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# The Effectiveness of Sell Discipline Strategies in Institutional Portfolios

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**Abstract**

Prospect theory predicts that individuals will be risk seeking when faced with a potential loss. An implication is that investors may be reluctant to sell losing stocks, leading to potentially greater losses. This study explores whether institutional portfolio performance is significantly related to the manager's stated sell discipline strategy. Six distinct sell discipline approaches are compared using four performance metrics. As predicted by prospect theory, this study finds sell discipline to be a statistically significant factor in performance for all performance metrics. The results also show that the best sell discipline strategy is dependent on which performance metric is used.

# The Effectiveness of Sell Discipline Strategies in Institutional Portfolios

## 1. Introduction

The decision on how or when to buy a stock has been given much thought by the investment community. Valuation methods and stock investing styles are pervasive throughout the field in finance, and many different methods have been put through rigorous empirical testing. Aside from the buy decision, many practitioners also note the importance of a consistent and rational sell discipline to successful portfolio management. A systematic approach to the sell decision can help the investor avoid attachment to the stock and unnecessary losses. Despite the supposed importance, most recommendations on when to sell are not clearly defined, and have not been put to the test in a scientific manner.

The purpose of this thesis is to explore whether certain sell disciplines are more effective than others. The study analyzes a large set of institutional portfolios from the Plan Sponsor Network (PSN) database, which provides information on fund characteristics, investment styles and securities utilized. The PSN database surveyed portfolios, and categorized sell disciplines into six main strategies: Up from Cost, Down from Cost, Valuation Level, Fundamental Deterioration Overview, Target Price, and Opportunity Cost. The study focuses on these six strategies and tests whether specific disciplines offer significantly higher returns than others, and under what circumstances specific strategies tend to be more effective. Fund performance under the six sell disciplines is analyzed over the period of January 2003 to August 2008, and

performance is measured by raw returns, benchmark-adjusted returns, risk-adjusted returns, and information ratio. Faugère et al. (2004) explored the topic of sell disciplines over the bull and bear markets between January 1996 and December 2002, and this study aims to shed light on sell disciplines under the subsequent bull market and financial crisis that ensued.

## 2. Literature Review

Discipline and rational criteria for when to sell a stock are considered vital to the management of a sound portfolio. Many recommendations for strategies can be found by practitioners, but the topic of sell discipline has not been studied scientifically by many sources, and has been largely ignored by academic journals. Norris (2002) discusses common advice such as keeping gaining stocks, cutting losses early, and even completely automating the sell decision. Norris himself recommends a sell discipline that involves specifying and quantifying the thesis behind the buy decision, and then selling at the reversal of the buy thesis. Although this approach may seem intuitive, Norris does not test the effectiveness of this strategy rigorously, and little light is shed on which sell discipline offers the best performance.

Although research into the topic has been scarce, Faugère et al. have contributed in the form of empirical research by analyzing the performance and other characteristics of funds with different sell disciplines. Additionally, the field of behavioral finance provides insight into the psychology of investors and how the sell decision may be flawed, and may provide a theoretical framework to explain the empirical findings.

## 2.1 Empirical Studies

Faugère et al. were the first to analyze this topic in a scientific manner. Faugère et al. explored portfolio characteristics and sell disciplines, the significance of sell disciplines on risk-adjusted returns and risk, the effectiveness of six individually defined sell disciplines, and sell discipline efficacies under different market conditions. The study used survey data from the Plan Sponsor Network (PSN) database to compare mutual funds with different sell disciplines. The PSN database defines six different sell disciplines as follows: Down from Cost, Up from Cost, Target Price, Valuation Level, Fundamental Deterioration Overview, and Opportunity Cost. Down from Cost and Up from Cost strategies set a maximum price gain or loss, and a sale is triggered if either boundary is hit. The Target Price discipline has a target price specified at the time of purchase, which should not be exceeded. The Valuation Level discipline is similar to the target price in that valuation should not be exceeded. Fundamental Deterioration Overview is a more subjective discipline where the sale is based on the overall deterioration of the industry or specific business. Lastly, Opportunity Cost is a discipline where a sale is made when better opportunities become available.

