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# **FIXED INCOME RELATIVE VALUE ANALYSIS**

A | PRACTITIONER'S GUIDE |

TO THE **THEORY, TOOLS, AND TRADES**

FOREWORD BY HENRY RITCHOTTE,  
CHIEF OPERATING OFFICER AND MEMBER OF THE  
MANAGEMENT BOARD, DEUTSCHE BANK



2003 2004 2005 2006 2007 2008 2009 2010 2011

— Germany — US

The chart displays two data series from 2003 to 2011. The orange line represents Germany and the blue line represents the US. Both series show a general upward trend until 2007, followed by a sharp decline and subsequent recovery. The US series shows more volatility than the Germany series.

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# **FIXED INCOME RELATIVE VALUE ANALYSIS**

A Practitioner's Guide to the  
Theory, Tools, and Trades

**Doug Huggins and  
Christian Schaller**

**WILEY**

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# Relative Value: a Practitioner's Guide

I remember very clearly the beginnings of the Relative Value Group at Deutsche Bank. The year was 1995. I was one of a small group of Research and Sales professionals who had recently arrived at Deutsche Bank. We became convinced that significant opportunities existed to apply relative value concepts to fixed income instruments in a way that was highly interesting for sophisticated clients. We realized that by analyzing separately the opportunities and risks of certain fixed income products, we could help our clients achieve the performance they aimed for while mitigating credit, market and liquidity risk. Our goal was simple: to help our clients achieve the best possible risk-reward equation.

We soon realized that we could apply these principles more widely across our client base in fixed income. For example, some of our clients held clear beliefs on areas of value in the market, but were seeking new ways to invest which reflected those beliefs. These were clients who provided important liquidity to the markets in which they operated, and this provided us with another important insight: as relative value addressed irrational differences between the prices of related instruments, we saw markets become more transparent, more liquid, and more efficient. Unquestionably, the science of relative value, and the transparency it brings to relationships between the prices of different instruments, has contributed to the growth of derivatives and other financial products which reduce market risk.

These were years in which Deutsche Bank was building up a world-leading markets platform, and as a comparable new

entrant in many areas, we needed to innovate to prosper. Relative value disciplines formed a core part of our intellectual capital. Relative value provided us with a way to reduce risk and spot opportunities between different instruments, both within and across asset classes, and thus to help our clients perform better for their investors. Relative value gave us a systematic way to address the fundamental question: what's expensive and what's cheap? That discipline contributed greatly as we advised clients on asset allocation in their portfolios, and gave us valuable insights about how to deploy our own resources: capital, technology and people. Already, relative value at Deutsche Bank had evolved far beyond its origins as a method of identifying pricing inefficiencies in fixed income instruments. It gave us a framework for a much wider range of portfolio and business decisions.

The financial crisis of 2008 and early 2009 was a defining period in the development of relative value analysis. Under conditions of extreme market stress and acute shortages of liquidity, we saw the 'conventional' relationships between the prices of related securities break down. Put simply: the normal rules ceased to apply. The risk of sovereign default, suddenly much more apparent, profoundly impacted the prices of government debt and the derivatives related to it. This posed a major challenge for our clients and for the sound functioning of financial markets on which the global economy depends. But this extremely difficult period also brought us fundamental insights. Our experience with Long-Term Capital Management, and the Russian and Asian crises, warned us that at times of significant market stress, the conventional 'rules' governing relationships between assets cease to function and for us, this was a clear signal to reduce our balance sheet and risk exposures. Perhaps most significantly of all: as market conditions stabilized and liquidity returned, well-funded investors were able to invest

in good-quality assets at very favorable prices. Relative value analysis was able to guide us toward many opportunities for us to create value for our clients.

In retrospect, the relative value perspective was invaluable to us throughout the most difficult months of 2008 and 2009. This perspective helped us protect ourselves better during the crisis, and take advantage of opportunities faster as stability returned. For Deutsche Bank in 2009, the ability to identify pricing anomalies enabled us to spot investment opportunities for our clients right across the fixed income spectrum. Relative value brings clarity to complex products, and helps us understand market behavior. We know now how important that is. There is no doubt that a deeper understanding and use of relative value disciplines across the world's markets would have helped the financial industry navigate through the financial crisis and contribute to the stabilization of financial markets which was the first step toward global economic recovery.

