FRED PIARD

QUANTITATIVE INVESTING

Strategies to exploit stock market anomalies for all investors

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STRATEGIES TO EXPLOIT STOCK MARKET ANOMALIES FOR ALL INVESTORS

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CONTENTS

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ABOUT THE AUTHOR

FRED PIARD GAINED EXTENSIVE EXPERIENCE in the software industry, information systems consulting and marketing before discovering an interest in the financial markets. Self-taught in this field, he puts into practice what he learnt from his previous activities to build his own methodology. From his years in research he has the ability to combine a systemic point of view and an analytic approach. As a software architect he knows that the things that work the best in the long term are the simplest. As a consultant he experienced the real economy through various sectors: energy, banking, healthcare, manufacturing and public administration. And he learned from marketing that human group behavior can sometimes be modeled, but never predicted. He has a PhD in computer science, an MSc in software engineering and an MSc in civil engineering.

PREFACE

Who this book is for

THIS BOOK WAS WRITTEN FOR ANYONE looking for simple, effective and low-risk investing strategies. The strategies described in the following pages can be managed in just five minutes a week, sometimes much less, making them suitable for investors with a full-time job. Although this is not a book for short term traders, they may discover here that, in the era of high frequency trading, a classical approach to the market may be more profitable than expected.

The book is designed to be short and actionable. It is also relatively simple; nevertheless the idea of simplicity is not the same for everyone. In case a word or concept is not clear, the reader may like to refer to an online knowledge base such as Wikipedia or Investopedia. It may help to have some knowledge of statistics to understand the more technical parts of the book. However, the understanding and implementation of the strategies needs only a logical mind and to feel comfortable with browsing online financial data sources. No specific background in finance or mathematics is needed.

All strategies can be implemented without purchasing any additional product or service. However, the appendix presents an offer for the tool that has been used for the studies in this book, it just makes the implementation simpler and faster.

What the book covers

All the strategies presented in this book share some common characteristics:

- They are **inspired by academic and professional publications**. Their presentation, simulation, interpretation, combination and choice of instruments may be original in this book, but the concepts have been known and documented for years, some of them for decades. This is an indication of their robustness.
- They use **only stocks and non-leveraged Exchange-Traded Funds** (ETFs) available in the U.S. stock market. The concepts may well work with other instruments and in other markets, but no representation is made about the expected results.
- All the instruments used are **very liquid**. However the use of orders with a limit price is recommended.
- All the strategies are **long only**. There is no short selling.

Structure of the book

The core content has been organized in chapters based on a strategy classification. It is preceded by a discussion of methodology, and followed by some tips and warnings for readers developing their own strategies. After the conclusion, the appendix provides an extract of research for a new kind of indicator.

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INTRODUCTION

THERE ARE TWO WAYS TO LEARN INVESTING: the hard way and the smart way. Most people start with the hard way – as I did.

When I decided to manage my own money, I started by following the financial media; I bought shares in a company and a tracker with a lot of confidence and then forgot them for three years. I also forgot this quote by Woody Allen:

> "Confidence is what you have before you understand the problem."

That was my first active experience in the financial market. I was lucky enough that my profits just about offset my losses – but I was aware that it was just luck. So I decided to follow the People Who Know. I tried half a dozen paid services. The result of my follow-the-gurus period was no better than when I started. However I had begun to learn something about the market.

The next stage was to study some technical indicators and patterns, and have a go at day-trading. I proved to myself that it could work, but with a lot of stress and time and it conflicted with my lifestyle. I like the idea of putting money to work for one's life, not the opposite.

I found a better way for me when I began to scan with screeners and simulation tools the history of fundamental and technical data on thousands of stocks and ETFs. I enjoyed this intellectual playing field: exploring dozens of strategies, coding hundreds of variations, performing thousands of simulations.

With a set of reasonably good strategies, quantitative investing allows one to act in the market at specific pre-planned times. It is possible to work on this just once a week or month, and ignore charts and the news. It removes most

of the doubts and emotions with the discipline of keeping a long-term vision and sensible money management. And it can be a complement or a replacement to legacy investing strategies.

This approach suited me.