Using the six sell disciplines defined by the PSN database, Faugère et al. test for differences over two distinct periods. As the authors expected a difference in up and down markets, they studied the bull market between January 1996 and March 2000, and the bear market between April 2000 and December 2002. Using a two-factor risk-return model, the authors find that a mutual fund's sell discipline is a statistically significant factor in returns over the time period. Considering the sell decision as a factor improved their regressions by 2% in an up market, and 5% in a down market, suggesting sell discipline is a significant factor in returns overall, and perhaps even more so in a down market.

After finding that the sell decision is a statistically significant factor on returns, the authors test the individual disciplines to see which offer the best benchmark-adjusted returns. The authors find that during bull markets, the fundamental deterioration overview strategy provided the highest benchmark-adjusted returns, with target price following, and valuation level performing the worst. The opposite was found for bear markets, where valuation level provided the highest benchmark-adjusted returns, with target price following, and fundamental deterioration overview performed the worst.

The study on sell discipline is an important contribution in that it is the first to analyze the subject rigorously, show the statistical significance of sell disciplines on returns, and has the key finding that the best sell discipline is dependent on the market environment. Although sell discipline has not been studied much, the field of behavioral finance has provided some insights into the sell decision, common fallacies regarding investment decisions, and perhaps a theoretical framework behind the findings of Faugère et al.

**2.2 Behavioral Contributions**

Jason Zweig (2011) explains, "Individual investors are 50% more likely to sell a winning stock than a loser – even though, on average, the stocks these investors sell go on to outperform while those they hold onto underperform." In addition, Zweig claims that mutual fund managers who hold onto losers underperform those who cut their losses by four percentage points. This idea is echoed by David Genovese in his study on seller behavior in the housing market. Genovese finds market participants are loss averse, and that home owners who expect a loss attempt to sell at a price 25 and 35 percent higher than others in the market. Genovese explains that under prospect theory, investors lose more utility when realizing losses than they gain when

realizing gains and this causes investors to be reluctant to realize losses. Given the reluctance to realize losses, investors may be inclined to hold on to stocks, hoping that they recover. As the prices continue to drop, the investor may feel the price is too low and continue to hold the stock, incurring significantly more losses than if the investor had cut the losses early. Adherence to a strict sell discipline can prevent this type of cognitive bias, and allow the investor to avoid unnecessary losses, especially in a down market where the securities tend to drop for significant periods of time.

Kahneman and Tversky (1979) introduced the underlying theoretical framework behind the findings of Zweig and Genovese, and perhaps Faugère et al. Prospect Theory challenges the ubiquitous expected utility theory as a descriptive model for decision making under risk. The primary finding of prospect theory is the existence of a certainty premium for positive prospects and a risk seeking preference for negative prospects. Kahneman found that when faced with a positive prospect such as a financial gain, respondents would prefer a certain gain, with a lower expected value, to that of a probabilistic gain with a higher expected value. Under expected utility theory, a person should prefer an 80% chance to win $4,000 ($3,200 expected value) over a guaranteed $3000 ($3,000 expected value). Kahneman finds, however, that 80% of respondents would prefer the guaranteed $3,000 despite its lower expected value. This shows a form of certainty premium and risk aversion for positive prospects. Most interesting, and perhaps most relevant to sell discipline, are the study's findings on negative prospects. When the problem is reversed, and respondents are now faced with a negative prospect such as financial loss, the opposite occurs, and respondents become risk seeking in order to avoid a guaranteed loss. Under expected utility theory, a sure loss of $3,000 should be preferable to an 80% chance at a loss of $4,000, as the latter option has an expected loss that is $200 greater than the former option.