It's therefore no surprise that relative value has become increasingly important in post-crisis markets. It has evolved into a way of comparing prices and valuing the different risk elements across a broad range of asset classes. It gives market participants a method for arriving at a deeper understanding of new instruments as they appear. This added visibility contributes to market transparency, which in turn gives investors confidence. This encourages liquidity across a wide range of market areas, and makes pricing more efficient - which benefits issuers and investors alike. In emerging or immature markets, relative value disciplines can contribute to a 'virtuous circle' of improved transparency, liquidity and pricing efficiency. This lays the ground for healthy and sustainable growth in a wide diversity of markets - from the funding of governments and large corporations, to the pricing of a wide range of essential commodities. In other words, relative value

disciplines make a host of real-world decisions clearer and easier to make. Deep, diverse, well-functioning and well-trusted markets have never been more important for the real economy than they are today.

Relative value thinking has played a significant role in my professional life. At its outset a way to serve sophisticated clients in fixed income markets, relative value gave me a methodology for identifying investment opportunities across a wide range of asset classes and added to my understanding of how markets behave. We can turn that knowledge to the advantage of our clients, and help financial markets do their job for the wider economy. At Deutsche Bank, relative value disciplines have contributed significantly to the development of our markets platform, as we allocate resources, mitigate risks, and find new ways of helping our clients perform. In my career, I have witnessed the evolution of relative value from a specialist methodology to an essential part of the market practitioner's toolbox. This *Practitioner's Guide* is both timely and relevant.

Enjoy the book.

Henry Ritchotte, Chief Operating Officer and member of the  
management board, Deutsche Bank



# Chapter 1

## Relative Value

### The Concept of Relative Value

Relative value is a quantitative analytical approach toward financial markets based on two fundamental notions of modern financial economics.

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**Proposition 1:** If two securities have identical payoffs in every future state of the world, then they should have identical prices today.

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Violation of this principle would result in the existence of an arbitrage opportunity, which is inconsistent with equilibrium in financial markets.

This proposition seems relatively straightforward now, but this wasn't always the case. In fact, Kenneth Arrow and Gérard Debreu won Nobel prizes in economics in 1972 and 1983 in part for their work establishing this result. And Myron Scholes and Robert Merton later won Nobel prizes in economics in 1997 for applying this proposition to the valuation of options. In particular, along with Fischer Black, they identified a self-financing portfolio that could dynamically replicate the payoff of an option, and they were able to determine the value of this underlying option by valuing this replicating portfolio.

Most of the financial models discussed in this book are based on the application of this proposition in various contexts.

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**Proposition 2:** If two securities present investors with identical risks, they should offer identical expected returns.

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This result may appear intuitive, but it's somewhat more difficult to establish than the first result. Of particular interest for our purposes is that the result can be established via the *Arbitrage Pricing Theory*, which assumes the existence of unobservable, linear factors that drive returns.

In this case, it's possible to combine securities into portfolios that expose investors to any one of the risk factors without involving exposure to any of the other risk factors. In the limit, as the number of securities in the portfolio increases, the security-specific risks can be diversified away. And in this case, any security-specific risk that offered a non-zero expected return would present investors with an arbitrage opportunity, at least in the limit, as the remaining risk factors could be immunized by creating an appropriate portfolio of tradable securities.

For our purposes, this is a powerful result, as it allows us to analyze historical data for the existence of linear factors and to construct portfolios that expose us either to these specific factors or to security-specific risks, at our discretion. In fact, *principal component analysis* (PCA) can be applied directly in this framework, and we'll rely heavily on PCA as one of the two main statistical models we discuss in this book.

## The Sources of Relative Value Opportunities

From these two propositions, it's clear that the absence of arbitrage is the assumption that drives many of the models we use as relative value analysts. This should come as no

surprise, since one of the main roles of a relative value analyst is to search for arbitrage opportunities.

But for some people, this state of affairs presents a bit of a paradox. *If our modeling assumptions are correct about the absence of free lunches, why do analysts and traders search so hard for them?*

This apparent paradox can be resolved with two observations. The first is the recognition that arbitrage opportunities are rare precisely because hard-working analysts invest considerable effort trying to find them. If these opportunities could never be found, or if they never generated any profits for those who found them, analysts would stop searching for them. But in this case, opportunities would reappear, and analysts would renew their search for them as reports of their existence circulated.

The second observation that helps resolve this paradox is that even seemingly riskless arbitrage opportunities carry some risk when pursued in practice. For example, one of the simpler arbitrages in fixed income markets is the relation between bond prices, repo rates, and bond futures prices. If a bond futures contract is too rich, a trader can sell the futures contract, buy the bond, and borrow the purchase price of the bond in the repo market, with the bond being used as collateral for the loan. At the expiration of the contract, the bond will be returned to the trader by his repo counterparty, and the trader can deliver the bond into the futures contract. In theory, this would allow the trader to make a riskless arbitrage profit. But in practice, there are risks to this strategy.

