CREDIT SUISSE

GLOBAL FINANCIAL STRATEGIES
www.credit-suisse.com

How to Model Reversion to the Mean

Determining How Fast, and to What Mean, Results Revert

September 17, 2013

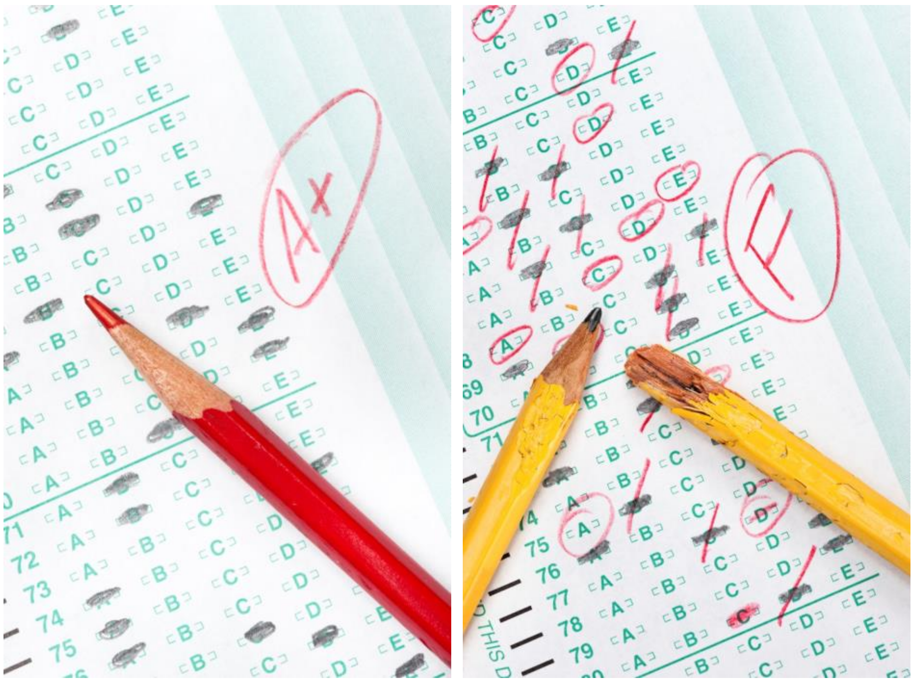
Authors

Michael J. Mauboussin
michael.mauboussin@credit-suisse.com

Dan Callahan, CFA
daniel.callahan@credit-suisse.com

Bryant Matthews
bryant.matthews@credit-suisse.com

David A. Holland
david.a.holland@credit-suisse.com



- Most investors know about reversion to the mean and think that they take it into account as they model corporate performance, but in reality few deal with it properly.
- You can use the correlation coefficient to estimate the rate of reversion to the mean. High correlations imply slow reversion, and low correlations imply rapid reversion.
- To determine the mean to which results revert, consider the stability of the mean in the past as well as the factors that affect the mean.
- We document the correlation coefficient and characteristics of the median and mean for the cash flow return on investment (CFROI®) for ten sectors from 1986 through 2012.

Introduction

The goal of this report is to provide guidance on how to model reversion to the mean. We will use data on cash flow return on investment (CFROI®) to explain the process for corporate performance, but you can use the approach for other value drivers as well. We address two central issues: the rate of reversion to the mean and the mean to which the results revert. HOLT® users recognize these issues as the basis for fade.[1]

Most investors know about reversion to the mean and think that they take it into account as they model corporate performance. But in reality few deal with it properly. Further, results show that investors in the aggregate do not behave as if they understand the concept.[2] Reversion to the mean is so tricky that it has even caused prominent economists to stumble.[3]

Secrist's Mistakes

In 1933, Horace Secrist, a statistician at Northwestern University, published a book called *The Triumph of Mediocrity in Business*. The title accurately reveals the content. Secrist summarized his argument, which was accompanied by more than 100 charts, by writing, "Mediocrity tends to prevail in the conduct of competitive business."[4]

The idea derives from the principles of microeconomics and makes sense. It says that companies earning high economic profits will draw competition, driving their returns lower over time, and that companies earning low returns will see investment flee, allowing economic profits to drift higher.[5] As Secrist wrote, "Both advantageous and disadvantageous conditions are continuously dissipated—equalization is in process."

Secrist's analysis seems to be a classic and somewhat intuitive example of reversion to the mean. But statisticians now use Secrist's book as one of the most famous examples of a *failure* to understand reversion to the mean.[6] Academics, including economists, initially received the book warmly. But a scathing review by a statistician and economist at Columbia University named Harold Hotelling set the record straight.[7]

Reversion to the mean says that an outcome that is far from average will be followed by an outcome with an expected value closer to the average. Here's an example to make the idea clearer. Say a teacher assigns her students 100 pieces of information to study, and one particular student learns 80 of them. The teacher then creates a test by randomly selecting 20 pieces of information. On average, the student will score an 80, but it is possible—albeit extremely unlikely—that he will score 100 or 0.

Assume he scores 90. You could say that his skill contributed 80 and that good luck added 10. Assuming the following test has the same setup, what score would you expect? The answer, of course, is 80. You could assume that his skill of 80 would persist and that his luck, which is transitory, would be zero. Naturally, there's no way to know if luck will be zero. In fact, the student may get luckier on the second test. On average, however, the student's score will be closer to his skill.

Building on our example, there will be reversion to the mean whenever luck plays a role in determining outcomes. Luck in this case derives from the questions the teacher selects for the test. But even something as simple as measurement error can introduce luck. Saying it differently, whenever there is an imperfect correlation between two scores, you will have reversion to the mean.

We can now look at Secrist's argument and see the mistakes that Hotelling points out. The first is assuming causality. We naturally look for what is *causing* results to revert to the mean. For example, Secrist writes, "The tendency to mediocrity in business is more than a statistical result. It is expressive of prevailing behavior relations." Secrist suggests directly that competition is causing returns to revert toward the mean. Hotelling calls Secrist's conclusion a "statistical fallacy" and adds, "These diagrams really prove nothing more than that the ratios in question have a tendency to wander about." This is not to say that there aren't causal factors, but we don't need them to observe reversion to the mean.[8]

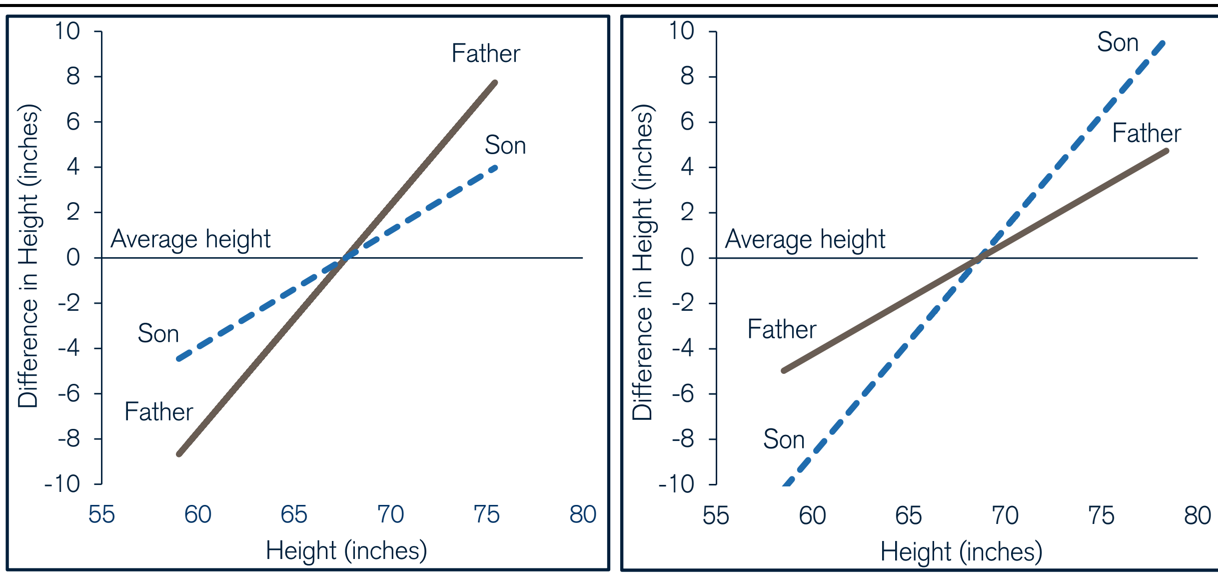
The other mistake is to assume declining variance in the population, as captured in Secrist's phrase "mediocrity tends to prevail." It is crucial to recognize that reversion to the mean doesn't provide specific guidance for any individual outcome, but rather it operates on a population. While luck may be zero on average, it is good for some and bad for others. Luck is shuffled and can exert the same influence on the overall result from one period to the next.

The student who scored 90 on the first test may score an 80 on the second as his good luck runs out, but a student with similar qualifications who scored an 80 the first time may enjoy good luck the second time and score 90. The distribution for the population need not change at all. This is one of the reasons reversion to the mean is so difficult to appreciate. Change, in the apparent form of high and low results getting closer to the mean over time, co-exists with no change, where the population's distribution remains constant.

We will turn our attention to business performance in a moment, but let's first look at a classic case of reversion to the mean, the heights of fathers and sons, to illustrate the mistakes that Secrist made. Exhibit 1 shows the heights of more than 1,000 fathers and sons relative to the average of each population.

The left side of the exhibit shows reversion to the mean. Tall fathers have tall sons, but the tallest fathers are about eight inches taller than the average of all fathers while the tallest sons are only about four inches taller than the average of all sons. The mirror image is true as well: Short fathers tend to have short sons, but the difference between the short fathers and the average of all fathers is larger than the same difference for the sons. All of this squares with intuition.

Exhibit 1: Heights of Fathers and Sons, and Sons and Fathers



Source: Karl Pearson and Alice Lee, "On the Laws of Inheritance in Man: I. Inheritance of Physical Characteristics," Biometrika, *Vol. 2, No. 4, November 1903, 357-462.*

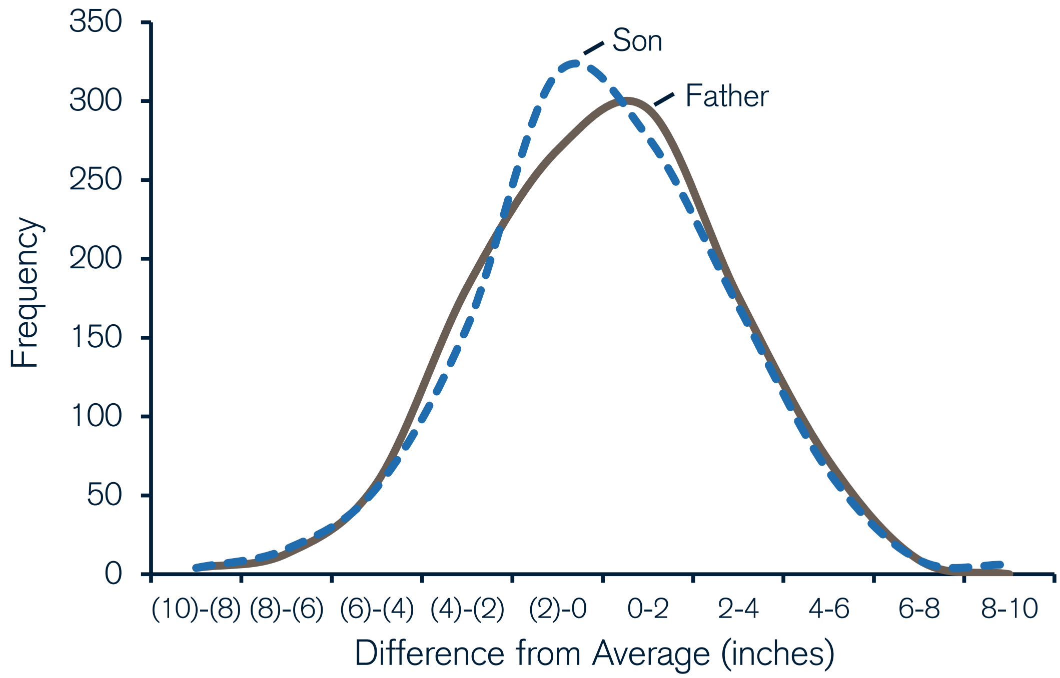
But reversion to the mean implies something that doesn't make as much sense: Because the phenomenon is the result of imperfect correlation, the arrow of time doesn't matter. So tall sons have tall fathers, but the sons have a greater difference between their heights and the average than their fathers do. The same relationship is true for short sons and fathers. The right side of Exhibit 1 shows this.

