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Risk budgeting for multi-asset portfolios

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Modern portfolio theory was born in 1952 from Harry Markowitz's seminal paper "Portfolio Selection". For the first time the importance of the trade-off between risk and return on an aggregate portfolio level, was established. In the last 70 years risk management has evolved considerably, but it is only in the last two decades that the use of advanced risk tools became a determinant part of asset allocation, at least for the most sophisticated investors. This paper introduces the concept of risk budgeting and explains how it can be applied to portfolio construction and monitoring, to achieve a better understanding of the underlying risks and ultimately more robust and better long term portfolio performances.

The most common way to describe a portfolio is using a set of weights that define the capital allocated to each investment. If you have $100 to invest, and allocate $60 to equities and $40 to buy bonds, your portfolio will be a 60-40 equity-bond portfolio meaning that you have 60% ($60/$100) invested in equities and 40% invested in bonds. The same mechanism works to define how much capital is allocated to domestic vs. foreign assets, or the percentage allocated to a specific sector of the economy such as banks, real estate, or healthcare. The beauty of *capital budgeting* is that it is intuitive and unambiguous. The potential pitfall is that it only tells a partial story, omitting what is often more important for an investor: the risks carried by the investment.

Investable and tradable assets are in fact merely a vehicle for an investor to gain exposure to a set of risks that are believed to be rewarded. Investing is less about exposure to asset classes, and more about exposure to risks. When you buy a stock, for instance, you take part in the success or failure of a company, an industry sector or the economy as a whole. When you buy a government bond you bare the risk of an unexpected rise in inflation, the (small but not negligible) risk of default of a country, or – in case of foreign bonds – of currency devaluation.

The global financial crisis was a remarkable wake-up call for everyone who forgot the ineluctable link between investment and risk. Billions of pounds, for instance, were lost in Icelandic saving accounts by UK savers who benefited for several years from the higher interest rates paid by Icelandic banks before bankruptcy. Hundreds of thousands of Polish households, who took a low-rate mortgage in Swiss francs between 2006 and 2008, watched helplessly as the Swiss currency suddenly soared, leaving them with unbearable debt repayments.

The point here is that not all saving accounts, or all mortgages, are the same. Depending on the risks they bare, they can end up being very different kinds of investments with extremely varied outcomes. These differences are rarely captured by a capital budgeting approach, which is the reason why, despite being less common, *risk budgeting* should be the preferred and more useful way to define a portfolio's risk.

RISK BUDGETING

Let us consider the aforementioned 60-40 portfolio. While from a capital budgeting standpoint 60% is invested in equities and 40% is invested in bonds, from a risk budgeting perspective the portfolio is clearly dominated by the equity allocation. Figure 1 shows the capital and risk allocation of the two assets portfolio, under standard conditions, using volatility as the measure of risk. Note that 87% of the overall portfolio volatility can be attributed to the equity allocation, while the investment in bonds only contributes 13%.

While volatility is used here as measure of risk, we are not limited to it. Different definitions of risk, such

as Value-at-Risk (VaR) and Conditional Value-at-Risk (also called Expected Shortfall - ES), can be used to compute the overall portfolio risk contribution. These two risk measures focus on the left tail of the return distribution and are particularly useful in assessing drawdown risk and portfolio performance in extremely adverse market environments, such as the 2008 global financial crisis or the COVID-19 pandemic.

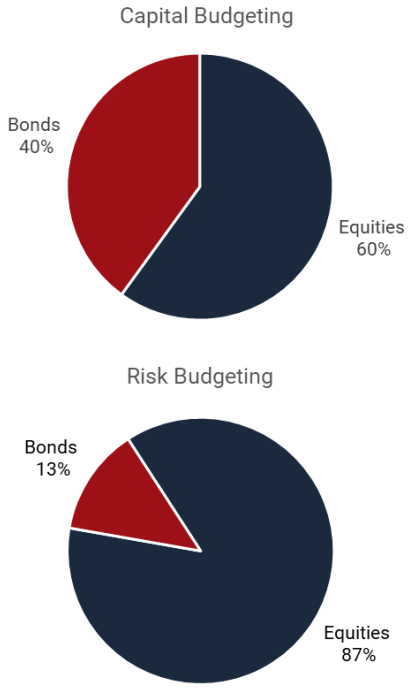

Figure 1. Capital and Risk budget of a passive portfolio invested 60% in equities and 40% in bonds, using portfolio volatility as measure of risk.