For example, the repo counterparty may fail to deliver the bonds to the trader promptly at the end of the repo transaction, in which case the trader may have difficulty delivering the bonds into the futures contract. Failure to deliver carries significant penalties in some cases, and the

risk of incurring these penalties needs to be incorporated into the evaluation of this seemingly riskless arbitrage opportunity.

These perspectives help us reconcile the existence of arbitrage opportunities in practice with the theoretical assumptions behind the valuation models we use. But they don't explain the sources of these arbitrage or relative value opportunities, and we'll discuss a few of the more important sources here.

## **Demand for Immediacy**

In many cases, relative value opportunities will appear when some trader experiences an unusually urgent need to transact, particularly in large size. Such a trader will transact his initial business at a price that reflects typical liquidity in the market. But if the trader then needs to transact additional trades in the same security, he may have to entice other market participants to provide the necessary liquidity by agreeing to transact at a more attractive price. For example, he may have to agree to sell at a lower price or to buy at a higher price than would be typical for that security. In so doing, this trader is signaling a demand for immediacy in trading, and he's offering a premium to other traders who can satisfy this demand.

The relative value trader searches for opportunities in which he can be paid attractive premiums for satisfying these demands for immediacy. He uses his capital to satisfy these demands, warehousing the securities until he can liquidate them at more typical prices, being careful to hedge the risks of the transactions in a cost-effective and prudent manner.

Because these markets are so competitive, the premiums paid for immediacy are often small relative to the sizes of the positions. As a result, the typical relative value fund will

be run with leverage that is higher than the leverage of, say, a global macro fund. Consequently, it's important to pay attention to small details and to hedge risks carefully.

## **Misspecified Models**

It sometimes happens that market participants overlook relevant issues when modeling security prices, and the use of misspecified models can result in attractive relative value opportunities for those who spot these errors early.

For example, until the mid-1990s, most analysts failed to incorporate the convexity bias when assessing the relative valuations of Eurodollar futures contracts and forward rate agreements. As market participants came to realize the importance of this adjustment, the relative valuations of these two instruments changed over time, resulting in attractive profits for those who identified this issue relatively early.

As another example, until the late 1990s, most academics and market participants believed vanilla swap rates exceeded the yields of default-free government bonds as a result of the credit risk of the two swap counterparties. Due in part to our work in this area, this paradigm has been shown to be flawed. In particular, the difference over time between LIBOR and repo rates now is considered to be a more important factor in the relative valuations between swaps and government bonds.

In recent years, as credit concerns have increased for many governments, it has become increasingly important to reflect sovereign credit risk as an explicit factor in swap spread valuation models, and we discuss this issue in considerable detail in this book.

## **Regulatory Arbitrage**

The fixed income markets are populated by market participants of many types across many different regulatory jurisdictions, and the regulatory differences between them can produce relative value opportunities for some.

For example, when thinking about the relative valuations of unsecured short-term loans and loans secured by government bonds in the repo market, traders at European banks will consider the fact that the unsecured loan will attract a greater regulatory charge under the Basel accords. On the other hand, traders working for money market funds in the US won't be subject to the Basel accords and are likely to focus instead on the relative credit risks of the two short-term deposits. The difference in regulatory treatment may result in relative valuations that leave the European bank indifferent between the two alternatives but that present a relative value opportunity for the US money market fund.

## **The Insights from Relative Value Analysis**

In some sense, relative value analysis can be defined as the process of gaining insights into the relationships between different market instruments and the external forces driving their pricing. These insights facilitate arbitrage trading, but they also allow us more generally to develop an understanding of the market mechanisms that drive valuations and of the ways seemingly different markets are interconnected.

As a consequence, relative value analysis, which originated in arbitrage trading, has a much broader scope of applications. It can reveal the origins of certain market relations, the reasons a security is priced a certain way, and the relative value of this pricing in relation to the prices of

other securities. And in the event that a security is found to be misvalued, relative value analysis suggests ways in which the mispricing can be exploited through specific trading positions. In brief, relative value analysis is a prism through which we view the machinery driving market pricing amidst a multitude of changing market prices.

As an example, consider the divergence of swap spreads for German Bunds and US Treasuries in recent quarters, which might appear inextricable without considering the effects of cross-currency basis swaps (CCBS), intra-currency basis swaps (ICBS), and credit default swaps (CDS).

In this case, CCBS spreads widened as a result of the difficulties that European banks experienced in raising USD liabilities against their USD assets. On the other hand, arbitrage between Bunds, swapped into USD, and Treasuries prevented an excessive cheapening of Bunds versus USD LIBOR. As a consequence, Bunds richened significantly against EURIBOR (see Chapter 14 for more details).