That the arrow of time can point in either direction reveals the risk of falsely attributing causality. While it may be true that tall fathers cause tall sons, it makes no sense to say that tall sons cause tall fathers. We find it difficult to refrain from assigning causality, even though reversion to the mean doesn't require it.[9]

Reversion to the mean conveys the sense that the difference between the extremes and the average shrinks over time. But that sense is deceptive. The way to think about it is that the values that are far from average basically have nowhere to go but toward the average, and the values that are close to average don't show much change in the aggregate as large moves up and down cancel out one another. Secrist observed the means of the groups converge and hence assumed that there was more "mediocrity" at the end of the period than at the beginning. Hotelling bluntly responds that, "The argument that business ratios converge because the means of initially arrayed groups converge is definitely incorrect."

An examination of the dispersion of values is the best way to evaluate whether the distribution has changed. You can do that by measuring the standard deviation of the distribution or, even better, the coefficient of variation. A normalized measure of dispersion, the coefficient of variation equals the standard deviation divided by the mean. Exhibit 2 shows the distribution of the heights of fathers and sons. While the distributions are different at the top, the tails are remarkably similar. The coefficient of variation is nearly identical. The heights of the sons are no more clustered toward the average than the heights of the fathers.

Exhibit 2: The Distributions of Heights for Fathers and Sons Are Nearly Identical



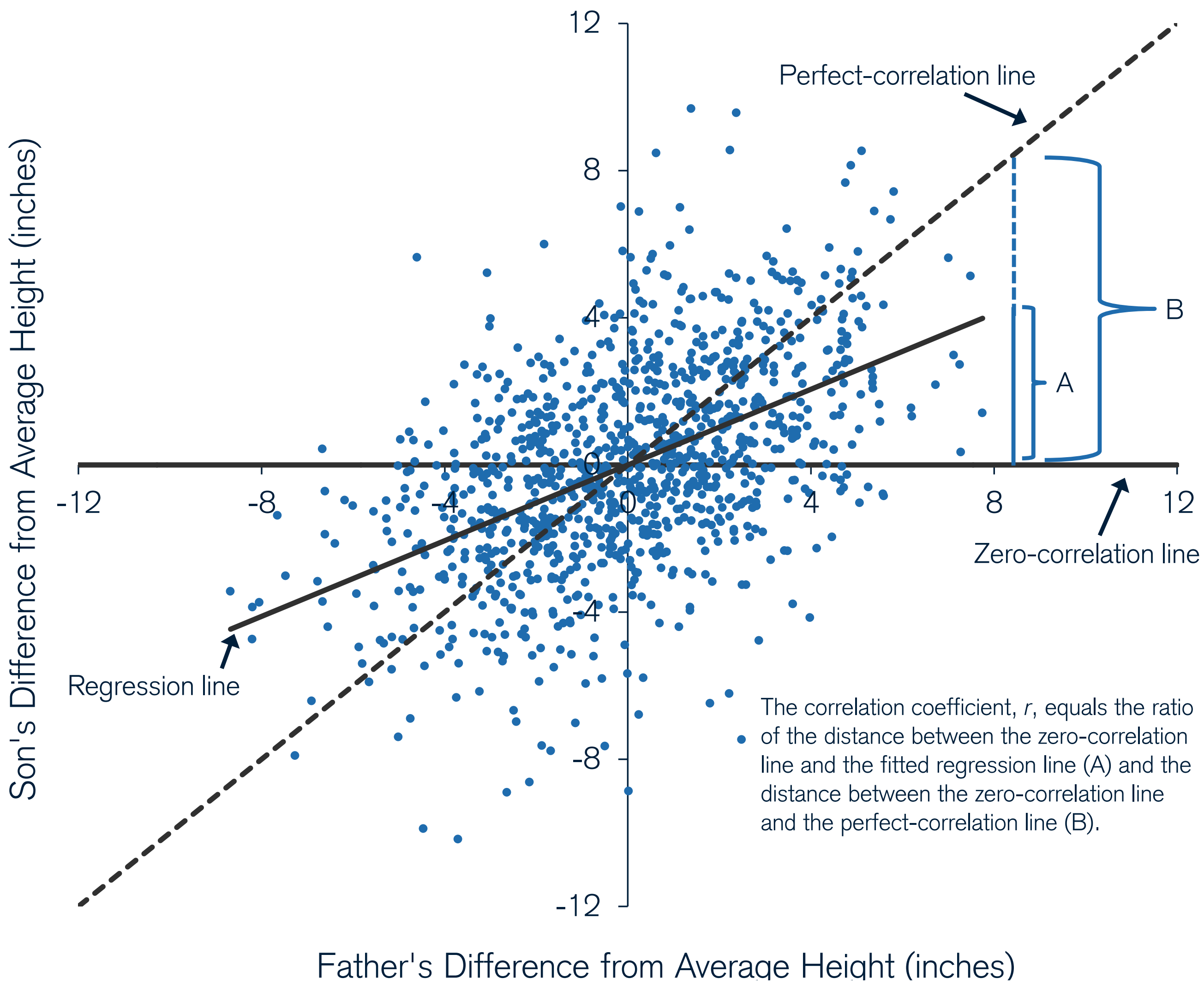
Source: Karl Pearson and Alice Lee, "On the Laws of Inheritance in Man: I. Inheritance of Physical Characteristics," Biometrika, *Vol. 2, No. 4, November 1903, 357-462.*

Visualizing the Correlation Coefficient

The correlation coefficient, *r*, is a measure of the linear relationship between two variables. Its value for our purpose is that it provides guidance about the rate of reversion to the mean. We'll share a specific formula to show that relationship in a moment. But what *r* means is not always clear. Here's a visual way to understand it.[10]

Exhibit 3 shows the correlation between the heights of the fathers and sons. Each point is a pair of one father and one son. These are the data from Exhibits 1 and 2. The correlation coefficient is 0.50. The height of the sons is the result of heredity and environmental factors including nutrition and health. Where does the 0.50 come from?

Exhibit 3: Correlation between the Heights of Fathers and Sons



Source: Karl Pearson and Alice Lee, "On the Laws of Inheritance in Man: I. Inheritance of Physical Characteristics," Biometrika, *Vol. 2, No. 4, November 1903, 357-462 and Credit Suisse.*

To get the answer, you need to examine three lines in the graph:

- The fitted regression line minimizes the sums of the squares of the vertical deviations of each data point from the line. In other words, you can't draw a line that is closer to each data point, on average, than the fitted regression line.

- The perfect-correlation line goes through the graph at a 45 degree angle. The slope of the line—rise over run—is 1.0. If the two data series were perfectly correlated, the fitted regression line would match the perfect-correlation line.

- The zero-correlation line runs along the x-axis. If two series were completely uncorrelated, you would see the fitted regression line lie on the x-axis.

So with visual inspection alone you can tell whether *r* is likely to be closer to 1.0 or zero by looking at whether the fitted regression is more similar to a perfect correlation or zero correlation. (We have left out negative correlations, but the logic extends accordingly.)

The correlation coefficient, *r*, equals the ratio of the vertical distance between the zero-correlation and fitted regression line, denoted in the exhibit by the letter A, and the vertical distance between the zero- and perfect-correlation lines, denoted by the letter B. So *r* is a measure of how far the data are from being uncorrelated.

In this case, the fitted regression line is almost exactly in the middle of the zero- and perfect-correlation lines. So the ratio is 1:2, equaling an *r* of 0.50. Reversion to the mean is relevant for any instance where the correlation is less than one.

Estimating the Rate of Reversion to the Mean

If *r* is 1.0, there is no reversion to the mean at all. The best estimate of the next outcome is the past outcome. You don't often see an *r* that high, but one example is a ranking within a transitive activity such as running races. You can line up six runners for a sprint, record their times, and rank them from fastest to slowest. If that group races again immediately, the expected ranking is the same as the prior one.

If *r* is zero, there is complete reversion to the mean. The best estimate of the next outcome is the mean, or average, of the population. For instance, for the years 1928-2012 the correlation coefficient between the total return for the S&P 500 in one year and the return in the following year was 0.02, effectively zero. So the best estimate of the market's return in any given year is simply the mean annual return over the whole period.[11]

For most activities, the correlation falls somewhere between those two extremes. Where it falls is essential to understanding the *rate* of reversion to the mean. We're now ready to examine the formula:[12]

Expected outcome = *r*(current outcome – mean) + mean

For example, if a father is 76 inches tall, the mean height of men is 70 inches, and the *r* = 0.50 between the heights of fathers and sons, the expected height of the son is 73 inches, determined as follows:[13]

73 = *0.50*(76 – 70) + 70

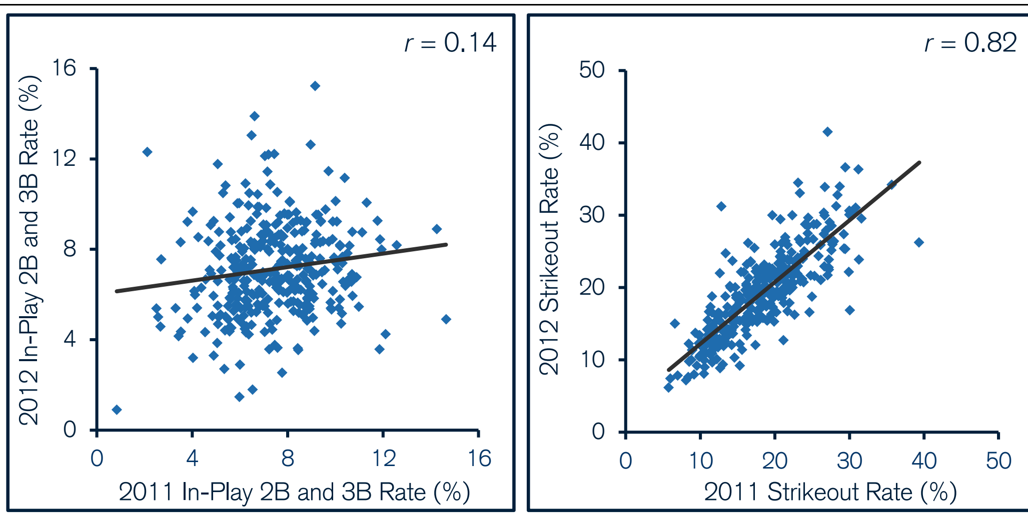
The relevance for forecasting should be evident. High correlations imply persistence—what you see next will closely resemble what you've seen before—and generally indicate the presence of skill. When the correlation is low, you need to rely heavily on the mean in making a forecast. Research in psychology shows that we commonly fail to move forecasts toward the mean as much as we should.[14]

Baseball is a sport that lends itself to statistics by nature. Many of the interactions are discrete, which means that you can measure them accurately over time. As a result, you can get a sense of which statistics reflect skill and which reflect luck. Here's a case of how you might use a calculation of *r* to make a forecast.