Despite the risk aversion of positive prospects and the higher expected loss, 92% of respondents chose an 80% chance at a $4,000 loss. This shows that risk tolerance is not symmetric across negative and positive prospects, and that individuals actually tend to seek risk when faced with negative prospects as they want to avoid a guaranteed loss. Markowitz (1952) and Tobin (1958) have noted the certainty premium, and attributed it to the idea that individuals prefer lower variability. This does not address negative prospects however, as the respondents actually preferred the option with worse expected value and higher variability.

In addition to the empirical findings through questionnaires, Kahneman proposes a modified utility theory which is of consequence to analyzing sell disciplines. In contrast to expected utility theory, Kahneman proposes a value function in which changes in utility or wealth are not considered independent of the initial position or reference point. Prospect theory claims that the value function has negative concavity for prospects greater than the reference point and a positive concavity for prospects lesser than the reference point, which implies diminishing marginal value of gains and losses. As losses can often cause a shift in living standards, there may be occurrences of negative concavity for prospects less than the reference point, causing the value function to become asymmetric with respect to the value of gains and losses, with losses having a steeper slope. More simply, a financial loss has a much greater effect on the individual than a financial gain.

Prospect theory is valuable to the study of sell discipline in that it provides a theoretical framework for the empirical findings of the previous authors. The theory is consistent with the findings of Zweig and Genovese in that selling a losing stock or piece of real estate is essentially guaranteeing a loss, which is not preferred by individuals. By holding onto the losing asset, they avoid locking in a loss, and prefer to take a chance that their loss will be minimized or eliminated

through price appreciation. In becoming risk seeking to avoid losses, the investor opens themself up to further loss potential, and essentially accepts a lower expected value by Zweig's findings of lower returns for losing stocks. The risk averse investor would accept a guaranteed loss, and end up with a higher utility through avoiding future losses. In this sense, a strict sell discipline could help an investment manager avoid their own cognitive biases, and reap higher returns.

The contributions from behavioral finance are important in that they in part explain the results of the Faugère et al. study. During a bear market, where most investors are facing losses, the valuation sell discipline performs best. Under this market environment, a more mechanistic discipline works best, as it forces the investor to realize losses instead of holding onto a losing stock, which prospect theory implies there is a tendency to do. With a more subjective sell discipline such as Fundamental Deterioration Overview, the investor may be more prone to risk seeking to avoid losses, and will hold onto a losing stock incurring further losses.

Given the theoretical framework of behavioral finance, it is suspected that sell disciplines will have an impact on mutual fund performance, especially during down markets. More explicitly, the hypothesis is that average monthly returns, risk-adjusted monthly returns, benchmark-adjusted monthly returns, and information ratio are not equivalent across sell disciplines, and that sell discipline can have an impact on the returns of a portfolio. This can be expressed by the following:

$$H_0: \overline{R_{DC}} = \overline{R_{UC}} = \overline{R_{VL}} = \overline{R_{FD}} = \overline{R_{TP}} = \overline{R_{OC}}$$

$$H_1: \overline{R_{DC}} \neq \overline{R_{UC}} \neq \overline{R_{VL}} \neq \overline{R_{FD}} \neq \overline{R_{TP}} \neq \overline{R_{OC}}$$

### 3. Data and Methodology

The hypothesis is tested by analyzing a survey of funds provided by the PSN database. The survey is updated through August 2008, and includes data on 11,739 mutual funds. Of these funds, 983 are balanced funds and 2,957 are fixed income, which will not be analyzed as the sell discipline strategies do not apply. Of the total 7,799 equity funds, only 4,056 report all the necessary variables and will comprise the sample of this study. The PSN database is not survivor biased, which prevents the results from being skewed by only accounting for winning portfolios. The PSN database lists many portfolio characteristics, such as market capitalization, which can be controlled for when regressing sell discipline onto returns. There are six different sell discipline strategies as explained above. The sell discipline of the fund is decided through a survey response, and is the sell discipline used most often by the portfolio manager. The type of discipline is up to the discretion of the fund itself, and it is possible that the fund uses many different sell disciplines or a combination of sell disciplines. Exhibit 1 summarizes the types of sell disciplines categorized by the PSN database.

