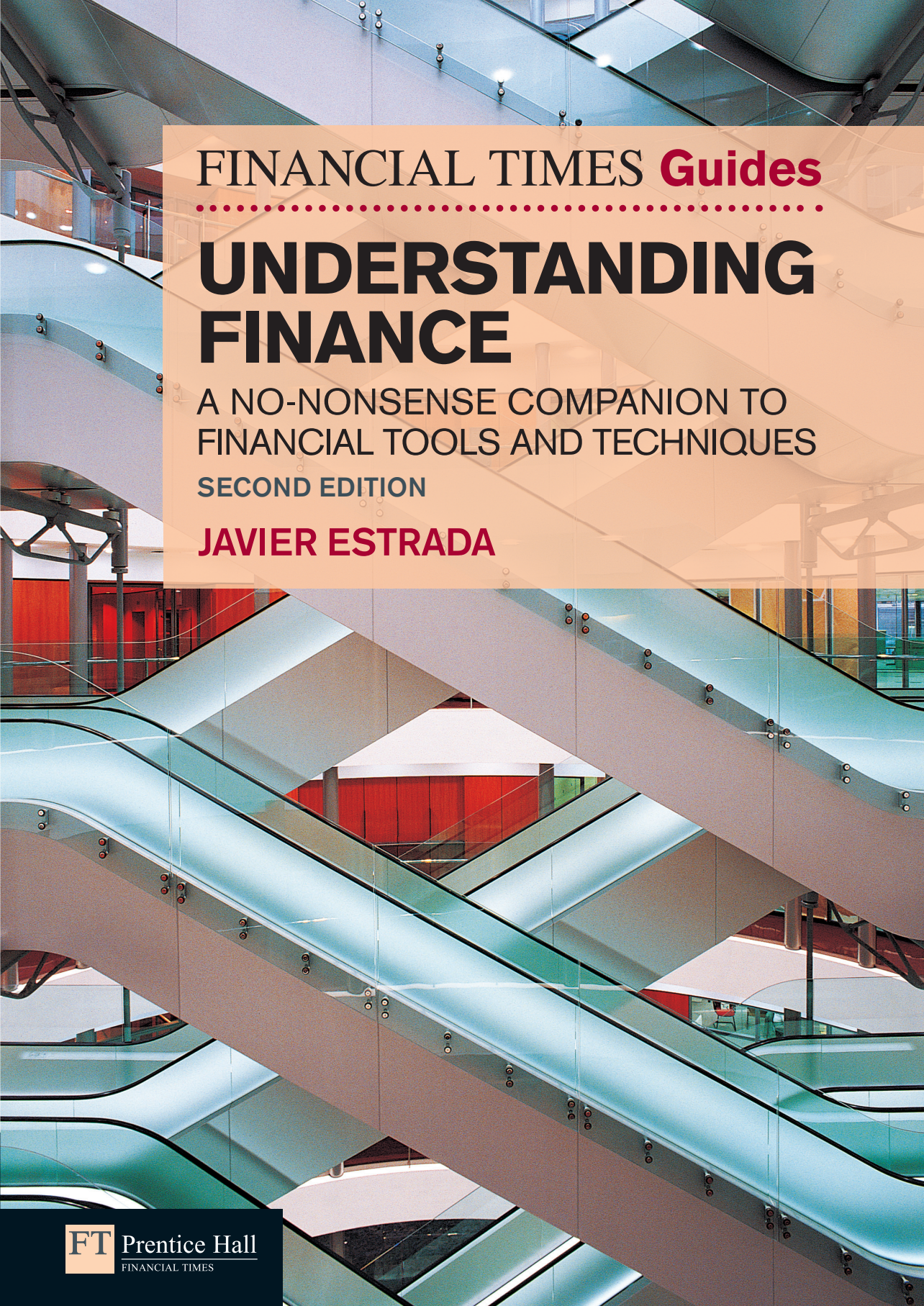

FINANCIAL TIMES **Guides**

UNDERSTANDING FINANCE

A NO-NONSENSE COMPANION TO FINANCIAL TOOLS AND TECHNIQUES

SECOND EDITION

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Preface to the second edition

I had mixed feelings when I received the request to write a second edition of *Finance in a Nutshell*. On the one hand it made me happy. I thought that publishers ask authors to write a new edition of a book only when they make a positive evaluation of the previous edition and are bullish about the prospects of a follow-up. I also thought it was a good chance to clarify explanations, update the data, correct typos, and ultimately take a fresh look at all the material discussed in the first edition and improve it.