However, given the relationship between European banks and sovereigns, the difficulties of European banks were also reflected in a widening of European sovereign CDS levels. Hence, Bunds richened versus EURIBOR at the same time as German CDS levels increased.

An analyst who fails to consider these interconnected valuation relations may find the combination of richening Bunds and increasing German CDS opaque and puzzling. But a well-equipped relative value analyst can disentangle these valuation relations explicitly to identify the factors that are driving valuations in these markets. And armed with this knowledge, the analyst can apply these insights to other instruments, potentially uncovering additional relative value opportunities.

# The Applications of Relative Value Analysis

Relative value analysis has a number of applications.

## Trading

One of the most important applications of relative value analysis is relative value trading, in which various securities are bought and others sold with the goal of enhancing the risk-adjusted expected return of a trading book.

Identifying relatively rich and relatively cheap securities is an important skill for a relative value trader, but additional skills are required to be successful as a relative value trader. For example, rich securities can and often do become richer, while cheap securities can and often do become cheaper. A successful relative value trader needs to be able to identify some of the reasons that securities are rich or cheap in order to form realistic expectations about the likelihood of future richening or cheapening. We discuss this and other important skills throughout this book.

## Hedging and Immunization

Relative value analysis is also an important consideration when hedging or otherwise immunizing positions against various risks. For example, consider a flow trader who is sold a position in ten-year (10Y) French government bonds by a customer. This trader faces a number of alternatives for hedging this risk.

He could try to sell the French bond to another client or to an interdealer broker. He could sell another French bond with a similar maturity. He could sell Bund futures contracts or German Bunds with similar maturities. He could pay fixed



in a plain vanilla interest rate swap or perhaps a euro overnight index average (EONIA) swap. He could buy payer swaptions or sell receiver swaptions with various strikes. He could sell liquid supranational or agency bonds issued by entities such as the European Investment Bank. Depending on his expectations, he might even sell bonds denominated in other currencies, such as US Treasuries or UK Gilts. Or he might choose to implement a combination of these hedging strategies.

In devising a hedging strategy, a skilled trader will consider the relative valuations of the various securities that can be used as hedging instruments. If he expects Bunds to cheapen relative to the alternatives, he may choose to sell German Bunds as a hedge. And if he believes Bund futures are likely to cheapen relative to cash Bunds, he may choose to implement this hedge via futures contracts rather than in the cash market.

By considering the relative value implications of these hedging alternatives, a skilled flow trader can enhance the risk-adjusted expected return of his book. In this way, the value of the book reflects not only the franchise value of the customer flow but also the relative value opportunities in the market and the analytical skills of the trader managing the book.

Given the increasing competitiveness of running a fixed income flow business, firms that incorporate relative value analysis as part of their business can expect to increase their marginal revenues, allowing them to generate higher profits and/or to offer liquidity to customers at more competitive rates.

## **Security Selection**

In many respects, a long-only investment manager faces many of the same issues as the flow trader in the previous

example. Just as a flow trader can expect to enhance the risk-adjusted performance of his book by incorporating relative value analysis into his hedging choices, a long-only investment manager can expect to enhance the risk-adjusted performance of his portfolio by incorporating relative value analysis into his security selection process.

For example, an investment manager who wants to increase his exposure to the 10Y sector of the EUR debt market could buy government bonds issued by France, Germany, Italy, Spain, the Netherlands, or any of the other EMU member states. Or he could buy Bund futures or receive fixed in a EURIBOR or EONIA interest rate swap. Or he might buy a US Treasury in conjunction with a cross-currency basis swap, thereby synthetically creating a US government bond denominated in euros.

An investment manager who incorporates relative value analysis as part of his investment process is likely to increase his alpha and therefore over time to outperform an otherwise similar manager with the same beta who doesn't incorporate relative value analysis.

## **The Craft of Relative Value Analysis**

Relative value analysis is neither a science nor an art. Rather, it's a craft, with elements of both science and art. For a practitioner to complete the journey from apprentice to master craftsman, he needs to learn to use the tools of the trade, and in this book we introduce these tools along with their foundations in the mathematical science of statistics and in the social science of financial economics.

We also do our best to explain the practical benefits and potential pitfalls of applying these tools in practice. In the development of an apprentice, there is no substitute for

repeated use of the tools of the trade in the presence of a master craftsman. But we make every effort in this book to convey the benefit of our experience over many years of applying these tools.

Since financial and statistical models are the tools of the trade for a relative value analyst, it's important that the analyst choose these tools carefully, with an eye toward usefulness, analytical scope, and parsimony.