Exhibit 4 shows two hitting statistics, "in-play doubles and triples rate" and "strikeout rate," for the 2011 and 2012 seasons. In-play doubles (2B) and triples (3B) rate measures the percentage of balls put into play that result in a double or triple. On average, that happens a little more than seven percent of the time. The correlation coefficient is just 0.14, which tells you that no matter what a player's rate is in a given year, you should expect his rate in the following year to be close to the mean of all players. This doesn't mean that any individual player's rate will revert to the mean, but rather that something close to the mean is a guess that will generate the smallest error for the population at large.

Strikeout rate is simply how frequently a batter strikes out, which averages a little less than one in every five plate appearances. The *r* is high at 0.82, which means a player's strikeout rate in one year is a solid predictor of his strikeout rate in the subsequent year. Contrast the fitted regression lines for each statistic. The line for in-play doubles and triples rate looks nearly flat, similar to a zero correlation line. The line for strikeout rate looks close to a perfect correlation line.

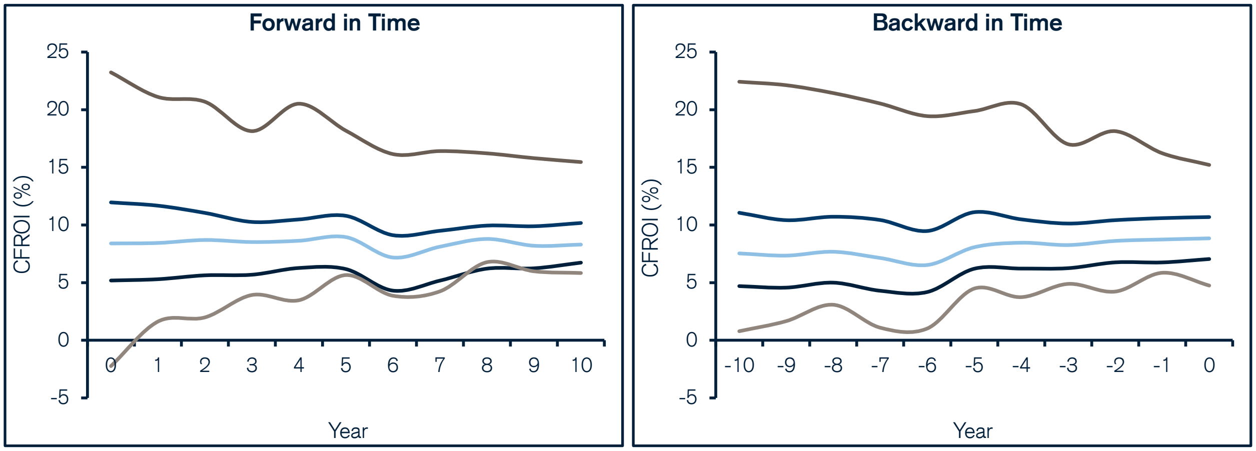
Exhibit 4: Skill and Luck in Baseball Statistics



Source: Baseball Prospectus.
Note: Minimum of 100 at-bats; In-play 2B and 3B rate = (2B + 3B) / (at-bats - strikeouts); Strikeout rate = strikeouts / plate appearances.

We are now ready to turn our attention to forecasting the rate of reversion to the mean for CFROI. Exhibit 5 starts by showing reversion to the mean in CFROI for the consumer discretionary sector. The exhibit reflects the results of 1,195 global companies for the years 2002-2012. The left panel starts by sorting the companies into quintiles by CFROI rank in 2002 and follows the cohorts through time. While reversion to the mean is not complete, the spread from the highest to the lowest quintile declines from 25 percentage points at the outset to 10 percentage points at the end of the period.

Exhibit 5: Reversion to the Mean for CFROI in the Consumer Discretionary Sector



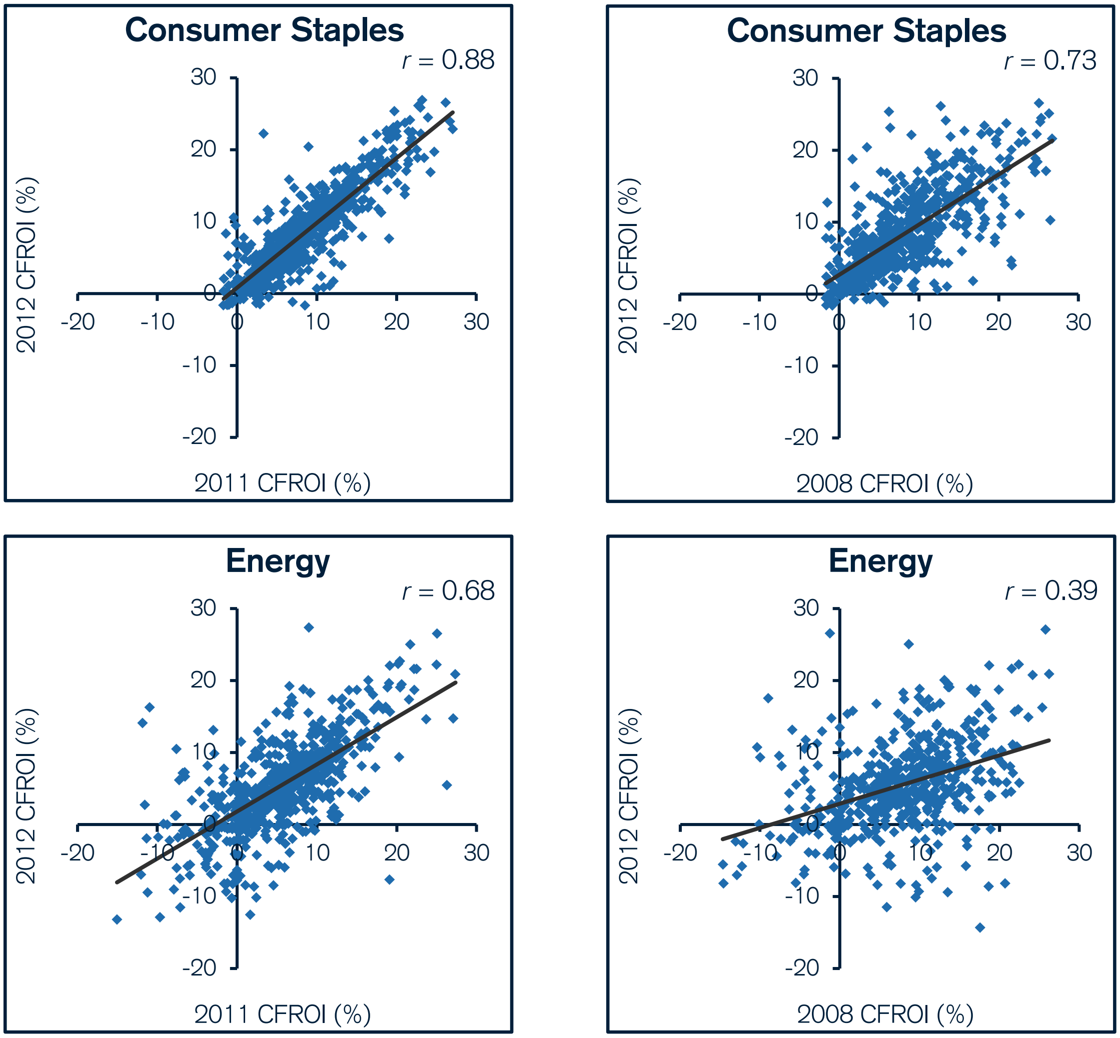
Source: Credit Suisse HOLT.

The right panel of Exhibit 5 goes backward in time. Here, we create the quintiles based on 2012 CFROIs, and go back to 2002. Just as with the heights of fathers and sons, we see that reversion to the mean in corporate performance works forward or backward in time. This shows that competition cannot be the sole explanation for reversion to the mean.

Now that we have established that reversion to the mean happens, we can turn our attention to estimating the rate at which it happens. To do so we calculate the correlation coefficient for each sector and insert it into the equation to estimate the expected outcome. Intuitively, you would expect that a sector with stable demand, such as consumer staples, would have a higher *r* than an industry exposed to commodity markets, such as energy.

Exhibit 6 shows that this relationship is indeed what we see empirically. The top charts examine the CFROI in the consumer staples sector. The left panel shows that the correlation coefficient, *r,* is 0.88 between 2011 and 2012. The right panel shows that the *r* for the four-year change, from 2008 to 2012, is 0.73. The bottom charts consider the same relationships for the energy sector. The one-year *r* for energy is 0.68 and the *r* for the four-year change is 0.39. This suggests that you should expect slower reversion to the mean in consumer staples than in energy.

Exhibit 6: Correlation Coefficients for CFROI in Consumer Staples and Energy



Source: Credit Suisse HOLT.

Note that the correlation coefficient for the four-year change in CFROI is higher than what you would expect by looking solely at the *r* for the one-year change. Take consumer staples as an illustration. Say a company has a CFROI that is 10 percentage points above average. Using the one-year *r*, you'd forecast the excess CFROI spread in 4 years to be 6.0 ($0.88^4 * 10 = 6.0$). But using the four-year *r*, you'd forecast the spread to be 7.3 (0.73 * 10 = 7.3). So using a one-year correlation coefficient overstates the rate of reversion to the mean.

Exhibit 7 shows the average correlation coefficient for the four-year change in CFROI for ten sectors from 1986-2012, as well as the standard deviation for each series. There are two aspects of the exhibit worth emphasizing. The first is the ranking of *r* from the highest to the lowest. This provides a sense of the rate of reversion to the mean by sector. Consumer-oriented sectors are generally at the top of the list, and those sectors that have exposure to commodities tend to be at the bottom.

Also important is how the *r*'s change from year to year. While the ranking is reasonably consistent through time, there is a large range in the standard deviation of *r* for each sector. For example, the *r* for the consumer staples sector averaged 0.70 from 1990-2012 and had a standard deviation of just 0.036. This means that

68 percent of the observations fell within a range of 0.66 and 0.74. The average *r* for the energy sector, by contrast, was 0.36 and had a standard deviation of 0.070. This means that most observations fell between 0.29 and 0.43. Appendix B shows all of the one-year and four-year *r*'s for each of the ten sectors.

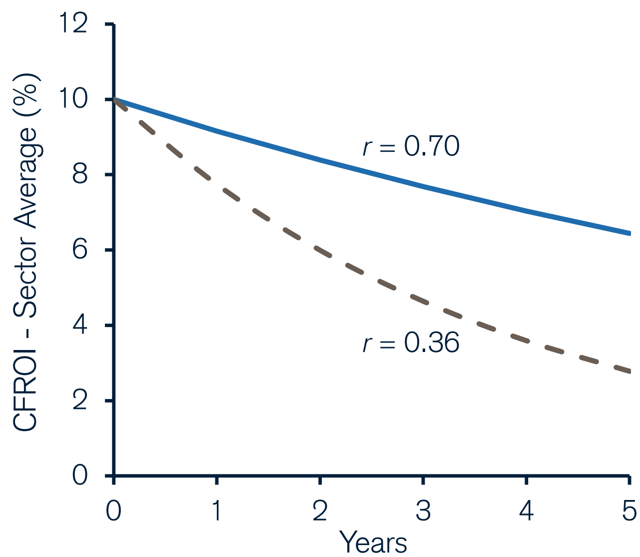
Exhibit 7: Average Correlation Coefficients for CFROI (Four-Year Change by Sector, 1986-2012)

Sector	Average	Standard Deviation
Consumer Staples	0.70	0.036
Health Care	0.60	0.068
Consumer Discretionary	0.56	0.044
Utilities	0.54	0.104
Industrials	0.52	0.048
Telecommunication Services	0.47	0.128
Materials	0.44	0.044
Financials	0.43	0.085
Information Technology	0.38	0.065
Energy	0.36	0.070

Source: Credit Suisse HOLT.

