore, the value of the accumulation bond with no outstanding contributions due will be zero.

3. Optimal investment policy

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4.2 Fund ratio developments

In implementing the strategy based on the multiple high share funds, the reason for using 
these ratios will be used.

To avoid this, as soon as the aspirational goal 
and therefore, is exposed to interest 
rate risk. Hence, as in the case of deferred 
annuities, duration hedging techniques are 
brought into play.

5. Scability and different floors

5.1 Parameters for mass customisation

In general, individuals differ according to the 
following variables:

- D1 - Gender
- D2 - Retirement age
- D3 - Retirement date
- D4 - Start date of the accumulation phase
- D5 - The initial contribution at the entry date and the annual scheduled contribution
- D6 - Essential (D6a) and aspirational (D6b) goals expressed as fractions of the initially 
affordable income

At one extreme of scalability, it will be good to 
have a single portfolio that accommodates 
all individuals and their various needs.

The portfolio solution outlined in section 4, 
was shown that no account is taken off a 
building block, as the block building up will 
be left for him/her to decide when his/her 
goals have been reached and take action accordingly. So, 
this D6b can be dropped from consideration for 
scalability.

It is assumed that D2, the retirement age is 
65 years in all cases in various countries.

The age and gender differentiation is catered 
for by having five entry ages, 45, 40, 55 and 
55 and having different funds for each 
individuals falling by provider and gender. Individuals 
falling between these ages are assigned to the nearest 
age group in this list. In each case, 
becaus of their age will differ a bit from the 
age assumed in the design of the portfolio, 
particularly in the GHP, they do not enjoy the 
same complete guarantees as the ones 
with the same age exactly.

The essential goal invested by D6max,0, the 
relevant fraction of the maximum affordable 
retirement income at the start, is fixed as 
mentioned earlier at 80% for everybody as a 
base level, though in some circumstances for 
everyone at the time of first term section a slightly 
higher ratio can be used.

Hence, the scalability process has to now 
only determine the individual investor's 
entry dates and D5, different levels of initial 
contribution (wealth) at the start date and 
the regular annual contribution at subsequent 
years.

In section 4 above, the allocation between 
the GHP and the PSP was based on a floor 
level, details of which was not given because 
its depends on the level of scalability in 
different variables, in the portfolio times 
5.2 below deals with the case of a portfolio 
without scalability with respect to the 
various variables.

In section 5.3, the different shape of the 
formula for the floor of a portfolio open to 
entry by investors at any date after the 
inception of the fund is explained, thus 
scaling D4.

The floors in 5.2 and 5.3 are different 
different fund for each client corresponding 
to the rest. The maximum affordable retirement income, 
that fund is set at year zero is protected though the floor 
level, though in some circumstances for 
everyone at the time of first term section a slightly 
higher ratio can be used.

Because the all individuals have the 
contribution ratio, it can be shown that the necessary 
affordable income as well as the total amount of 
the essential goal of the fund managed by the 
individuals at the time of the initial contribution remains 
and is dealt with in section 6.

5.2 Basic floor for different 
contribution levels

As explained in section 4, a critical aspect 
of the allocation strategy between the three 
building blocks the GHP, the PSP and the 
accumulation bond is the floor level of the 
portfolio which has to be protected at all 
times and this floor level is that of the GHP.

In this subsection, the floor of a fund scalable 
in either D4 or D5 is discussed.

All investors share the same entry date and the 
same ratio of contribution to annual 
replacement goal.

In general, investors entering at the start 
and at the same time and same 
commit to scheduled annual contributions.

They may also make unscheduled 
contributions from time to time (savings). 
Though individuals’ contributions differ, it is not 
simply the size of the contribution that is important. 
In this context, the minimum affordable 
retirement income which is to be assumed for all investors.

If unscheduled contributions occur, the 
reasoning below would not hold. However, 
because these cannot be anticipated in 
advance, they cannot be allowed for 
everyone at the time of first term section a slightly 
higher ratio can be used.

Also suppose that the floor value at year 5 
has jumped to $1,100,000 because of the PSP 
investment which means that the maximum 
retirement goal of $800,000 to be affordable. 
Because only the original retirement income 
set at year 0 is taken into account, the new 
retirement goal at year 5 of $800,000 will not be fully protected.

The number of investors times the 
minimum or 5 investors invest 
the same complete guarantees as the ones 
that fund is set at year zero is protected though the floor 
level, though in some circumstances for 
everyone at the time of first term section a slightly 
higher ratio can be used.

If we imagine the whole fund to be 
held by one individual as in the example above, 
this floor value corresponds to the 
individual contributions in the fund, as investor B 
but each will have their 
share constant.

Consider an example of a fund where the 
lowest possible investment is an initial wealth of 
$1000 and a commitment to an annual 
contribution of $0. Unscheded contributions are allowed. This 2%-pronged 
purchase price of $0.50 and $0.75 is rather similar if the 
users with a present value, Q, the fund management companies 
cannot economically provide the 
building block the GHP, the PSP and the 
accumulation bond as outlined in section 4. Thus, 
the portfolios in sections 5.2 and 5.3 are practicable.

The derivations of the floors in 5.2 and 5.3 
involve some very basic mathematical 
reasoning and are extremely, every individual with 
different characteristics will have his/her own 
portfolio, the fully customised solution.

This is not scalable for the practical reason 
that fund management companies cannot 
economically provide this.

It is possible to have a solution to 
in this situation is key to the next section.

Thus, an investor brings in (5000, 500).

Now that a method for catering to different 
entry dates in the same fund has been 
built up, it is required that still new entrants should be dealt with 
without scalability with respect to the 
various variables.

In section 5.3, the different shape of the 
formula for the floor of a portfolio open to 
entry by investors at any date after the 
inception of the fund is explained, thus 
scaling D4.

The floors in 5.2 and 5.3 are different 
but both can be used in the 
implementation of the building block 
allocation as outlined in section 4. Thus, 
the portfolios in sections 5.2 and 5.3 are practicable.

6. Scability for different contribution levels

6.1 Two funds for everybody

In section 4 above, the allocation between 
the three building blocks the GHP, the PSP and the 
accumulation bond as outlined in section 4. Thus, 
the portfolios in sections 5.2 and 5.3 are practicable.

The derivations of the floors in 5.2 and 5.3 
involve some very basic mathematical 
reasoning and are extremely, every individual with 
different characteristics will have his/her own 
portfolio, the fully customised solution.

This is not scalable for the practical reason 
that fund management companies cannot 
economically provide this.
Suppose in a (1,c) fund where for example c is fixed at the value 1/10 and the initial contribution is C_0, the regular contribution is equal to 1/10 of $1,000, this means the regular contribution is equal to 1/10 of $1,000, $100 per annum.

Consider another person whose initial wealth is $500 which means that the income is $1/10 of $500, $50 per annum. The ratio of initial wealth to regular contributions is 50%. The overall contribution ratio of individuals with different contribution levels varies from 50% to 100%.

In both cases, both individuals would invest in an identical way except that the first one would have double the assets of the other.

The choice of fixed c is that of the fund management company. A different company may choose a different c for these two funds. People with different ratios of initial contribution to final contribution then invest differently for these two funds. (1,c) strategy and (1,0) strategy where the allocation between the two funds is fixed at date 0.

It is also shown that the investor through unscheduled contributions then these are considered as the essential goal. However, if you compare the two funds, (1,c) and (1,0) as shown below:

6.2 Allocation between (1,0) and (1,c) funds

So the allocation of an investor’s wealth where the initial wealth is C_0 and their regular annual contribution C in subsequent years is split up between the two funds, (1,0) and (1,c) as follows:

There are two cases considered:

a) When the initial wealth C_0 is equal to or larger than the annual regular contribution C in subsequent years. Typically, this is the case for the entire contribution in the (1,0) fund and C is invested in the (1,c) fund.

b) When the initial wealth C_0 is smaller than the annual regular contribution.

The first case is the most straightforward one. At date 0, (C_0 - C) is invested in the (1,0) fund and C is invested in the (1,c) fund. Then C in subsequent years is invested in the (1,c) fund.

If there are irregular unscheduled contributions this will be invested in the (1,0) fund. When the investor makes exactly the same annual contribution every year, the number of shares held in each fund by him remains constant from year to year. Thus, this strategy is described as a buy and hold strategy where the allocation between the two funds is fixed at date 0.

In general, if stated above there are additional unscheduled contributions then these are invested in the (1,0) fund and his number of shares in this fund increases but the number of shares he holds in the (1,c) fund remains constant.

An important issue is that the investor never reallocated between the two funds and therefore, does not sell any part of either fund and thus not incur transaction fees or taxes. It is also shown that the investor through this strategy enjoys the same guarantee as he/she would enjoy had he/she been invested in a hypothetical (1,c) fund where c is not fixed but equals the investor’s personal contribution ratio.

Thus, his/her essential goal is secured and therefore, this strategy of investing in the two fixed funds is an effective strategy for achieving scalability for individuals with differing contribution levels, D5.

Case b is more difficult than case a. In this case, C_0 is less than C and therefore C - C_0 as in case a in the (1,0) fund is not possible since the entire contributions at date 0 and the contribution at date 0 is not possible: therefore, the entire contributions at date 0 and the contribution at date 0 is not possible.

In subsequent years only a proportion of the regular contribution is invested in the (1,c) fund and the rest is invested in the (1,0) fund. In general, the essential goal in this case is not sufficiently clear.

Under these conditions only part of the regular contributions that can be treated as essential contributions can be secured in terms of the essential goal. However, if the fixed c is sufficiently large e.g., 1, then it might be secured.

7. Resets and new funds

7.1 Risk budgets and resets

It will be recalled that in the cases (L_1, 0) of the maximum goal is essential and the rest is free for investments for taking risks in order to reach the aspiration goal. Typically, L_1 starts at 80% so that the risk budget amounts to 20% of the initial wealth.

It is true that if the multiplier m is greater than 1, initially more than the risk budget can be invested in the PSP but even here if the PSP falls sufficiently, the risk budget of 20% of the fixed value is no problem to the new fund is indicated but in practice, it also depends on the fund’s performance and other criteria such as the demand for new funds.