| Sell Discipline (Exhibit 1) | | |
|---|---|---|
| **Strategy** | **Type** | **Description** |
| Down from Cost | Mechanical/Restrictive | sell when a security exceeds the maximum allowable loss |
| Fundamental Deterioration Overview | Subjective/Less Restrictive | sell on the deterioration or reversal of the investment thesis |
| Opportunity Cost | Subjective/Less Restrictive | sell when more lucrative investments are identified |
| Target Price | Mechanical/Restrictive | sell when a specific target price is surpassed |
| Valuation Level | Mechanical/Restrictive | sell when a specific valuation metric is surpassed |
| Up from Cost | Mechanical/Restrictive | sell when a security exceeds the maximum allowable gain |

**3.1 Sell Discipline Frequency**

In the universe of 7,799 funds classified as equity, 2,332 funds do not report which sell discipline is used most often. A large majority of equity portfolios do report the predominant sell discipline, with over 70% reporting. This gives a total sample size of 5,467 out of 7,799 in which the funds report sell discipline. Out of the 5,467 funds which report sell discipline, only 4,056 funds report all the necessary information such as management tenure and monthly returns.

From the data, favorite sell disciplines emerge, with some strategies clearly dominating others in terms of popularity. The favorites are consistent across market capitalization and the total universe of funds. Fundamental Deterioration Overview (FDO) is by far the most popular, representing 49% of all disciplines used in the universe. Following FDO is Valuation Level (VL) at 34%, Target Price (TP) at 12%, Opportunity Cost (OC) at 3%, Down from Cost (DFC) at 1%, and Up from Cost (UFC) at 0%.

The frequency of sell disciplines remains consistent across market capitalizations, with the rank above holding for all market capitalizations except for micro capitalization funds. In micro capitalization funds, the Valuation Level strategy is as equally prevalent as the Fundamental Deterioration Overview strategy. These results are summarized in Exhibit 2 below.

| Sell Discipline Categories (Exhibit 2) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL | UFC | |
| **Fund Type** | | | | | | | |
| Equity | 56 | 1984 | 127 | 499 | 1390 | 0 | **4056** |
| | 1% | 49% | 3% | 12% | 34% | 0% | |
| **Market Capitalization** | | | | | | | |
| Micro Cap | 0 | 14 | 0 | 5 | 14 | 0 | **33** |
| | 0% | 42% | 0% | 15% | 42% | 0% | |
| Small Cap | 9 | 423 | 25 | 109 | 271 | 0 | **837** |
| | 1% | 51% | 3% | 13% | 32% | 0% | |
| Mid Cap | 2 | 306 | 10 | 83 | 174 | 0 | **575** |
| | 0% | 53% | 2% | 14% | 30% | 0% | |
| Large Cap | 30 | 939 | 68 | 203 | 645 | 0 | **1885** |
| | 2% | 50% | 4% | 11% | 34% | 0% | |
| All Cap | 15 | 302 | 24 | 99 | 286 | 0 | **726** |
| | 2% | 42% | 3% | 14% | 39% | 0% | |

Sell discipline can also be separated by the buy decision. When broken up by buy decision some differences in sell discipline frequencies arise. Funds whose primary buy decision is quantitative prefer valuation level to fundamental deterioration overview by a 10% margin. Quantitative and computer-screening funds were also less likely to use the target price sell discipline, with target price being used with the fifth most frequency compared to the third most frequency for the entire sample. Lastly, top-down funds were more likely to use down from cost rather than opportunity cost, which is the reverse of the sample's frequency. These results can be summarized by Exhibit 3 below.