A scientific approach to investing

Scientific investment strategies have been pursued for decades, not only by hedge funds but also by more traditional managers. All types of data may be used, provided that they can be measured: fundamental data, technical indicators, market sentiment, and newsfeeds. The assets managed by quantitative funds have grown first slowly, then in an explosive way to an estimated 1.5 trillion dollars before the 2008 crisis. Victims of overcrowding and excessive leveraging, they fell to a quarter of the previous value in 2009.

But what exactly is quantitative investing?

Although it has been mainly developed and used by technologically advanced funds, it cannot be defined by actors or technology. It is a scientific approach based on hypotheses and empirical testing. It is not limited to only sophisticated funds – some techniques are accessible to individual investors.

There are various possible definitions of quantitative investing. This is mine:

Identifying reasonable and measurable hypotheses about behaviours of the financial market so as to make investment decisions with an acceptable confidence in expected returns and risks.

The main advantages in using quantitative models are:

- making the investment process independent of opinions and emotions (the most important factor for an individual investor), and
- making it reproducible by anyone at anytime (the most important factor for a fund)

The first risk comes from misinterpretations of what is a "reasonable hypothesis" and an "acceptable confidence" in the definition. In other words, choosing a bad strategy because of wrong or incomplete criteria.

Another risk is that an idea that has been good in the past may become bad in the future. On the one hand, some techniques are condemned to a shorter and shorter lifespan due to accelerated information diffusion. On the other hand, some old ideas have continued to perform quite well in recent years. My aim here is to shed new light on the second category.

CHAPTER 1:
METHODOLOGY

THIS CHAPTER FIRST DEFINES the market anomalies that will be used in the strategies and then the criteria to evaluate them. It also lists the tools and requirements to execute strategies. Finally, it ends with a brief overview of the hypotheses, vocabulary and formalisms used in the book.

FOCUS ON SIMPLE BASIC PRINCIPLES

This book is built around four concepts. Four categories of anomalies that have been used for decades by successful investors to beat the market. Four concepts that have continued to beat the market in recent years, despite the fact that they are well-recognised.

The four aces of our game are:

1. market timing,
2. momentum,
3. seasonals,
4. valuation.

Before looking at these in some detail, let's be clear: there's nothing magic here – these anomalies don't work every time.

They are also controversial; you will find articles claiming that they don't work. These articles are generally poorly documented and written or sponsored by people that have an interest in making individual investors believe that they don't work. On the other hand, you can find very well documented academic

articles claiming that they have brought a significant statistical advantage to those who were able to apply them with consistency for decades.

Will these anomalies continue to work?

Nobody can be sure, however studying the past over a long period is the best way to plan the future. Please note that I have used the word *plan*, not *predict*.

We will now look at these four categories of anomalies in the market.

1. Market timing

The idea of market timing is to get out of an asset class when an indicator or a combination of indicators enters a risky zone. Market timing is generally built on technical indicators, typically moving averages.

A *moving average* is an average price on a trailing period of N time units. The values to average are the prices on close of each time unit (often day). We will see examples and applications of moving averages in the next chapter.

Sophisticated aggregate indicators may also be used. Some examples:

- put/call ratio for options on an index derivative or a set of stocks,
- investor sentiment surveys,
- number of S&P 100 stocks above their 200-day moving average,
- ratio of bullish/bearish chart patterns in a set of stocks,
- average provisional EPS for S&P 500 companies.

Using an appropriate indicator, market timing generally works quite well with global indexes.

2. Momentum

Momentum is generally defined as the return (relative increase in price) between two points in time separated by a fixed interval:

(P2-P1)/P1

or as the ratio between the prices at these two points:

P2/P1

When used as a relative strength indicator to rank two or more assets, both definitions are equivalent. Momentum is an indicator of the average speed of price on a timescale defined by the interval. The most used intervals by investors are 1, 3, 6 and 12 months, or their equivalent in trading days.

Investing on momentum is investing on the current trend. The idea is that the price has a kind of inertia and is likely to continue in the same direction if its speed is high enough.

Momentum generally works well with global and specialized indexes (sectors for example).

3. Seasonals

Many human activities have seasonal cycles. Seasonal patterns can be identified in any financial market: indexes, individual stocks, currencies, commodities, etc.

The stock market's seasonal cycle is not reliable every year, but it is powerful over the long term. Seasonal patterns on the Dow Jones have been documented since the 1920s, but scientific explanations for their consistency and resistance to arbitrage have failed in spite of interesting academic publications.