Using VaR and ES as measures of risk highlights even more the disproportionate contribution to risk coming from equities, as the 60% portfolio allocation to equity represents around 90% and 95% of the overall VaR and ES risk budget, respectively.

RISK BUDGETING AND RISK RATED PORTFOLIOS

The use of risk budgeting becomes even more interesting when considering risk rated multi-asset portfolios. Asset managers worldwide commonly offer a series of risk-rated funds, from lower to higher risk, to accommodate the full spectrum of clients' risk appetite and investment horizons. In the UK, these rank from so called *cautious* or *defensive* portfolios, mainly invested in fixed income securities, up to *adventurous* or *aggressive* funds, generally entirely invested in equities. The way to transition from the lower end to the upper end of the risk spectrum is by gradually moving the asset allocation from bonds into equities. Table 1 shows a typical example of a risk rated portfolio offering of a UK asset or wealth manager.

	Defensive	Conservative	Balanced	Growth	Adventurous
Domestic Equities		9.0%	18.0%	26.0%	34.0%
Foreign Equites		14.0%	28.0%	42.0%	57.0%
EM Equities		2.0%	4.0%	7.0%	9.0%
Gov'n Bonds	30.0%	24.0%	16.0%	9.0%	
Corp. Bonds	40.0%	33.0%	24.0%	13.0%	
IL Bonds	30.0%	18.0%	10.0%	3.0%	
Equities	0.0%	25.0%	50.0%	75.0%	100.0%
Bonds	100.0%	75.0%	50.0%	25.0%	0.0%

Table 1. Example of the range of risk rated offering of a typical UK asset/wealth manager.

Note the linear increments in the bond-equity allocation, with a balanced mandate that generally has a 50-50 allocation between equities and bonds (figure 2).

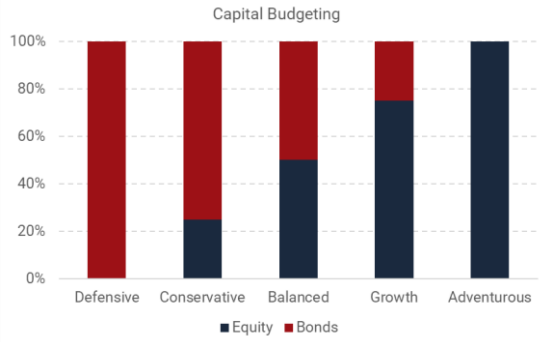

Figure 2. Capital budgeting between equity and bond allocation across different risk profiles of a typical UK asset/wealth manager.

The picture looks very different when we move from capital budgeting to risk budgeting. Similar to the 60-40 portfolio in our previous example, while a 50-50 equity bond portfolio might look a balanced investment from a capital budgeting point of view, the allocation to equity dominates the contribution to the overall portfolio risk. Figure 3 shows the risk budgeting for each of the portfolios in Table 1 (again using volatility as the measure of risk).

Roughly 80% of the volatility risk of a *balanced* portfolio comes from its equity allocation. Note the big gap moving from a *conservative* 25-75 equity-bond allocation to a *balanced* 50-50 portfolio: while the equity allocation increases by 25%, the risk contribution from equities jumps by more than 40%,

from 26% to 78%. In risk budgeting terms a 50-50 balanced portfolio looks far more like an all equity portfolio, such as an *adventurous* mandate, than a *conservative* 25-75 allocation.

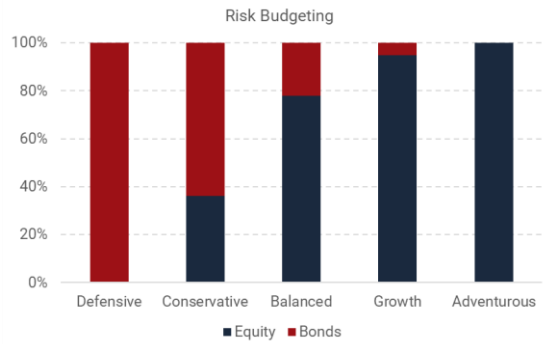

Figure 3. Risk budgeting between equity and bond allocation across different risk profiles of a typical UK asset/wealth manager.