7.2 New funds

New funds are launched on two types of occasions. First, when younger cohorts are coming for whom the existing funds don’t fit in terms of the age criterion.

The second occasion is when old funds are either sterilised or quasi-sterilised. What sterilisation means is that when the fund value reaches a very high level such that the upside to the GHP. The essential goal is safe, aspirational goals are no longer possible justifying the use of ‘sterilisation’.

In the case of quasi-sterilised funds, the fund value has not quite reached the floor but almost there and hence, the potential for good performance is very limited.

Typically, even after the reset only a large outperformance of the PSP can save the day as the gap is still small. Then a new fund becomes necessary with the same gender, maturity date and age date as the existing fund but with a later start date.

A mechanical rule such the maximum floor value exceeding 95% can point to the need for a new fund is indicated but in practice, it also depends on the fund’s performance and other criteria such as the demand for new funds.

8. Numerical analysis

A major part of the analysis consists of examining how (1,0) and (1,c) performed under simulation for different values of m in various age groups, 35, 45 and 55. Two sets of probabilities are evaluated. Also, separate simulations are carried out based on start dates of 1996 and 2016. These two dates are distinguished by the prevalence of very high interest rates at the earlier time and the interest rates recently.

It is found that essential goals were secured up to m=3 in all cases but slightly less so for higher values of m when 2016 interest rates were used. But the risks became higher with the 1996 data. This is understandable because high interest rates make it more difficult for the funds in the PSP to outperform the annuities of the GHP. In many cases, while the risk to the essential goals were low, there were much higher chances of achieving the aspirational goals up to m=1.

It is a shame that the optimal value of m is 1 based on the simulations from the perspective of keeping the floor secure but maximising the aspirational achievements and that m=1 is never the best choice.

A very interesting conclusion is that for older people and for investment, there is a case for increasing the value of m and hence the risk taken in order to increase the probability of achieving aspirational goals. This result goes counter to conventional wisdom that people should take less risk as they grow older.

In the analysis, strategies with different levels of customisation in terms of the probabilities of achieving essential and aspirational goals are compared.

In addition, customised strategies are compared with many currently available retirement funds such as balanced funds and target date funds. It is found that while many of them performed rather well on the upside, it is the PSP that achieves the best success probabilities for high aspirational goals. One of course, compromise, many people, and therefore, this strategy of investing in the PSP falls sufficiently, the risk budget of 20% of the maximum retirement income in a reliable way.

The effect of resets was investigated and it is found that the reset prevents the creation of a new fund in many cases. This development is much to be desired given fund providers need to limit the expenses of launching new funds.

For a fuller appreciation of the principles and techniques outlined above, reading of the numerical analysis chapter of the original paper recommended is handful. The technical detail given there can be taken as read.

9. Summary and conclusion

The objective of the mass customisation solution is to establish a reasonably small number of portfolios which will cater for individuals with different entry ages, retirement dates, genders, entry dates into the fund, contribution levels and their essential and aspirational goals defined as proportions of L_1 and L_2 of their maximum affordable retirement income.

In terms of gender and age the individuals can be grouped in clusters of 35, 40, 45, 50 and 55 and separate gender portfolios. L_1 is assumed to be 80% and L_2 in some solutions has to be fixed and is usually 130%. Therefore, the mass customisation solutions are based on selecting just the entry date and contribution levels.

The overall portfolio consisted of three parts, the goal-hedging portfolio (GHP) securing the essential goal, the performance-seeking portfolio (PSP) and the accumulation bond. The latter is introduced so that the expected regular contributions at the outset can be invested along with the initial wealth by effectively borrowing in advance the value of the initial contributions. The borrowing takes place outside the accumulation bond which is paid off with the contributions in coming.

People entering at different dates are easily allowed for by having a different floor that is distinct from the case where all investors have the same entry date. The questions allowing for investors having different contribution levels is solved by the remarkable step of everybody investing in different combinations of two basic portfolios, the combinations varying according to their contribution levels.

As funds get older, the risk budget that is the amount that can be invested in the PSP can decrease leading new comers at later dates having less upside risk. The cost of providing them with new funds is significantly reduced by allowing the floor level of the fund to be reset but new funds are still needed when reset essentials are exhausted and also for catering to new younger members.

The prescription in the paper promises to make a big difference to the lot of future retirees, if adopted widely. The tough engineering problem – in the title of the paper, words used earlier by the distinguished Robert Merton appears to have been cracked with the ingenious introduction of just two fund types in which masses can invest while allowing for the individual needs.

This is the third of a group of related articles on retirement investing. Please see the previous two on "Retirement Goal-Based Investing" and "A Path-Breaking Solution for Individual Investors’ Problems" and the next two on "Individual Investment Processes for the 21st Century" and "Multi-Asset Products and Solutions".

Reference

The tough engineering problem...appears to have been cracked with the ingenious introduction of just two fund types in which masses can invest while allowing for the individual needs.
INDIVIDUAL INVESTMENT PROCESSES FOR THE 21st CENTURY

Arjuna Sittampalam, Editor, IMR Magazine

For the most part, private individuals have a poor second in terms of the attention paid to their problems by the asset management industry. The solutions put forward in the two in-depth academic studies conducted by EDHEC-Risk Institute, summarised in the preceding two articles, go a long way to redressing the balance. These solutions, if adopted by the industry as is needed, will put individuals closer to par with leading institutional investors, with respect to the techniques and advice available for their specific needs.

The two papers on the goals-based framework and mass customisation complement each other very well. Together they are applicable to the entire wealth spectrum of individuals with the former covering the mass affluent upwards and the latter addressing the needs of the more average investor. These solutions could trigger some much-needed revolutionary changes in asset management.

The goals-based framework, while introducing path-breaking precision to the implementation of individuals’ goals, will make the dialogue between an individual and his/her advisor more sophisticated. The ingenious solution to the mass customisation problem of allowing large numbers to address their specific needs just by investing in two funds will vastly improve the lot of future retirees. These people, coping with investment decisions that they are not qualified for and suffering from inadequate advice, are shooting in the dark when applying their hard-earned savings towards achieving a reasonable retirement income. However, the fact that a solution is available and should be adopted does not mean that it will be a powerful push is required from the industry to start with. Three groups have to adapt. Fund management companies have to not only provide new types of funds but also be proactive in propagating the new processes in a committed manner.

The advisory sector has to recognise and accept the superiority of the new solutions compared with what they are accustomed to. Previously, they had nothing better available and had to resort to fairly broad groupings of funds but the future is a different matter.

Finally, end-investors have to have a basic understanding of why the investment solution is much better for them than any vehicle they used before.

The industry will not find it easy to change direction. Both asset managers and advisors have to consider costs of training staff, new computer systems and the time needed to educate clients. Time and money is already invested in existing products which most institutions would be reluctant to abandon without strong motivation.

In fact, any commercial organisation would be reluctant to change its business model and product portfolio unless confident that the appropriate market exists. This is the classic chicken and egg argument. The market cannot arise without the supply and in turn, suppliers need to be assured of some demand. In the past, innovative funds were introduced, classic examples of which are index funds, exchange-traded funds and hedge funds; but these are all funds. The new solutions represent investment processes, not just products and there has to be collaboration between asset managers and the intermediaries from the word go. Perhaps the solution is for a few enlightened asset management companies to take the lead and undertake the training and supporting of advisors who are willing to participate.

Fortunately, some of the current trends in the industry mitigate in favour of change. The most important stimulus comes from the downward pressure on fees with active managers being squeezed by passive and smart beta vehicles. Industry consolidation is widely predicted. The economies of scale offered by mass customisation could encourage some of the survivors to kickstart the process. Note that BlackRock has announced its intention to shift its investment decision-making to more computerised practices, relying less on human involvement.

In spite of Trump’s presidency in the US being unsympathetic about the new rule mandating fiduciary advice, it looks as if that is the way of the future with the momentum being unstoppable. If the new processes can be shown to be obligatory in a fiduciary ‘best advice’ sense, then the pressure for advisors to adopt it could be intense and the rest of the world could follow.

Hitherto, the industry has been able to sell products with high distribution charges, which many advisors had every incentive to recommend without much regard for the customer’s best interests. It will be different in the future. Digital disruption reinforcing the pressure for higher fiduciary standards will help with the propagation of a much-needed focus towards goals-based solutions.

If the new solutions are included in academic curricula, much progress could be made. Widespread industry applications of Modern Portfolio Theory took off with the vast increase in the number of alumni learning about it at universities. This year, the CFA Institute announced the introduction of fintech and robo advisor elements into their syllabus, remarkably within a few short years of their widespread usage. Should the CFA and other organisations incorporate the new approaches in their examinations, a major breakthrough becomes more likely.

Capital markets can also make important contributions. Some of the finer detail in the goals-based and mass customisation solutions ideally need sophisticated instruments such as zero-coupon bonds, indexed vehicles and particular types of options. Even many developed markets in various countries do not have access to these and the two papers certainly have limited applicability in many emerging financial markets worldwide.

The new approaches should have universal applicability and financial markets should help to ensure this. If market impediments are removed and innovation is encouraged by governments, even developing markets could leapfrog many of their developed counterparts in using the available sophisticated tools. This can already be seen in Asia with respect to derivatives.

With ageing societies in many countries, inadequate pensions potentially pose social problems. Furthermore, it is widely accepted that long-term savings are in the interests of society. Individual savings and retirement provisions, therefore, are of vital concern to society as a whole and governments need to play a part.

The impact of taxes was pinpointed as a problem, though minor in effect, in the goals-based framework paper and governments can do something about this. Pension schemes are already exempt from taxes. Perhaps the same should apply to other long-term savings.

The new robo advisory trend is fast growing. At this stage, it is difficult to predict whether the new proposals will compete with them or come in at the top end as the cream of partly-automated systems for individuals.

The fund management industry is not in very good odour, as many leaders admit. Keith Skeoch, the joint CEO of the new Standard Life Aberdeen group, has written in FTfm that the industry needs to rebuild trust. If the asset managers pick up the baton of implementation following the new ideas, then it could go a long way in repairing its image in society.

This is the fourth of a group of related articles on retirement investing. Please see the previous three on "Retirement Goal-Based Investing", "A Path-Breaking Solution for Individual Investors’ Problems" and "Tailor-Made Funds with Economies of Scale" and the next one on “Multi-Asset Products and Solutions”.