But on the other hand I was not so happy. Writing a book is fun, or at least it was to me; but rewriting it is not, or at least not nearly as much. I also had many more time constraints than I had when I wrote the first edition. So I did think long and hard about it, at times leaning one way and at other times leaning the other way.

It was a hard decision but in the end I accepted, as evidenced by the book you're holding in your hands. And I'm glad I did, because this edition retains all the positive characteristics of the first but also improves upon it in more than one way. If you liked *Finance in a Nutshell*, I have no doubt you'll like *The FT Guide to Understanding Finance* even more.

Why do I say this? Two reasons. First, I did not try to fix what was not broken. I received a lot of positive feedback about both the coverage and the style of the first edition. Readers found that the topics discussed properly reflected those they considered most relevant, and liked the conversational style in which those topics were discussed. Retaining both the topic selection and the style, then, was a no-brainer. Second, I tried to repair what was damaged. Very often when working on this second edition, I found things that I could have explained better. So, whatever readers thought was well done in the first edition, I'm sure it's better done in this one.

Which brings me to the following recommendation to whoever is considering buying this book. If you liked *Finance in a Nutshell*, you'll find *The FT Guide to Understanding Finance* to be an improved and updated version of the original. If you never read *Finance in a Nutshell* but heard a good thing or two about it, see for yourself why the original was well received. And if you never even heard about *Finance in a Nutshell*, well, give a chance to this book which at least is not nearly as expensive or heavy as the typical 900-page textbook!

This second edition is divided into the same 4 parts and 30 chapters as the first edition was. The first part consists of 12 chapters and tackles issues related to risk and return. It covers a wide range of topics such as different ways of calculating returns and mean returns; ways of assessing risk; diversification; the CAPM, the three factor-model, required returns, and the cost of capital; risk-adjusted returns; and portfolio optimization.

The second part consists of eight chapters and focuses on the valuation of stocks and bonds. It covers different models for stock valuation including four versions of the discounted cash flow model, reverse valuation, and multiples. It also discusses bonds, their valuation, their return, and the factors that affect their risk.

The third part consists of six chapters that, unlike those in the other three parts of the book, are not closely related to each other. These are topics that, in my view, no book of essential tools could afford not to cover, which include project evaluation through NPV, IRR, and real options; corporate value creation; derivatives such as options, futures, and forwards; and currencies.

Finally, the last part provides some statistical background. It covers some widely-used statistical terms, such as the mean, median, variance, standard deviation, covariance, and correlation; two widely-used distributions, the normal and the lognormal; and regression analysis.

Readers of *Finance in a Nutshell* will find that *The FT Guide to Understanding Finance* retains the same 30 topics (chapters) of the first edition. As already mentioned, I received positive feedback on the topic selection, which gave me no reason to fix what was not broken. But beyond that, my fresh look at the whole book did not bring to mind any topic that I considered essential and was missing.

Having said that, I did receive some requests from *Finance in a Nutshell* readers to include this or that topic in subsequent editions of the book. Some of those topics included market efficiency, capital structure, and dividend policy, to

name but a few. But, however important or interesting those topics are, this is *not* a corporate finance textbook. Such a book typically contains several topics not discussed here, but also omits several topics discussed in this book. In other words, they are very different books.

One of the reasons I strongly resist considering this book a textbook is because such books tend to have 900 pages, weigh 5 pounds, and have unbearably long chapters. *This book is a reaction to that!* I tried to make it short, light, and with chapters short enough that they can be read in one sitting, without falling asleep.

Yes, this book discusses many issues typically covered in a corporate finance textbook. But it also discusses many issues typically covered in an investments textbook. In fact, I think this book is much closer to the latter than to the former. But again, this is no textbook. Hold this book in your hand and curl your arm 10 times, or put it in your purse and walk around a few blocks; you probably can't do either with a textbook, but you can with this book!

Wide coverage, short chapters, conversational style, intuitive explanations, and real-world examples are the trademarks of this book. And that's why, as was the case with *Finance in a Nutshell*, I think *The FT Guide to Understanding Finance* will appeal to a wide range of current and future finance practitioners, as well as to all those who always wanted to know a bit more about finance but found it intimidating to begin with.

