1 Introduction

1.1 STRATEGIC ASSET ALLOCATION

Despite its title, this book does not present a universal step-by-step guide to strategic asset allocation! Since a strategic asset allocation framework is tailored to the institution that is its user, it is by definition impossible to outline a general and unifying approach covering this particular niche of financial theory, at least if one aims at doing this at any reasonable level of detail. Rather, the aim and purpose of what follows are to outline financial and econometrical modelling techniques that can be helpful in implementing idiosyncratic strategic asset allocation methods in practice. The included examples are supported by annotated MATLAB code, as a means to aid the reader's effort to implement his/her own model specifications.[1]

Before we really start (in the next chapter), let us try to narrow down the concept of 'strategic asset allocation' by looking at what the terms 'strategic' and 'asset allocation' mean.

According to AskOxford.com, a 'strategy' is:

> noun (pl. strategies) **1** a plan designed to achieve a particular long-term aim. **2** the art of planning and directing military activity in a war or battle. Often contrasted with tactics.

wikipedia.org states that 'asset allocation'

> is a term used to refer to how an investor distributes his or her investments among various investment vehicles (e.g. stocks and bonds).

So, in essence, a 'strategic asset allocation' represents a set of portfolio weights showing how a particular investor wishes to spread his/her wealth between different generic asset classes, such as bonds, equity and cash, over a long-term horizon. One can say that the 'strategic asset allocation' is a time-stable (or passive) anchor for the total amount of risk an organisation is willing to take onboard, and at the same time it shows the amount of compensation (return) the organisation expects to receive for

[1] Other publications that aim at deriving approaches relevant for long-term investors are, among others, Merton (1992)[Part II], Bernadell, Cardon, Coche, Diebold, and Manganelli (2004)[chs. 1 and 3], Campbell and Viceira (2002), Binseil, Gonzalez, and Tabakis (2008 forthcoming)[ch. 2] and IMF (2004).

assuming this particular amount of risk. The strategic asset allocation *framework* is then the process by which the strategic asset allocation is found.

A strategic asset allocation decision can be contrasted by a tactical asset allocation decision, similar to the semantic definition of the word 'strategic' referred to above from AskOxford.com. Tactical asset allocation decisions represent active risk positions taken 'against' the strategic allocation with the aim of generating out-performance, i.e. a better return than that obtained by the strategic allocation, by assuming as little additional risk as possible.

Since the strategic asset allocation reflects a long-term market view, and since this portfolio is revised at a relatively lower frequency, it is possible that active position taking may generate a better performance than that of the strategic allocation. One possible source of out-performance stems from the optimal use of the information that flows to the market between revisions of the strategic allocation; another source comes from the difference between the investment horizons of the strategic and tactical portfolios: changing market sentiment between revisions of the strategic allocation can potentially be exploited by tactical position taking. Finally, skilled portfolio managers are possibly able to generate out-performance through instrument selection, i.e. choosing instruments that are incorrectly priced, at a given point in time vis-à-vis the instruments included in the strategic allocation. In addition, skilled portfolio managers may be able to generate out-performance by correctly timing market movements not anticipated by the strategic asset allocation. In the book we will not deal with tactical asset allocation per se; however, it is still necessary to be aware of its existence.

A number of strategic framework parameters need to be specified before financial and econometrical tools can be deployed on data, with the aim of singling out optimal portfolio allocations aiding the investor in his/her choice of the right strategic asset allocation composition. Such parameters specify the central dimensions of the strategic asset allocation framework, which may be difficult, or even impossible, to incorporate directly as investment constraints. Therefore, these parameters will often be treated as exogenous decision variables, chosen by the senior management of the institution in question. Among the exogenous decision parameters are: the length of the investment horizon; the revision frequency; the composition of the investment universe; the specification of the investment objective function; and the leeway/risk budget given to the tactical investment layers. A summary of the link between strategic and tactical asset allocations as well as the key framework design parameters are provided in Table 1.1.