Exhibit 8 visually translates *r*'s into the downward slopes for excess CFROIs that they suggest. It shows the rate of reversion to the mean based on four-year *r*'s of 0.70 and 0.36, the numbers that bound our empirical findings. We assume a company is earning a CFROI ten percentage points above the sector average, and show how those returns fade given the assumptions.[15]

Exhibit 8: The Rate of Reversion to the Mean Assuming Different Four-Year *r*'s



Source: Credit Suisse.

Here's an application of this approach. Let's look at AutoZone, an auto parts retailer that competes in the consumer discretionary sector. AutoZone's CFROI was 20.8 percent in the most recent fiscal year, the mean CFROI for the consumer discretionary sector was 8.7 percent from 1990-2012, and the four-year *r* for the sector is 0.56. Based on the formula, AutoZone's projected CFROI in four years is 15.5 percent, calculated as follows:

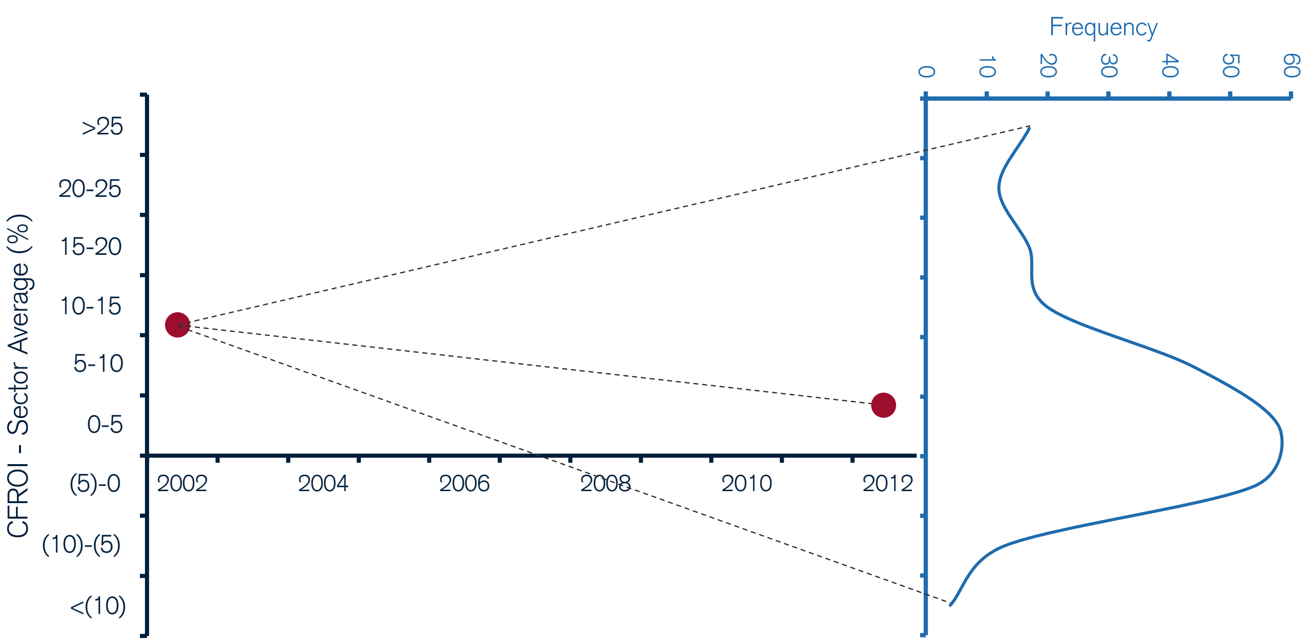
$$15.5 \quad = \quad \mathit{0.56}(20.8 - 8.7) + 8.7$$

After five years, we can assume that about one-half of AutoZone's excess CFROI will be gone, either as a result of internal or external factors.

It is important to underscore that this is not a specific prediction about AutoZone. More accurately, it is a characterization of what happens on average to a large sample of companies in the same sector that start with similar excess CFROIs. Exhibit 9 shows this graphically. The dot on the left is the median less sector average CFROI for companies in the highest quintile of the consumer discretionary sector in 2002. The dot on the right shows the median less sector average CFROI for that same group in 2012.

The exhibit demonstrates two points. The first is that the median excess CFROI reverts toward the mean for the sector, as you would expect. The second is that the dot on the right summarizes a distribution of CFROIs. Some of the companies with high CFROIs in 2002 have even higher CFROIs in 2012, while others sink to levels below the sector average. A simple picture of reversion to the mean belies the texture of the data.

Exhibit 9: Reversion to the Mean Happens on Average



Source: Credit Suisse HOLT.

Modeling corporate performance is not simply a matter of plugging in assumptions about reversion to the mean. You may have well-founded reasons to believe that a particular company's results will be better or worse than what a simple model of reversion to the mean suggests, and you should reflect those results in your model. That said, reversion to the mean should always be a consideration in your modeling because it is relevant for a population of companies.

Estimating the Mean to Which Results Revert

The second issue we must address is the mean, or average, to which results revert. For some measures, such as sports statistics and the heights of parents and children, the means remain relatively stable over time. But for other measures, including corporate performance, the mean can change from one period to the next.

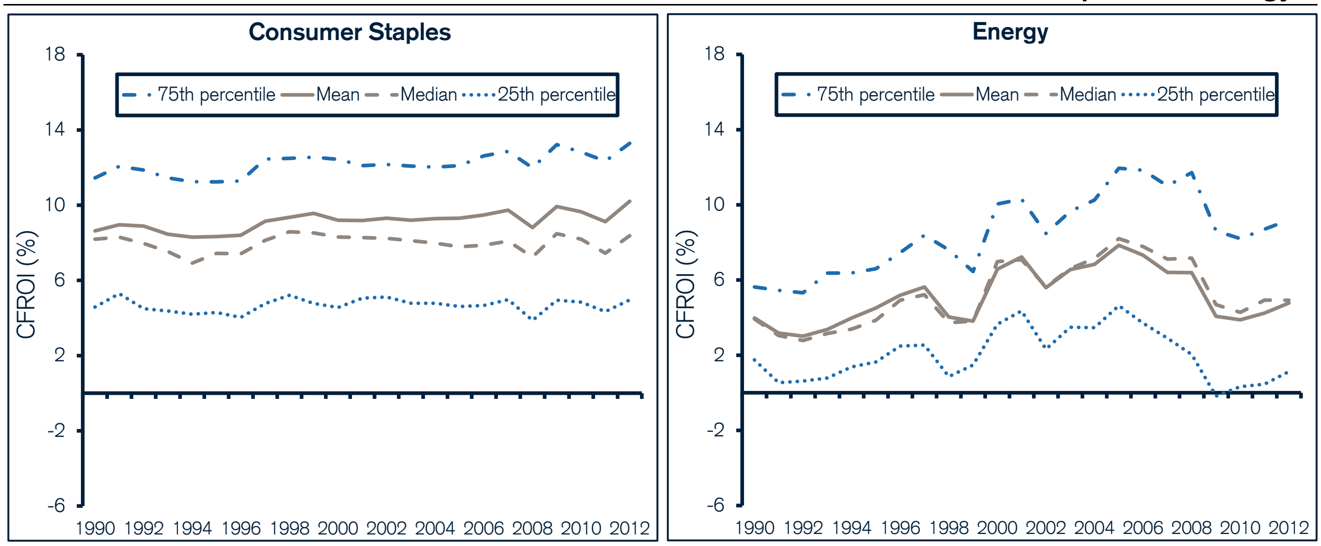
In assessing the stability of the mean, you want to answer two questions. The first is: How stable has the mean been in the past? In cases where the average has been consistent over time and the environment isn't expected to change much, you can safely use past averages to anticipate future averages.

The gray lines in the middle of each chart of Exhibit 10 are the mean (solid) and median (dashed) CFROI for each year for the consumer staples and energy sectors. The consumer staples sector had an average CFROI of 9.2 percent from 1990-2012, with a standard deviation of 0.5 percent. The energy sector had an average CFROI of 5.1 percent, with a standard deviation of 1.5 percent over the same period. So the CFROI in the energy sector was lower than that for consumer staples and moved around a lot more.

It comes as no surprise that the CFROI for energy is lower and more volatile than that for consumer staples. This helps explain why reversion to the mean in energy is more rapid than that for consumer staples. You can associate high volatility and low CFROIs with low valuation multiples, and low volatility and high CFROIs with high valuation multiples. This is what we see empirically for these sectors.

Also in Exhibit 10 are blue dashed lines that capture the CFROI for the 75th and 25th percentile companies within the sector. If you ranked 100 companies in a sector from 100 (the highest) to 1 (the lowest) based on CFROI, the 75th percentile would be the CFROI of company number 75. So plotting the percentiles allows you to see the dispersion in CFROIs for the sector. Appendix C shows the same chart for all ten sectors. Another way to show dispersion is the coefficient of variation, which is the standard deviation of the CFROIs divided by the mean of the CFROIs. The coefficient of variation for 1990-2012 was 0.76 for consumer staples and 1.25 for energy. For every 100 basis points of CFROI, there's much more variance in energy than in consumer staples.

Exhibit 10: Mean and Median CFROI and 75th and 25th Percentiles – Consumer Staples and Energy



Source: Credit Suisse HOLT.

The second question is: What are the factors that affect the mean CFROI? For example, the CFROI for the energy sector might be correlated to swings in oil prices, or returns for the financial sector might be dictated by changes in regulations. Analysts must answer this question sector by sector.

As reversion to the mean is a concept that applies wherever correlations are less than perfect, thinking about this second question can frame debates. Currently, for instance, there's a contested debate about whether operating profit margins in the U.S. are sustainable.[16] The answer lies in what factors drive the level of profit margins—including labor costs, depreciation expense, financing costs, and tax rates—and what is happening to each. There will obviously be reversion to the mean for the operating profit margins of companies within a sector or industry. The question is whether aggregate profit margins will decline in coming years following a strong rise since the depths of the recession.

Summary

We're now ready to wrap up the discussion. Exhibit 11 presents guidelines on the rate of reversion to the mean, as well as the proper mean to use, for ten sectors based on more than twenty years of data.

Exhibit 11: Rate of Reversion and to What Mean CFROIs Revert for Ten Sectors

	How Much Reversion? (1986-2012)	To What Mean? (1990-2012)			
Sector	Average Correlation Coefficient	Median CFROI (%)	Average CFROI (%)	Standard Deviation CFROI (%)	Coefficient of Variation
Consumer Staples	0.70	8.0	9.2	0.5	0.76
Health Care	0.60	7.8	6.5	1.4	1.68
Consumer Discretionary	0.56	7.7	8.7	0.6	0.88
Utilities	0.54	3.7	4.1	0.6	0.72
Industrials	0.52	6.5	7.3	1.0	0.81
Telecommunication Services	0.47	5.5	4.6	1.7	1.82
Materials	0.44	4.4	4.1	0.8	1.82
Financials	0.43	6.6	6.8	1.6	1.41
Information Technology	0.38	7.9	7.7	2.4	1.38
Energy	0.36	5.2	5.1	1.5	1.25

Source: Credit Suisse HOLT.
Note: Coefficient of variation = average standard deviation / average CFROI.