As was also the case with the first edition, this second edition shows how to implement in Microsoft Excel all the tools discussed. Which brings me to a couple of points you should keep in mind. First, I have used and described everything for the US version Excel 2007. Most of the commands discussed in this book are virtually identical across different versions of Excel, but if yours is not the 2007 version and you have trouble implementing something, keep this point in mind.

Second, if you want to reproduce precisely all the calculations discussed in this book, it's important that you use the data in the accompanying Excel file (on the book's website, **www.pearsoned.co.uk/estrada**). I have performed all calculations in spreadsheets, which remember many more decimal places than would be wise to report in a book. If you try to reproduce the calculations discussed in the following chapters, with the figures discussed in those chapters, you may find that your results are close but not exactly equal to

those reported. If you use the Excel file that contains the data I used instead, you should have no problem with rounding errors. Note also that dates are presented in the US style: month, day, year.

I wrote every word and crunched every number in this book, but that doesn't mean I didn't receive any help. First and foremost, I would like to thank students and executives in countless programs without whose encouragement this book would never have existed. I would also like to thank readers of *Finance in a Nutshell* for their comments, suggestions, feedback, and ideas; had I felt that the first edition of this book was ignored, I wouldn't have had the enthusiasm to write this second edition.

Last, but certainly not least, I would like to deeply thank my research assistant, Gabriela Giannattasio. Her *extremely* detailed comments on each and every chapter were of invaluable help. And because I know her attention to detail is such that she'd find any mistake I could have made, I had the peace of mind I needed to write this book. Needless to say, I'm the only one to blame for any mistakes that may remain in the following chapters.

Regardless of how many more books I write, *Finance in a Nutshell* will always be the first one. But as much as I'll always hold dear that first little guy, I have to admit that *The FT Guide to Understanding Finance* you hold in your hands is better.

Barcelona, November 2010

Preface to the first edition

I always thought I'd write a book but never quite knew when or on what topic. I never felt the need of doing it and, to be honest, I never set it as a goal for myself. But eventually I got to a point when I decided to surrender to the evidence: Too many people were asking for the same thing, and the market, in my opinion, had not delivered. So I thought I'd deliver it myself.

A brief history of this book

It happened many times. During the course of an executive education program, I'd come in to give a few sessions on finance topics. After finishing those sessions, someone would come to me and say something like, 'Listen, this was very interesting and, though my job is only marginally related to finance, I'd like to know more about it. What would you advise me to read?' Or something like, 'Hey, I work in finance but my job is so specialized that I feel I need to refresh my knowledge of the basics. Can you recommend some book that covers a wide range of essential topics?'

Depending on the topic I had discussed in the program and what the participant had asked, I usually did one (or both) of the following: Recommend a few short books that, when put together, would cover a wide range of topics; or recommend a textbook, which as you are well aware usually contains between 600 and 900 pages and chapters no less than 20 pages long. Often, I would show the recommended references to the inquiring participant.

And that's when I started getting the two standard replies. If I recommended the few short books, the reply would be something like, 'Well, all these books look very interesting, but isn't there *one* book that tackles all these topics?' If I recommended the textbook, the reaction would be something like, 'Listen, I'm sure this book is very good, but I really have no time to

read so many pages, or even half of them. Plus, you don't expect me to carry this book around with me, do you? They'd charge me for excess luggage at the airport!' (OK, I'm dramatizing a bit.) I can't really tell how many times I went through similar exchanges, but I do know that eventually there was a straw that broke the camel's back.

But wait, it wasn't then that I decided to write this book. In fact, it was then that I decided to do something that would take a lot less of my time: I decided to look for a book I could recommend to all these people. I made a mental list of the characteristics that were in high demand and started my search. And, to my surprise, such a book didn't exist. Or maybe I didn't find it. Either way, it was then, and only then, that I thought I had to write this book.