The investment horizon specifies the period over which expectations to risks and returns are formed, and thus the period over which the portfolio optimisation is optimal *ex ante*. A precise quantification of the length of the investment horizon is thus a necessary prerequisite for the explicit generation of return and risk measures relevant for the chosen investment universe. For example, the investment horizon for the strategic asset allocation could be defined as one, five or ten years. The actually chosen time-span should naturally follow from the institution's definition of 'long

Table 1.1 Dimensions of the asset allocation process

Allocation	Strategic	Tactical
Investment horizon	Long term	Short to medium term
Revision frequency	Lower	Higher
Investment universe	Matching the objectives and resources of the organisation	Broader or the same as the strategic layer
Objective	Construct a portfolio having an optimal *ex ante* return/risk profile	Generate out-performance

term': it could be that the organisation wants a strategic allocation that is constant through economic cycles, or that it wishes to adapt the strategic asset allocation to swings in the economic cycles. The choice also depends on the assumed activities or the tactical levels, and the leeway given through the specified risk budgets.

By revision frequency is meant the regular time intervals between the dates when it is investigated whether the current strategic asset allocation is still in accordance with the overall return–risk preferences of the organisation, and whether it still is *ex ante* optimal. Hence, the revision frequency should be related to the flow of information relevant for the assets comprising the eligible investment universe. If, on the one hand, the investment universe constitutes assets for which much new information is generated on a continuous basis, e.g. financial options, equities and low-grade corporate bonds, then one should choose a relatively high revision frequency. If, on the other hand, the investment universe is relatively conservative and comprises only high-grade government bonds, then a relatively low revision frequency, of perhaps an annual frequency, should suffice. To avoid potential confusion, at this stage it should be mentioned that there is a difference between the revision frequency and the term 'rebalancing frequency'. The latter refers to the operations that some institutions practise as regards the implementation of a particular strategic portfolio. In this context it should also be mentioned that strategic asset allocation is most often conducted at the level of generic instrument classes, i.e. not at the level of actual issues/instruments that trade in the financial markets. Instead, notional indices exhibiting the relevant risk and return characteristics are used, such as indices for foreign-denominated equity, foreign-dominated emerging market equity, domestic equity, domestic government bonds with a constant maturity of 0–1 years, domestic government bonds with a constant maturity of 1–2 years, and so forth. While the strategic asset allocation process identifies the optimal exposure to these generic asset classes, the subsequent implementation of the strategic portfolio is done by adding tradable instruments to an actual portfolio that,

when completed, will match the risk–return profile of the (notional) strategic asset allocation.

Returning to the issue of 'rebalancing frequency', consider a fixed-income portfolio as an example: assume that the optimal modified duration for the organisation's strategic asset allocation has been found to be 3. When this portfolio is implemented, say 1 January in year X, it is ensured that instruments are selected so that the portfolio of assets has a modified duration of 3. Let us assume further that the organisation in question has an annual revision frequency. As a result, if the portfolio is left unchanged between the annual revisions, the risk characteristics of the strategic allocation will change over time as the bonds included in the portfolio approach their redemption day, and the portfolio's central characteristics will thus drift further and further away from their specified targets. If nothing is done between 1 January in year X and 1 January in year $X+1$, and depending on the level of yields in year $X+1$, the portfolio will approximately have a modified duration of 2, at the time of the annual rebalancing in year $X+1$.[2] To avoid the maturity shortening, and to ensure that the characteristics of the selected instruments fulfil the requirements of the organisation in question, regular portfolio rebalancings are often instituted at a higher frequency than the chosen revision frequency. A fixed-income strategic asset allocation may for example have a monthly rebalancing frequency, where it is then ensured that the risk characteristics of the current portfolio composition are in line with the target characteristics found at the most recent strategic asset allocation review.