Here are the practical recommendations:

- **Rate of reversion to the mean**. The second column shows the average correlation coefficient, *r*, based on four-year changes in CFROI for each sector from 1986-2012. As Exhibit 7 shows, these correlations tend to be reasonably stable and hence are a useful approximation for the rate of reversion to the mean over a multi-year period. You can plug these *r*'s into the formula to forecast expected outcomes. Remember that reversion to the mean works on a population, not necessarily on every individual company.

- **The mean to which CFROIs revert**. This aspect of the forecast is more difficult than the rate of reversion to the mean because the mean CFROI rarely stays stable. The third and fourth columns of the exhibit show the average annual medians and means from 1990-2012, and the fifth column shows the standard deviation of the annual means. We show medians as well as means because the CFROIs in many of these sectors do not match a normal distribution. Still, you can use the means and medians interchangeably in most cases as they tend to be close to one another.

In some sectors, including consumer staples and consumer discretionary, the mean CFROIs are stable. Others, including information technology and telecommunication services, have a great deal of volatility. For sectors with CFROIs that have a low standard deviation, it is reasonable to assume that the historical mean is the number to which CFROIs revert. For sectors that are volatile, you should assess where the sector is in its cycle and aim to shade the historical average up or down to reflect mid-cycle profitability. Note that even mid-cycle profitability changes if the structure of the sector improves or deteriorates.

- **This dispersion of CFROIs.** The column on the right shows the coefficient of variation (average annual standard deviation / average annual mean) for each sector based on data from 1990-2012. This is a measure of how much variance there is in the distribution of returns for the sector. The CFROIs for companies within a sector with a low coefficient of variance, such as utilities, tend to be very similar. Sectors, including healthcare, have a high coefficient of variance, which means that some companies earn CFROIs much higher than others relative to the sector average.

Reversion to the mean is a tricky concept that many investors fail to fully comprehend. This report defined reversion to the mean, showed some of the common mistakes associated with it, and developed a general model for forecasting both the rate of reversion to the mean and the mean to which results revert. While the primary focus here was on forecasting CFROI, you can apply the framework to consider any activity where reversion to the mean applies.

The report's specific guidelines are based on more than 20 years of global data for ten sectors. It comes as no surprise that some sectors are much easier to model than others. But even for those sectors that are more challenging, these figures should provide a basis for healthy debate and deliberation.

Endnotes:

[1] HOLT uses a three-step process to fade the CFROI of all firms. The first step is the explicit fade period, where the model fades the CFROI for a company over the next five years based on its position in the corporate life cycle. The second step is the residual period, where the model eliminates ten percent of the economic spread per year. The economic spread is the difference between the CFROI and the long-term average. For instance, if a firm's economic spread is 10 percentage points at the end of the fifth forecast year (say, CFROI of 16 percent less an average of 6 percent), the economic spread would be 9 percentage points in the subsequent year. The final step is the terminal period, where the model assumes the company earns a return on capital equal to the cost of capital and that the level of earnings will continue into perpetuity.
[2] Scott D. Stewart, CFA, John J. Neumann, Christopher R. Knittel, and Jeffrey Heisler, CFA, "Absence of Value: An Analysis of Investment Allocation Decisions by Institutional Plan Sponsors," *Financial Analysts Journal*, Vol. 65, No. 6, November/December 2009, 34-51 and Amit Goyal and Sunil Wahal, "The Selection and Termination of Investment Firms by Plan Sponsors," *Journal of Finance*, Vol. 63, No. 4, August 2008, 1805-1847.
[3] Milton Friedman, "Do Old Fallacies Ever Die?" *Journal of Economic Literature*, Vol. 30, December 1992, 2129-2132.
[4] Horace Secrist, *The Triumph of Mediocrity in Business* (Evanston, IL: Bureau of Business Research, Northwestern University, 1933). While many use the word "mediocrity" disparagingly, it is likely that Secrist used the word to depict movement toward the middle. The word mediocrity derives, in part, from the Latin "medius," which means "middle."
[5] George J. Stigler, *Capital and Rates of Return in Manufacturing Industries* (Princeton, NJ: Princeton University Press, 1963). On page 54 of the book, Stigler writes, "There is no more important proposition in economic theory than that, under competition, the rate of return on investment tends toward equality in all industries. Entrepreneurs will seek to leave relatively unprofitable industries and enter relatively profitable industries, and with competition there will be neither public nor private barriers to these movements."
[6] Harold Hotelling, "Review of *The Triumph of Mediocrity in Business,* by Horace Secrist," *Journal of the American Statistical Association*, Vol. 28, No. 184, December 1933, 463-465.
[7] Stephen M. Stigler, *Statistics on the Table: The History of Statistical Concepts and Methods* (Cambridge, MA: Harvard University Press, 1999), 173-188.
[8] Donald T. Campbell and David A. Kenny, *A Primer on Regression Artifacts* (New York: The Guilford Press, 1999).
[9] Michael S. Gazzaniga, "The 'Interpreter' in Your Head Spins Stories to Make Sense of the World," *Discover*, August 1, 2012.
See http://discovermagazine.com/2012/brain/22-interpreter-in-your-head-spins-stories.
[10] Donald T. Campbell and David A. Kenny, *A Primer on Regression Artifacts* (New York: The Guilford Press, 1999), 7-11.
[11] In reality, the forecast is not so simple. It makes sense to give weight to two variables in a forecast: 1. The mean; and 2. Measures of current valuation. A low valuation would suggest a forecast higher than the historical average, and a high valuation would suggest a lower-than-average forecast.
[12] Campbell and Kenny, 27; William M.K. Trochim and James P. Donnelly, *The Research Methods Knowledge Base-3rd Ed.* (Mason, OH: Atomic Dog, 2008), 166.
[13] In this case we have assumed that the mean height of the sons is the same as that for the fathers. If that is not the case, you can standardize the two variables by computing Z scores. To calculate the Z score, you take an individual score, subtract the sample mean, and divide the difference by the standard deviation.

Say you wanted to study reversion to the mean in the heights of fathers and daughters. Assume the mean height for men is 70 inches and the standard deviation is 2.8 inches. Assume the mean height for women is 65 inches and the standard deviation is 3.3 inches. A 75.6 inches tall man would have a Z-score of 2.0 [(75.6 – 70) / 2.8 = 2.0] as would a woman standing 71.6 inches [(71.6 – 65) / 3.3 = 2.0].

[14] Daniel Kahneman, *Thinking, Fast and Slow* (New York: Farrar, Straus and Giroux, 2011), 175-184.

[15] In theory, this is not the best way to model this problem. The equation we present is relevant mostly for one-time adjustments. See John R. Nesselroade, Stephen M. Stigler, and Paul Baltes, "Regression Toward the Mean and the Study of Change," *Psychological Bulletin*, Vol. 88, No. 3, November 1980, 622-637.

A more promising approach, and an approach we hope to take up, is the "trait-state-error" model. (See David A. Kenny and Alex Zautra, "The Trait-State-Error Model for Multiwave Data," *Journal of Consulting and Clinical Psychology*, Vol. 63, No. 1, February 1995, 52-59.) This model has three components: permanent (trait), which is a proxy for stable industry conditions; autoregressive (state), which captures competition; and error, which reflects actual errors as well as exogenous events. Research on Spanish companies suggests that the permanent component explains about 30 percent of corporate returns, the autoregressive component 60 percent, and error the last 10 percent. (See Juan Carlos Bou and Albert Satorra, "The Persistence of Abnormal Returns at Industry and Firm Levels: Evidence from Spain," *Strategic Management Journal*, Vol. 28, July 2007, 707-722.)

[16] John Owens, CFA, "The Corporate Profit Margin Debate," *Morningstar Investment Services Commentary*, February 2013.

Appendix A: Data Set

The companies we use in this analysis are from HOLT's proprietary database. The sample includes global companies with publicly-traded equity over the years 1985-2012, with 1987 representing the first year in which non-U.S. companies compose more than 50 percent of the sample. Thereafter, non-U.S. companies represent, on average, 65 percent of the sample.

The sample includes both active and inactive ("dead") companies to remove survivorship bias. We use companies with market capitalizations, adjusted in current dollars, of $250 million and greater. This represents the vast majority of investable equities for our clients.

We performed winsorization of the data at the 2nd and 98th percentiles of CFROI, plowback (i.e., reinvestment), and CFROI volatility. This is in an attempt to limit spurious outliers, which are generally the result of measurement error, accounting anomalies, or poorly collected or reported financial data.

CFROI

The HOLT Cash Flow Return on Investment (CFROI) metric reflects economic returns by measuring a company's inflation-adjusted cash flow return on operating assets. With CFROI, HOLT aims to cut through the vagaries of traditional accounting results and to provide a consistent metric that allows for comparison of performance over time and across a portfolio, a market, or a global universe of companies. HOLT calculates CFROI for a company using two steps. First, it measures the inflation-adjusted gross cash flows available to all capital owners and compares that to the inflation-adjusted gross investment made by the capital owners. Second, it translates this ratio into an Internal Rate of Return (IRR) by recognizing the finite economic life of depreciating assets and the residual value of non-depreciating assets.

While CFROI applies to industrial and service firms, Cash Flow Return on Equity (CFROE®) applies to financial companies. Like CFROI, CFROE reflects economic adjustments but also takes into account the fact that lenders utilize the liability side of the balance sheet to generate value. The long-term global average CFROI and CFROE are 6 percent and 7.5 percent, respectively.

Appendix B: Historical Correlation Coefficients for All Sectors

Exhibit 12 shows the average correlation coefficient for year-over-year change in CFROI for ten sectors from 1989-2012, as well as the standard deviation for each series. Exhibit 13 shows the average correlation coefficient for the four-year change in CFROI for ten sectors from 1986-2012, as well as the standard deviation for each series.

Exhibit 12: Year-over-Year Correlation Coefficients for CFROI in Ten Sectors, 1989-2012

	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Telecomm. Services	Utilities
1990	0.69	0.69	0.78	0.73	0.82	0.67	0.72	0.69	0.56	0.81
1991	0.67	0.73	0.75	0.77	0.86	0.78	0.75	0.70	0.57	0.81
1992	0.68	0.77	0.71	0.77	0.87	0.82	0.75	0.73	0.46	0.69
1993	0.70	0.76	0.76	0.78	0.87	0.77	0.73	0.65	0.82	0.71
1994	0.55	0.70	0.77	0.78	0.85	0.79	0.69	0.73	0.76	0.74
1995	0.64	0.66	0.79	0.79	0.83	0.80	0.75	0.68	0.81	0.78
1996	0.58	0.65	0.79	0.79	0.84	0.77	0.75	0.67	0.69	0.73
1997	0.62	0.71	0.80	0.79	0.82	0.81	0.73	0.68	0.70	0.75
1998	0.64	0.72	0.80	0.79	0.83	0.75	0.71	0.62	0.72	0.81
1999	0.53	0.69	0.77	0.78	0.80	0.78	0.69	0.68	0.72	0.76
2000	0.43	0.65	0.77	0.77	0.82	0.78	0.70	0.62	0.59	0.68
2001	0.64	0.64	0.70	0.78	0.85	0.81	0.66	0.57	0.70	0.70
2002	0.49	0.69	0.73	0.80	0.84	0.82	0.72	0.63	0.66	0.68
2003	0.56	0.71	0.75	0.82	0.87	0.83	0.68	0.71	0.77	0.73
2004	0.58	0.64	0.75	0.82	0.87	0.83	0.70	0.74	0.83	0.68
2005	0.65	0.69	0.79	0.84	0.88	0.85	0.68	0.75	0.84	0.74
2006	0.69	0.72	0.80	0.82	0.89	0.86	0.69	0.74	0.79	0.74
2007	0.65	0.75	0.82	0.80	0.86	0.83	0.62	0.72	0.73	0.67
2008	0.61	0.62	0.79	0.80	0.86	0.83	0.51	0.69	0.77	0.66
2009	0.51	0.51	0.72	0.79	0.80	0.81	0.52	0.71	0.78	0.69
2010	0.64	0.67	0.74	0.83	0.87	0.81	0.63	0.71	0.79	0.78
2011	0.72	0.74	0.81	0.85	0.87	0.77	0.60	0.75	0.79	0.82
2012	0.68	0.68	0.85	0.87	0.88	0.81	0.53	0.80	0.85	0.67
Average	**0.61**	**0.69**	**0.77**	**0.80**	**0.85**	**0.80**	**0.67**	**0.69**	**0.73**	**0.73**
St. Dev.	**0.07**	**0.06**	**0.04**	**0.03**	**0.03**	**0.04**	**0.07**	**0.05**	**0.10**	**0.05**

Source: Credit Suisse HOLT.