Finally, note that from a risk budgeting point of view there is little difference between the two more risky profiles: having a 0% or 25% bond allocation, with the rest of the portfolio invested in equities, makes very little difference. The portfolio volatility of each of the two mandates is (almost) entirely explained by the equity allocation.

RISK FACTORS

Moving from capital to risk budgeting using asset classes is an important step towards understanding the true nature of an investment and to appreciating the outcomes that might occur during adverse market conditions. As previously highlighted, however, assets are only the instruments used to access the risks for which an investor hopes to be rewarded. Icelandic saving accounts paid higher interest rates because they bore a higher bankruptcy risk, Swiss franc mortgages required a lower repayment because they carried a higher currency risk. Once again, the same asset classes might hide different risks and, therefore, different expected returns.

To appreciate the intrinsic risks of each investment, we could compute the risk contribution of each single security in a portfolio. However, it is far more informative and effective to directly capture the contribution to the overall portfolio risk coming from the risks that drive asset performance. To do this, we must first identify, define, and measure what those risks are. This is done using risk factors.

A risk factor is identified by observing that movements in asset prices can be explained, in a statistical sense, by their sensitivity to certain common factors. These common factors are defined either by aggregated asset indices such as a global equity index, or by macroeconomic variables such as inflation expectations or interest rates.

The goal is to define a set of factors, which give an accurate picture of the full investment universe (i.e. they explain the performance of the assets in a portfolio), while reducing complexity (i.e. rather than calculating the risk contribution of dozens of assets, we do risk budgeting on a limited number of common risk factors).

We find that most of the returns of asset classes in a generic multi-asset portfolio can be explained by three main factors: *Inflation*, *Interest Rate*, and *Economic Growth*.

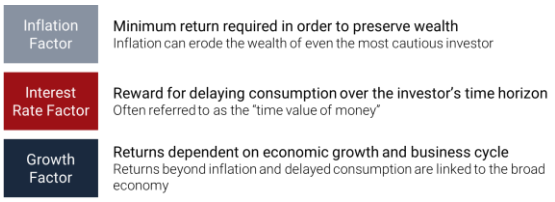

Figure 4. Three main risk factors defining the return of the asset classes in a generic multi-asset portfolio.

Inflation. Because investors want to preserve their spending power, inflation is an important risk factor; in particular when real assets such as commodities (oil, gold and other metals), real estate and infrastructure, or inflation-linked bonds, are used in the portfolio. Inflation risk is measured using a combination of movements in shorter-term commodity prices, and relative movements in index-linked bonds versus nominal bonds (to capture changes in inflation expectations).

Interest rates. The interest rate risk factor rewards investors for delaying their consumption over time (or, alternatively, is the price paid by borrowers for bringing consumption forwards). It generally represents the more defensive part of a portfolio, acting as a diversifier when economic growth is subject to significant short-term corrections. It is measured by changes in short- and long-term real rates.

Economic Growth. This is the cyclical component of asset returns, the risk factor that incorporates the business cycle. It represents the part of the portfolio

linked to the general growth of the economy, whose returns are significantly skewed to the left, i.e. the main driver of long term returns but also sharp short-term corrections. It is measured by equity and credit risk.

The link between asset classes and risk factors is quite intuitive. Consider corporate bonds, for instance. While equities and government bonds have very distinctive features, with the former loading primarily on equity risk and the latter holding primarily interest rate risk, a corporate bond is, from a risk perspective, a hybrid between a stock and a government bond. While it is structured like a generic bond and is affected by changes in interest rates, its price also depends on the financial situation of the issuing company, in a similar way to the company's common stock. As a result, its risk factor exposure is a composite of both interest rate risk and economic growth risk.

Figures 5 illustrates the theoretical risk factor exposure for different asset classes. Like corporate bonds, high-yield bonds are also a combination of interest rate risk and economic growth risk, but with generally higher exposure to economic growth. REITs are mainly driven by economic growth, but with an additional exposure to inflation and interest rates, while inflation linked bonds are exposed to both interest rate and inflation factors.