References

If the new solutions are included in academic curricula, much progress could be made... Should the CFA and other organisations incorporate the new approaches in their examinations, a major breakthrough becomes more likely.
MULTI-ASSET PRODUCTS AND SOLUTIONS

Vincent Milhau, Research Director, EDHEC-Risk Institute

within the old paradigm, the asset management industry had long focused on the design of products with attractive performance, in a context where the distinction between active management with high fees and the passive replication of a benchmark at more moderate fees was a structuring frontier. At least since the turn of the millennium, profound changes have been taking place, which have led to the value proposal for investment management being entirely rethought. The first of the changes is the increasing interest from investors for “smart beta” products, which give them access to investible risk premia at much lower costs than actively managed funds. The factor investing approach is an important aspect of this trend, because these premia can be interpreted as compensation for bearing exposure to undiversifiable risk factors. The second paradigm change is perhaps even more important and consists in the recognition that investors, be they individuals or big institutions, need dedicated (customised or mass-customised) solutions to achieve their goals, as opposed to off-the-shelf products. Modern portfolio theory can serve as a useful guide towards the design of meaningful solutions, by teaching us what the right building blocks are, and how they should be combined over time to improve investor welfare. In practice, it will be needed, of course, to deviate from theoretical optimal portfolios to satisfy implementation constraints, but at least the key desirable properties of the building blocks and the allocation rule can be accounted for when defining implementable solutions. In particular, fund separation theorems state that optimal strategies combine at least two blocks: a performance-seeking portfolio with the highest possible Sharpe ratio, and a liability or goal-hedging portfolio that should track the present value of an investor’s liabilities or goal. This distinction has important implications when it comes to a better understanding of multi-asset solutions, since it implies that good risk-adjusted performance is only one possible objective – admittedly, one that is far from obvious to reach – for such multi-asset products, and the focus of a multi-asset solution should extend beyond this simple objective.

Scientific Diversification in Performance-Seeking Portfolios

The maximum Sharpe ratio (MSR) portfolio, defined as the portfolio that maximises the expected excess return over the risk-free rate per unit of risk taken, is a fundamental tenet of modern portfolio theory. It appears in (i) the two-fund separation theorem of Sharpe’s (1966) Capital Asset Pricing Model, (ii) dynamic portfolio strategies designed to strike the best balance between unexpected return and risk (Merton, 1973), (iii) optimal liability-driven investing strategies for pension funds or insurance companies (Martellini and Milhau, 2012), and (iv) goal-based strategies that maximise the probability of reaching a target wealth level (Brown, 1999).

While conceptually straightforward, the prescription to hold the MSR portfolio has proved extremely difficult to implement in practice, because of the need to estimate expected returns and volatilities and the dramatic impact of estimation errors on out-of-sample performance. Estimation risk is so large that it can offset the expected benefits of scientific diversification, and the “naive” diversification rule that weights all constituents equally proves to be a not-so-easy-to-outperform benchmark (DeMiguel, Garlappi and Uppal, 2009). To view this problem, it is tempting to use a portfolio construction technique that does not rely on expected returns, which are more the most difficult parameters to estimate.

The global minimum variance (GMV) portfolio is attractive from that perspective because it is the only point of the efficient frontier that depends solely on covariances, and it can be justified as an MSR portfolio under the agnostic assumption that all expected returns are equal. Moreover, in asset allocation, the number of constituents is typically small, so the sample size is sufficiently greater than the universe size to make sample risk in the covariance matrix limited (Kan and Zhou, 2007). Were constituents too numerous with respect to available sample data, efficient estimation procedures, such as statistical shrinkage, are available to obtain a more robust parameter estimate. However, even if that is true and even with a perfectly estimated covariance matrix, a GMV portfolio has no reason to deliver an Investor welfare, regardless of the opportunity cost in terms of performance. Moreover, it tends to be concentrated in the least volatile asset classes, like Government bonds, so it does not necessarily reflect an intuitive idea of what a “well-diversified portfolio” should look like.

Risk and Factor Allocation

To construct a well-diversified portfolio, one may go back to conventional wisdom, which advocates to “spread eggs across many baskets”. But what are eggs and baskets in asset allocation? The equal-weighting rule answers that eggs are dollars and baskets are constituents. But it is well known that a 50%-50% stock-bond portfolio, while being perfectly diversified in terms of dollar contributions, is poorly diversified in terms of risk contributions because its volatility is largely dominated by equity risk, which is by far the most volatile asset class. Risk parity has become a popular approach to correct for such imbalances since its goal is to ensure that all constituents (baskets) have the same contributions to risk (eggs) in the portfolio. In particular, this avoids the concentration in assets with low volatilities, even though such constituents still tend to have the largest weights.

This methodology, however, has its own limits. The first is inherent to the use of volatility as a risk measure: while volatility is symmetric and equally penalises upside potential and downside risk, investors are clearly more averse to downside risk than to uncertainty on the upside. As a result, standard forms of multi-class risk parity portfolios tend to overweight bonds, even in an environment where interest rates are expected to go up from historically low values to higher levels and bonds have a high downside risk. The adaptation of risk parity portfolios to interest rate conditions is the focus of a research paper by Martellini, Milhau and Tarrell (2015), supported by Lyxor in the context of the “Risk Allocation Solutions” research chair at EDHEC-Risk Institute. In this paper, we argue that a “duration-based volatility” measure for bonds, equal to current duration multiplied by interest rate volatility, more adequately captures increasing risk as interest rates decrease (see Exhibit 1). Extensions of the risk parity methodology to non-symmetric risk measures, such as semi-variance (the variance restricted to negative returns), value-at-risk or expected shortfall, are also discussed in this paper and in a related effort by Roncalli (2013). Users of these latter methods should be aware that they bear the risk of estimation errors in expected returns (required for downside risk estimates), but not as much as by attempting to estimate the MSR portfolio, because under suitable mathematical conditions given by Roncalli (2013), the extended risk parity portfolio is long-only, unlike the MSR portfolio, which can completely rule out assets with perceived unattractive risk-return profiles.

The second limitation of the risk parity approach is that by focusing on the contributions of constituents, it completely disregards the underlying factors that explain the risk of constituents, which can lead to a misleading picture for correlated constituents

With a strong common factor. For instance, it would be close to 1 because portfolio risk is almost entirely explained by the interest rate level factor. The factor perspective in the construction of well-diversified portfolios is gaining popularity, since it is partly supported by asset pricing models, and because it makes intuitive sense. As Ang (2014) points out, factors are the key to understanding how to collect these nutrients. Moreover, factors go a long way towards explaining returns on long-only actively managed portfolios, as Ang, Brandt and Denisson (2014) show in their study of the Norwegian sovereign wealth fund. Smart beta products, which have been largely developed in the equity class, are investment vehicles that allow factor premia with a strong common factor. For instance, an equally-weighted portfolio of two bonds with similar durations spreads dollars evenly, and is almost at risk parity, because the two volatilities are close to one another. Yet, the risk of this portfolio is related to a single factor bet, which is a bet on the level of interest rates. To better assess the extent of diversification in a multi-class portfolio, Carli, Deugst and Martellini (2014) propose to look through the constituents and to consider the risk contributions of underlying systematic factors. Implicit factors, which are extracted by analysing the returns of the securities to explain, are well suited for this purpose because they are uncorrelated, and they exhaust by definition all uncertainty over asset returns, in contrast to macroeconomic factors, which generally have low explanatory power. The effective number of uncorrelated bets that the authors use was introduced in Deugst, Martellini and Mesucci (2014) to quantify the degree of diversification as a quantitative measure of the dispersion of risk contributions (eggs) across factors (baskets). In the previous example, it would be close to 1 because portfolio risk is almost entirely explained by the interest rate level factor.


The ultimate objective is to offer a high probability of reaching the investor’s aspirational goals while securing their essential goals...
use of a minimum variance equity benchmark based on a double-sort procedure of stocks according to (high) dividend yield and (low) volatility would have generated, over the period 1999-2012, an annualized excess return reaching 270 basis points for the same funding ratio volatility, as well as a lower funding ratio drawdown, compared to what is obtained with the use of the standard cap-weighted S&P 500 index as a benchmark.

**Equity Benchmarks with Improved Liability-Friendliness**

We consider two alternative approaches to the definition of liability-friendliness. The first one is based on a Liability-Matched capability; under this definition, liability-hedging aims to find securities with dividend payments that match the pension payments as closely as possible. The stocks which are expected to display above-average liability-friendliness in terms of cash-flow matching capability are those that generate large and stable dividend yields.

The second definition is based on factor exposure matching. Since perfect cash-flow replication is typically difficult to achieve in practice, investors who need to hedge liabilities may instead choose to match the risk factor exposures of their assets with those of their liabilities. The objective pursued in this case is to minimise the tracking ratio of the portfolio to the liability proxy.

In this setting with a focus on risk factor matching, a stock will be said to be liability-friendly if the tracking error of the stock returns with respect to the returns on the liability proxy is low. Given the decomposition of the tracking error into two components (one that is related to the portfolio volatility and one that is related to the portfolio correlation with the liability proxy), a low tracking error can be achieved if the volatility of the stock is low and/or if the correlation between the stock and the liability proxy is high.

Using data from the CRSP database from 1975-2012, we construct portfolios with stocks originating from the S&P 500 universe. We cast the analysis at the individual stock level, as opposed to the sector level, given the expected presence of very substantial levels of cross-sectional dispersion in interest rate hedging benefits across individual stocks. The portfolios are rebalanced every year in March. In the analysis, the liability proxy is computed as a constant maturity bond and its returns are computed using 15Y US Treasury yields. The second step of the procedure establishes the weights that are assigned to each stock.

We start by considering equal weights for all stocks (no selection EW) to assess the benefits of the selection stage, and we additionally provide the results for the cap-weighted portfolios of all stocks (no selection CW), which is the commonly used benchmark.

