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The Second-Order Risk of Portfolio Factor Bets

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Introduction

- It is widely asserted that active managers should avoid "inadvertent factor bets", but few people recognize all aspects of this concept. *What is often missed in the analysis is the potential performance impact of times series variation in accidental factor bets.*
- There a couple strands of logic behind idea. The first is that any active factor bet is a source of risk in terms of benchmark relative performance. If the factor bet is accidental we should have no expectation that it will enhance performance, so we are taking risk for no economic reward.
- However, the concept of an active factor bet is typically considered only at a moment in time.
- The second rationale is that "you only get hit by a car you don't see coming", so the potential for harm from an inadvertent bet is conceptually greater than from an intentional active bet.

Stylized Example

- Even if we are factor or industry neutral on average this does not guarantee that we are neutral at each moment in time.
  – Consider the example of a portfolio that has no particular "bullish" or "bearish" outlook on the market and so intends to have a market beta of one to the benchmark. If by virtue of security selection decisions the portfolio beta varies randomly over time from .7 to 1.3 there will be a very meaningful impact on active performance even if the average *portfolio beta is exactly one*
- We will illustrate the performance impact of random variation in the magnitude of factor bets. *We will show that in many cases the random time series variation in factor bets represents a far greater influence on realized performance than having a fixed level of those same factor bets, even if inadvertent.*
  – To the extent that more frequently rebalancing of portfolios can reduce both *average* factor bets and *also the random variation in bet magnitudes over time* the potential improvement in return/risk tradeoffs must be carefully weighed against the performance drag of greater transaction costs.

A Finer Definition of "Inadvertent"

- One of the misconceptions of the issue of inadvertent factor bets is that any factor bet for which there is no expectation of alpha must be inadvertent. This is not correct, unless your definition of factors requires that all common factors impacting the portfolio must be orthogonal, which cannot usually be achieved in the real world.
  - An inadvertent bet is one that contributes to greater portfolio risk than is necessary to fully achieve the intent of the portfolio strategy.
- Consider a portfolio manager who believes that corporate CEOs who have learned Latin are more effective and therefore their companies should be over-weighted relative to other firms.
  - Compared to conventional benchmark indices this will inevitably lead to over-weights in European and Latin American markets and underweighting of Asia/Pacific.
- Such geographic bets are *intentional rather than inadvertent* because they the unavoidable byproduct of the intended strategy.

Expectations of Non-Random "Style Drift"

- To describe the extent to which portfolios develop unintended factor bets over time, the term "style drift" is often used. The implicit assumption is that some factor bets (e.g. "small value") were intended, but that *random* market events change the magnitude of the active factor bets.
- *Active managers must believe their portfolios will outperform* benchmarks (even if this is an incorrect assumption).
  - For any strategy that is related to asset price movements, there must be an expectation of *non-random changes in active factor bets.*
  - For a "value" strategy to outperform, the securities must be less undervalued which implies a reduction in the magnitude of the intended bet and any required collateral bets. For a "momentum" strategy to outperform the securities must continue to outperform peers, which implies an increase in the magnitude of the intended bet and the required collateral bets.
- Another way to think of this problem is that any common factor strategy will exhibit "stale alphas" over time which trading costs will eventually offset. See Sneddon (JOI, 2008)

Endogenous Factors and "Intervaling" Effects

- Many commercial models of risk include the use of valuation ratios such as Earnings/Price or Book/Price. It is widely asserted that such models have the desirable feature of exactly observable factor exposures. This is simply untrue.
- Accounting based values such as earnings, book value, revenues and dividends are typically not updated more frequently than quarterly. In many countries, these accounting values are updated only annually.
- To the extent that security prices may change daily or even intraday, any relationship between a security price and an accounting variable is mis-specified by definition. Endogenous risk factors based on accounting ratios are no more exact that factors that are estimated by an appropriate regression or other statistical procedure.
- As such, *random drift in factor exposures is not mitigated* by use of fundamental factors for risk.