| The Buy and Sell Decision (Exhibit 3) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL | UFC | |
| **Buy Type** | | | | | | | |
| Bottom-Up | 16 | 1306 | 48 | 392 | 834 | 0 | **2596** |
| | 1% | 50% | 2% | 15% | 32% | 0% | |
| Computer-Screening | 17 | 51 | 20 | 7 | 38 | 0 | **133** |
| | 13% | 38% | 15% | 5% | 29% | 0% | |
| Fundamental Analysis | 0 | 252 | 13 | 64 | 142 | 0 | **471** |
| | 0% | 54% | 3% | 14% | 30% | 0% | |
| Quantitative | 11 | 200 | 32 | 9 | 253 | 0 | **505** |
| | 2% | 40% | 6% | 2% | 50% | 0% | |
| Top-Down | 5 | 64 | 3 | 10 | 42 | 0 | **124** |
| | 4% | 52% | 2% | 8% | 34% | 0% | |
| Other | 7 | 111 | 11 | 17 | 81 | 0 | **227** |
| | 3% | 49% | 5% | 7% | 36% | 0% | |

## 3.2 Performance Metrics

The study analyzes four performance metrics over the period from January 2003 to August 2008. Monthly Return, Risk-adjusted Monthly Return, Benchmark-adjusted Monthly Return, and Information Ratio are tested for the period. Monthly return represents the average monthly raw returns over the period for each fund. Risk-adjusted returns (RAR) represent monthly return adjusted by the fund's average standard deviation over the same time period. Benchmark-adjusted returns (BAR) are monthly returns adjusted by each fund's respective benchmark, and Information Ratio is the benchmark-adjusted return adjusted by the standard deviation over the same period. All performance metrics are limited to the period in which the current manager has managed the portfolio in order to capture a true performance metric for each individual fund.

Over the period from January 2003 to August 2008, the Target Price sell discipline was associated with the highest average monthly returns, while the Opportunity Cost strategy had the lowest returns. Funds with the Target Price strategy had average monthly returns of 1.23%, while the Opportunity Cost strategy had returns of 1.01%. Valuation Level performed next best and saw returns of 1.13%, Fundamental Deterioration Overview performed at mid-level with returns of 1.08%, while Down from Cost posted returns of 1.18%. Fundamental Deterioration Overview, by far the most popular discipline, performed third to last. Target Price and Valuation Level were associated with high-level performance, which is inconsistent with their popularity.

Risk-adjusted returns for the five sell disciplines were fairly consistent to the raw monthly returns. Target Price posted the highest risk-adjusted returns with 0.34%, however Down from Cost had the lowest with 0.19%, despite having better raw returns than Opportunity Cost. Valuation Level again had the second highest with 0.32%, with FDO following at 0.31% and Opportunity cost at 0.30%.

Benchmark-adjusted returns differ significantly from raw and risk-adjusted returns. Opportunity Cost performed best in benchmark-adjusted returns with 0.18% despite performing at mid-level for raw and risk-adjusted returns. Fundamental Deterioration Overview had average BAR of 0.09% slightly beating out Target Price at 0.09%. Valuation Level returned 0.06% while Down from Cost performed worst with 0.04%.

Information Ratio (IR) was relatively consistent with the BAR results. Opportunity Cost again performed best with an IR 0.12%. Target Price exceeded FDO with 0.06% versus 0.05%. Lastly Valuation Level posted 0.02% and Down from Cost performed worst with -0.09%. These performance metrics can be summarized by Panel C and Graph C below.