We find that the various selection procedures indeed deliver what they are designed for. In particular, the equally-weighted (EW) portfolio of the 20% of stocks with the lowest volatilities has a tracking error of 14.6% with respect to our liability proxy over the sample period, while the EW portfolio of the 20% of stocks with the highest volatilities is almost twice as large at 27.8%. This spectacular improvement in tracking error does not only emanate from a lower portfolio volatility; it is also linked to a strong increase in correlation with the liabilities. Hence, the selection of low volatility stocks generates a positive 7.7% correlation with the liability proxy, while a selection of high volatility stocks generates a negative correlation of -6.7%. Intuitively, this improvement can be traced down to the fact that low volatility stocks, which tend to be low dividend uncertainty stocks, offer the stocks that tend to be the closest approximations to fixed-income securities, and as a result, the best approximation to bond-like liabilities.

In terms of correlations, the high correlation selection ranks only second (although close to first), with a large turnover, suggesting that empirical correlations are highly unstable. We further observe that all selections increase the Sharpe ratio as well as the turnover, compared to both the EW and CW benchmarks, and the increased liability-friendliness of the portfolio is therefore not penalised by lower risk-adjusted performance. We also confirm that the selection on dividend yield generates a statistically and economically significant increase in this dimension with respect to the use of the standard S&P 500 index as a benchmark.

Addressing the focus on liability hedging through a double-sort procedure, starting with the 200 highest dividend yield (DY) stocks, selecting the 100 lowest volatility stocks amongst them, and subsequently performing a minimum variance optimisation, it is found to lead to further improvements in the liability-friendliness of the selected portfolio.

Hence, combining the double-sort selection procedure with the minimum-variance weighting scheme with norm constraints (MV-C), leads to improvements in all indicators with respect to the base case results, and reaches the following attractive levels – 14.1% tracking error, 12.5% volatility, 8.2% correlation and 5.4% average dividend yield. Overall, double sorts starting with DY and then low volatility generate comparable levels of factor matching liability-friendliness (tracking error at 14.1% with improved cash-flow matching properties (average DY at 5.4%) compared to selection purely based on volatility. The Sharpe ratio further increases to 0.79, even though this comes at the cost of a higher turnover, which should deserve dedicated attention at the implementation stage.

**Measuring the Impact on Investor Welfare**

Due to the resulting improvement in liability-hedging benefits, liability-driven investors can allocate a higher fraction of their portfolios to equities without a corresponding increase in funding ratio volatility. For example, we find that a pension fund allocating 40% of its assets on the basis of a cap-weighted equity benchmark can allocate as much as 33.3% to a minimum variance portfolio of selected stocks from the aforementioned double-sort procedure for the same volatility of the funding ratio. This substantial increase in equity allocation without a corresponding increase in ALM risk budgets confirms that the aforementioned improvements obtained in terms of improved liability-friendliness are economically significant.

The resulting increase in equity allocation for the same ALM risk budget, combined with an improved risk-adjusted performance of the dedicated equity benchmark with respect to the S&P500 index, leads to an improvement in performance, reaching 1.58 basis points annualised over the 1975-2012 sample period. This improvement can be decomposed into a contribution purely emanating from the increase in equity allocation or assuming no impact on performance (39 basis points) and a contribution purely emanating from the improved performance of the equity benchmark assuming no increase in allocation (119 basis points).

In terms of historical trajectories, we plot the evolution of the funding ratio over the sample period assuming an initial funding ratio normalised at 100%, and compute the corresponding risk measures (funding ratio maximum drawdown).

We find that LDI strategies based on all improved liability-friendly portfolios strongly outperform LDI strategies based on the S&P 500 over the sample period, and Exhibit 1 shows that the outperformance is even more spectacular when the allocation to the improved equity benchmark is adjusted to generate the same volatility of the funding ratio as when investing 40% in the S&P 500 index. Moreover, the volatility of the funding ratio lies between 1.1% and 1.9% lower in absolute value when the equity benchmark is the liability-friendly portfolio compared to the use of the S&P 500.

With the exception of the MV-C portfolio of all stocks, the reduction of the maximum drawdown is at least 10% in absolute value, or 30% in relative value. Furthermore, we observe that even after controlling for the volatility of the LDI strategies with liability friendly portfolios dominate those with S&P500 in terms of extreme risk measures (funding ratio maximum drawdown).

**Increasing Equity Allocation without a Corresponding Increase in Risk Budgets**

The LDI paradigm advocates that pension plans divide their investments between fixed-income securities matching the investor’s liabilities, and a riskier performance-seeking portfolio that is heavily invested in global equities. However, asset managers can actually provide more value to LDI clients by incorporating low volatility and high-yielding equities as part of a broader LDI solution. While separating performance from liability matching makes theoretical sense, in practice, pension funds cannot use as much leverage as necessary to fully hedge their liabilities. If a manager places the majority of a pension funds money into equities, the portfolio could run the risk of high levels of short-term funding volatility. On the other hand, a more moderate equity allocation would require lower risk budgets but less upside potential. For underfunded pension funds, this type of allocation would have a lower chance of solving the funding problem without substantial levels of additional contributions.

We have found that it is possible to construct a customized “liability-friendly” equity portfolio with better liability-hedging properties than an off-the-shelf broad equity index. Customisation can allow for an increased allocation to stocks for the same level of funding ratio volatility, which could result in higher overall performance and the improvement in liability-hedging benefits coming at an exceedingly large opportunity cost in terms of risk-adjusted performance.
Bond Risk Premia: The New Frontier in Factor Investing and Smart Beta

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One first possible explanation behind the scarcity of the research on risk premia harvesting in bond markets and related investable solutions is that bonds are often held as part of investors' hedging portfolios, where the focus is on matching interest rate risk factor exposures on the asset side to interest rate risk factor exposures on the liability side, as opposed to risk/return ratio maximisation. This is, however, not a sufficient reason for ignoring the need to generate attractive risk-adjusted performance. After all, there are infinitely many bond portfolios with a given target duration, and selecting the one with the highest risk-adjusted performance should intuitively improve investor welfare. Another possible explanation is that bond portfolio construction models pose a number of technical and implementation challenges that do not exist in the equity universe. In particular, individual bonds, unlike stocks or constant maturity bond indices, have a finite maturity, which imposes a very specific structure on the covariance matrix and expected return vector. Moreover, no-arbitrage relationships exist between bonds of various maturities and these relationships impose a set of constraints on risk/return and factor exposure parameter estimators, for which there is no equivalent in equity portfolios. Additional implementation hurdles include the lack of reliable market prices for bonds.

...individual bonds, unlike stocks or constant maturity bond indices, have a finite maturity, which imposes a very specific structure on the covariance matrix and expected return vector.

that typically trade in thin markets and the concern over high implementation costs. In what follows, we provide a brief review of the theoretical, empirical and practical challenges related to factor investing in the fixed-income space. The modern approach to factor investing actually suggests that we should first identify robust and economically-motivated sources of risk in fixed-income markets, select securities on the basis of the desired factor tilts, and then apply an efficient weighting scheme aiming to enforce the highest level of diversification to as much unrewarded risk as possible from investor portfolios. In this context, our ambition is to discuss each one of these aspects, with applicability to various segments of fixed-income markets, most importantly sovereign and corporate bond markets.

Limits of Traditional Bond Benchmarks

Over recent years, a number of concerns have been expressed about the (ir)relevance of existing forms of corporate and sovereign bond indices offered by index providers, many of which are simply not investable in the first place. Beyond the lack of investability, there are two major problems with existing bond benchmarks, namely (1) an excessive concentration and lack of proper diversification and (2) a lack of stability and control over the underlying set of factor exposures.

Lack of Diversification in Sovereign and Corporate Bond Indices

Lack of diversification is the first major problem with bond indices that is typically made by the debt issuers by their market value. Given the large share of the total debt market accounted for by issuers with large amounts of outstanding debt, market-value-weighted corporate bond indices will have a tendency to overweight bonds with large amounts of outstanding debt. This weighting scheme will inevitably lead to excessive concentration and lack of diversification. The issuer concentration in government-bond indices is very undesirable from the perspective of the construction of a well-diversified portfolio. Staal et al. (2015), for instance, document that 55% of the Barclays Treasury Index (which is supposed to refer to 36 different countries) is made up of US and Japanese bonds, and that the same two bonds account for over 65% of the total risk of the index.

While the claim that over-represented issuers may give rise to adverse selection and poor diversification is compelling, simplistic rules to correct for issuer size are likely to be ineffective, since it is not size itself that is ‘dangerous’, but size relative to ability to repay and to refinance debt (see the next section for a more detailed discussion of fundamentally-weighted indices). So, for example, a correction of the market-capitalisation benchmarking rule based on the naive comparison of the size of debt outstanding for US Treasuries or Greek government debt would do little to redress an over-representation of supposedly riskier bonds, nor would looking at the amount of debt outstanding as a fraction of GDP do much to redress re-financing risk in the case of the government debt of Italy and Japan, two markets which are predominantly financed by foreign and domestic investors, respectively.

Moreover, it is often argued that such indices not only give too much weight to some assets but also that they give too much weight to riskier assets, a problem that has been dubbed the “hubs’ problem” (Stiegel, 2003). This concern may be particularly relevant in the corporate bond market, if, during periods of sector-specific speculative bubbles, some industry sectors find that tech stocks in the run-up to 2001 or financial stocks in the run-up to 2006) found it ‘excessively easy to issue cheap debt, thereby becoming over-represented in a market-capitalisation benchmark.

While it is actually debatable whether debt weighting really leads to the most risky securities being over-weighted, it is clear that market-value debt-weighted indices leads to concentrated portfolios that are in opposition to investors’ needs for efficient risk premia harvesting, which involves holding well-diversified portfolios. In a nutshell, a good case can be made that existing bond indices tend to be poorly diversified portfolios, regardless of whether or not the over-weighting applies to the wrong constituents.

1 In principle, some of the insights discussed in this paper can also be applied to other fixed-income markets such as MBS markets, swap markets, etc.
2 A higher weight for an issuer with a high market value of debt does not necessarily mean that the index is over-weighting issuers with a high face value of debt. An issuer with a high amount of par value debt outstanding will only get a high weight if the market value is relatively close to its par value, which implies that this issuer is not perceived to be very risky. It is therefore not clear why the market value-weighted index should become riskier. In addition, holding onto riskier issuers should not necessarily be a problem if this risk is rewarded by higher expected returns.
Lack of Stability and Control in Factor Exposures

In addition to the problem of concentration, fluctuations in risks’ exposure (such as duration or credit risk in existing indices) are another source of concern — see Campani and Goltz (2011) for more detail. Such uncontrolled time variation in risk exposures is incompatible with the requirements of investors that these risk exposures be relatively stable so that allocation decisions are not compromised by implicit choices made by an unstable index. For example, an asset-liability mismatch would be generated by changes in the duration of the bond index if the latter were used as a benchmark for a pension fund bond portfolio.