Exhibit 13: Four-Year Correlation Coefficients for CFROI in Ten Sectors, 1986-2012

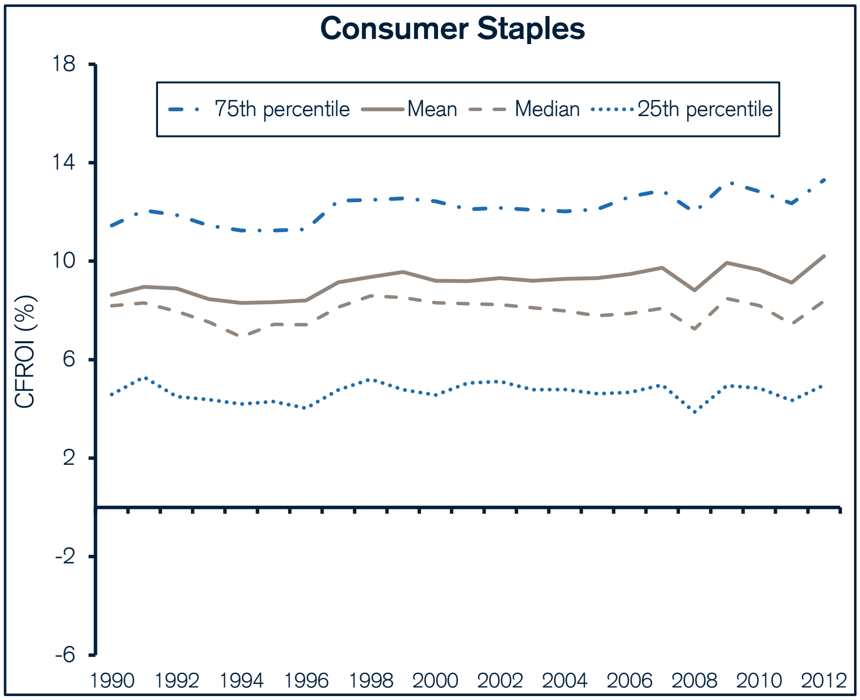
	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Telecomm. Services	Utilities
1990	0.42	0.44	0.52	0.43	0.67	0.49	0.37	0.35	0.07	0.57
1991	0.45	0.53	0.47	0.48	0.72	0.45	0.42	0.32	0.54	0.78
1992	0.40	0.46	0.45	0.53	0.65	0.50	0.41	0.34	0.61	0.74
1993	0.41	0.47	0.51	0.53	0.69	0.49	0.41	0.39	0.51	0.67
1994	0.28	0.43	0.52	0.50	0.73	0.55	0.48	0.42	0.57	0.50
1995	0.44	0.36	0.44	0.51	0.69	0.64	0.57	0.37	0.47	0.41
1996	0.40	0.48	0.43	0.54	0.71	0.60	0.55	0.29	0.35	0.71
1997	0.37	0.45	0.50	0.56	0.71	0.55	0.51	0.37	0.48	0.56
1998	0.41	0.45	0.54	0.57	0.59	0.57	0.47	0.36	0.50	0.64
1999	0.32	0.44	0.58	0.56	0.70	0.62	0.45	0.32	0.52	0.55
2000	0.29	0.41	0.59	0.57	0.69	0.65	0.43	0.31	0.49	0.52
2001	0.40	0.50	0.57	0.59	0.70	0.64	0.48	0.30	0.33	0.49
2002	0.41	0.51	0.53	0.62	0.72	0.62	0.55	0.30	0.31	0.48
2003	0.28	0.44	0.53	0.58	0.68	0.62	0.45	0.41	0.44	0.50
2004	0.33	0.39	0.52	0.60	0.74	0.63	0.49	0.32	0.41	0.45
2005	0.42	0.37	0.50	0.59	0.76	0.64	0.48	0.35	0.35	0.49
2006	0.33	0.44	0.52	0.57	0.71	0.65	0.39	0.37	0.48	0.41
2007	0.24	0.42	0.51	0.59	0.72	0.62	0.40	0.40	0.54	0.43
2008	0.28	0.45	0.48	0.57	0.74	0.68	0.34	0.42	0.65	0.45
2009	0.21	0.39	0.49	0.55	0.71	0.67	0.25	0.44	0.52	0.49
2010	0.34	0.40	0.55	0.57	0.73	0.67	0.28	0.49	0.63	0.48
2011	0.44	0.40	0.59	0.59	0.68	0.67	0.34	0.49	0.52	0.53
2012	0.39	0.40	0.61	0.61	0.73	0.65	0.33	0.53	0.61	0.50
Average	**0.36**	**0.44**	**0.52**	**0.56**	**0.70**	**0.60**	**0.43**	**0.38**	**0.47**	**0.54**
St. Dev.	**0.07**	**0.04**	**0.05**	**0.04**	**0.04**	**0.07**	**0.09**	**0.06**	**0.13**	**0.10**

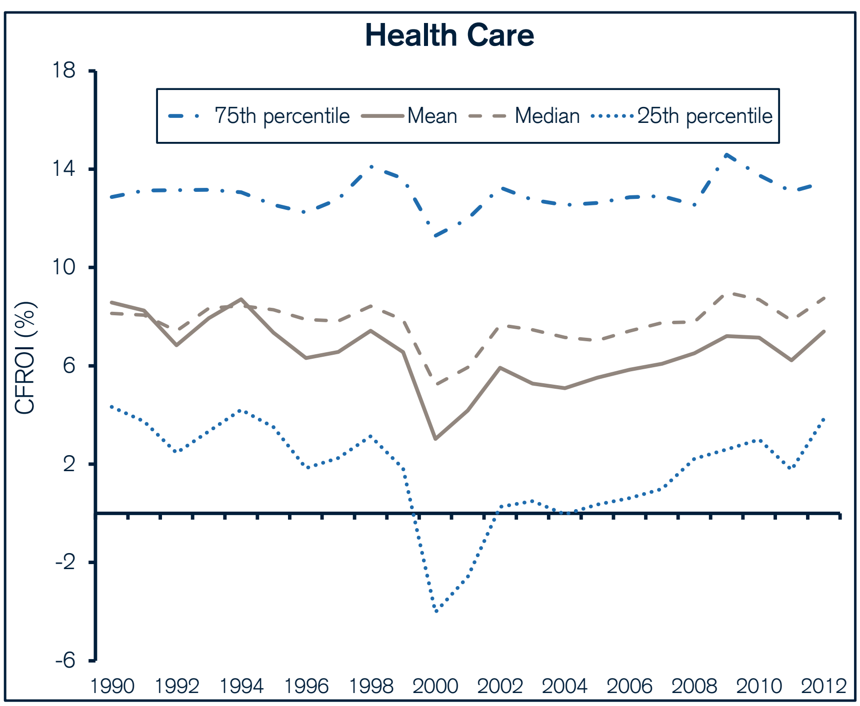
Source: Credit Suisse HOLT.

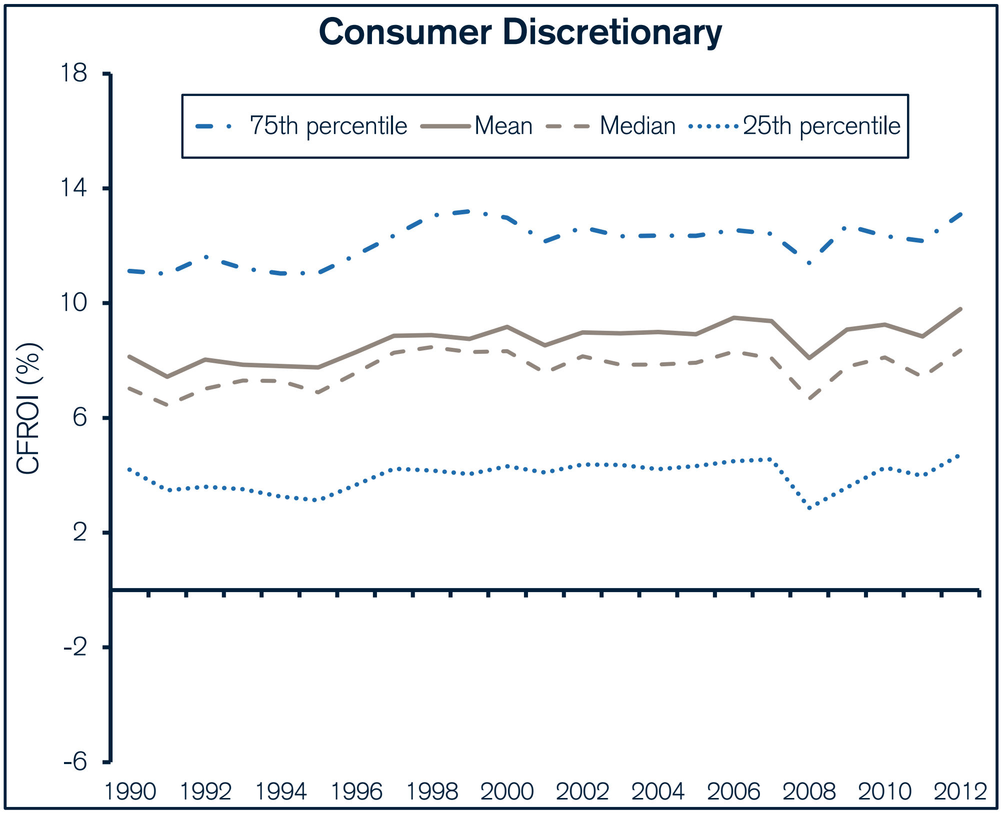
Appendix C: Historical CFROI for All Sectors

