

RISK-BASED INVESTMENT MANAGEMENT IN PRACTICE

FRANCES COWELL

Second Edition

GLOBAL FINANCIAL MARKETS

Risk-Based Investment Management in Practice

Global Financial Markets series

Global Financial Markets is a series of practical guides to the latest financial market tools, techniques and strategies. Written for practitioners across a range of disciplines it provides comprehensive but practical coverage of key topics in finance covering strategy, markets, financial products, tools and techniques and their implementation. This series will appeal to a broad readership, from new entrants to experienced practitioners across the financial services industry, including areas such as institutional investment; financial derivatives; investment strategy; private banking; risk management; corporate finance and M&A, financial accounting and governance, and many more.

Titles include:

Daniel Capocci

THE COMPLETE GUIDE TO HEDGE FUNDS AND HEDGE FUND STRATEGIES

Frances Cowell

RISK-BASED INVESTMENT MANAGEMENT IN PRACTICE 2nd Edition

Guy Fraser-Sampson

INTELLIGENT INVESTING

A Guide to the Practical and Behavioural Aspects of Investment Strategy

Michael Hünseler

CREDIT PORTFOLIO MANAGEMENT

A Practitioner's Guide to the Active Management of Credit Risks

Ross K. McGill

US WITHHOLDING TAX

Practical Implications of QI and FATCA

David Murphy

OTC DERIVATIVES, BILATERAL TRADING AND CENTRAL CLEARING

An Introduction to Regulatory Policy, Trading Impact and Systemic Risk

Gianluca Oricchio

PRIVATE COMPANY VALUATION

How Credit Risk Reshaped Equity Markets and Corporate Finance Valuation Tools

Andrew Sutherland and Jason Court

THE FRONT OFFICE MANUAL

The Definitive Guide to Trading, Structuring and Sales

Michael C. S. Wong and Wilson F. C. Chan (*editors*)

INVESTING IN ASIAN OFFSHORE CURRENCY MARKETS

The Shift from Dollars to Renminbi

Global Financial Markets series

Series Standing Order ISBN: 978-1137-32734-5

You can receive future titles in this series as they are published by placing a standing order. Please contact your bookseller or, in case of difficulty, write to us at the address below with your name and address, the title of the series and the ISBN quoted above.

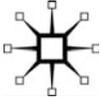
Customer Services Department, Macmillan Distribution Ltd, Houndmills, Basingstoke, Hampshire RG21 6XS, England

Risk-Based Investment Management in Practice

2nd Edition

Frances Cowell

palgrave
macmillan



© Frances Cowell 2013

Softcover reprint of the hardcover 1st edition 2013 978-1-137-34639-1

All rights reserved. No reproduction, copy or transmission of this publication may be made without written permission.

No portion of this publication may be reproduced, copied or transmitted save with written permission or in accordance with the provisions of the Copyright, Designs and Patents Act 1988, or under the terms of any licence permitting limited copying issued by the Copyright Licensing Agency, Saffron House, 6–10 Kirby Street, London EC1N 8TS.

Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages.

The author has asserted his right to be identified as the author of this work in accordance with the Copyright, Designs and Patents Act 1988.

First published 2013 by
PALGRAVE MACMILLAN

Palgrave Macmillan in the UK is an imprint of Macmillan Publishers Limited, registered in England, company number 785998, of Houndmills, Basingstoke, Hampshire RG21 6XS.

Palgrave Macmillan in the US is a division of St Martin's Press LLC, 175 Fifth Avenue, New York, NY 10010.

Palgrave Macmillan is the global academic imprint of the above companies and has companies and representatives throughout the world.

Palgrave® and Macmillan® are registered trademarks in the United States, the United Kingdom, Europe and other countries.

ISBN 978-1-349-46692-4 ISBN 978-1-137-34640-7 (eBook)
DOI 10.1057/9781137346407

This book is printed on paper suitable for recycling and made from fully managed and sustained forest sources. Logging, pulping and manufacturing processes are expected to conform to the environmental regulations of the country of origin.

A catalogue record for this book is available from the British Library.

A catalog record for this book is available from the Library of Congress.