Distinctive features

The stylized story above happened many times, give or take a few details, in many executive programs. It also happened many times while teaching in MBA and executive MBA programs. And it happened often while talking with former students who needed to refresh or broaden their knowledge of finance. After failing in my search for a book to recommend, and starting to think that maybe I should write the book myself, I thought long and hard about the characteristics of the book the market had, in my opinion, failed to deliver. This was, more or less, my list:

- *The book needs to be comprehensive*. It doesn't have to address a few issues in depth; rather, it should cover a wide variety of topics, concepts, and tools that professionals forget, find hard to understand, and need or would like to know more about.
- *The book needs to be easy to read*. Professionals are put off by academic books written in academic style. There is a need for a book written in a way that sounds pretty much like having an instructor talking right in front of them.
- *The book needs to be relatively short*. Not an 800-page, 5-pound book, but one that could be easily taken around from the office to home, and from the hotel to the airport. Something that could be always at hand, like a desktop companion.
- *The book needs to have relatively short chapters*. Most professionals dislike starting a chapter and not being able to finish it after two or three

sittings. There is a need for a book with short chapters that can be read in one sitting. Short chapters would also make it easy for readers to quickly grasp the essentials of a concept or tool.

- *The book needs to contain some elementary theory and many real-world examples*. It's a lot easier to understand and remember concepts and tools when an elementary conceptual framework and its application are discussed together. And if the application is not hypothetical but about an actual situation the reader can quickly identify with, even better.
- *The book needs to explain how to implement things in Microsoft® Excel*. Spreadsheets have become an inseparable tool for finance, and the book needs to show how to implement in Excel all the concepts and tools discussed.
- *The book needs to have a few short problems at the end of each chapter*. Many books have them, to be sure, but this book would have just two or three that go to the heart of the issues discussed in the chapter.
- *The book needs to be self-contained*. Other than some elementary math, no other previous knowledge should be required.

Well, that's a long list! But I promised myself that I wouldn't start writing a book before making sure I could deliver one that had *all* of the characteristics above. I trust the book you have in your hands does. So, if I had to define this book in one paragraph, it would be this:

> *Many professionals have long forgotten some key financial concepts or tools; others never learned them properly; some need to broaden the scope of their financial knowledge; others need a desktop companion for quick reference; and most of them have neither the time nor the motivation to dig into either several books or an 800-page textbook. This book solves all these problems in 30 short, easy-to-read, very practical chapters full of real-world examples and applications in Excel.*

Target audience and intended use

Let me tell you first what this book is *not*. First, it is not a textbook; I didn't write it as a required reference for a specific course. Second, it is not a specialized book; it's not for those who want to acquire a deep knowledge of one or two topics. And third, it is not a cookbook; I didn't write it for those

who want to blindly follow a few steps to solve a problem without understanding what's going on. If you're looking for a book to satisfy any of these needs, you've picked the wrong one.

The distinctive features of this book outlined above should give you an idea of who this book is for. Again, it was born as an answer to the demand of professionals who wanted to broaden their knowledge of finance; refresh their memory of some topics; learn other topics from scratch; or simply have a light desktop companion covering a wide range of essential topics in finance. And all that subject to the constraints of limited time and lack of patience to read an academic textbook.

I firmly believe that executives, professionals, and practitioners in different areas unrelated to finance will find this book useful. Their need to understand financial concepts and tools at the user level was constantly in my mind as I wrote this book. I also firmly believe that finance professionals such as investment bankers, portfolio managers, brokers and security analysts will find this book valuable. Their need for a reference book to quickly get up to speed on many different issues was also in my mind. In this regard, participants of executive education programs, MBA and executive MBA students, and former students, all of them in both finance and non-finance jobs, provided invaluable feedback.

I also trust the individual investor will find this book valuable. It provides the tools to value assets, assess risk, diversify and optimize portfolios, evaluate performance, and invest for retirement, to name just a few issues interesting to investors and covered in the book. And it discusses these and many other issues from scratch, showing how to implement everything in Excel.

Finally, I think that academics in finance and economics will find this book useful. It could be used as a complementary or recommended reference in many general courses such as corporate finance or investments; or in more specific courses dealing with asset pricing, stocks, bonds, and portfolio analysis, among other topics. I also think academics themselves will find the book useful as a personal desktop companion, a reference book to consult on a wide range of finance topics.

Organization of the book

The book is divided into four parts. The first, entitled 'Risk and return,' covers a wide range of issues that deal with different definitions of returns, different ways of assessing risk, different ways to put risk and return together, and the optimization of portfolios.

The second part, entitled 'Valuation,' focuses on stocks and bonds. It covers different models of stock valuation, including several versions of the DCF model, reverse valuation, and relative valuation. It also covers issues related to fixed-income securities, including pricing, sources of risk, duration, and convexity.

