Factoring Profitability

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Recent studies in financial economics posit a connection between a gross-profitability strategy and quality investing. We explore this connection with two widely used factor models. The first is the four-factor Fama-French-Carhart model, which is a mainstay of empirical research in academia. The second is the Barra USE4 multi-factor model, which is a standard for practitioners. Our findings are:

- Consistent with results reported by other researchers, the Fama-French-Carhart model does not provide a satisfactory replication of the gross-profitability strategy over the period July 1995–December 2012.
- Over the same period, the Barra USE4 multi-factor model, which is a standard for practitioners, replicates a substantial portion of the gross-profitability strategy with quality and momentum factors.
- The book-to-market factor, which is one of three value factors in the Barra USE4 model and the only value factor in the Fama-French-Carhart model, does not make a significant contribution to the gross-profitability strategy.
- However, the Barra USE4 earnings-yield factor, which is another measure of value, *does* make a significant contribution to the gross-profitability strategy.

It is important to note that our results rely on relatively short data histories. We will not be able to determine the long-term efficacy until the data history itself is longer.

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Quality Is an Active Investment Strategy with a Long and Distinguished History

Quality, like value, momentum, and size, is a popular investment style or factor tilt that draws some investors away from market capitalization–weighted indexes.[1] The idea of quality investing is generally attributed to Graham (1949),[2] who characterized quality firms in terms of attractive features such as positive and stable earnings, low volatility, and low leverage. However, there is no single definition of quality just as there is no single definition of value.

Recent studies in financial economics connect quality investing to gross profitability, which is the difference between revenue and cost of goods divided by firm assets. The relationship between gross profitability and quality investing is developed in Novy-Marx (2013a):

> Gross profit is the cleanest accounting measure of true economic profitability. The farther down the income statement one goes, the more polluted profitability measures become, and the less related they are to true economic profitability.

The relationship is further developed further in Novy-Marx (2013b). Using a technique that is well established in the empirical finance literature, Novy-Marx (2013a) builds an idealized strategy based on the ranking of firms by gross profitability.[3] The word `"idealized" is important here: turnover, impediments to short selling, and other market frictions may render the gross-profitability strategy uninvestable. Nevertheless, the gross-profitability strategy can provide insight into the drivers of risk and return, and it serves as an element in the construction of the investable factor-tilted strategies mentioned above.[4,5]

According to Novy-Marx (2013a), the gross-profitability strategy earned a significant positive excess return between July 1963 and December 2010 over and above the product of its beta with the excess return of the market. This qualifies the gross-profitability strategy as a Capital Asset Pricing Model (CAPM) anomaly.[6] There are numerous candidate explanations for gross-profitability and other CAPM anomalies. For example, it may be that high-gross-profitability stocks were underpriced in July 1963 and overpriced in December 2010. If that is the case, high-gross-profitability stocks might be a poor investment at this point. It is also possible that the abnormal returns to high-gross-profitability stocks were a statistical fluke, in which case there is no compelling reason to buy them or not to buy them. The abnormal returns may be compensation for risk, in which case each investor needs to evaluate the tradeoff between risk and expected return that is represented by a bet on profitable stocks. It seems beyond the reach of current scientific practice to determine with conviction the explanation for gross-profitability or other CAPM anomalies.

Replicating Gross Profitability with Style Factors

Even though we cannot determine the explanation for the abnormal returns delivered by complex or opaque investment strategies, it is sometimes possible to replicate these returns using simpler and more transparent elements. For example, Hasanhodzic and Lo (2007) replicate the returns to a variety of hedge fund strategies with liquid, exchange-traded instruments. They find that a significant fraction of the risk and return of hedge funds can be captured by well-chosen linear combinations of these liquid and low-cost instruments.

	1963 to 2012	1995 to 2012
R-Squared	0.27	0.47

	1963 to 2012		1995 to 2012	
Factor Name	**Coefficient**	**t-Statistic**	**Coefficient**	**t-Statistic**
Intercept	0.00	7.43	0.01	6.21
MKT	-0.08	-6.59	-0.16	-7.79
SMB	-0.12	-7.14	-0.14	-5.23
HML	-0.10	-5.62	0.00	-0.05
MOM	0.08	7.14	0.09	5.09

Table 1: *Monthly regression coefficients, t-statistics, and R-squared values for the replication of the gross-profitability strategy with the Fama-French-Carhart model. Left panel: long history. Right panel: recent period.*