Performance by Sell Discipline (Exhibit 4)
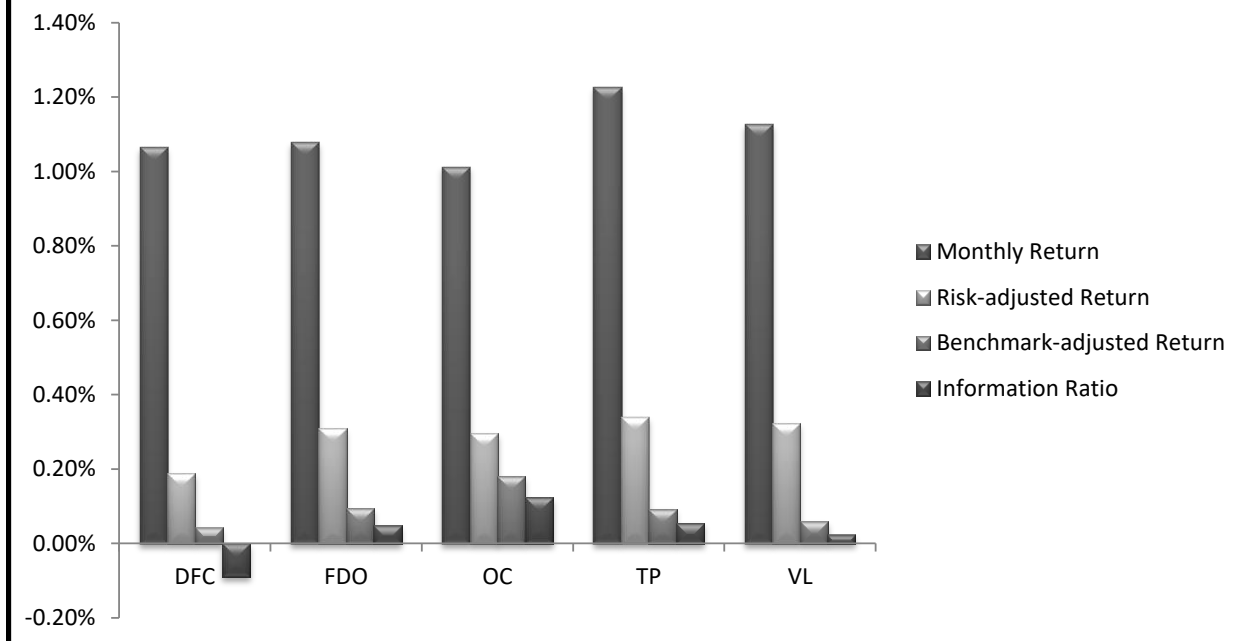
| Performance Metrics (Exhibit 5) | | | | | | |
|---|---|---|---|---|---|---|
| | **DFC** | **FDO** | **OC** | **TP** | **VL** | **Sample** |
| **Performance Metric** | | | | | | |
| Monthly Return | 1.06% | 1.08% | 1.01% | 1.23% | 1.13% | **1.11%** |
| (Rank) | 4 | 3 | 5 | 1 | 2 | |
| Risk-adjusted Return | 0.19% | 0.31% | 0.30% | 0.34% | 0.32% | **0.32%** |
| (Rank) | 5 | 3 | 4 | 1 | 2 | |
| Benchmark-adjusted Return | 0.04% | 0.09% | 0.18% | 0.09% | 0.06% | **0.09%** |
| (Rank) | 5 | 2 | 1 | 3 | 4 | |
| Information Ratio | -0.09% | 0.05% | 0.12% | 0.06% | 0.02% | **0.04%** |
| (Rank) | 5 | 3 | 1 | 2 | 4 | |

## 4. Analysis

In order to test whether sell disciplines have a significant impact on the various performance metrics, Analysis of Variance (ANOVA) and multi-regression and will be performed on the strategies. Down from Cost, Fundamental Deterioration Overview, Opportunity Cost, and Target price are all assigned 1 or 0 as a dummy variable, with Valuation Level left out to be reflected within the y-intercept of the regression model. The regression models can be written as follows:

$$\widehat{y_{PM}} = \propto_{VL} + \beta Xi_{DFC} + \beta Xi_{FDO} + \beta Xi_{OC} + \beta Xi_{TP}$$

### 4.1 Monthly Raw Returns

The ANOVA on average monthly raw returns with sell discipline strategies as explanatory variables produces an F-statistic of 5.06, which corresponds to a p-value superior to the 1% level. This implies that sell discipline choice is associated with significant differences in monthly raw returns.