The third part, entitled 'Other important topics,' puts together several issues that no book of finance essentials could ignore. These include project evaluation through NPV, IRR, and real options, as well as derivatives such as options, futures, and forwards.

Finally, the fourth part, entitled 'Statistical background,' contains a refresher of essential statistical topics for practitioners, including summary statistics, the calculation of probabilities with the normal and lognormal distributions, and regression analysis. The discussion includes the implementation of all these concepts and tools in Excel.

How to read this book

I wrote the book thinking of professionals who needed to jump in for a specific issue. As a result, I wrote the chapters as independent of each other as possible. This means that this is not a book that you need to start reading at Chapter 1 and finish at Chapter 30. Some readers will not need to read the statistical background and others will find it essential reading. Some readers will be interested in stocks and others in bonds. Others may want to focus on issues related to investing or corporate finance.

Every chapter concludes with an Excel section and a Challenge section. The Excel sections aim to show how to implement in Excel the concepts and tools discussed in the chapter. These sections range from discussing some elementary functions, such as logs and exponentials, to more complex implementations, such as multiple regression analysis and portfolio

optimization programs. If you're not fully familiar with Excel, I think you will find these sections essential. And if you are familiar with Excel, these sections will probably take you a few steps further.

The Challenge sections aim to test the essential concepts and tools discussed in each chapter. The problems are few, short, and go straight to the key points. Most of them are based on data from well-known companies so that you can not only test what you've learned but also learn a bit about the companies too. Some people may find these sections useful and others will probably ignore them. It's your choice.

Finally, if you want to reproduce precisely all the calculations discussed in the book, it is important that you use the data in the accompanying Excel file (see **www.pearsoned.co.uk/estrada**). I have performed all calculations in Excel, which 'remembers' many more decimals than would be wise to report in a book. That's why you may find 'rounding errors,' particularly in calculations based on previous calculations. Similarly, if you go over the problems in the Challenge sections, you may want to use the data in the accompanying Excel file rather than that provided in the tables and exhibits.

Take a good look at the index and a quick look at the rest of the book. I trust you will find the scope comprehensive, the chapters short, the style engaging, the approach practical, and the discussions easy to follow. You will also find loads of information on many companies that are household names, which are used throughout to keep your feet firmly on the ground.

Acknowledgments

My deepest gratitude goes to the long list of participants in executive education programs, MBA students, executive MBA students, and former students who directly or indirectly encouraged me to write this book. Most of them did not actually ask me to write a book, but their search for a book that the market had not provided was the main reason for writing this one.

I'm also indebted to my research assistant, Alfred Prada, who read every chapter, checked every formula, double checked every table, and triple checked every calculation. He put up with all my demands, which were not few, and delivered every time he had to. Needless to say, he is in no way responsible for any errors that may remain in this book. Those are, of course, my sole responsibility.

Finally, I want to dedicate this book to my dad, who was alive when I started writing it but did not live to see me finish it. I know he would have been even prouder than I am for having written this, my first book. I'm sure he would have read it just because I wrote it, and I'm sure he would have told me that *even he* could understand what I was writing about. And of course, I also dedicate this book to my mom, who will most likely not read it, but will proudly and insistently show it to every single person that passes by within a mile of her house.

A final word

Time will tell whether I have delivered the book that so many people seem to have been looking for. I certainly hope so. And yet I'm also sure it can be improved. For this reason, if you have any comments or suggestions, feel absolutely free to send me an email at *jestrada@iese.edu*. I would be more than glad to know your opinion.

This concludes what for me has been a long journey. And as much as I wanted to finish, I now realize that I'll miss working on this book. It was, above all, a whole lot of fun. I certainly hope you enjoy reading it as much as I enjoyed writing it.

Barcelona, March 2005

3

Risk I: Total risk

- What is risk?
- The standard deviation of returns
- Interpretation of the standard deviation
- Mean returns and the standard deviation
- The big picture
- Excel section

In the previous chapter we discussed three ways to summarize return performance, but so much for the 'good' stuff; here comes the 'bad' stuff. In this chapter we'll focus on one way to summarize risk. Keep this in mind, though: Risk can be defined in more than one way and we'll explore other definitions later in the book.

What is risk?

Silly question, huh? Well, not really. The fact is that, simple as it may sound, academics and practitioners in finance have been wrestling with this definition for a very long time. And it gets worse. Nobody seems to have provided a definition that everybody else agrees with. In fact, it may well be the case that risk, like beauty, is in the eyes of the beholder.