Contents

List of Tables, Figures and Examples vii

Preface x

Acknowledgements xii

Part I: Introduction

1 Introduction 3
2 Risk-Based Portfolio Selection – An Overview 24
3 Investment Management Theory 32

Part II: Risk Management

4 Risk Management 47
5 Risk Modelling 65
6 Risk Measurement 85
7 Derivatives Risk Management 113

Part III: Risk-Based Portfolio Selection

8 Asset Allocation 127
9 Indexed Equities Portfolios 159
10 Equities Portfolios 185
11 Optimization for Equity Stock Selection 220
12 Fixed Interest Portfolios 239
13 Credit Portfolios 261
14 Property Portfolios 280
15 Structured Products 294
16 Hedge Funds and Funds of Hedge Funds 313

Part IV: Peripherals

17 Implementation 335
18 Performance Measurement and Attribution 348
19 Trends in Investment Management 366

Appendices

Appendix 1 Pricing Interest Rate Securities 374

Appendix 2 Forward Contracts 377

<i>Appendix 3 Futures Contracts</i>	386
<i>Appendix 4 Swaps</i>	397
<i>Appendix 5 Options</i>	406
<i>Appendix 6 Convertible Notes</i>	421
<i>Bibliography</i>	430
<i>Glossary</i>	432
<i>Index</i>	459

List of Tables, Figures and Examples

Tables

1.1	Typical investment management process	5
1.2	Investment structures: advantages and disadvantages	15
5.1	Simulation and mean-variance: instrument coverage	74
5.2	Simulation and mean-variance: advantages and disadvantages	75
6.1	Risk measures and their applications	101
10.1	A typical rights issue	208
15.1	Comparison of four protection methods	310

Figures

5.1	Risk modelling methodologies	66
-----	------------------------------	----

Examples

1.1	Assessing the value of tactical asset allocation	21
2.1	Exposure and contribution to risk	27
2.2	Scenario analysis	29
3.1	The efficient frontier	33
3.2	Value of dividend tax credits for domestic and international investors	34
3.3	Active portfolio and market returns	38
3.4	The normal distribution	40
3.5	Observed and theoretical normal distributions	41
3.6	Discounted cash flow	42
5.1	Data periodicity	77
5.2	Timing of observations	78
5.3	Risk model testing	80
5.4	Portfolio contribution to risk	83
6.1	Risk versus volatility	89
6.2	Volatility and tracking error	90
6.3	95 per cent VaR	92
6.4	Equity portfolio risk profile	96
6.5	Convertible bond portfolio risk profile	108

7.1	Economic exposure versus accounting treatment for forwards, futures and swaps	118
7.2	Economic exposure versus accounting treatment for options	119
8.1	Extrapolating from past returns	132
8.2	Interest rate parity calculating the forward price	137
8.3	Purchasing power parity	138
8.4	Comparing correlation matrices	141
8.5	Exposure versus weighting	144
8.6	Risk budgeting	148
8.7	Return contribution of short-term asset allocation	155
8.8	Asset allocation call option spread	156
9.1	Stratified samples	167
9.2	Expected beta and tracking error – stratified sample and optimized	170
9.3	Stock index arbitrage	173
9.4	Long-term strategic asset allocation	180
9.5	Portfolio structure	181
9.6	Portfolio performance	183
9.7	Attribution analysis	184
10.1	Analysis of moving average	196
10.2	Dividend discounting	197
10.3	A simplified single stock model	198
10.4	Arbitrage pricing theory	199
10.5	Risk and return	202
10.6	Return measurement	209
10.7	Comparison of return and volatility for Australian All Ordinaries, All Industrials and All Resources Indices	212
10.8	Comparison of return and volatility for Australian All Ordinaries, All Industrials and All Resources Indices: years 14 and 15	213
10.9	Results for Australian All Ordinaries, All Industrials and All Resources Indices and 90/10 portfolio: years 14 to 17	213
10.10	Risk-return trade-off for Australian All Ordinaries, All Industrials and All Resources Indices and 90/10 portfolio from 1980 to 1999	214
10.11	Composition of the international index fund and benchmark	215
10.12	Performance of the international index fund and benchmark: years 1 to 5	216
10.13	Summary attribution analysis of the international index fund	217