More generally, it appears that existing bond indices can be regarded as more “issuer-friendly” than “investor-friendly”, in the sense that these bond indices passively reflect the collective decisions of issuers regarding the maturity and size of bond issues. Bond issuers make a decision on the duration of the bonds that they issue, the decision being based on minimising funding costs for the issuer. When investors make duration decisions, they are based on optimising an investor’s investment objectives. There is no reason to believe that there will be any consistency between the cost minimisation objective of issuers and the investment optimisation objective of investors in the determination of market duration. As a result, the duration that is obtained from an index can be considered as a “historical accident” (Siegel, 2003).

Smart Beta Bond Portfolios

By contrast, the diversification approaches rely on risk and/or return parameter estimates as well as risk-based portfolio optimisation models to design well-diversified bond portfolios. These include minimum variance (MV) portfolios (which correspond to the closest approximation of an equally-weighted strategy subject to constraints such as duration or notional constraints), global minimum variance (GMV) portfolios and diversified risk parity (DRP) portfolios, also known as factor risk parity portfolios.

One may also use expected return estimates based on economically motivated factor portfolios for Sharpe ratio maximisation exercises as in Dégaut et al. (2013).

This is the first of a group of related articles on smart beta and factor investing. Please see the next three on “Factor-Based Approaches to the Design of Smart Bond Portfolios”, “Factor Investing: Efficient Harvesting of Risk Premia Across and Within Asset Classes” and “Be Serious with Equity Factor Investing”.

References


The modern approach to factor investing (see for example Amenc, Golz and Martellini (2013) for an application to the equity space) suggests that before applying a weighting scheme, we should first identify robust and economically-motivated sources of differential cross-sectional returns, which can be regarded as ‘factors’, with rational or behavioural interpretation, or ‘fractions’. In this context, more work is required both in academia and in the industry to start addressing these challenges in a careful way, before we are able to see the emergence of improved bond benchmarks that will provide investable answers to investors’ needs. An economic motivation is not just an academic add-on. Understanding the source and origin of the cross-sectional differential returns matters a lot from the point of view of a robust benchmark creation.

If the origin of the excess returns can be traced to a source of systematic risk, then the attending compensation (the corresponding ‘market price of risk’) will not disappear by discovering it, but may decrease or increase over time with variations in the stochastic discount factor (the investors’ risk aversion); 1 • If the excess returns are due to a ‘behavioural finance’ irrationality it could, in principle, be arbitraged away by rational investors, and revealing the behavioural anomaly could therefore be the first step towards its disappearance. However, its persistence or otherwise may be linked to the availability or scarcity of arbitrage capital2; • If the excess returns are due to institutional frictions, they can be an ‘easy’ source of predictability for investors who are not affected by the regulatory or collateral constraints. However, they can disappear at the stroke of a regulatory pen.

If, finally, the excess returns are truly due to an ‘anomaly’, then they are likely to disappear after discovery as the anomaly gets exploited (for instance, one of the explanations for the ‘disappearance’ of the equity size factor is that it was really an anomaly which was readily arbitraged away once it was found).

For the sake of brevity, we therefore refer in this article to all these sources of differential cross-sectional returns as ‘generalised factors’, but it should be kept in mind that, from the perspective of the creation and long-term profitability of investable factor benchmarks, the underlying differences can be very important. It turns out that the recent discovery about generalised factors that used to ‘work well’ for equities also seem to be effective in the fixed-income area does create an embarrassing explanation problem. As Amenc, Moskowitz and Pedersen (2013) eloquently put it, “[t]he strong correlation structure among value and momentum strategies across such diverse asset classes is difficult to reconcile under existing behavioural theories, while the high Sharpe Ratios of a global […] diversified portfolio presents an even more daunting hurdle for rational-risk-based models.” So, we seem to find more and more factors and to observe that the ‘old’ factors seem to work even where they were not expected (or even supposed) to, however we are far and farther away from a unified understanding of why they do so. As argued above, unfortunately this imperfect understanding does matter when it comes to building robust and stable investable portfolios.

1. Cochrane (2010) stresses the recent shift in emphasis in asset pricing research from variations in expectations to variation in discount rates.
2. This clear distinction between ‘irrationality’ based and institutional-based source of differential cross-sectional returns can easily become blurred if, for instance, have become greatly reduced because of regulatory initiatives such as the Volcker rule in the States, or the Markkinvasive act proposals in the EUR area.
Modern 'generalised factor discovery' in the fixed-income area is also made more difficult by the fact that a very small number of market-driven or fundamental economic factors may manifest themselves through a variety of highly correlated yet individually powerful proxies. After all, if a factor proxy is associated with a true risk premium, the attendant 'excess' return is simply a compensation for receiving good or bad payoffs in periods of high or low consumption, respectively. High or low consumption in turn, can be paired in terms of a relatively small number of (often highly correlated) economic configurations, the precise reason for the low risk generalised factor.

This has led to the proliferation of proxies, and, sometimes, to the creation of proxies of proxies. For instance, in a recent interview, Moskowitz and Pedersen (2013) investigate value and momentum in fixed income, and circumvent the problem of defining what a proxy (a concept that, according to Fama and French (1993) ‘has no meaning of itself’) – see footnote 5) by arguing that “individual stock portfolios formed from the negative of past 5-year returns are highly correlated with those formed on RE/MF ratios in our sample. […] Hence, using past 5-year returns to measure value seems reasonable…”. The logic here is to use a proxy (the 5-year returns) to stand in for another proxy (value) for an unspecified latent factor. The choice may well be reasonable, but the link to the desired variable (value) (as originally defined) is neither transparent nor unique: indeed, in the literature a number of additional measures are proposed, such as the 5-year yield change in nominal yields, the difference in the 10-year to the 5-year inflation forecast (for real bonds), 10-year yield spread to the short rate, not to mention a composite average of all of the above. In addition, this concern is of relevance for the construction of robust benchmarks as we have seen can be the case in the fixed-income space linked to the factors attached to the factors, which has actually been studied in the recent literature are often proxies most of which are complementary to the additional fundamental quantities they ‘stand in’ for. This can create not only ambiguity, but also ample scope for data snooping and over-fitting. ‘Needless to say, the cost of over-fitting in-sample is poor performance out-of-sample. Apart from the dangers of over-fitting and data mining, discovering more and more factor proxies (just in the equity space, Fama recently counted more than 350!) is not necessarily desirable from the perspective of investors in a truly diversified portfolio.’ Indeed, as Cochrane (2010) reports, “in 2007 and 2008, hedge fund managers created a large number of proprietary portfolios they had constructed to exploit multiple ‘signals’ all at the same time. This is exactly the sort of ‘risk bias’ corresponding to multiple signals of ‘return’. A multitude of putative proxies can therefore engender a false sense of high portfolio diversifiability, and obscure the fact that a very small number of market-driven or fundamental economic factors may manifest themselves through a variety of highly correlated yet individually powerful proxies. After all, if a factor proxy is associated with a true risk premium, the attendant ‘excess’ return is simply a compensation for receiving good or bad payoffs in periods of high or low consumption, respectively. High or low consumption in turn, can be paired in terms of a relatively small number of (often highly correlated) economic configurations, the precise reason for the low risk generalised factor.

4. Liquidity is a particularly promising rewarded ‘true’ factor in the fixed-income space. Various studies have shown that the reduction in liquidity is often associated with adverse economic conditions (and hence with periods of low consumption). Recently Acharya and Pedersen (2005) have put liquidity on a firm asset-pricing footing by embedding its treatment in a CAPM-like framework, and identifying three liquidity-related ‘betas’ in addition to the traditional market beta. The problem with their approach is that there is a latent quantity, and the choice of a suitable proxy is fraught with difficulties – see Adler (2012) for a discussion of this problem. But also, a fundamental reason for the low risk generalised factor.

2. Momentum has been documented in all sorts of asset classes, including fixed-income – as can be seen from the very title of the well-known paper of Anes, Moskowitz and Pedersen (2013), ‘Value and Momentum Everywhere? It should be remembered, however, that momentum is not truly a generalised factor (i.e. an attribute of a security – such as its volatility – or of an issuer – such as the debt-to-equity ratio) but the result of a trading strategy. The origin of this well-documented feature is still hotly debated in academic circles. When it comes to fixed-income securities, the profitability of momentum is not yet defined, and it may be that it is a relatively recent phenomenon (Huang and King (2004) and Gebracht, Hvidjær and Swanumathan (2005) find reversal, while others, as for instance in Canning et al. (2011) find no momentum in the corporate credit market).

In preliminary work, Rebonato (2017) uses the Treasury-derivate discount bond data by Gürkaynak, Sack and Wright (2007) to create self-financing (zero-cash) portfolios that are long ‘winners’ and short ‘losers’. With this strategy, it is found that momentum in US Treasuries is profitable over a relatively wide combination of training and investment periods. Following this work, Peipich and Zhang (2010) and Jin and Jostova et al. (2013) find momentum in the corporate high-yield market.

3. Value was identified as a factor for corporate bonds by H’Hoi and Boulahbel (2010) and by Anes, Moskowitz and Pedersen (2013) for US Treasuries. Above, we mentioned the difficulties in ascribing a precise meaning to the ‘value’ in the fixed-income context, and the particularly ‘creative’ adoption of proxies and second-order proxies that this difficulty has generated. Here we present these problems, current work (Rebonato 2017) and show how the making of affine structural models or of time-series return-predicting factors (see Cochrane and Piazzesi, 2005; Jostova et al., 2013) to establish cross-sectional differentiations in the returns of Treasury bonds. While initial results are encouraging (see below), current studies still require further analysis and confirmation.