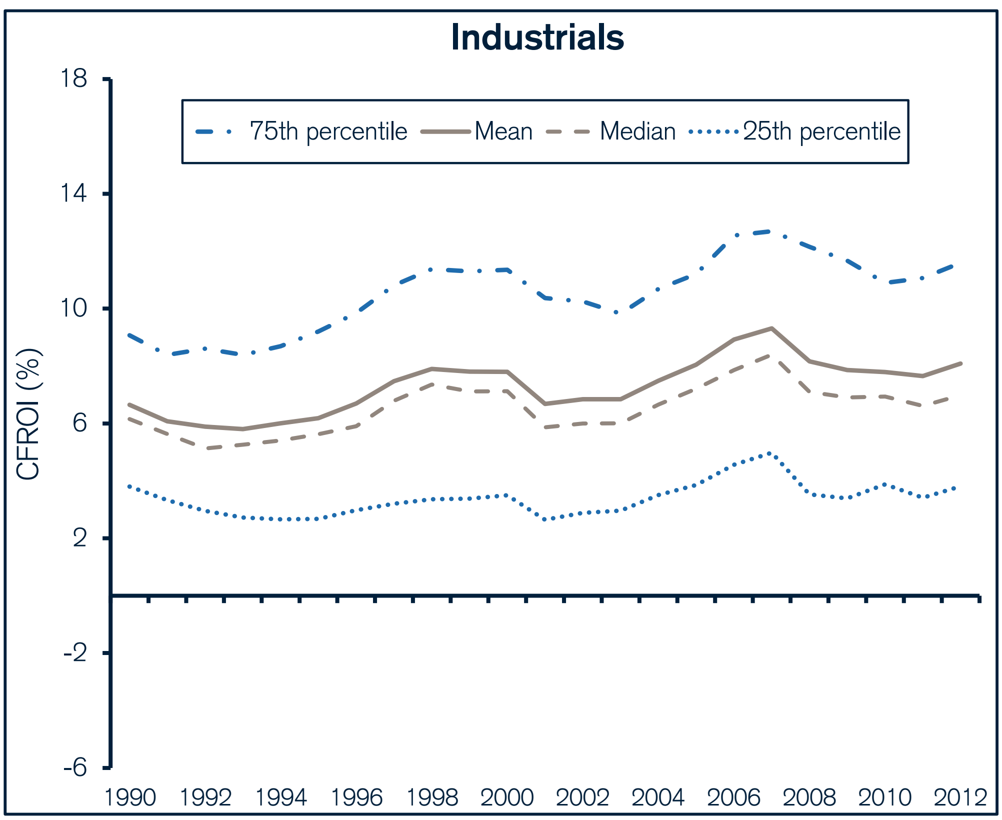
The charts in Exhibit 14 portray CFROI trends for each sector from 1990-2012. The gray lines in the middle are the mean (solid) and median (dashed) CFROI. The blue dashed lines capture the CFROI for the 75th and 25th percentile companies within the sector, with the 100th percentile being the highest. Plotting the percentiles allows you to see the dispersion in CFROI for the sector.

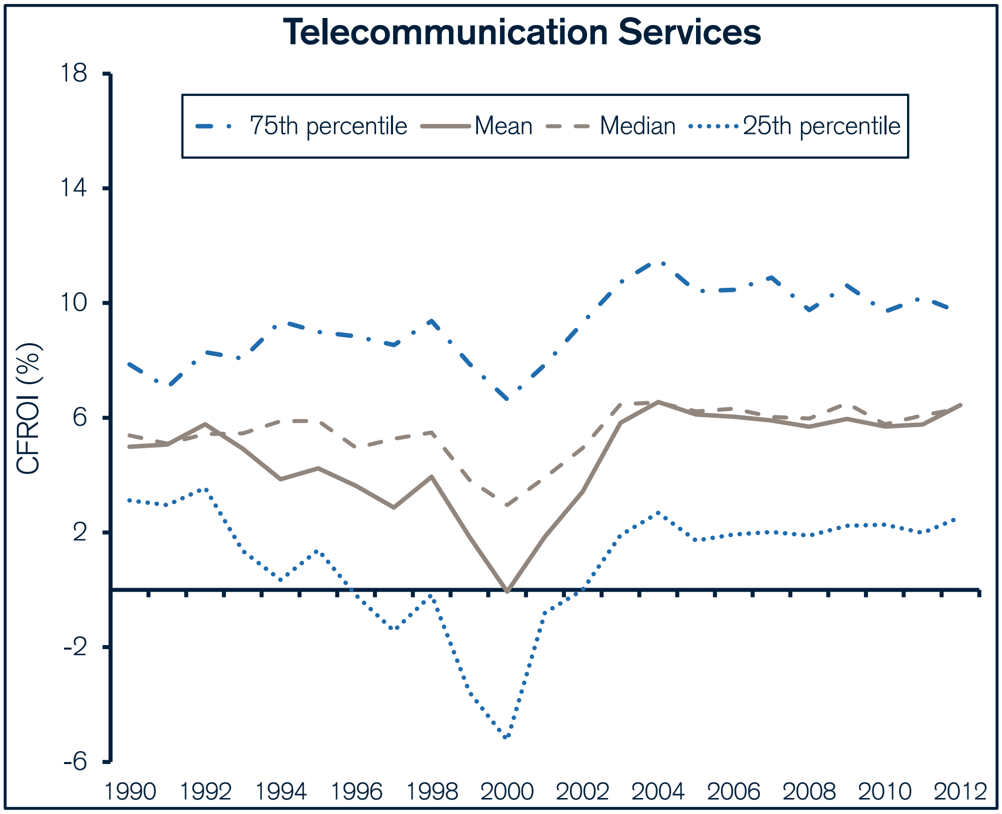
Exhibit 14: Mean and Median CFROI and 75th and 25th Percentiles for All Sectors