11.1	Risk and return	220
11.2	Constrained and unconstrained optimization	228
11.3	Reverse optimization by stock	235
11.4	Reverse optimization by factor	236
12.1	A yield curve	242
12.2	A simple fitted yield curve	247
12.3	Discounting	248
12.4	Compounding monthly over one year	249
12.5	Compounding daily over more than one year	249
12.6	Continuous compounding	250
12.7	Calculating the bond price	250
12.8	Portfolio value per basis point for three bonds	251
12.9	Duration for two bonds	252
12.10	Convexity of two bonds	253
12.11	Pull to par	254
12.12	Put-call parity in terms of yield	259
12.13	Put-call parity in terms of settlement value	260
14.1	A property swap	290
15.1	Hold shares and buy put options versus sell portfolio and buy call options	301
15.2	An option on a portfolio of assets versus a portfolio of options	303
15.3	Replicating options and actual options	305
15.4	Cost of option for partial protection	306
15.5	Capital guarantees	312
16.1	Short call and put at the same exercise price with short stock position	330
16.2	Short call and put at the same exercise price without short stock position	331
16.3	Payoff to option strategy	332
17.1	Performance of a transition portfolio	347
18.1	Single period portfolio return with cash flow	350
18.2	Geometric linking	351
18.3	Monthly portfolio returns	352
18.4	Return summary to August 2011	352
18.5	Return summary to July 2011	352
18.6	Attribution analysis by industry group	355
18.7	Return and risk	357
18.8	Risk-based performance analysis by portfolio risk factor	358
18.9	Return attribution by benchmark exposure	359

Preface

As an investment manager in Australia before the days of risk models, it often intrigued me that stock prices often did not behave as expected, for example gold stock prices seemed disconnected from the price of gold itself, so holding them in the portfolio did not necessarily give the exposure that might have been expected.

The explanation of course is that gold stocks include prospectors as well as producers, many of which hedge their future production in order to protect themselves from volatility in the price of gold. They thereby dampen or even cancel the relationship with the price of the underlying metal. Many commodities producers are similarly unresponsive to the price of their respective commodities because they sell their produce through long term, fixed price contracts, and so are insensitive to fluctuations in the spot price.

Before the days of risk models, the relationship between commodity stocks and their commodities could be estimated only through laborious and error prone analysis of company reports and broker research. A good risk model can tell you in a few seconds.

This meant in effect that, as an investment manager I often misunderstood the risk exposures in my own portfolio. How therefore, could I hope to achieve my target returns, except mainly by chance?

Before the days of reliable risk measurement, this problem was of course very common. What is surprising is how frequently it still happens that investment managers understand their portfolios less well than they think they do.

In a dealing room I once visited was a poster shouting: 'No pain, no gain!' Clearly the aim was to encourage aggressive risk taking. But it intrigued me that it seemed to equate risk with losses – of other people's money, of course. Nowhere was there evidence of any value placed on objective evaluation of exactly how the risk/losses were to result in gains.

Until relatively recently, risk management was typically regarded as a supporting act to investment managers, largely confined to generating risk analyses and reports (it sometimes still is). Yet of the two, the risk manager's job, if done well, is the more intrinsically interesting and intellectually demanding. While the investment manager seeks out sources of return hidden in valuations of individual securities, the risk manager seeks ways to harness the investment managers' insights so they are not swamped by unintentional risk and in doing so, ensures that the whole is worth at least as much as the sum of its parts.

While simple risk management is mostly invisible, effective risk based investment management, which distinguishes calculated from incidental risks, adds value continuously and visibly.

In writing this book I have sought to expand on the difference between the two, and show how the value added by effective risk management can be crystalized.

The aim is to help investors ask the right questions of investment managers and to make sense of the answers. As well as investors, this will benefit any non-financial professional who is interested in a serious explanation of how risk management works, how it sometimes fails and how it can add value in the form of materially enhanced investment performance.

Any book about risk-based investment management can hardly avoid going into some detail about how risk is modelled and measured and the assumptions and work-arounds that are necessary for any practical application. Conscious that the details can seem daunting to a non-financial reader, I have sought to avoid jargon as much as possible. Where it cannot be avoided, I have tried to make the explanation intuitive.