You have probably already heard of some of the best-known effects:

- *Sell in May and Go Away*: the stock market tends to be relatively weak for a few months from May
- *Halloween Effect*: the odds are favorable again in November and a rally may take place before Halloween.
- *Santa Claus Rally*: December is usually a good month for stocks.

The terms "Sell in May..." and "Halloween" effects are often used to name the same annual cycle. In fact, they are separate effects with different (and still unclear) theoretical explanations, giving together an annual cycle.

Seasonal patterns are more reliable for diversified indexes. It is more complicated for sectors because of the superposition of different cycles.

4. Valuation

Calculating a company's value and identifying possible anomalies in the stock price is the field of fundamental analysis. Three main factors influence the perception of the value on the market:

1. **Intrinsic Value**. It relies on a snapshot of the latest accounting data of the company (generally last quarter's earnings).
2. **Growth History**. Analysts use different metrics to measure growth. The stock price has more resilience if the company has a steady growth record; but investors may also overreact to an acceleration or deceleration in growth.
3. **Dividend History**. A steady dividend yield and, even better, a steadily increasing dividend yield, is an attracting thing for buy-and-hold investors.

Note: in elaborating valuation strategies I care less about what is the "real value" of a stock, than on identifying combinations of fundamental data that have a significant probability to move the price.

EVALUATING STRATEGIES

This sub-chapter covers mathematical formulas and concepts. They help you to understand the ratios used to evaluate strategies, but they are not necessary to implement them. You may want to skip this section, or read it again later, if you find it complicated.

Average return

The average return of an investment can be calculated on any time unit, from days to years. Moreover, there are different mathematical ways of "averaging" a data series. Unless otherwise stated, *average return* in this book means the Compound Annual Growth Rate (CAGR).

If the total return of a period of Q years is T%, the CAGR is:

$$\mathbf{CAGR = (1+(T/100))^{1/Q} -1}$$

In words, it is the hypothetical constant annual return that would have given the total return, reinvesting gains. Therefore, it is a compound return.

For example, let's suppose that a strategy has a 50% total return over 2 years.

It's CAGR is 0.225 = 22.5%.

If a strategy multiplied capital by 10 in 10 years (+900%), the CAGR is 25.9%.

The number of years does not need to be an integer; the CAGR may be calculated on 10 years as well as on only 6 months. Of course, a CAGR calculated for a short period has little significance regarding a strategy's performance.

An average return on a long period is an imprecise indicator. When evaluating in detail a strategy, I take the time to calculate the CAGR for each year during the evaluation period. The CAGR variations helps to understand the behavior in different market conditions.

Drawdown

The drawdown is sometimes defined as "the decline in value from a peak to a bottom". However things are not so simple: *which peak* and *which bottom*?

First I will define the drawdown at the present time, then in the past, then define the maximum drawdown, which is really the concept of interest. Doing so I hope to explain in simple words that the maximum drawdown is the result of what scientists call a *recursive calculation*.

The current value of drawdown is usually defined as the loss in percentage terms between the highest portfolio value and the current portfolio value. For example, if the highest value was 500,000 and the current value is 450,000, the drawdown is:

$$\mathbf{(50-45)/50 = 0.1 = 10\%}$$

By definition, if the current value is at its highest point, the drawdown is zero.

The drawdown at a date in the past is the loss in percentage between the highest value before or at this date, and the value at this date.

The maximum drawdown for a period of time is the maximum of the drawdowns for all dates in the period.

If we define the drawdown at a time t as a mathematical function DD(t) and the maximum drawdown as another function DDM(t), then:

DDM(t) = max (DDM(t-1), DD(t))

Here comes recursivity: DDM at time t is defined from its own value in the previous state at t-1. In finance, time is discrete: the variable t is an integer. It may measure any time unit in your charting tool, from tick to year.

That was about the drawdown depth. Another important aspect of drawdown is its length (or duration).

The maximum drawdown duration on a period of time is the longest interval (in days, weeks, months) during which the portfolio (or strategy) has not made a new high. The longest drawdown is not always the deepest.

In this book drawdowns are generally calculated using the daily close price. The intraday drawdowns may be deeper. For leveraged and very volatile trading strategies, it is better to use intraday lows and highs.

Be careful when reading studies, sometimes drawdowns are calculated using weekly or monthly close prices, which may be quite inaccurate to represent what really happens to a portfolio.