We carry out an analogous exercise by replicating gross profitability with factor models, which are important extensions of the CAPM. Factor models provide insight into the risk and return drivers of investment strategies. First, we attempt to replicate the gross-profitability strategy using the Fama-French-Carhart four-factor model, which includes the excess return to the market (MKT), the size (SMB), and book-to-market (HML) factors developed in Fama and French (1992) and Fama and French (1993), and the momentum (MOM) factor developed in Carhart (1997). Next, we replicate a substantial component of the gross-profitability strategy with the Barra USE4 model.[7]

The Four-Factor Fama-French-Carhart Model Does Not Explain Gross Profitability

The replication of the gross-profitability strategy with the four-factor Fama-French-Carhart model was carried out over a long horizon, June 1963–December 2012, and also over a shorter, more recent period, July 1995–December 2012. The model coefficients and their t-statistics are shown in Table 1. Over both periods that we examined, the intercept and the market (MKT) made small but significant contributions[8] to the return of the gross-profitability strategy. The significant intercept indicates that alpha may be present in the strategy or that one or more factors may be missing from the model. The intercept can be interpreted as an estimate of monthly return. That translates to an alpha of 4.6 basis points per year for the long horizon and 6.7 basis points per year for the recent period. The small but significant negative coefficient of MKT suggests that the gross-profitability strategy may be slightly anti-correlated with the market. The size factor, SMB, made a significant negative contribution during both periods, indicating a bias toward large-capitalization companies. The book-to-market factor, HML, made a significant negative contribution over the longer period but not over the more recent period. The difference can be explained by the high volatility of the book-to-market factor around the turn of the millennium: over the shorter period, the high volatility overwhelmed any signal that may have been present in the factor. The gross-profitability strategy exhibited small but significant contributions from momentum (MOM) over both horizons we considered.

An important diagnostic on the replication is the R-squared, which indicates what fraction of the strategy's variation over time is picked up by the model. In the example under consideration, a relatively small portion of the time variation of the gross-profitability strategy is explained by the Fama-French-Carhart model. The Fama-French-Carhart model explained the time variation in the gross-profitability strategy with an R-squared of 27% over the long horizon, and 47% over the recent period. For this reason, and in light of the incompatibilities described above, we conclude that the Fama-French-Carhart model does not provide a satisfactory representation of the gross-profitability strategy.[9] However, there may be a broader collection of style factors that does a better job of replicating the gross-profitability strategy. We explore this below.

The Barra USE4 Model Explains a Substantial Portion of Gross Profitability over the Past Two Decades

While the Fama-French-Carhart models may not provide a great deal of explanatory insight into gross profitability, a broader set of style factors can explain much more. We replicate a substantial component of the gross-profitability strategy with the Barra USE4 style factors. The full set of Barra USE4 style factors is shown in the first column of Table 2, and it includes familiar investment drivers such as size, leverage, and liquidity. The Barra USE4 model has three value factors: book to market, earnings yield, and dividend yield. Only the first of these, book to market, is part of the Fama-French-Carhart model.[10]

Between July 1995 and December 2012, five significant style factors explained time variation in the gross-profitability strategy with an R-squared of 69%. The strategy had a positive weight on earnings yield, which is one of the three Barra USE4 value factors, and negative weights on beta, residual volatility, and leverage factors. This profile is consistent with quality investing. Notably, there is a substantial positive loading on momentum, which is not part of a quality profile. Book to market, which is the only value factor in the Fama- French-Carhart model, did not play an important role in explaining the return to the gross-profitability strategy. Similarly, the contribution of the intercept to the gross-profitability strategy was negligible between July 1995 and December 2012. The model coefficients and their t-statistics are shown in the Full Model columns of Table 2.

	Full Model	Even Model
R-Squared	0.69	0.68

	Full Model		Even Model	
Factor Name	**Coefficient**	**t-Statistic**	**Coefficient**	**t-Statistic**
Intercept	0.00	0.92	0.00	1.10
Beta	-0.30	-5.69	-0.27	-3.12
Book to Price	-0.25	-1.70	-0.29	-1.36
Earning Yield	0.38	4.90	0.32	2.41
Leverage	-0.81	-6.36	-0.69	-3.14
Momentum	0.19	4.01	0.31	3.91
Residual Volatility	-0.35	-4.27	-0.30	-2.25
Beta Non-Linear	0.04	0.26	-0.29	-1.27
Dividend Yield	0.16	1.25	0.35	1.75
Growth	0.18	1.40	-0.21	-0.91
Liquidity	-0.18	-1.58	0.11	0.53
Size	0.09	1.00	0.10	0.71
Size Non-Linear	0.01	0.07	0.21	1.41