Now, don't throw your arms up in despair just yet. The fact that there is no universally accepted definition of risk doesn't mean that risk cannot be quantified in a variety of more or less plausible ways. But before we get into definitions and formulas, take a look at Figure 3.1, which shows the annual returns of Intel and ExxonMobil in 2000–09.

Now, the concept of risk may be hard to pin down, but your eyes probably won't fool you: Compared with ExxonMobil, Intel's steep rises and falls have given investors quite a ride. At the same time that ExxonMobil's returns fluctuated within a range of –15% to 40% (no small range, to be sure), Intel delivered losses in excess of 50% and gains larger than 100%. Just by looking at the graph, most people would agree that Intel appears to be a lot riskier (that is, more volatile or unpredictable) than ExxonMobil.

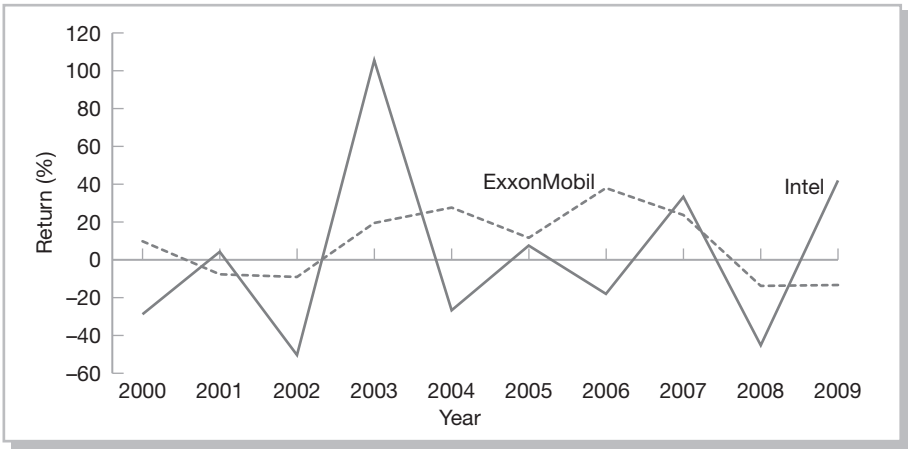

figure 3.1 **Returns on Intel and ExxonMobil**

So here's one informal way to think about risk: The more returns fluctuate over time, the greater the uncertainty about the prices and returns we'll observe in the future; and the greater that uncertainty, the greater the risk. Makes sense? Well, if it does, then read on so we can formalize this idea a bit.

The standard deviation of returns

One way to formally capture the uncertainty we just mentioned is to compute the **standard deviation of returns (*SD*)**, which is (hold on to your seat) the square root of the average quadratic deviation with respect to the arithmetic mean return. Read that again. Does it still sound like Sylvester Stallone speaking Chinese? If so, then stop reading this chapter and go to the stats review in Chapter 27. Otherwise, keep reading for more insight into this measure of risk.

The standard deviation of a series of returns, often referred to simply as **volatility**, is formally defined by the expression

$$SD = \sqrt{(1/T) \cdot \sum_{t=1}^{T} (R_t - AM)^2} \tag{3.1}$$

where R_t denotes returns in period t; AM the (arithmetic) mean return of the series of returns; and T the number of observations. Note that sometimes the standard deviation is calculated by dividing the sum of quadratic deviations

by T–1 instead of by T. For practical purposes, you don't really have to worry about this distinction, but if you want to know a bit more about it, take a look at the (very) brief discussion on this issue in Chapter 27.

Just to make sure you understand the idea behind the calculation of this magnitude, let's go over a step-by-step calculation of the standard deviation of Intel's returns. Table 3.1 shows the returns of Intel (R) between 2000 and 2009; the arithmetic mean annual return (AM) during this period was 3.3%. The column (R–AM) shows the difference between each annual return and the mean annual return. And the last column shows the figures in the (R–AM) column, squared. The average of the numbers in the fourth column is the *variance of returns* (0.2059), but this is not widely used as a measure of risk largely because it is expressed in per cent squared. The number in the intersection between the last row and the last column, the square root of the variance, or the square root of the average quadratic deviation with respect to the mean, is the standard deviation of returns, which in the case of Intel is 45.4%. Although not shown in the table, over the same period the standard deviation of ExxonMobil's returns was just 17.9%.