There are various drawdown-based formulas to evaluate the strength and robustness of an investment. The simplest is the Sterling ratio:

Average Annual Return/(Maximum Drawdown + 10%)

The higher the ratio, the better.

Sharpe ratio

The Sharpe ratio is a risk-adjusted performance indicator: the higher, the better. It takes into account the difference of the average return with a benchmark, and its volatility. The Sharpe ratio promotes strategies that have good *and* steady returns.

The formula is:

(<R>-Ro)/Std

<R> is the expected return, usually the average annual return is used.

Ro is a benchmark return, usually a risk-free rate or a global index return (e.g. S&P 500).

Std is the standard deviation. In the original definition of 1966 it was the standard deviation of the return. Since a revision in 1994 the standard deviation of the excess return (return minus Ro) is preferred.

I doubt that you will ever have to calculate a Sharpe ratio yourself, nowadays software does this. If you don't have such software, look for *free sharpe ratio spreadsheet* and *free sharpe ratio calculator* in an internet search engine.

Sortino ratio

The drawback of the Sharpe ratio is that it penalizes strategies that have sometimes exceptionally good years (because they have a higher volatility). The Sortino ratio corrects that, taking into account only the "negative" volatility.

The formula is:

(<R>-Ro)/Stdn

<R> and Ro have the same definitions as for the Sharpe ratio.

Stdn is the standard deviation calculated only on negative returns. A variant is to calculate it on negative excess returns (returns minus Ro).

Kelly Criterion

Both previous ratios rely on Gaussian statistical hypotheses. It means that the data series are supposed to be attracted to average values by a kind of gravity whose strength is in inverse relation with the standard deviation. The reality is more chaotic.

Gambling theory is supposed to be more general. The Kelly criterion is the best known ratio in this field. Its value gives the theoretical percentage of an available capital to bet on a strategy to maximize performance in the long term. In reality this should be considered as the maximum limit. I use it as a probabilistic indicator of robustness. The higher the result, the more reliable the strategy.

Nevertheless the Kelly criterion also relies on probabilistic hypotheses: the probability of gain and the average gain/average loss ratio are supposed to be constant.

There is no unique and perfect ratio to assess the quality of a strategy. It's better to use several.

The formula is:

K = P- (1-P)/W

where:

W is the average win/average loss ratio.

P is the probability to win. The experimental probability of the data sample is generally used (number of positive returns divided by total number of returns).

As a game theory indicator it is designed to be calculated not on annual returns but on the whole set of trades or points of decision. It makes sense when the set of data is big enough.

The Kelly criterion is invariant with leveraging. Therefore it can be used as a robustness indicator, but not as a risk indicator.

The following technical note is for readers with a scientific background.

TECHNICAL NOTE

It is possible to take into account that P and W are not so constant or quite different from the experimental values. A simple differential calculus on K gives:

$$dK/dP = 1+1/W$$

$$dK/dW= (1-P)/W^2$$

In the following strategies W is between 0.9 and 1.7 and P is between 0.5 and 0.7:

So

$$dK/dP>1.59$$

and

$$dK/dW< 0.62$$

It means that the Kelly criterion is at least 2.5 times more sensitive to a variation in P than to a variation in W. So the incertitude on W may reasonably be ignored.

When I want to take into account the incertitude on P, I replace the experimental probability with the statistical probability for a 95% confidence interval. This is a value (let's name it P95) such that the real probability to win has a 95% odds to be better than P95. The Kelly criterion using P95 (let's name it K95) adds a security margin, especially when the data sample is not big enough. You can find how to calculate a probability with a confidence interval in a book on statistics.

Limits

Strategies can be evaluated and compared if they can be simulated on a period long enough with a set of sufficient decision points (or trades), covering various market conditions. The longer the period, the better the evaluation.

However, even with statistics on data over decades, take the figures with caution. A high numercial precision makes no sense, and a difference of 2% in average return between two strategies may be random.

Interpreting the criteria?

Now that I have defined the evaluation criteria for investing strategies, you would probably like the acceptable values for these criteria. Unfortunately, there is no definitive answer. In fact these criteria should be taken as relative values to compare investment strategies. No absolute conclusion should be made about them.