The individual slope coefficients of the dummy variables are 1.13 for Valuation Level, the variable reflected in the y-intercept, 0.06 for Down from Cost, -0.05 for Fundamental Deterioration Overview, -0.12 for Opportunity Cost, and 0.10 for Target Price. This can be interpreted as the DFC strategy offered 6 basis points in returns over the VL strategy, with FDO underperforming by 5 basis points, OC underperforming by 12 basis points, and TP outperforming by 10 basis points. Of these slope coefficients, all but Down from Cost are found to be statistically significant. VL, FDO, OC, and TP are statistically significant at 99%, 95%, 90%, and 99% significance levels, respectively.

| Monthly Raw Returns (Exhibit 6) | | | | | |
|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL |
| Coefficient | 0.06 | -0.05 | -0.12 | 0.10 | 1.13 |
| P-value | 54.9% | 4.9% | 9.0% | 1.0% | 0.0% |
| T-statistic | 0.60 | -1.97 | -1.70 | 2.59 | 57.35 |
| Significance | N/A | 95% | 90% | 99% | 99% |

As implied by Prospect Theory, the more subjective and less restrictive sell disciplines such as Fundamental Deterioration Overview and Opportunity Cost underperformed relative to Valuation Level, and more mechanic and restrictive sell discipline. Target Price was the only sell discipline which had a statistically significant outperformance measure relative to Valuation Level.

### 4.2 Monthly Risk-adjusted Returns

The ANOVA on monthly risk-adjusted returns produced an F-statistic of 2.75, which equates to a p-value of 3%. Sell discipline has a statistically significant impact on risk-adjusted returns, but at a lower confidence level than raw returns.

On an individual basis, VL had a coefficient of 0.32, with DFC, FDO, OC, and TP at 0.01, -0.01, -0.03, and 0.02 respectively. Of these disciplines, only Valuation Level and Fundamental Deterioration Overview are statistically significant. FDO is statistically different from VL, and produces 1 basis point per month in underperformance relative to the Valuation Level discipline. Similar to raw returns, the less restrictive strategies produced negative coefficients, but in this case only FDO was significant.

| Monthly Risk-adjusted Raw Returns (Exhibit 7) | | | | | |
|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL |
| Coefficient | 0.01 | -0.01 | -0.03 | 0.02 | 0.32 |
| P-value | 66.0% | 7.2% | 15.5% | 12.9% | 0.0% |
| T-statistic | 0.44 | -1.80 | -1.42 | 1.52 | 57.33 |
| Significance | N/A | 90% | N/A | N/A | 99% |

## 4.3 Monthly Benchmark-adjusted Returns

Analysis of Variance on benchmark-adjusted returns produced an F-statistic of 4.62. The p-value associated with this F-statistic is 0.00%, implying sell discipline is a statistically significant factor in BAR at a confidence level greater than 99%.

The coefficients of the sell disciplines were all statistically significant at least at a 90% confidence level. VL, the baseline variable, had a coefficient of 0.06. DFC, FDO, OC, and TP had respective coefficients of 0.11, 0.03, 0.12, and 0.03. On a benchmark-adjusted basis, all of the six disciplines saw outperformance relative to the Valuation Level strategy. Opportunity Cost saw the greatest outperformance despite being a more subjective sell discipline. FDO however performed poorly relative to the other restrictive strategies such as Down from Cost.

| Monthly Benchmark-adjusted Returns (Exhibit 8) | | | | | |
|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL |
| Coefficient | 0.11 | 0.03 | 0.12 | 0.03 | 0.06 |
| P-value | 4.15% | 0.92% | 0.05% | 9.07% | 0.00% |
| T-statistic | 2.04 | 2.61 | 3.49 | 1.69 | 57.33 |
| Significance | 95% | 99% | 99% | 90% | 99% |

## 4.4 Information Ratio

ANOVA for monthly information ratio found an F-statistic of 3.19 and a p-value of 1%. This suggests that sell discipline is a statistically significant explanatory variable for information ratio to the 99% level.