table 3.1

Year	*R* (%)	*R–AM* (%)	$(R–AM)^2$
2000	–26.9	–30.2	0.0912
2001	4.9	1.6	0.0002
2002	–50.3	–53.6	0.2878
2003	106.6	103.3	1.0667
2004	–26.6	–29.9	0.0894
2005	8.1	4.8	0.0023
2006	–17.2	–20.5	0.0421
2007	34.2	30.9	0.0954
2008	–43.5	–46.8	0.2191
2009	43.9	40.6	0.1646
Average	**3.3%**		**0.2059**
Square root			**45.4%**

Of course, you don't have to go through all these calculations to estimate a standard deviation; Excel calculates this magnitude in the blink of an eye and in just one cell. But the table helps you to see where the number that Excel calculates come from, and hopefully to understand what we're really calculating too.

Interpretation of the standard deviation

Let's think a bit about the interpretation of the standard deviation as a measure of risk. Here's an easy way to think about it: The larger this number, the riskier the asset. Not too difficult, huh?! Well, the best part of it is that, when assessing the risk of individual assets (that is, assets taken one at a time rather than combined in a portfolio), this is a perfectly correct way to interpret this magnitude. For informal confirmation, take another look at Figure 3.1, and recall that the standard deviation of returns of Intel and ExxonMobil are 45.4% and 17.9%. Doesn't a comparison of these two figures confirm what your eyes tell you about the relative risk of these two stocks? There you have it.

Now let's push it a bit further. Basically, a small standard deviation indicates that returns fluctuate closely around the mean return, and a large standard deviation indicates the opposite. In other words, the larger the standard deviation, the more that returns tend to depart from the mean return (both above and below), and therefore the higher is the uncertainty about the returns we'll obtain in the future.

Here's another (complementary) way to think about it. You may (or may not!) recall that, if the distribution of returns considered is normal, then approximately 68.3%, 95.4%, and 99.7% of the returns are clustered one, two, and three standard deviations around the (arithmetic) mean. Keeping this in mind, consider two hypothetical assets with a mean return of 20% and standard deviations of 5% (asset A) and 30% (asset B).

Note that there is roughly a 95% probability that the returns of asset A will fluctuate between 10% and 30%; that is, two standard deviations around the mean return. However, in the case of asset B, there is roughly 95% probability that returns will fluctuate between –40% and 80%, a range so large as to be useless. We could drive a train sideways between these two numbers!

This simple example illustrates another way to see why the standard deviation is a measure of risk: We can use it to estimate the interval within which returns will fluctuate with any chosen probability; the larger the interval, the larger the uncertainty, and therefore the riskier the asset. In fact, if you run a similar calculation for Intel and ExxonMobil (you should, it's easy!), you'll find that there's roughly a 95% probability that the returns of Intel will fluctuate between –87.4% and 94.1%, and those of ExxonMobil between –26.6% and 45.0%. So, given that the range between the low end and the high end of the interval is far larger in the case of Intel (181.5%) than in the case of ExxonMobil (71.5%), we have another way to see that Intel is far riskier.

Having said that, do keep in mind the following: The calculations we just ran are *exclusively* valid when the returns considered are normally distributed. This assumption, widely used and abused, may be plausible in some cases and implausible in some others. So, as long as you can safely determine that the returns of the asset you're considering are normally distributed, the intervals calculated as just discussed are plausible. If you don't know the type of distribution those returns follow, or do know that it is not normal, then stay away from running this type of calculation.

Mean returns and the standard deviation

We intuitively know that risk is 'bad,' and the discussion in the previous section attempts to explain why the standard deviation may be a plausible measure of how 'bad' an asset may be. Essentially, the standard deviation is a measure of variability and uncertainty, both of which most investors would agree are 'bad.'