Their interpretation depends on the:

- **market conditions** during the period of evaluation,
- **trading rhythm**, the expected average return and risk-adjusted ratios are not the same for a day-trader and an investor rebalancing his portfolio once a year,
- **capital**, a fund with $10 billion of assets under management doesn't have the same constraints as an individual investing $10,000,
- **objective, risk profile, leverage**, etc...

For example, an individual investor may be happy with a Sharpe ratio of 0.8. Whereas a Sharpe ratio above 2 might be required by a professional day-trader.

I can tell you some criteria to select the weekly and monthly strategies I use for my newsletters and my own account (these strategies are not described in this book):

- the criteria are calculated on **10-year simulations** or more,
- **minimum CAGR**: 15%,
- **maximum drawdown**: 30% and lower than (or reasonably close to) the CAGR,
- **minimum Sortino ratio**: 0.9,
- as for **Kelly's criterion**, when I calculate it I generally reject strategies with values below 0.2 (20%).

These are the criteria for *individual* strategies. I think that it is wise to combine at least three strategies with different rationales, and try to get a global CAGR above 20% and a global maximum drawdown below 15%.

These criteria give an edge, not a guarantee. Past performance, simulated *or real*, is never a guarantee for the future.

THE COST OF A DRAWDOWN

Increasingly, investors are using simulations on the past (or *backtests*) to make investment decisions for the future. Unfortunately they often make two mistakes: they assume that a simulation has a predictive power and they focus on the return. Whereas the main interest of a simulation is in evaluating the risk of a strategy. It can be assessed on two levels:

- The **robustness** of the game. Sterling ratio, Sortino ratio and Kelly criterion are good indicators for this purpose: the higher, the better. Looking at the three gives a better picture of a strategy.
- The **history of drawdowns**. The most obvious indicators are the maximum drawdown (maximum relative loss in %) and the maximum drawdown length (maximum duration in loss): the lower, the better.

Two other significant data may be calculated from the drawdown:

THE GAIN NECESSARY TO MAKE UP FOR A LOSS

If the drawdown is x, the formula is:

f(x) =x/(1-x)

For example:

When a portfolio has a 30% drawdown, it needs a 43% gain to recover:

0.30/(1-0.30)= 0.428

When it has a 50% drawdown, it needs a 100% gain:

0.5/0.5= 1

This is an indication of the *drawdown cost*, or the effort to recover.

THE ADDITIONAL GAIN NECESSARY TO MAKE UP FOR AN ADDITIONAL 1% IN DRAWDOWN

The formula is:

$$df(x)/dx = 1/(1-x)^2$$

For example:

When a portfolio has a 30% drawdown and falls to a 31% drawdown, it needs an additional 2% gain to restore the initial state (zero drawdown):

$$1/(1-0.30)^2 = 2.04$$

When an additional 1% occurs at a 50% drawdown, it needs a 4% additional gain to restore the initial state:

$$1/(1-0.50)^2 = 4$$

It is a kind of *drawdown marginal cost*.

TOOLS AND REQUIREMENTS

DATA SOURCES

For any stock or ETF ticker symbol listed in this book, you can find more information on financial websites. For example in Yahoo! Finance: you go to the home page and enter the ticker in the *Enter Symbol* field, then click the *Get Quotes* button. Once on the result page, tabs on the left allow you to see corporate information, news, technical and fundamental data.

For strategies with ETFs, you need to compare ETF prices and moving averages. There are various free online charting platforms like Yahoo! Finance, Google Finance, Stockcharts.com, Freestockcharts.com. I prefer the latter for its design and versatility.

For strategies involving stocks, you need a screener on fundamental data. At the time of writing, the best free screener I know is on Finviz.com.

Fundamental data may differ from one data supplier to another. As simulations are impossible on Finviz, there is no way to compare backtest results. Finviz is considered as a reliable source of information, but if you think you have better tools, feel free to use them.

SIMULATION SOFTWARE

You don't need simulation software to implement the strategies described in this book. However I think it is necessary to tell you which tool I have used and why.

When I was looking for a simulation tool to test strategies, the requirements were:

- covering the widest possible set of ETFs and stocks on the U.S. market,
- reliable end-of-day data feed (the aim is not day-trading),
- historical data for 10 years or more,
- technical and fundamental screening,
- keeping dead companies in simulations (no survivor bias),
- time-stamped fundamental data (no look-ahead bias),
- realistic simulation parameters (slippage/commission),
- independent software editor or platform,
- affordable for an individual investor.