1. Low risk has been found both in corporate bonds and in Treasuries – see, for example, de Vries and Vosmaer (2004), Franciuzzi and Pedersen (2014), Frazzini and Pedersen (2014), Howelwid and van Zundert (2017). In the case of Treasuries, it is well known (Nilsson and Pedersen et al., 2016) from time-series studies that low maturity bonds offer a higher Sharpe ratio in virtually every economic environment. While these results are statistically very robust, their economic relevance and potential exploitability is not obvious. This is especially true for Treasuries and high-yield corporate bonds where reasonable pricing has been made. One recent very low yield environment has made the attainment of equity-like returns only obtainable with unreasonably high leverage - de Carvalho et al. (2014) document a required leverage of 50 to 100 to achieve ‘debt-equity ratio’ bonds! The existence of leverage-constrained investors also suggests a (corroborated) reason for the low risk generalised factor.

7. Fallen angels, defined as corporate bonds downgraded to just below investment grade, seem to offer a premium when investing for a short period (up to 6 months). The effect has been analysed by Staa et al. (2015) for a comparison of the profitability of an unconventional strategy that always longs the Barclays US high-yield index with a fallen-angel strategy: “The same study reports a ratio of 4 to 3 in favour of the fallen-angel strategy for the relative Sharpe Ratios for the period from April 1996 to March 2015. Institutional frictions are the most likely explanation for the fallen-angel effect, which is mostly explained by delayed or different redemption or default tolerances, because a large number of mandates prohibit investment in non-investment-grade bonds with or force liquidation after a downgrade.

New Frontiers in Smart Bond Portfolios

Overall, the research clearly needed before risk premia can be as efficiently extracted in the fixed-income space as in the equity space, and this must be done with emphasis on the implementation constraints and data qualities issues, some of which are missing in the current work by Rebonato and Hong (2017). Nonetheless the construction of smart beta equity portfolios has already come in the form of two significant challenges as an important new frontier in smart beta investing.

This is the second of a group of related articles on smart beta and factor investing. Please see the previous one on “Bond Portfolios: Smart Beta vs. Factor Investing and Smart Beta” and the next two on “Factor Investing: Efficient Harvesting of Risk Premia in Fixed Income and Within Asset Classes” and “Be Serious with Equity Factor Investing”.

It is probably for this reason that very few studies document the link between excess returns and the profitability of bond portfolios. They tend to focus on the profitability when combined with Low Risk, Value and Momentum. They find that the returns from this multi-factor portfolio are up to three times higher than the market, and that the link to the profitability is driven by risk or by equivalent equity factors. We should keep in the mind the caveats expressed above in the case of factor portfolios with the smallest company index weights. Of course, since smaller companies tend to issue smaller bonds, and since smaller issue tend to be less liquid, the size-generalised factor inevitably picks up a liquidity contribution. The size-specific factor is a potential contributor to profitability when combined with Low Risk, Value and Momentum. They find that the returns from this multi-factor portfolio are up to three times higher than the market, and that the link to the profitability is driven by risk or by equivalent equity factors. We should keep in the mind the caveats expressed above in the case of factor portfolios with the smallest company index weights.
Risk factors, defined as systematic underlying sources of risk that impact a large set of securities, have long been used in investment practice for analysing the risk and performance of actively or passively managed portfolios. More recently, a new approach has emerged, where factors have a more explicit role in the investment process. This approach, known as factor investing, recommends that allocation decisions be directly expressed in terms of risk factors, as opposed to standard asset class decompositions.

While the relevance of factor investing is now widely accepted amongst sophisticated investors, an ambiguity remains, however, with respect to the exact role that risk factors are expected to play in the investment process. This approach, known as factor investing, recommends that allocation decisions be directly expressed in terms of risk factors, as opposed to standard asset class decompositions. While the role of factor investing is now widely accepted amongst sophisticated investors, an ambiguity remains, however, with respect to the exact role that risk factors are expected to play in the investment process. This approach, known as factor investing, recommends that allocation decisions be directly expressed in terms of risk factors, as opposed to standard asset class decompositions.


Rebonato, R. 2017. Smart Beta in Fixed Income. Working paper presented at the L’AGEFI Day: Indexing, ETF & Smart Beta Investment Strategies” research chair at EDHEC-Risk Institute, we argue that there actually exist two main types of benefits that can be expected from factor investing. On the one hand, factor investing across asset classes allows for a better structuration of the investment process, both from an asset-only perspective and from an asset-liability management perspective. On the other hand, factor investing within asset classes allows for a more efficient harvesting of risk premia compared to traditional approaches that focus on sector decompositions.


From an allocation perspective, factor investing is the process in which investors decide how much to allocate to each factor as opposed to each asset class. Even if factor allocation decisions must of course be eventually translated back into asset weights in order to be implemented, there are reasons to believe that this approach allows for a better structuration of the investment process, both from an asset-only perspective and from an asset-liability management perspective. To provide some initial intuitive support for this claim, we should note that the first rationale for factor investing is that the focus on factors allows investors to gain a more holistic understanding of risk and performance by allowing investors to analyse the commonalities in the key drivers for the returns on seemingly disparate asset classes. One of the key problems experienced by institutional investors during the sub-prime crisis and the severe market downturn that has followed is indeed that even a seemingly well-diversified allocation to multiple asset classes can result in an extremely concentrated set of factor exposures. In this context, the use of risk factors with relatively high explanatory power is critically important since it is only by framing the allocation exercise in the factor space as opposed to the asset space that investors will be able to understand how well or how poorly diversified their performance portfolios actually are.
As macro-economic factors have typically low explanatory power for asset returns, implicit factors appear to be the most natural approach for representing underlying sources of risk and the more appropriate tools in risk budgeting exercises (Deguest et al., 2013). Implicit factors, extracted in a multi-asset universe via principal component analysis or minimum linear variance techniques (Menegli et al., 2013) for a more robust outcome, can be used to build efficiently diversified portfolios. To better assess the contributions of underlying risk factors, Menegli (2009) and Deguest et al. (2013) propose to decompose the portfolio returns (which can be seen as combinations of correlated asset returns or correlated factor returns) as a combination of the contributions of uncorrelated implicit factors. The factor risk parity (FRP) portfolio is then defined as the portfolio that maximizes the “effective number of uncorrelated bets” (ENUB), that is it ensures an equal contribution of the various uncorrelated implicit factors to the risk of the portfolio.

Explicit macro-economic factors like the GDP or inflation, on the other hand, can still be useful as state variables that characterize market conditions, or more precisely state variables that define various regimes of economic activity, and these regimes are relevant for asset allocation if expected performance and risk of assets and asset classes vary across these states of the economy. There are well-known advantages to identifying and employing economic regimes within a consistent asset allocation framework – see Ang and Bekaert (2002) or Mulvey and Liu (2016) for a recent reference. One may for example identify four regimes based on whether inflation and real GDP fall above or below their median values. Formally, let us define regime 1 as a situation where inflation is below the median and growth is above average, regime 2 as a situation where growth and inflation are above average, regime 3 as a situation where both inflation and growth are below average, and regime 4 as a situation where inflation is above the median and growth is below average. It can then be shown (Martellini and Mulvey, 2017) that U.S. and international equities do best when inflation remains modest (regimes 1 and 3), and suffer when inflation is above the median, especially with growth below average (regime 4). Government bonds, on the other hand, do reasonably well except for when growth and inflation are above average (regime 2). Real estate has excellent returns under regime 3, and has under-performed during regime 4. Commodities outperform under regimes 1 and 2, but suffer when inflation is above average and growth is below average. Treasury-inflation-linked bonds do best when both inflation and growth are below average (regime 3). These historical patterns, backed by sound economic theory explaining the patterns, confirm that the construction of a well-developed portfolio should take into account the behaviour of asset categories under varying economic regimes. These relationships also demonstrate the opportunities to take advantage of patterns to improve risk-adjusted returns at the asset allocation level, and even more so when liabilities are to be taken into account since liabilities for most pension plans are also sensitive to changes in economic growth and inflation.

**Factor Investing and Benchmarking Decisions: A More Efficient Harvesting of Risk Premia**

Factors are not only useful to understand the cross-sectional and time-series determinants of asset returns across asset classes, but they can also be used as investable building blocks within asset class. Individual securities earn their risk premium through exposure to rewarded factors, while the remaining risk is uncompensated for. The academic literature has identified a number of rewarded factors, the existence and persistence of which seem to be robust over different time periods and across different regions. Starting with the equity space where the concept of factor investing is most mature, the most commonly accepted risk premia include the value and the size factors (Fama and French, 1993), the momentum factor (Carhart, 1995), the low volatility factor (Ang et al., 2006), and the quality factor (Asness et al., 2013).

The outstanding question from an investor perspective is to determine the best way to harvest such multiple risk premia. This decision is in fact embedded within the choice of a benchmark, which is then used as a reference portfolio for passive or active mandates. While cap-weighted (CW) indices are typically used as default investment benchmarks by asset owners and asset managers, they have in fact been shown to suffer from two main shortcomings. On the one hand, CW indices are ill-suited investment benchmarks because they tend to be concentrated portfolios that contain an excessive amount of unrewarded risk. On the other hand, CW indices represent bundles of factor exposures that are highly unlikely to be optimal for any investor, if only because they have not been explicitly controlled for. For example, by constructing CW equity indices show a large cap and a growth bias, while the academic literature has instead shown that small cap and value were positively rewarded risk exposures. In practice, it has been shown that the use of investable forms of smart factors indices allows for substantial improvements in risk-adjusted performance compared to these traditional benchmarks (Asness et al., 2014).

It is fair to say that the smart beta approach is now firmly grounded in equity investment practices, and the key question for an increasing majority of institutional investors is not whether one should use smart beta, but instead which and how much smart beta to use. In contrast, the concept of smart beta in the fixed-income space is still relatively less mature, despite the obvious importance and relevance of the subject. Over recent years, a number of concerns have been expressed, however, about the (ir)relevance of existing forms of corporate and sovereign bond indices offered by index providers, both in terms of lack of diversification and absence of control of the underlying factors (exposure to high default risk and Golli, 2011). More generally, it appears that existing bond indices can be regarded as more “issuer-friendly” than “investor-friendly”, in the sense that these bond indices passively reflect the collective decisions of issuers regarding the maturity and size of bond issues, with no control over risk exposures associated with such choices nor over the behavior that investors should deserve from holding a well-diversified portfolio of such factor exposures. In this context, there is an increasing understanding of the need for improved bond benchmarks that will provide adequate answers to investors’ needs through the construction of investable proxies for rewarded risk factors. This relates to factors that are suitably defined in fixed-income markets, namely interest rate risk (level of the yield curve, slope of the yield curve, curvature of the yield curve), credit risk factors, liquidity risk factors, low risk factors, carry factors, value factors, momentum factors, etc. This issue is discussed further within this special issue, in an article by Riccardo Rebonato and myself.