Traditionally, the investment universe relevant for the strategic asset allocation has been stocks, bonds and cash, possibly with a separation of the bond category into maturity buckets, such as 0–1, 1–2, …, 29–30 year maturity segments. However, this is no longer generally the case. Even organisations which used to be considered as risk averse in their strategic investment decisions now seem to take onboard exposures to instrument classes that can be viewed as being relatively risky.

In its broadest sense, the investment universe comprises equity, government bonds and corporate bonds (domestic and foreign, as well as high and low credit grade), commodities, emerging market exposures (this category could naturally also be subsumed in the category of foreign assets), hedge funds, ethical investments, and cash. Policy considerations as regards the overall market, credit, liquidity and headline risk exposures that the organisation is willing to assume in its investment operations will determine the composition of the investment universe eligible for strategic and tactical investments. In the remainder of this book we will focus exclusively on a fixed-income investment universe.

[2] This change in modified duration stems from the maturity shortening of fixed-income instruments, which we will talk more about in subsequent chapters.

The organisation's objective function (utility function) is a preference organising mechanism, which supports the identification of the optimal strategic asset allocation, subject to the specified investment universe and possibly additional investment constraints. Ideally, the objective function should be specified in terms of a mathematical formula that expresses the value that the organisation attaches to expected return, and how severely it wants to penalise risk taking. It may also incorporate additional constraints in the form of maximum allowed exposures to certain risk factors and minimum holding constraints on specific generic instrument groups, and/or encourage a certain degree of diversification among the eligible investment vehicles. To make this a bit more concrete, one example of an objective function could be: to maximise expected portfolio return in local currency, while ensuring that there are no losses at a 90 % confidence interval over the investment horizon, and that there is a minimum allocation of 30 % to government bonds. The objective function can also be formulated in terms of the cashflows needed to service liabilities, as it is relevant for asset-and-liability management, e.g. in the form of minimising the shortfall between liability-driven cashflows and the cashflows generated by the strategic asset allocation (i.e. the assets), again at a given confidence level. Finally, and in the same vein, the objective function can also be expressed relative to an observable market rate, e.g. in the form of generating return in excess of the short-term interest rate, at a given level of certainty. At any rate, it is rarely the case in practice that an organisation will state its preferences in the form of a traditional utility function, e.g. in the form of a power utility function with a given risk aversion parameter.

1.2 OUTLINE OF THE BOOK

This book is about learning MATLAB, finance and econometrics. Its material is framed in the context of strategic asset allocation for a fixed-income investment universe. This means that the tools, techniques and examples relate to bond investments and implicitly are relevant for long-term investors. All presented theories are backed by MATLAB implementations and mathematical derivations, to the extent that they are necessary, and aim to be pedagogical and self-explanatory rather than mathematically rigorous. I have striven to write the book so that it is ideal for self-study by including many annotated programming examples, and by presenting the material in an easy-to-read format emphasising the usefulness of financial and econometrical methods, rather than their theoretical underpinnings. In this sense the book is intendedly of a very applied nature.

When using the book for self-study, it can be read from start to end, beginning with Chapter 1 and ending with Chapter 7. Chapter 8 is included to show the usefulness of MATLAB in terms of making the functionalities of user programs easily available to fellow students and/or colleagues via the construction of graphical user interfaces (GUIs). Chapter 9 includes a reference to relevant formulae and as such is not intended

for reading, but should serve as a point of reference, when needed. Other than this, one can say that the book falls into two parts. The first part establishes a (loose) foundation for strategic asset allocation (Chapter 1), the usage of MATLAB (Chapter 2) in fixed-income investments (Chapter 3) and in risk measurement (Chapter 4). The second part contains more challenging material: Chapter 5 treats term structure models by means of examples of arbitrage-free and not necessarily arbitrage-free models; Chapter 6 explains asset allocation models using the efficient frontier as a central concept; and Chapter 7 introduces various econometric techniques such as vector autoregressive and regime-switching models.