I eventually chose Portfolio123.

All simulation charts in this book are courtesy of Portfolio123. This tool is not necessary to execute the strategies, but it does allow the strict duplication of them. [The appendix explains how to obtain an extended free trial and the code of some strategies (this offer may be limited in time).]

To calculate maximum drawdowns and lengths, flat returns (return with a fixed amount invested, without compounding), probabilities with a confidence interval and Kelly formula, I use spreadsheets in LibreOffice Calc (a free equivalent of Microsoft Excel®).

COMMON HYPOTHESES, VOCABULARY AND PRESENTATION

Unless otherwise stated, all the strategies and simulations in this book share the following characteristics:

- orders are simulated on open price,
- the data used for calculations and decisions are the data available after the close of the market the day before,
- gains and dividends are reinvested.

I call *rebalancing* the double action of:

- making a decision to change (or not) the assets in a portfolio,
- changing the position sizes in a portfolio (for example to keep an equal weight).

In this book, I will mainly describe strategies where portfolios are rebalanced every week (*weekly rebalancing*) or every 4 weeks (*4-week rebalancing*). The expression *monthly rebalancing,* sometimes used in this book, designates a 4-week rebalancing.

Each rebalancing date is a *decision point*.

All dates use the US system (i.e. mm/dd/yyyy).

The word *day* is used for trading day. There are usually 5 trading days in a week.

Strategy definition

Strategies are described with the following table format:

Name	Designation to identify the strategy later in the book
Assets	List of the ticker symbols that may be part of the portfolio
Simulation period	Time interval on which the backtest is run. Defined by a *starting date* and an *end date*.
Re-balanced	Weekly or 4-week
Positions	Number of positions in portfolio. Each *position* is defined by a ticker symbol and an amount of money (or % of portfolio).
Maximum size	Maximum size of an individual position in % of the portfolio value
Rules	List of conditions checked at each rebalancing date for assets to be bought or kept. The assets in portfolio that don't comply any more are sold.
Leverage	1 (no leverage) or 2 (leveraged twice)
Transactions costs	% of the transaction modelling the spread and brokerage commission
Benchmark	Reference to a standard investment, usually the S&P 500 Index or its ETF SPY (which includes dividends)

The *inception date* of an ETF is the first day the product was available for trading.

For an ETF strategy, the starting date cannot precede any of the assets' inception dates.

The result of a simulation will be summarized by statistical data and a chart representing the portfolio total return (%) in time.

The charts will also sometimes track the number of positions in portfolio (*#Pos*) and the percentage of positions changing on each rebalancing date (*turnover*).

CHAPTER SUMMARY

- This book explains investment strategies that are simple enough to be executed in a few minutes per week or per month by an individual investor.
- It is focused on stocks and ETFs. Strategies are classified in four categories: market timing, momentum, seasonal patterns, valuation.
- The criteria to evaluate strategies include: average return, drawdown depth, drawdown duration, Sharpe ratio, Sortino ratio, Sterling ratio, Kelly criterion.
- The tools, vocabulary, hypotheses and generic presentation of a strategy are defined in this chapter.

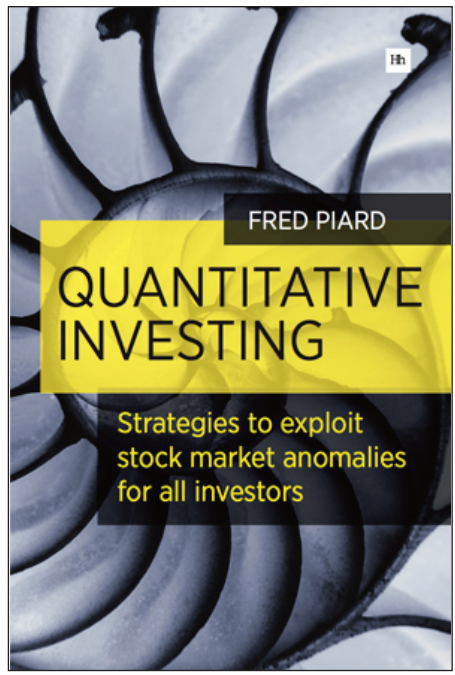
The four following chapters focus on the four categories of anomalies previously explained.

Let's begin with market timing.

Quantitative Investing

Strategies to exploit stock market anomalies for all investors

Fred Piard



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