Now we'll take another, usually less explored, look at why volatility is bad for investors. Consider the six hypothetical assets in Table 3.2, all of which have an arithmetic mean return (*AM*) of 10% but different volatility (*SD*). Note that as we move from asset A to asset F volatility increases; that is, as we move from left to right the assets become riskier.

table 3.2

Year	*A (%)*	*B (%)*	*C (%)*	*D (%)*	*E (%)*	*F (%)*
1	10.0	12.0	15.0	20.0	25.0	40.0
2	10.0	8.0	5.0	0.0	–5.0	–20.0
3	10.0	12.0	15.0	20.0	25.0	40.0
4	10.0	8.0	5.0	0.0	–5.0	–20.0
5	10.0	12.0	15.0	20.0	25.0	40.0
6	10.0	8.0	5.0	0.0	–5.0	–20.0
7	10.0	12.0	15.0	20.0	25.0	40.0
8	10.0	8.0	5.0	0.0	–5.0	–20.0
9	10.0	12.0	15.0	20.0	25.0	40.0
10	10.0	8.0	5.0	0.0	–5.0	–20.0
AM (%)	**10.00**	**10.00**	**10.00**	**10.00**	**10.00**	**10.00**
SD (%)	**0.00**	**2.00**	**5.00**	**10.00**	**15.00**	**30.00**
GM (%)	**10.00**	**9.98**	**9.89**	**9.54**	**8.97**	**5.83**
GM-2 (%)	**10.00**	**9.98**	**9.89**	**9.55**	**8.98**	**5.98**
GM-3 (%)	**10.00**	**9.98**	**9.87**	**9.50**	**8.88**	**5.50**
TC ($)	**25,937**	**25,895**	**25,671**	**24,883**	**23,614**	**17,623**

Now take a look at the geometric mean returns (*GM*). As we move from left to right, the arithmetic mean return remains constant, volatility increases, *and the geometric mean return decreases*. This is sometimes referred to as the 'variance drag,' which is just a fancy way of saying that volatility reduces mean compound returns.

As you hopefully remember from our discussion in the previous chapter, an investment does not compound over time at its arithmetic mean return but at its geometric mean return. So here we have another way to rationalize why volatility is bad: Because it lowers the compound return of an investment, thus reducing its terminal value.

The last row of the table shows the terminal capital (*TC*) that results from a $10,000 investment in each of the six assets in the table at the beginning of the 10-year period considered. The six assets, remember, have the same arithmetic mean return of 10%. However, because as we move from asset A to asset F volatility increases, the geometric mean return decreases and so does the rate at which each asset compounds our money. Put differently, our terminal capital is negatively related to the volatility of the assets.

Formally, the relationship between the arithmetic mean, the geometric mean, and volatility is given by this expression

$$GM \approx \exp\left\{\ln(1 + AM) - \frac{(1/2)\cdot SD^2}{(1 + AM)^2}\right\} - 1 \tag{3.2}$$

which holds well as an approximation for returns not much larger than ±30%. The row labeled 'GM-2' in Table 3.2 shows the geometric mean return of the six assets considered calculated with this expression. If you compare these figures with those from the row above (the *exact* geometric mean returns), you can see that the approximation is in fact very good. You can also see that, as the size of the returns increases, the approximation becomes worse.

If you find the expression above intimidating, here comes the good news: There's a simpler approximation that works almost as well

$$GM \approx AM - (1/2)\cdot SD^2 \tag{3.3}$$

The row labeled 'GM-3' in Table 3.2 shows the geometric mean return of the six assets considered calculated with this expression. And once again, if you compare these figures with those of the exact geometric means you'll find that this approximation, though a bit worse than the previous one, is also pretty accurate.

The big picture

Risk is probably the most elusive concept in finance. One of the most widely accepted ways to assess it, however, is with the standard deviation of returns, usually also referred to as the volatility of an asset. This volatility can be thought of as uncertainty about future prices or returns, or as dispersion around the asset's arithmetic mean return.

Importantly, volatility is 'bad' not only because we use it as synonymous with risk. It is also 'bad' because it causes a drag on mean compound return, thus decreasing an asset's ability to compound our money over time.

Excel section

Just as in the Excel sections of the previous two chapters, the stuff in this section is straightforward.

- To calculate a square root in Excel you need to use the 'sqrt' function. Calculating the square root of any number x is as simple as typing

  =sqrt(x)

  and hitting Enter.

Calculating a standard deviation in Excel is also simple. Suppose you have ten returns in cells A1 through A10; then, you do the following:

- To calculate a standard deviation that divides the average of squared deviations from the mean by T, you type

  =stdevp(A1:A10)

  in cell A11 and hit Enter.

- To calculate a standard deviation that divides the average of squared deviations from the mean by T–1, type

  =stdev(A1:A10)

  in cell A11 and hit Enter.

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