Example: Transient Inadvertent Bets

Fundamental Factor Return Impacts

Factor	Port Exposure	Bench Exposure	Actv Exposure	Factor Ret	Impact	Impact T	D*E
Price/Earnings	-0.42	-0.32	-0.09	0.01	-0.01	-0.62	0.00
Price/Books	0.29	0.31	-0.02	0.23	-0.01	-0.68	0.00
Dividend Yield	0.10	0.21	-0.11	0.20	-0.01	-0.89	-0.02
Trading Activity	-0.08	0.01	-0.09	0.08	-0.02	-1.10	-0.01
Relative Strength	-0.07	0.01	-0.09	-0.21	-0.05	-1.85	0.02
Market Cap	2.31	2.20	0.11	-0.24	-0.03	-1.75	-0.03
Earnings Variability	-0.43	-0.36	-0.07	-0.17	0.01	0.79	0.01
EPS Growth Rate	0.00	-0.04	0.04	-0.01	0.00	0.58	0.00
Price/Revenue	0.13	0.21	-0.08	-0.12	0.01	0.92	0.01
Debt/Equity	0.20	0.13	0.07	-0.13	-0.01	-0.57	-0.01
Price Volatility	-0.63	-0.63	0.00	-0.58	-0.01	-0.43	0.00
				Sum	-0.12		-0.03

Explaining the Table

- The table in the previous slide represents an analysis of a US equity portfolio against the S&P 500 benchmark for a 60 month period.
  - The first three columns (A,B,C) present 60 month average Z-score factor exposures under Northfield US Fundamental Model. The columns describe the portfolio, the benchmark and active exposure,
  - The fourth column (D) represents the 60 month average of the monthly factor returns to the factors. The fifth column (E) is the 60 month average of each factor's month by month impact of the contemporaneous factor bet times the relevant factor return. The sixth column (F) is the T stat on the average month impact (E)
  - The seventh column (G) is the simple product of the value in columns D and E. This represents what the average monthly impact of the factor would have been if the active factor exposure had been held constant.
- Notice that the summation of final column is only one quarter of the summation of the impact column. ***Seventy five percent of the negative performance impact came from shifting in the active factor exposures.*** Only twenty five percent of the effect came from persistent average exposure.

Long Term Variance Drain Effects

- Assume that a portfolio has beta one on average, but half the time is randomly beta = .7 and the other half the time beta = 1.3. Assume the market volatility is 20 and there is zero idiosyncratic risk.
- Variance of the portfolio:
  - (.5 * 20^2 * .7^2) + (.5 *20^2 * 1.3^2) = 436 = 20.88^2
- The incremental 36 units of variance will reduce the expectation of the absolute compounded equivalent fixed annual return by 18 basis points.
- If the beta switches are random, the 36 units of additional variance imply a tracking error of 6% (high for traditional asset managers).
- Under our "rule of thumb" based on the "Discretionary Wealth Hypothesis" of Wilcox (JPM, 2003) this is equivalent to a decrease of 30 basis points per annum in investor utility.

Balancing Rebalancing

- In the real world, things change and our parameter estimates for return, risk, and factor exposures are likely to change as well.
- If transaction costs are zero, we can simply adjust our portfolio composition constantly to optimally reflect our new information and beliefs whenever they change.
- If transaction costs are not free, the single period assumption is a serious problem.
- If transaction costs are large (e.g. capital gain taxes), the single period assumption is wholly unrealistic. Tax authorities also seem to be interested in things like weeks, months and especially "tax years."

Single Period Optimization: Unlike Units

- In trying to trade off between expected return, risk and transaction costs, over one time period we can't combine these items unless they are in the same units.
  - Transaction costs occur at a moment in time while risk and return are experienced over time
  - Common practice is extend the objective function to include transaction costs (C) that are linearly amortized at a periodic rate "A" that reflects the expected economic life of the benefits of the transaction

$$U = R - (S^2 / T) - (C \times A)$$

  - The expected average holding period for the positions resulting from a transaction is just the reciprocal of the expected one-way turnover

Multi-period Optimization

- Mossin (1968) suggests an explicit multi-period formulation for portfolio optimization.
- Cargill and Meyer (1987) focus on the risk side of the multi-period problem.
- Merton (1990) introduces continuous time analog to MVO
- Pliska (1997) provides a discrete time analog to MVO
- Li and Ng (2000) provide a framework for multi-period MVO using dynamic programming
- Multi-period optimization is rarely employed because you need *period by period expected values* for the return and risk inputs. Parameters typically have very high estimation error which limits real world use.