**References**

- Meucci, A., A. Santangelo and R. Deguest. 2013. Factor Investing and Smart Beta: Reconciling Innovations in Equity Portfolio Construction. The Design of Smart Bond Portfolios and the next one entitled “Be Serious with Equity Factor Investing”.

**The New Frontier in Factor Investing and Smart Beta: Reconciling Innovations in Equity Portfolio Construction**

This is the third of a group of related articles on smart beta and factor investing. Please see our special issue "The New Frontier in Factor Investing and Smart Beta and ‘Factor-Based Approaches to the Design of Smart Bond Portfolios’" and the next one entitled “Be Serious with Equity Factor Investing”.

...the key question for an increasing majority of institutional investors is not whether one should use smart beta, but instead which and how much smart beta to use...
Factor definitions

Product providers across the board put strong emphasis on the construction of their factor indices. At the same time, they try to differentiate their products using proprietary methodologies in their strategy, often leading to the creation of products using new factors or novel strategy construction approaches that seek to establish a consistent framework for smart beta index creation. One of the possible ways to construct a multi-factor index is to combine different single factor indices. Amenc et al. (2016) show that well-diversified factor indices which pursue a diversification objective through an alternative weighting scheme based on a relatively broad set of securities can offset considerable benefits over more concentrated single factor indices. Their results suggest that well-diversified factor portfolios or indices outperform their highly-concentrated counterparts in terms of risk-adjusted performance, because concentrating factor portfolios increases the probability of exposure to unrewarded factors. In addition, they show that factor-tiled portfolios on narrow stock selections may or may not be consistent with the broad consensus on empirical asset pricing in the academic literature. As for factor definitions, many factor indices show considerable divergence from academic definitions. For example, the Fama and French (2012, 2015) factor definitions, which are widely used in academic research, are based on straightforward stock selection criteria such as price-to-book value for example. However, for most factor or multi-factor offerings, product providers typically favour more complex factor definitions that may indeed reflect a stark disagreement with academic research. For example, some providers use industry or regional adjustments for certain variables within a given factor score while not using the same adjustments for other variables that make up the same factor score. Moreover, providers often use variables that are quite far removed from the original factor definition – for example, change in asset turnover in quality scores. In fact, most of the Quality indices on offer have more to do with the preempt of stock-picking gurus than with the academic literature, where profitability and investment have been identified as asset pricing factors.

While sharing the same objectives, equity indices that aim to provide multiple factor exposures may opt for very different methodologies, thus reflecting differences in the underlying beliefs about multi-factor investing. This article looks at the conceptual considerations involved in designing different approaches. The key issues that we discuss involve the robustness and consistency and diversification of different approaches when designing multi-factor indices.

Consistencies in methodologies

A large source of potential data-mining bias that may result in overrated backtested performance is the flexibility offered by the testing of many variations in search of the winning one. Such flexibility is obviously increased when a provider allows indexes to adopt different methodologies to be inconsistent. On the contrary, a very effective mechanism to avoid data-mining is to establish a consistent framework for smart beta index creation. Such a framework can limit ad-hoc choices while providing the necessary flexibility needed for smart beta index construction. Surprisingly, while most major index providers argue that cap-weighted indices should employ a consistent set of rules across regions to avoid unintended investment outcomes, said consistency is often overlooked for factor indices.

Perhaps the most severe form of inconsistency is inconsistency among index offerings across time. For example, it is commonplace that two multi-factor indices launched at different points in time by the same provider use different definitions of the Value factor. This may be surprising, especially for the Value component, as Value seems to be among the most standard factors. Just like inconsistencies across factors open the room for a large number of variations in index design, it is clear that inconsistencies over time further increase such flexibility. Such inconsistency over time is, however, widely present among index offerings. Amenc et al. (2015) emphasise that inconsistency over time is all but day-to-day business for index providers.

Concentration issues

An important issue that can be easily neglected when constructing a multi-factor index is diversification. Positive exposure to rewarded factors is obviously a strong and useful contributor to expected returns. However, products that aim to capture explicit factor tilts often neglect adequate diversification. This is a serious issue because diversification has been described as the only “free lunch” in finance. Diversification allows a given exposure to be captured with the lowest level of risk required. In contrast, gaining factor exposures exposes investors to additional types of risk, and therefore, such exposures do not constitute a “free lunch”. They instead constitute compensation for risk in the form of systematic factor exposures. Such capturing of risk premia associated with systematic factors is attractive for investors who can accept the systematic risk exposure in return for commensurate compensation. However, factor-tiled strategies, when they are very concentrated, may also take on other non-rewarded risks. Non-rewarded risks come in the form of idiosyncratic or firm-level risk, as well as potential risk for sector concentration, currency, sovereign or commodities risk exposure. Financial theory does not provide any reason why such risk should be rewarded. Therefore, a sensible approach to factor investing should not only look at obtaining a factor tilt, but also at achieving proper diversification within that factor tilt. In fact, if the objective were to obtain the most pronounced value tilt, for example, the strategy that succeeds in this objective is to hold 100% in the single stock with the largest value exposure. This clearly shows that the objective of maximising the strength of a factor tilt is not reasonable. While practical implementations of concentrated factor-tilded strategies will be less extreme than this example, we can expect problems with high levels of idiosyncratic risk and high levels of turnover whenever index construction focuses too much on concentration and pays too little attention to diversification.
Concentration may arise in particular in indices that do not have such a diversification objective, especially in multi-factor indexing methodologies that, rather than combining single factor indices, actually build multi-factor indices from the stock level up. In addition to concentration, stock level approaches carry further issues that we turn to now.

When using multi-factor scores in portfolio optimisation, it should not be forgotten that the score is ultimately used as a proxy for expected returns. It is well known for example that mean-variance optimisation that integrates expected returns can result in an “error maximisation exercise” since expected returns are hard to estimate at the individual stock level, and since mean-variance optimisers are very sensitive to estimation error for expected returns (Best and Grauer, 1991).

Achieving high absolute factor scores at the portfolio level by concentrating on picking champion stocks that score highly on all targeted factor definitions is probably intuitively attractive but it is prejudiced on a high-precision relationship between factor scores and returns at the stock level. There is no question that factor investing is motivated by an attempt to capture higher long-term returns through the right risk exposures. However, return estimation at the stock level is notoriously difficult. Black (1993) distinguishes between explaining returns, which is easy because it is really explaining variance, and predicting returns which is hard. He contends that the accurate estimation of average expected return requires decades of data. For variance, he notes, “We can use all the data”. For expected returns, he states “The accuracy of expected return predictions is more of an issue”.

When academics have tested standard factors, they have done so by running portfolio sorts, and assessing return differences at the portfolio level, not by assessing returns at the stock level. For example, they have observed that, on average, value stocks tend to have higher returns than growth stocks over the long-term. If one now tries to design strategies based on very fine distinctions at the stock level, such relations may be drowned in noise. More generally, making very fine distinctions at the stock level is prone to capturing estimation error.

Thus, any stock-level approach needs to be handled with care and one needs to assess whether suitable mechanisms have been built in to achieve robustness.

Conclusions

The offerings in the area of multi-factor indices are multiplying rapidly and investors have to assess how such indices match their investment needs. Given that most products have been launched recently, analysis of risk and performance is mostly limited to backtested data. Therefore, the methodological principles behind index construction should become a key area of attention in the assessment of these indices. Analysing robustness requires an assessment of index design principles and the conceptual considerations underlying index design. Our brief review of offerings aims to shed light on several issues such as complex proprietary factor definitions, potential inconsistencies in methodologies, and concentration issues. In principle, multi-factor indices aim at explaining the compounded geometric mean return of the corresponding buy-and-hold portfolio, sometimes also referred to as the volatility pumping effect or the diversification bonus, since volatility and diversification turn out to be key components of the rebalancing premium. The rebalancing premium, intrinsically linked to long-term investing, is typically defined as the difference between the expected growth rate of a rebalancing strategy and the expected growth rate of the corresponding buy-and-hold strategy, where the portfolio growth rate is the compounded geometric mean return of the portfolio – a meaningful measure of performance in a multi-period setting.

The growth rate of a portfolio \( G(t) \) on the period \([0, t]\) is defined as

\[
G(t) = \exp \left( \frac{\ln(1 + r)}{t} \right)
\]

If we now consider a fixed-weight portfolio \( P = \) and a buy-and-hold portfolio \( P_B \), then the rebalancing premium \( \pi \) over the period \([0, t]\) is simply defined by:

\[
\pi(t) = \ln \left( \frac{G(t)}{G_B(t)} \right)
\]

This research is supported by BDF Gestion.
the period August 2004-October 2008, and the lowest value (lower than -50 bps) for the starting dates in the period July 2002-March 2004. We note that among the 302 historical 5-year scenarios, 36% of them display a growth rate difference higher than 100 bps; 61% display a growth rate difference higher than 50 bps and 16% display a negative growth rate difference. Overall, these results suggest that the rebalancing premium can be substantial in equity markets.

Rebalancing Premium and Stock Characteristics

The objective of this section is to determine whether the rebalancing premium differs for various groups of stocks. To see this, we test for the empirical relationship between the (out-of-sample) historical rebalancing premium and standard characteristics such as market capitalisation, book-to-market ratio, past performance, volatility and serial correlation. We are also interested in the persistence of the criteria used in the stock selection process since it is only if the characteristic is persistent that investors could benefit from tilting their portfolio towards that particular characteristic in an attempt to increase the rebalancing premium.

We still consider the 132 stocks which were in the S&P 500 over the period November 1985-December 2015 as our base universe and take five possible time horizons: 1, 2, 3, 4 and 5 years. We do not consider longer horizons for a persistence criterion.