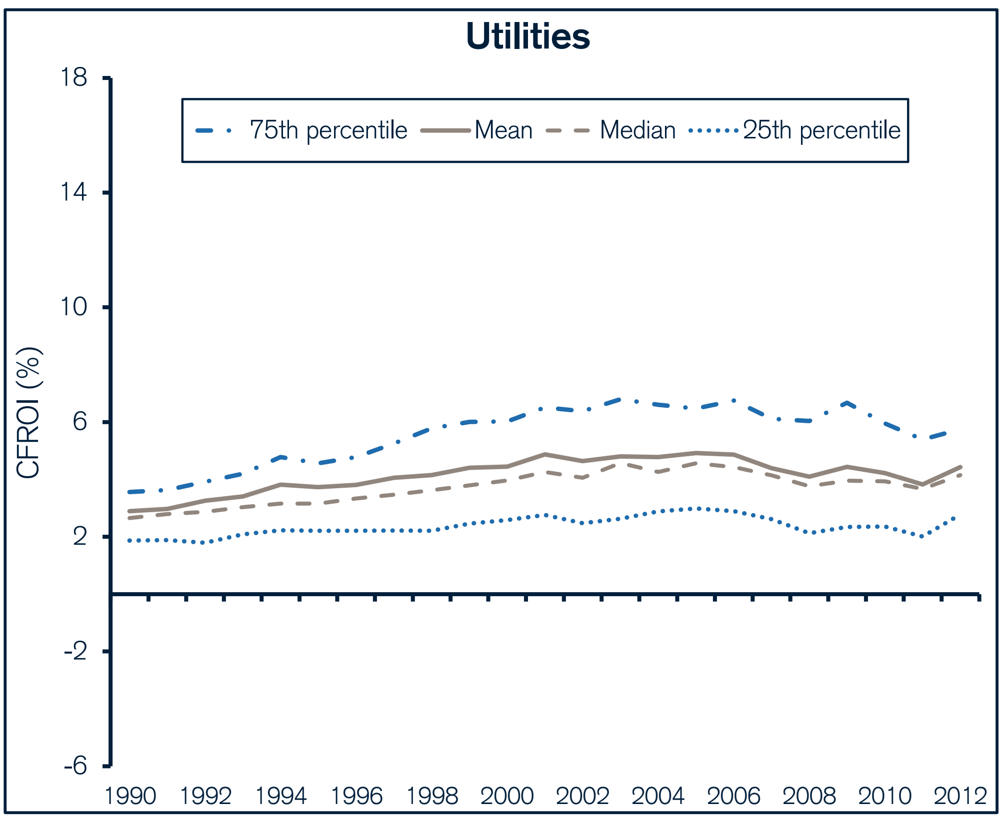


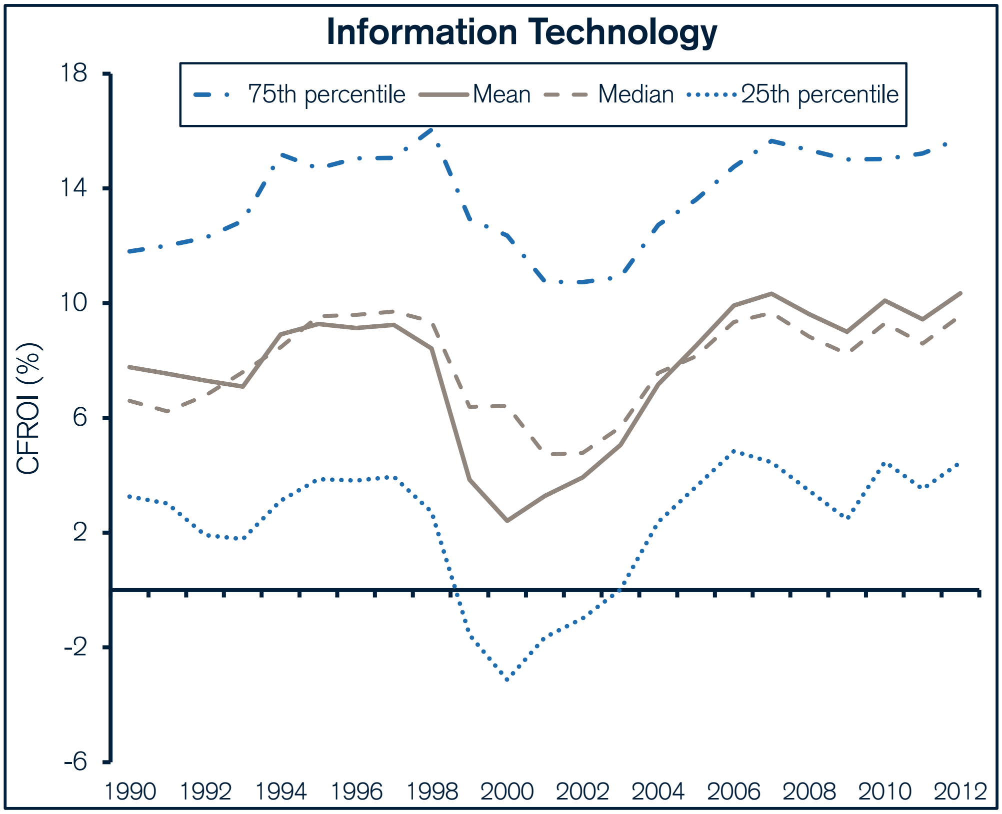


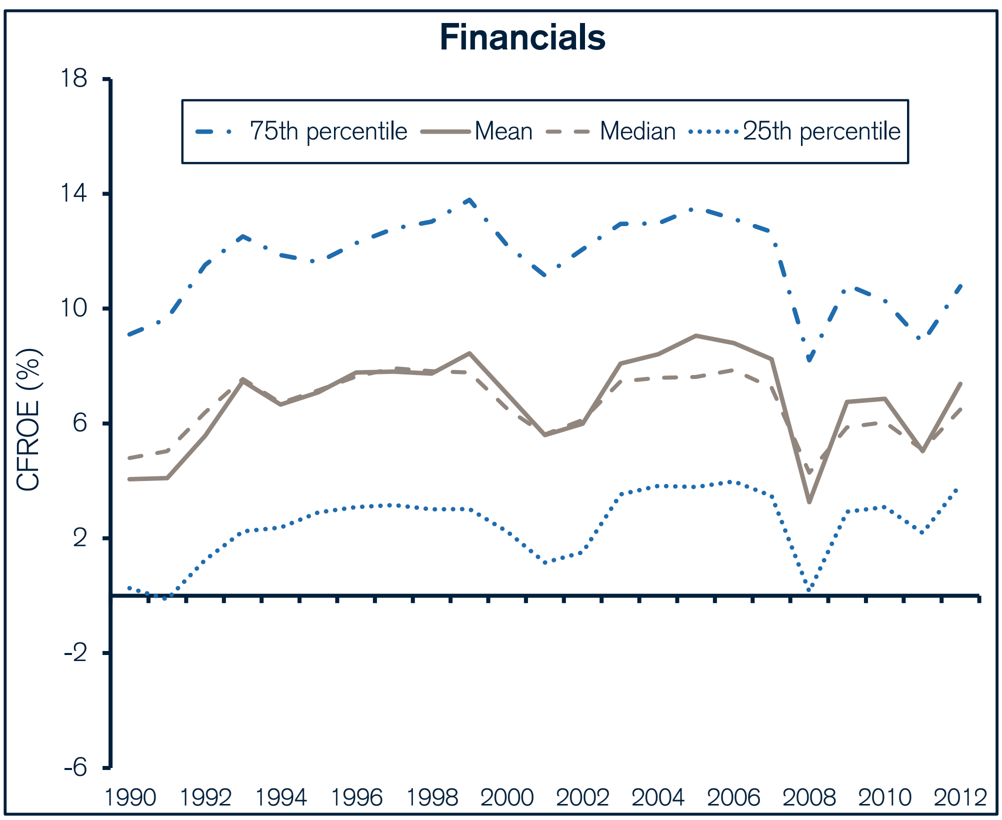

Consumer Discretionary
75th percentile
Mean
Median
25th percentile
CFROI (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012

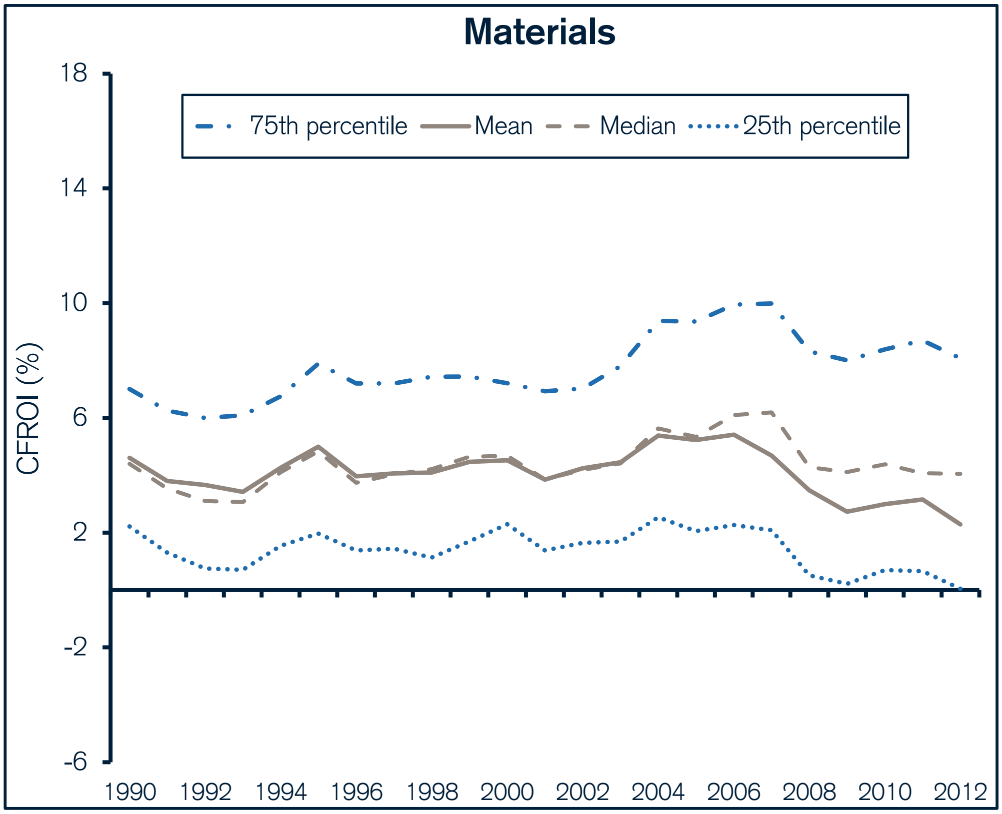

Industrials
75th percentile
Mean
Median
25th percentile
CFROI (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012

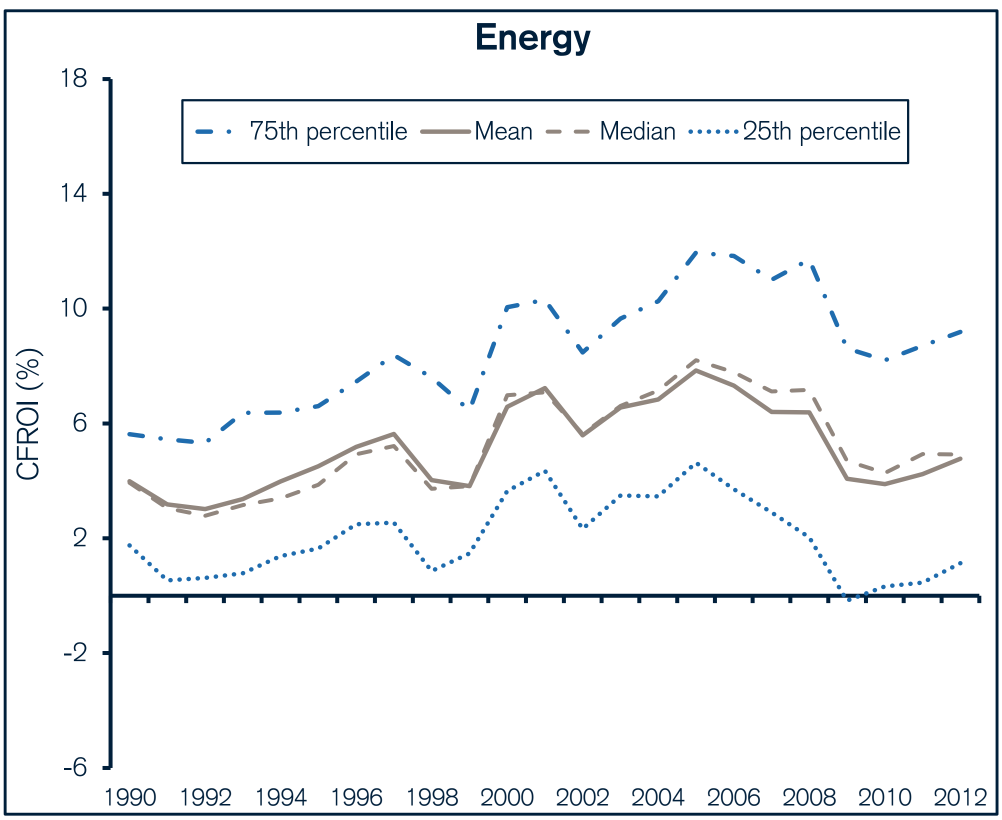

Telecommunication Services
75th percentile
Mean
Median
25th percentile
CFROI (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012


Utilities
75th percentile
Mean
Median
25th percentile
CFROI (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012


Information Technology
75th percentile
Mean
Median
25th percentile
CFROI (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012


Financials
75th percentile
Mean
Median
25th percentile
CFROE (%)
18
14
10
6
2
-2
-6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012





Source: Credit Suisse HOLT.

Important information

This document was produced by and the opinions expressed are those of Credit Suisse as of the date of writing and are subject to change. It has been prepared solely for information purposes and for the use of the recipient. It does not constitute an offer or an invitation by or on behalf of Credit Suisse to any person to buy or sell any security. Nothing in this material constitutes investment, legal, accounting or tax advice, or a representation that any investment or strategy is suitable or appropriate to your individual circumstances, or otherwise constitutes a personal recommendation to you. The price and value of investments mentioned and any income that might accrue may fluctuate and may fall or rise. Any reference to past performance is not a guide to the future.

The information and analysis contained in this publication have been compiled or arrived at from sources believed to be reliable but Credit Suisse does not make any representation as to their accuracy or completeness and does not accept liability for any loss arising from the use hereof. A Credit Suisse Group company may have acted upon the information and analysis contained in this publication before being made available to clients of Credit Suisse. Investments in emerging markets are speculative and considerably more volatile than investments in established markets. Some of the main risks are political risks, economic risks, credit risks, currency risks and market risks. Investments in foreign currencies are subject to exchange rate fluctuations. Before entering into any transaction, you should consider the suitability of the transaction to your particular circumstances and independently review (with your professional advisers as necessary) the specific financial risks as well as legal, regulatory, credit, tax and accounting consequences. This document is issued and distributed in the United States by Credit Suisse Securities (USA) LLC, a U.S. registered broker-dealer; in Canada by Credit Suisse Securities (Canada), Inc.; and in Brazil by Banco de Investimentos Credit Suisse (Brasil) S.A.

This document is distributed in Switzerland by Credit Suisse AG, a Swiss bank. Credit Suisse is authorized and regulated by the Swiss Financial Market Supervisory Authority (FINMA). This document is issued and distributed in Europe (except Switzerland) by Credit Suisse (UK) Limited and Credit Suisse Securities (Europe) Limited, London. Credit Suisse Securities (Europe) Limited, London and Credit Suisse (UK) Limited, authorised by the Prudential Regulation Authority (PRA) and regulated by the Financial Conduct Authority (FCA) and PRA, are associated but independent legal and regulated entities within Credit Suisse. The protections made available by the UK's Financial Services Authority for private customers do not apply to investments or services provided by a person outside the UK, nor will the Financial Services Compensation Scheme be available if the issuer of the investment fails to meet its obligations. This document is distributed in Guernsey by Credit Suisse (Guernsey) Limited, an independent legal entity registered in Guernsey under 15197, with its registered address at Helvetia Court, Les Echelons, South Esplanade, St Peter Port, Guernsey. Credit Suisse (Guernsey) Limited is wholly owned by Credit Suisse and is regulated by the Guernsey Financial Services Commission. Copies of the latest audited accounts are available on request. This document is distributed in Jersey by Credit Suisse (Guernsey) Limited, Jersey Branch, which is regulated by the Jersey Financial Services Commission. The business address of Credit Suisse (Guernsey) Limited, Jersey Branch, in Jersey is: TradeWind House, 22 Esplanade, St Helier, Jersey JE2 3QA. This document has been issued in Asia-Pacific by whichever of the following is the appropriately authorised entity of the relevant jurisdiction: in Hong Kong by Credit Suisse (Hong Kong) Limited, a corporation licensed with the Hong Kong Securities and Futures Commission or Credit Suisse Hong Kong branch, an Authorized Institution regulated by the Hong Kong Monetary Authority and a Registered Institution regulated by the Securities and Futures Ordinance (Chapter 571 of the Laws of Hong Kong); in Japan by Credit Suisse Securities (Japan) Limited; elsewhere in Asia/Pacific by whichever of the following is the appropriately authorized entity in the relevant jurisdiction: Credit Suisse Equities (Australia) Limited, Credit Suisse Securities (Thailand) Limited, Credit Suisse Securities (Malaysia) Sdn Bhd, Credit Suisse AG,Singapore Branch,and elsewhere in the world by the relevant authorized affiliate of the above.

CREDIT SUISSE