## Usefulness

In our view, models are neither right nor wrong. Pure mathematicians may be impressed by truth and beauty, but the craftsman is concerned with usefulness. To us, various models have varying degrees of usefulness, depending on the context in which they're applied.

As Milton Friedman reminds us in his 1966 essay "The Methodology of Positive Economics", models are appropriately judged by their implications. The usefulness of a particular model is not a function of the realism of its assumptions but rather of the quality of its predictions.

For relative value analysts, models are useful if they allow us to identify relative misvaluations between and among securities, and if they improve the quality of the predictions we make about the future richening and cheapening of these securities.

For example, we agree with critics who note that the Black-Scholes model is *wrong*, in the sense that it makes predictions about option prices that are in some ways systematically inconsistent with the prices of options as repeatedly observed in various markets. However, we've found the Black-Scholes model to be useful in many contexts, as have a large number of analysts and traders. It's important to be familiar with its problems and pitfalls, and like most tools it can do damage if used improperly. But

we recommend it as a tool of the trade that is quite useful in a number of contexts.

## **Analytical Scope (Applicability)**

For our purposes, it's also useful for a model to have a broad scope, with applicability to a wide range of situations. For example, principal component analysis (PCA) has proven to be useful in a large number of applications, including interest rates, swap spreads, implied volatilities, and the prices of equities, grains, metals, energy, and other commodities. As with any powerful model, there is a cost to implementing PCA, but the applicability of the model once it has been built means that the benefits of the implementation tend to be well worth the costs.

Other statistical models with broad applicability are those that characterize the mean-reverting properties of various financial variables. Over considerable periods of time, persistent mean reversion has been observed in quite a large number of financial variables, including interest rates, curve slopes, butterfly spreads, term premiums, and implied volatilities. And in the commodity markets, mean reversion has been found in quite a number of spreads, such as those between gold and silver, corn and wheat, crack spreads in the energy complexes, and crush spreads in the soybean complex.

The ubiquity of mean-reverting behavior in financial markets means that mean reversion models have a tremendous applicability. As a result, we consider them some of the more useful tools of a well-equipped relative value analyst, and we discuss them in some detail in this book.

## **Parsimony**

From our perspective, it's also useful for a model to be parsimonious. As Einstein articulated in his 1933 lecture "On the Method of Theoretical Physics", "It can scarcely be denied that the supreme goal of all theory is to make irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience".

In our context, it's important to note the relative nature of the word "adequate". In most circumstances, there is an inevitable trade-off between the parsimony of a model and its ability to represent experience. The goal of people developing models is to improve this tradeoff in various contexts. The goal of people using models is to select those models that offer the best tradeoff between costs and benefits in specific applications. And it's in that sense that we characterize the models in this book as being useful in the context of relative value analysis.

## **Summary of Contents**

Relative value analysis models can be divided into two categories: statistical and financial. Statistical models require no specific knowledge about the instrument that is being modeled and are hence universally applicable. For example, a mean reversion model only needs to know the time series, not whether the time series represents yields, swap spreads, or volatilities, nor what drives that time series.

Financial models, on the other hand, give insight into the specific driving forces and relationships of a particular instrument (and are therefore different for each instrument). For example, the specific knowledge that swap spreads are a function of the cost of equity of LIBOR panel banks can explain why their time series exhibits a certain statistical behavior.

While we present the models in two separate categories, comprehensive relative value analysis combines both. The successful relative value trader described above might first use statistical models to identify which instruments are rich and cheap relative to each other, and then apply financial models in order to gain insights into the reasons for that richness and cheapness, on which basis he can assess the likelihood for the richness and cheapness to correct. If he sees a sufficient probability for the spread position to be an attractive trade, he can then use statistical models again to calculate, among others, the appropriate hedge ratios and the expected holding horizon.

## **Statistical Models**

The two types of statistical models presented here are designed to capture two of the most useful statistical properties frequently observed in the fixed income markets: the tendency for many spreads to revert toward their longer-run means over time and the tendency for many variables to increase and decrease together. Chapter 2 and Chapter 3 are largely independent and therefore do not need to be read sequentially. However, Chapter 3 does refer to the application of mean-reverting models to the estimated factors and to specific residuals, so a reader with no preference would do well to read the chapter on mean reversion first.

## **Mean Reversion**

Many financial spreads exhibit a persistent tendency to revert toward their means, providing a potential source of return predictability. In this chapter, we discuss stochastic processes that are useful in modeling this mean reversion, and we present ways in which data can be used to estimate the parameters of these processes. Once the parameters