For a given characteristic (market capitalisation for instance) we build at each initial (end-of-month) date t0 two sets (1

Conclusion

Using a selection of stocks from the S&P 500 universe we find an average historical rebalancing premium of almost 90 bps (in the absence of transaction costs) for a 5-year time horizon. Our analysis on individual stocks’ characteristics highlights that size, value, momentum and volatility are sorting characteristics that have a significant out-of-sample impact on the rebalancing premium. In particular, the selection of small cap, low book-to-market, past loser and high volatility stocks generates a higher out-of-sample rebalancing premium compared to random portfolios for time horizons from 1 year to 5 years. Taken together, these results suggest that a substantial rebalancing premium can be harvested in equity markets over reasonably long horizons for suitably selected types of stocks.

While our analysis has focused on an individual stock universe, it could be usefully applied to various equity benchmark portfolios such as style, sector, factor or country indices. The analysis of the volatility pumping effect may also be transported beyond the equity universe, either in a bond portfolio context or in a multi-asset context. Once a deep understanding of how to most efficiently harvest the rebalancing premium has been obtained, we could also focus on how to transport these benefits in a portfolio context. In particular, one would like to analyse the conditional performance of the rebalancing premium harvested within and across asset classes so as to better assess its diversification benefits.

The analysis of the volatility pumping effect may also be transported beyond the equity universe, either in a bond portfolio context or in a multi-asset context.

Exhibit 1 – Historical rebalancing premium (bps)

This figure displays the historical rebalancing premium (in bps) as a function of the time horizon (in years) considered for different number of stocks in the portfolios.

Exhibit 2 – Historical distribution of the growth rates difference (bps)

This figure displays, for different characteristics, the historical rebalancing premium (in bps) as a function of the time horizon (in years) when portfolios are sorted by corresponding characteristic of the stocks (blue lines and red lines). The characteristics tested are market capitalisation, book-to-market ratio, volatility, past performance and serial correlation as sorting characteristics.

Exhibit 3 – Historical rebalancing premium (bps) with market capitalisation, book-to-market ratio, volatility, past performance and serial correlation as sorting characteristics
PREDICTING RISK PREMIA FOR TREASURY BONDS: THE EDHEC BOND RISK PREMIUM MONITOR

Riccardo Rebonato, Professor of Finance, EDHEC Business School

Deciding the relative portfolio weights among the different risk factors hinges in great part on the time-varying compensation attached to these different factors.

1. Why Risk Premia Matter

Investors in the Treasury market often observe an upward-sloping yield curve. “This means that, by assuming duration risk, they can very often invest at a higher yield than their funding cost. Yet, if the steepness of the yield curve purely reflected expectations of future rising rates, no money could on average be made from this strategy. This prompts the obvious question: When does the steepness of the yield curve simply reflects expectations of rising rates, and when does it embed a substantial risk premium?”

The investment relevance of being able to answer these questions is clear. Take, for instance, a bond manager whose performance is assessed against a Treasury benchmark. His or her main strategic investment choices are assessed against a Treasury benchmark. Therefore engineering an upward-sloping yield curve. Investors in the Treasury market often observe an upward-sloping yield curve. It is also natural to assume that investors should become more risk averse in periods of rising rates, and when does it embed a substantial twist to the yield curve?

Now, recessionary periods are associated with the different risk factors?

2. Predicting Excess Returns

What predicts excess returns in Treasury bonds? And how much can one explain?

Until recently, the answers to both questions used to be: “the slope” and “rather little,” respectively. States of the world characterised by a steep upward-sloping yield curve used to be considered indicators of positive expected excess returns. However, the degree of predictability was modest (with R² of the regression of the predicted and realised excess returns never exceeding 20%).

To understand why the slope was deemed to be a good predictor of excess returns consider Tab (1).

1. Since 1971, the yield curve has been upward sloping (with the 10-year yield above the 1-year yield) for almost 84% of the time. Unless investors repeatedly and erroneously expected rates to rise almost all of the time, this prima facie evidence of the existence of a risk premium.


3. For instance, the return-predicting factor of Cochrane- Piazzesi (2005) is usually referred to as a ‘unit’ and is built by the orthogonalisation of different signs and magnitudes to give forward rates. In general, the common features of the new-generation factors are that they require (implicitly or explicitly) much holier principal components than the second — sometimes as high as the fifth.

Starting from the mid-2000s, several results have questioned this received wisdom: these more recent investigations suggest that different return-predicting factors may be far more complex than the simple slope; and their predictions of excess returns sometimes produce much higher R². Why is this the case? And what is the economic significance of the new, more complex, factors?

The motivation of the question can be readily understood by looking at Figures (1) and (2), which focus on the predictions made by the old- and new-generation factors.

More precisely, Figure (1) shows the realised average excess returns, and the excess returns predicted by the slope and the other ‘new generation’ return-predicting factors. While all these predictions are all strongly correlated it is clear that the new-generation factors add a substantial twist to the slope story.

Figure 1: Average excess returns from the invest-long/short strategy described in the text, and the excess returns predicted by the slope and by ‘new generation’ return-predicting factors (in-sample analysis, US data).

Figure 2: The differences between the prediction of average excess returns produced by the slope, and the predictions produced by the new-generation factors (in-sample analysis, US data.)

Figure 3: Normalised frequency components of the power spectrum for the 2-, 6-, and 9-year returns. Frequencies in years⁻¹.

Figure (2) makes this intuition clearer by showing the differences between the predictions produced by the slope, and the predictions produced by the new generation factors (in-sample analysis). Despite the fact that the new return predicting factors are constructed following very different prescriptions, what is added on top of the slope predictions is remarkably similar.

This qualitative analysis therefore prompts the following questions:

1. Are these ‘extra predictions’ informative, or, as Bauer and Hamilton (2015) argue, are they just a result of over-fitting?

2. Why do such apparently different return-predicting factors produce such similar incremental predictions (with respect to the slope predictions)?

3. What is their financial and economic interpretation?

A full answer would take too long a detour (see, eg, Rebonato (2018)). We can however summarise the main findings as follows. The first insight is linked to the power spectrum of excess returns: one can clearly see both low-frequency (business-cycle) and high-frequency components. When we look at Figs (4) and (5), which show the frequency components of the slope factor and of a ‘new generation’ factor, we note how the slope recovers the low frequency peaks of the excess returns, but essentially misses the medium and high-frequency components.

Contrast this with the power spectrum of the 5-year excess returns and of modern factors, which displays a remarkable match across all frequencies. The second ‘modern’ insight alluded to above suggests that a large fraction of return predictability comes from detecting the cyclical straying of yields from a long-term fundamental trend. Once an effective decomposition of the yield dynamics into trend and cycle is carried out, one finds that the different degrees of mean reversion of the various return-predicting factors explain the different degrees of excess returns predictability very well.

Why do these two different ‘types of’ factors help the prediction of excess returns?

We propose that two distinct financial mechanisms can explain excess returns: the first, associated with low-frequency changes in

Tab 1: Sharpe ratios for the excess return ‘carry’ strategy applied to US Treasuries during the 1955-2014 period, subdivided i) into different cyclical sub-periods, ii) into periods of recessions or expansions, and iii) during tightening cycles. Data adapted from Naik et al. (2016).

<table>
<thead>
<tr>
<th>Period</th>
<th>2-year</th>
<th>5-year</th>
<th>10-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sample</td>
<td>0.20</td>
<td>0.20</td>
<td>0.16</td>
</tr>
<tr>
<td>1955-1966</td>
<td>0.04</td>
<td>-0.01</td>
<td>-0.07</td>
</tr>
<tr>
<td>1967-2014</td>
<td>0.59</td>
<td>0.56</td>
<td>0.49</td>
</tr>
<tr>
<td>Recession</td>
<td>0.82</td>
<td>0.72</td>
<td>0.59</td>
</tr>
<tr>
<td>Expansion</td>
<td>0.01</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>1st half Expansion</td>
<td>0.52</td>
<td>0.30</td>
<td>0.45</td>
</tr>
<tr>
<td>2nd half Expansion</td>
<td>-0.61</td>
<td>-0.50</td>
<td>-0.48</td>
</tr>
<tr>
<td>Tightening Cycles</td>
<td>-1.06</td>
<td>-1.13</td>
<td>-1.23</td>
</tr>
<tr>
<td>1979-Q3-1981-Q2</td>
<td>-0.79</td>
<td>-0.86</td>
<td>-0.86</td>
</tr>
<tr>
<td>1993-Q3-1995-Q1</td>
<td>-1.52</td>
<td>-0.90</td>
<td>-0.50</td>
</tr>
<tr>
<td>2004-Q2-2006-Q2</td>
<td>-1.52</td>
<td>-0.90</td>
<td>-0.50</td>
</tr>
</tbody>
</table>
Figure 4: Frequency power spectrum of the 2-year excess returns and of the slope return-predicting factor.

Figure 5: Frequency power spectrum of the 5-year excess returns and of the return-predicting factor built using the slope and the cycle to the 4-year moving average of the level of yields.

excess returns, is linked with changes in risk aversion with business-cycle periodicity. As for the second financial mechanism, associated with higher-frequency cycles, we suggest that it comes from the actions of pseudo-arbitrageurs who bring the level and slope of the yield curve back in line with fundamentals. These deviations have a much quicker mean-reversion, and are therefore associated with the higher-frequency components of the excess return spectrum. The full picture is more complex, but one can see the two key insights are that the frequency components of excess returns and their mean reversion levels are the associated reversion levels of the level and the cycle to the 4-year moving average of the level of yields.

Figure 6: The path traced by the Fed ‘blue dots’ and the most similar path for the expectation of the measure path of the Fed funds.

Figure 7: Estimates from the statistical models and the affine model, rescaled to have the same volatility. The correlation among all the estimates is over 90%.

4. Conclusions

In this article, we have given a glimpse of the latest and most exciting research strands carried out in the academic world in general, and at EDHEC-Risk Institute in particular, about the robust estimation of the yield risk premia. The predictions about the term premia for various yield maturities of the US Treasuries will be regularly provided, together with more formal research papers on these and related topics. Much work remains to be done, for instance by looking at different currencies, and at related asset classes. However, we believe that the present offering can already be of real practical use and interest for practitioners and for academics.
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