Inevitably this brings the reader face-to-face with CAPM, the Nobel Prize winning insight of Harry Markowitz, who is widely regarded as the father of Modern Portfolio Theory (MPT). There are many criticisms of CAPM, many of them justified but, as Winston Churchill observed in the House of Commons in 1947: 'Democracy is the worst form of government, except for all those others that have been tried from time to time'¹, even tenacious adherents to MPT (of which I am one), might say something similar about CAPM.

At the very least there is a benefit in working with the devil you know. The longevity and sheer tractability of CAPM means it has been tested continuously for several decades in academia and by practitioners, so its limitations are well understood.

Many, if not most alternatives to CAPM revert to pre-1952 methodologies. This prompts the question: 'If we did not have CAPM, would we have to invent it?' and the answer: 'Yes, because we didn't and so we did.' The relationship between commodity stocks and commodities illustrates that.

Most people with no investment experience will tell you that you can't achieve investment returns without taking risks – preferably calculated risks – and ask if managing calculated risk isn't what investment management is about. I agree, but would add that that it is about not only managing calculated risks, but also eliminating unnecessary risks and knowing how to tell the difference. This book aims to confirm this common sense observation and elaborate on how it works in practice.

¹ [http://wais.stanford.edu/Democracy/democracy_DemocracyAndChurchill\(090503\).html](http://wais.stanford.edu/Democracy/democracy_DemocracyAndChurchill(090503).html)

Acknowledgements

The biggest thank you is to my colleagues at R-Squared Risk Management, with whom I have worked both as colleague and as their client for more than two decades, and from whom I have learned – and continue to learn – so much.

My other teachers are my clients, who continue to challenge me with new investment problems and new perspectives on old problems.

The other big contributors to this book are my past colleagues, who, over the decades have corrected me, encouraged me and prodded me; and who provided the material in the case studies.

One feels spoiled by the abiding readiness of Wikipedia to help with fact-checking and supplementary research, making possible in minutes or hours what would, only a few years ago, have taken days. ‘If we didn’t have Wikipedia, would we have to invent it?’

FactSet and R-Squared Risk Management have been more than generous with supporting data and analyses, and have been a source of both practical help and encouragement.

Part 1

Introduction

1

Introduction

Investment management is one of the few highly paid professions for which no formal qualification is universally recognized. Yet few people would dismiss the responsibilities of investment managers as simple or trivial. Even evaluating the quality of their work is complex and inexact.

Professional investment management is relatively recent and for the first half of the twentieth century was confined to a limited range of investment techniques and instruments. That started to change in the second half of the century: financial instruments have proliferated and become more complex and markets have become more volatile, for example.

Yet derivatives were used in the Middle East in ancient times, in the markets in Rotterdam in the sixteenth and seventeenth centuries and in the USA during the 1930s. With inferior information and non-existent supervision and regulation, many of these early investments carried risks that would be unthinkable today.

Markets appear more volatile now than they used to be – but there has never been a time when investments did not sometimes go wrong, because there was never a time when people were infallible. Soundness of judgement has always been subject to compromise; alchemy was once regarded as a trusted mainstream science. Before the invention of the telegraph, markets would swing violently on rumours during wars. Investors from time to time seemed to behave irrationally, giving rise to investment ‘bubbles’, which burst – ‘inevitably’. One need only be reminded of Tulipmania to realize that this is by no means a modern phenomenon. Many people today know somebody who became rich or poor, or both, as a result of the Poseidon boom in 1966.¹

Markets are perceived to be more global nowadays, with large capital flows to and from emerging markets such as South America and South East Asia. In this trading environment, currencies can appear to be growing ever more volatile. Certainly international capital flows are greater

nowadays than they were in the twentieth century, when most countries were subject to controls on international capital movements and very high transactions costs, but currencies were not necessarily less volatile. Prior to World War I, international investment was a major source of wealth to the economies of the Old World. The South Sea Bubble, the Dutch East India Company and the British venture that followed it are some examples. The very purpose of Columbus' voyage was to seek access to new markets and investment opportunities in East Asia. The Romans accumulated vast investments outside their home country, trading in places as far away as Africa and South East Asia. It is true that money moves about the globe much faster now than it used to, but so do goods – and people.