The multi-regression with dummy variables produced 4 statistically significant slope coefficients. DFC was not significantly different from VL, while FDO, OC, and TP were. VL had a slope coefficient of 0.02, while DFC, FDO, OC, and TP had slope coefficients of 0.02, 0.03, 0.01, and 0.03 respectively. Target Price achieved the greatest relative outperformance, with the two subjective disciplines lagging slightly. TP achieved 3 basis points of outperformance while OC outperformed by slightly under 1 basis point and FDO outperformed by 2.5 basis points.

Again the more restrictive sell disciplines outperform to the largest degree, which is consistent with the theoretical implication.

| Monthly Information Ratio (Exhibit 9) | | | | | |
|---|---|---|---|---|---|
| | DFC | FDO | OC | TP | VL |
| Coefficient | 0.021 | 0.026 | 0.100 | 0.032 | 0.023 |
| P-value | 65.37% | 3.28% | 0.17% | 7.26% | 1.07% |
| T-statistic | 0.45 | 2.13 | 3.14 | 1.80 | 2.55 |
| Significance | N/A | 95% | 99% | 90% | 95% |

## 4.5 ANOVA Results

Overall the Analysis of Variance test found that sell discipline is a significant explanatory factor in performance. The test found a statistical significance for all the performance metrics, with p-values ranging from less than 1% in raw returns and BAR, to 3% in RAR.

| ANOVA Summary (Exhibit 10) | | | | |
|---|---|---|---|---|
| | **Raw Return** | **RAR** | **BAR** | **IR** |
| F-Statistic | 5.06 | 2.75 | 4.62 | 3.19 |
| P-value | 0.05% | 2.68% | 0.10% | 1.26% |

## 5. Conclusion

The high F-statistics for each performance regression provide strong evidence for rejecting the null hypothesis that sell discipline has no impact on performance. Each of the four performance regressions had F-statistics well beyond the 95% confidence levels, with 2 metrics surpassing the 99% confidence level.

The multi-regression using dummy variables also found statistically significant differences among slope coefficients for a large majority of the individual sell disciplines. All of the coefficients for BAR were significant, while IR and raw returns had significance in 4 out of 5 coefficients. The RAR performance however only had significance in 2 of the coefficients.

Statistical significance in a total of 17 out of 20 coefficients provides strong evidence against the null hypothesis that the sell disciplines produce equivalent performance. Given the p-values and confidence levels, the null hypothesis is rejected.

In terms of performance, the more restrictive sell disciplines tended to perform better. Target Price provided the greatest outperformance for raw returns, while FDO and OC provided significant underperformance relative to Valuation Level. For RAR, FDO again had significance underperformance relative to VL, while the other disciplines did not significantly differ from the benchmark. For these performance metrics the more subjective disciplines underperformed while the more restrictive disciplines outperformed or were neutral.

For BAR and IR, the FDO strategy continues to underperform relative to the other strategies, but the subjective OC discipline performed best in both categories. This is inconsistent with the previous metrics and creates some ambiguity as to whether the more restrictive sell disciplines tend to do better.

Overall, the more restrictive sell disciplines tended to perform best, as they either had the highest relative performance, or did not lag far behind the more subjective disciplines. The evidence is not conclusive however, and it seems to an extent the best sell discipline is dependent on which performance metric is used. Without adjusting for benchmarks, restrictive disciplines were the clear winner. Once benchmarks are introduced the answer becomes less clear.

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