Smart Rebalancing

- Numerous "smart" rebalancing rules have been proposed to avoid trading costs when the expected improvement is not significant.
- Rubenstein (1991) examines the efficiency of continuous rebalancing and proposes a rule for avoiding spurious turnover.
- Kroner and Sultan (1993) propose a "hurdle" rule for rebalancing currency hedges when return distributions are time varying.
- Engle, Mezrich and Yu (1998) propose a hurdle on alpha improvement as the trigger for rebalancing.

Smarter Rebalancing

- Bey, Burgess, Cook (1990) use bootstrap resampling to identify "indifference" regions, along a fuzzy efficient frontier.

- Michaud (1998) uses resampling to measure the confidence interval on portfolio return and risk to form a "when to trade rule". Elaborated upon in Michaud and Michaud (2002) and patented.

- Markowitz and Van Dijk (2003) propose a rebalancing rule designed to approximate multi-period optimization, but argue it is mathematically intractable (at least in closed form).

- Kritzman, Mygren and Paige (2007) confirm the effectiveness of MvD(2003) to be similar to full dynamic programming up to five assets. They show that MvD can be used up to one hundred assets.

The Fundamental Law and Turnover

- In Grinold (1989), the "Fundamental Law of Active Management" describes one of the properties of a strategy as "breadth".
  - Breadth is often described as the "number of independent bets in a portfolio strategy" times annual turnover.
  - Per the Fundamental Law, Grinold and Stuckelman (1993) show that the value added by an investment strategy is approximately a *square root function of turnover, while dollar transaction costs are roughly a linear function of turnover, so an optimal level of turnover must exist for a given strategy.*
  - Quantifying the number of "independent bets" in a portfolio is problematic which has led to ad hoc choices of turnover levels.

Diamond Are Forever But Utility Isn't

- Once we've imposed a finite time horizon on a portfolio strategy, we also have to consider that probability that our optimal portfolio might underperform our current portfolios.
- Consider an optimal portfolio that is better than my current portfolio by *annual utility increment positive D.*
  - If I knew that the increment D would be fixed forever, we should be willing to pay a lot of trading costs now to get to the optimal portfolio. In the long run we know the optimal portfolio will provide more terminal wealth.
  - However, if we knew that increment D would only last 30 seconds, then we would not want to spend material trading costs now for a benefit that might not be realized during the horizon.

Probability of Realization

- We need to adjust the rate at which return/risk and trading costs are traded off to incorporate the likelihood that a positive increment in utility will be realized as better risk-adjusted returns during the expected active holding period.

- We define the probability of realization, P, like a one-tailed T test

$$P = N\left(\left(\left(Uo - Ui\right) / TEio\right) * \left(1/A\right)^{.5}\right)$$

N(x) is the cumulative normal function

The Algebra of Realization Probability

- The numerator is the improvement in utility (risk adjusted return) between the optimal and initial portfolios.

- The denominator is the tracking error between the optimal and initial portfolios. Essentially it's the standard error on the expected improvement in utility.
  - If there is no tracking error between the initial and optimal portfolios, P approaches 100%. Consider "optimizing a portfolio" by getting a manager to cut fees. The improvement in utility is certain no matter how short the time horizon. Not something to which we investors paid attention until recently.
  - If turnover is very low, A will approach zero, so P will approach 100%. For long time horizons, we have the classical case that assumes certainty

Recursion and What's Left?

- If we assume trading costs are small, so we don't have to worry about the geometric issues, we get that the active amortization constant should be divided by the probability of realization.
  - Optimal turnover in high frequency strategies could be cut by half.
- Unfortunately, the probability of realization is a function of the optimal portfolio, which itself is a function of the amortization constant.
- *The problem is recursive.*
  - For manual cases, we can either do a lot really complex algebra, or rely on a little trial and error. The Northfield optimizer already handles this.

Conclusions

- Unintended active factor bets are an important source of the risk of benchmark relative performance.
- Not all zero alpha factor bets are inadvertent. Some are the inevitable byproduct of a strategy.
- Time series variation in the magnitude of unintended factor bets can be an even larger contributor to the volatility of active performance than persistent bets on the same factors.
- The obvious solution for both persistent and transient unintended active factor bets is to formally rebalance portfolios as frequently as is possible given the required transaction costs.
- The traditional "single period" model of MVO must be supplemented with one of the many techniques to active "smarter rebalancing".