Some major changes have occurred however. One is that investments are much more widely held than even a few decades ago. In most western countries, investors now come from all backgrounds. People who grew up in developed countries after World War II, rich and poor alike, have collectively accumulated vast sums of personal savings, either privately or in company or government sponsored pension funds, mutual and trust funds and elsewhere. Investments are no longer the preserve of the very wealthy. Since these investments will, for the majority of investors, one day be their primary source of income, risk control and accountability are more important than ever before. The average investor has a fairly low tolerance for losing money and, because there are now large numbers of 'average' investors who vote, governments take an increasingly active interest in seeing that things do not go too horribly wrong. This 'democratization' of investment management is driving the imperative for greater accountability and risk control.

Another important difference between these and earlier decades is the way in which advances in technology have increased the amount of available information and transformed the way it is used and transmitted. The communications revolution speeds up funds flow around the world, sometimes even challenging governments and monetary authorities to keep up with appropriate policy responses.

The ability to analyse data in bulk encouraged the development of new ways of applying it to gain insights into the behaviour of investments. Thus we see an increasing number of investment modelling techniques, based on advanced mathematics, which are not immediately comprehensible to many investors.

The purpose of this book is to examine how investment theory developed since the middle of the twentieth century has improved understanding of the relationship between risk and investment outcomes, and how this understanding is used to select investment portfolios. This chapter gives an overview of some of the issues that usually determine investment management objectives and precede the investment selection process.

Table 1.1 Typical investment management process

Define fund structure	Pension, mutual, trust, other Defined benefit or defined contribution Open or closed pooled funds Domicile and tax status The investment consultant
Define investment strategy	Risk and return The strategy benchmark Risk tolerance How many investment managers? Specialist or balanced? Investment universe Permitted investments Currency management
Design mandates	Define mandate specific benchmarks Define risk tolerance
Select investment managers	Qualifications and experience Service level Sensible processes Fees
Evaluate investment managers	Scrutinize both good and bad performance

A typical investment management process might look something like Table 1.1

Defining the investment fund structure

Individual investors may choose to do their own investing, by purchasing stocks and bonds or investing in specialist funds, trusts or investment companies on their own behalf, or they may follow the advice of their stockbroker. To accommodate tax or other legal considerations they may choose to engage a financial planner or tax expert. At the other end of the spectrum are investors entrusting their savings to professional investors, usually large institutional investors, such as mutual funds, pension funds or insurance companies, who typically provide a package of research, investment strategy, structure and administration.

Many investors invest in small and medium-sized pension funds and other pooled funds. These funds make use of a mixture of external and in-house advice for tax and economic analysis. Because different kinds of investment funds can cater to different fiduciary and tax requirements and constraints, the investor is usually faced with enough choice of investment funds to ensure a reasonable fit with his or her investment requirements.

For pension funds, mutual funds, trust funds, investment companies and other pooled funds, how investments are structured depends on the

objectives and constraints of the majority of investors. Issues that are usually taken into account when devising investment structure for a fund are:

- The expected investment horizon.
- Cash flow and other liquidity requirements.
- Domicile and tax status.
- Minimum investment required.
- Any special ethical or legal constraints?

The investment horizon can range from a few months to many years. For example, pension funds tend to have long investment horizons, reflecting the expected length of the working and retirement lives of their members, while mutual and trust funds generally have short horizons, reflecting investors' preference to trade in and out of them regularly.

Liquidity requirements can be driven by the membership profile, as in the case of mature pension funds, perceived market demand or tax status. The question of income versus capital growth tends to be closely aligned with the tax status of the fund, and this in turn affects the choice of domicile.

Many funds stipulate minimum investment amounts, both for initial investment in the fund, and for subsequent investment and withdrawal. The purpose of these limitations is usually to contain the manager's administration costs: the cost of administering a \$1000 investment is the same as a \$1000 000 investment. But, because administration is usually charged to the investor as a percentage of the sum invested, minimum investment amounts are set to ensure that administration fees cover their cost to the investment manager.

Ethical funds have enjoyed increasing popularity in recent decades. Investors have the choice of avoiding financing arms manufacturers, tobacco companies and organizations engaging in environmentally contentious businesses. Sometimes legal limitations are imposed on the fund; for example, many corporate pension funds are prohibited from owning large interests in the company itself.