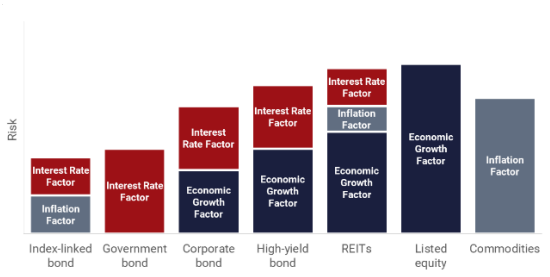

Figure 5. Illustration of factor exposure of different asset classes.

In practice we quantify the exposure by computing the long-term relations between risk factors and asset classes using almost forty years of historical data. We find not only that the empirical results are consistent with the theory, but also that the relations are largely stable and robust over time. Moreover, we capture over 95% of the long-term risk of a generic portfolio independently of the definition of risk used.

RISK BUDGETING WITH RISK FACTORS

Having established the link between the different asset classes and the risk factors, we can now analyse how the risk budgeting across risk factors looks for each of the risk-rated portfolios. Figure 6 illustrates the results, using volatility as the measure of risk.

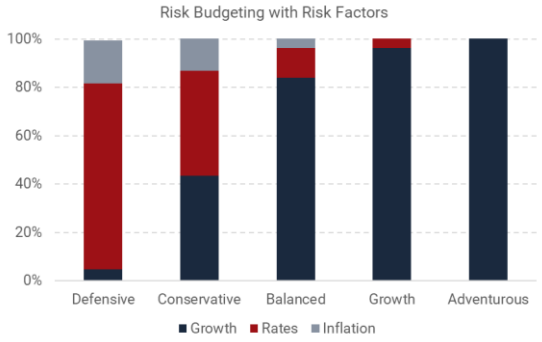

Figure 6. Risk budgeting between inflation, interest rates and growth risk across different risk profiles of a typical UK asset/wealth manager.

First, note that we can now quantify the risk contribution from bonds into inflation and interest rate risk. About one fifth of the risk budget of a defensive portfolio, for instance, is linked to changes in inflation and in inflation expectations. Second, the contribution from economic growth risk, generally linked to equities and credit, increases across all the risk profiles. This source of risk is notably higher than in the traditional capital budgeting approach, and even the more sophisticated approach of risk-budgeting using asset classes does not capture the full extent of the exposure. Interestingly, the main difference in risk exposure derives from the use of corporate bonds in the asset allocation.

We can then recalculate the exposure to risk factors using the alternative measures of risk mentioned earlier, such as VaR and ES. These measures demonstrate that the skew towards economic risk in left-tail scenarios is even greater, suggesting that, in an economic crisis, the Balanced, Growth and Adventurous risk profiles will all tend to fall together as a result of their true exposures being substantially the same, with the only difference being the overall magnitude, influenced by the portfolio volatility level.

This analysis suggests that portfolios commonly characterised as "balanced" in their asset class exposure are not balanced in their true risk exposure.

This begs the question as to how the return characteristics of portfolios can be maintained while diversifying the underlying risk factor exposure. We will address this question in a future study, in which we will show how is it possible to achieve the same overall portfolio risk – measured as volatility, VaR or ES – but at the same time increase the diversification across the risk factors, with a beneficial effect to the portfolio risk-adjusted return.

CONCLUSIONS

Recessions, severe market corrections, bubbles and crashes are part of the life of an investor. A better understanding and management of the risks will help investors find an asset allocation that bears up through different investment regimes and will, ultimately, result in more robust and resilient long-term performance.

Using risk factors in the context of risk budgeting complements capital budgeting through its focus on how underlying sources of risk are allocated across the different instruments in a portfolio. It contributes to an understanding of the risks driving the overall investment performance and can be used to mitigate the potential consequences of a sudden deterioration in market conditions.

Risk budgeting with risk factors more accurately and intuitively conveys the actual sources of portfolio risk, offering investors the ability to break free from the unintentional concentration of risk that accompanies capital budgeting. Risk budgeting using risk factors can be used to define an optimal asset allocation that achieves the desired risk exposure among risk factors, as well as an intuitive and flexible framework in which to understand and monitor the performance of an investment.

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