Table 2: *Monthly regression coefficients, t-statistics, and R-squared values for the replication of the gross-profitability strategy with Barra USE4 style factors. The entire data set is used to fit coefficients. In the Even Model, only even-numbered months are used to fit the coefficients. Factors with t-statistics of magnitude greater than 1.96 are shaded. July 1995–December 2012.*

A strategy replication is far more credible if its in-sample characteristics persist out-of-sample.[11] To analyze the persistence of the replication of gross profitability by Barra USE4 factors, we re-estimated the replication with half the data: the returns from even- numbered months. The linear combination of significant factors from this exercise is called the Even Model.[12] The coefficients (betas) and their t-statistics are shown in the Even Model columns of Table 2. Note that while there are differences between the Full Model and Even Model coefficients, the same set of factors is significant and the factor coefficients have the same signs. In other words, the two sets of coefficients are qualitatively similar.

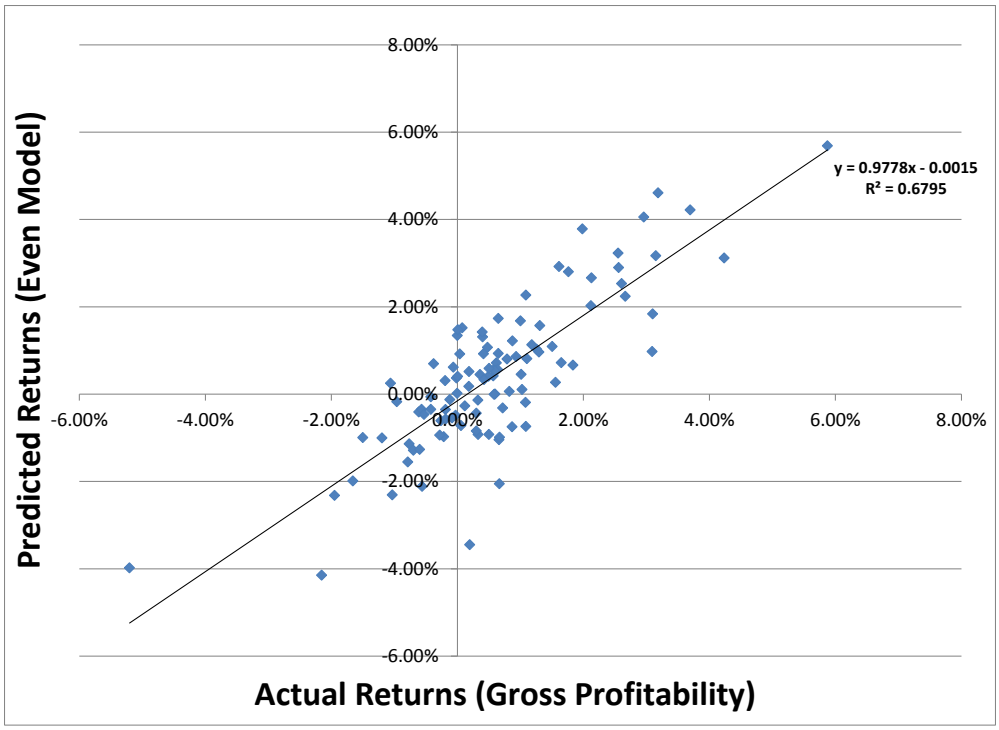

Figure 1: *Scatter plot of (out-of-sample) odd-numbered month returns to the gross-profitability strategy against Even Model forecasts. July 1995–December 2012.*

We use the Even Model to forecast returns in odd-numbered months, and we compare those forecasts to the returns of the gross-profitability strategy out-of-sample in the odd-numbered months.[13] The best out-of-sample line describing the gross-profitability strategy in terms of the Even Model is shown in Figure 1. The line has a significant slope of 0.98 and an intercept that is insignificant. Out-of-sample in odd months, the Even Model explained the time variation in the gross-profitability strategy with an R-squared of 68%. The remaining 32% is not explained by the Even Model.[14]

Table 3 shows return, risk, and Sharpe ratios for gross profitability and its replication with the Barra USE4 model. We consider both the Full Model and out-of-sample performance by the Even Model in odd months.[15] In both examples, the replication outperforms the gross-profitability strategy. Of course, it is often the case that a strategy will outperform its replication.