Fund structures

The main fund structure types are:

- Defined benefit or defined contribution.
- Open or closed.

Defined benefit, or final salary, funds assure the investor a fixed payment at the end of the investment period, that will be paid either as a

lump sum or an annuity. The investor's contribution to the fund may vary over time as the fund's total value fluctuates according to varying returns on its investments. Managers of defined benefit funds usually maintain a reserve as part of the fund to smooth the impact of withdrawals and disappointing investment returns.

When reserves do get too high relative to the estimated future obligations of the fund, the fund manager may declare a 'contribution holiday' – a period during which investors pay lower contributions than normal, or none at all, until the reserves again reach an acceptable level. This practice runs the obvious risk of being unfair to some investors while providing a windfall to others. It can also give the impression that the fund is unacceptably volatile, and reduce fund member confidence in the fund's manager and administration. To reassure investors, some defined benefit funds build into the investment strategy guarantees, either of capital or minimum returns.

The fund's future obligations, also known as its liabilities, are valued using a Discounted Cash Flow procedure (an example of which is given in Chapter 3). This means that the value of the fund depends not only on the nominal amount held in the fund and its reserves but also on its future obligations and the discount factor used to value them. Funds with long-dated liabilities can be very sensitive to changes in the discount factor. Many corporate pension funds use the company's borrowing rate as the discount factor, which can be much higher than the prevailing government bond rate. Many believe that this can be misleading, arguing that, as fund members believe their pension will be paid no matter what, such discount rates are too high; understating the liabilities of the fund and therefore over-stating the value of the fund. They maintain that the interest rates earned by government bonds would better reflect members' belief that their pension is a low-risk asset.

Defined contribution funds require the investor to pay in a fixed sum each week, month or year; although many defined contribution funds in fact allow members to contribute additional funds as the opportunity arises. Upon withdrawal from the fund, the investor receives both the principal paid in and the investment returns to the fund less fees and costs.

Defined contribution funds do not need to maintain reserves: each member's account grows according to his or her contributions plus or minus net investment returns. Of course it is not really that simple because each member's differing appetite for risk depends on such factors as his or her age and whether or not he or she has other assets and liabilities. When designing the investment strategy for a defined contribution fund, the fund's managers try to accommodate the majority of members' risk preferences, so members whose risk tolerance is very different from

the majority may suffer from an inappropriate balance of risk and return. To accommodate different risk preferences, many plan sponsors offer target funds, whereby the investment mix adjusts automatically as the member's investment horizon shortens.

Defined contribution funds shift the risk of investment shortfall from the fund's manager to the investor/member. Because each member's account is in effect an individual account, similar to a holding in a mutual fund, investors tend to compare the returns of their fund with those of other funds, and can hold the management accountable for any disappointing results. This comparison is often unfair since apparently comparable funds may be managed to different specifications, and so have a correspondingly different balance of risk and return. Many investors make the mistake of comparing their multi-asset class, balanced fund with the local share price index without fully appreciating that the inevitable difference in returns merely reflects the differences in risk profiles.

An **open fund** allows the investor to put money in and take it out at any time, simply by applying to the fund manager for new units or advising the manager of the intention to redeem units. Units are thus issued or redeemed at the fund's current market valuation, which is the sum of the market values of the fund's holdings.

A **closed fund** creates and issues its units at the inception of the fund, after which investors buy and sell them at prices determined by supply and demand. Closed funds are often listed on stock exchanges and traded in the same way as any other equity. Theoretically their market values should always be very close to the sum of the market value of the fund's holdings, but closed funds can exhibit surprising divergences between their theoretical unit price and their market price. This divergence can be driven by perceived scarcity of units in the fund, or anticipation of a sharp downturn in the market for the assets held by the fund. More often, the observed price divergence can reflect the cost of transacting the fund's underlying assets.

The role of the investment consultant

Consultants provide investment advice and a number of other services. For individual investors, they can help coordinate decisions regarding retirement savings, insurance and tax. For pension funds and other pooled funds, the consultant can provide the expertise necessary to administer and manage asset and liability structures, as well as legal and regulatory issues. An important function for defined benefit schemes is to provide estimates of the likely timing of contributions and withdrawals, thus forecasting the overall growth of the fund, ensuring a prudent