	Full Model		Even Model		
	Gross Profitability	**Replication**	**Gross Profitability**	**Replication**	**S&P 500 Index**
Arithmetic Annual Return	5.52%	5.52%	5.24%	7.25%	8.98%
Annual Standard Deviation	6.00%	4.99%	5.82%	4.93%	15.80%
Sharpe Ratio	0.43	0.52	0.40	0.87	0.37

Table 3: *Performance statistics for the gross-profitability strategy and its replication using Barra USE4 style factors. Statistics for the Even Model are taken out-of-sample in odd months. July 1995–December 2012.*

Conclusion

Recent research has posited a connection between the accounting-ratio-based gross-profitability strategy and quality investing. We found that the Fama-French-Carhart four- factor model does not shed light on this assertion because it does not provide a satisfactory representation of the gross-profitability strategy during the period July 1995 to December 2012. However, during that period, a substantial portion of gross profitability can be explained by five style factors from the Barra USE4 model. Four of the five explanatory factors indicate a quality investment. However, the momentum tilt that was highlighted by our analysis is not part of the standard quality profile and may warrant further investigation. Importantly, these results rely on relatively short data histories.[16] More time is required to determine their efficacy in the long term.

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Endnotes

[1] A factor tilt is an active bet that requires frequent rebalancing versus a capitalization-weighted index.

[2] Graham (1949) has been reprinted numerous times, most recently in 2006.

[3] The idealized strategy is long top-quintile profitably firms and short bottom-quintile firms. In practice, these quintiles are often constructed within size or industry cohorts and then averaged.

[4] For this reason, idealized strategies of this type are often called “factors" in the literature.

[5] Table 1 in Novy-Marx (2013b) reports the performance of the long and short sides of the factor separately over the period from July 1963 to December 2012. The long side, which corresponds to high-gross-profitability securities, had a Sharpe ratio of 0.47 driven by a net excess return of 6.7% and a volatility of 14.3%. This is inconsistent with quality investing, which typically includes low risk as a distinguishing feature.

[6] There is an enormous amount of literature on CAPM anomalies. The best known CAPM anomalies are size and book to market, which were popularized in Fama and French (1992) and Fama and French (1993), and momentum, which is documented in Carhart (1997). Other important anomalies include accruals, whose investigation is pioneered in Sloan (1996); low risk, which was documented in Black et al. (1972) and is reviewed in Goldberg et al. (2013); and asset growth, which is documented in Li and Sullivan (2013).

[7] We focus on style factors in both replications since we are using an industry-neutral version of the gross-profitability strategy. A strategy is industry-neutral if its industry exposures match the industry exposures of the market.

[8] In keeping with standard protocol, we call a replication factor significant if the t-statistic of its coefficient exceeds 1.96 in magnitude. However, the standard connection between the likelihood that a coefficient is different from zero and the t-statistic depends on strict assumptions that are rarely satisfied in practice. A sensational example is in Anderson et al. (2013).

[9] It is also possible that there is a mismatch between the gross-profitability strategy, which has been adjusted to have the same industry exposures as the market, and the four-factor Fama-French-Carhart model, which is not industry-adjusted.

[10] The book-to-price factor in the Barra USE4 model is based on the same accounting ratio as the book-to-market factor (HML) in the Fama-French-Carhart model. However, returns to the two factors differ due to different model estimation processes. For example, the estimation of the Fama-French-Carthart book-to-market factor does not control for industry effects, but the estimation of the Barra USE4 book-to-market factor does.

[11] The Full Model is in-sample because its goodness of fit to the gross-profitability strategy is evaluated using the same data used to estimate the model. In an out-of-sample test, the evaluation is based on complementary data. Out-of-sample tests can indicate whether an in-sample fit is a statistical fluke. However, an out-of-sample test is not a panacea; see, for example, Markowitz and Xu (1994).

[12] Specifically, the Even Model forecast return for time t is $r_t = \sum_i \hat{\beta}^i \, r_t^i$ where $\hat{\beta}^i$ is the estimated coefficient of (significant) factor i in the Even Model fit and r_t^i is the return to factor i at time t.

[13] A disadvantage of this test is that it has look-ahead bias. However, to the extent that the strategy returns are independent, this is not an issue, and an advantage of this test is that it uses data from different economic climates in both the fit and the forecast.

[14] This is consistent with a missing factor or a violation of the axioms of OLS regression, which was used to fit the model. A deeper inquiry is required to determine the source of the lost R-squared.

[15] The out-of-sample results for the Even Model in odd months are not achievable through investment due to trading costs associated with liquidation at the end of each odd month and reinvestment at the start of each odd month.

[16] Ideally, one would like to assess the factor replication of the gross-profitability strategy in as many different economic climates as possible.

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