Innovation Lab

Inverting factor strategies

No more ‘monkey business’

September 2020

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Executive summary

Factor investing is a simple concept. Put simply, factor exposures drive the performance of diversified portfolios. With a construction technique that furnishes the ability to achieve precise and controlled factor exposures, it is possible to readily construct factor strategies—and their opposites—in a transparent manner.

Some key points in this paper include:

- Stock weighting schemes in a portfolio have a profound effect on factor exposures and, hence on the portfolio performance. Popular weighting schemes create unintended and potentially undesirable factor exposures.
- Mere inversion of the stock weights of a portfolio does not invert a portfolio’s factor exposures. Using a factor tilting methodology, we demonstrate that it is possible to produce portfolios with precisely opposite factor exposures.
- The magnitude of the factor exposures has a direct impact on the portfolio performance outcomes.
- Factor exposures resulting from the interaction of stock selection and stock weighting schemes explains the phenomenon of Malkiel’s Monkey portfolio.

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1 Introduction

There is a substantial body of research regarding the performance of active managers relative to market capitalization-weighted benchmarks. A common theme is the difficulty of consistently outperforming a market capitalization-weighted benchmark. A recent report from Morningstar [1] showed that only 24% of active funds outperformed their respective passive peers over a 10-year period.

In this context, the award-winning paper by Arnott et al [2] appears controversial. The paper suggests that most “sensible investment beliefs”, once translated into portfolio strategies using “simple weighting heuristics”, outperform the market capitalization benchmark. Paradoxically, it also demonstrates that inverting the weighting scheme of the original strategy also outperforms the market capitalization benchmark. In fact, it concludes that beating the market is so easy that a monkey can do it. The “monkey” is the mythical one, imagined by Malkiel in his book “A Random Walk Down Wall Street” [4], that picks stocks by throwing darts at the Wall Street Journal.

Their analysis spanning various markets led the authors to conclude that smart beta strategies result in similar performance outcomes because they share common active factor exposures to Size and Value, which determine the strategy’s outperformance. They also suggest that the opposite investment strategy can be obtained by a simple form of portfolio weight inversion and that these “upside-down” portfolios also outperformed because they retained the Size and Value exposures of the original strategy. Outperformance of the market capitalization benchmark is, therefore, readily achieved through the application of a weighting scheme or its inverse, since both typically result in Size and Value exposures.

Given these findings the research drew attention from other academics; in particular, Amenc et al produced a response [3] critiquing Arnott’s findings. Amenc et al construct smart beta strategies by selecting the top half of a stock universe by factor score and then weighting those stocks using a set of “diversified weighting schemes”. However, each upside-down strategy is created by selecting the bottom half of the universe by factor score and then applying the inverted versions of the diversified weights. The results demonstrate that the original and upside-down portfolios perform differently and that the original portfolios outperform their upside-down equivalents, exactly as one would expect on the basis of their exposure to rewarded factors.

However, both sets of portfolios outperform the market capitalization weighted benchmark as a result of the Value and Size exposures introduced by the diversified weighting schemes. Amenc et al therefore employ an alternative portfolio construction technique, albeit one that they have previously been critical of [8]; they construct factor tilt portfolios by selecting the top 50% of stocks by factor score and weighting stocks by their factor scores multiplied by market capitalization weights.

Using this approach, they were able to show that smart beta indexes do not necessarily exhibit Size and Value exposures. However, having arrived at a portfolio construction technique that allows a more precise control of factor exposures, they again create upside-down portfolios through weight inversion and thereby lose control of the portfolio factor exposures.

Factor investing is actually quite a simple concept, despite the convoluted arguments and constructions set out above. Put simply, factor exposures drive the performance of diversified portfolios. Neither papers written by Arnott or Amenc appear to be clear that the factor exposures in smart beta indexes are simply a function of portfolio construction. With a proper construction technique that furnishes precise and controlled factor exposures, it is possible to readily construct factor strategies and their opposites in a transparent manner.

In Section 2, we demonstrate that portfolio weighting schemes have a direct effect on portfolio factor exposures. In Section 3, we show that “weight inversion” is not an appropriate way to create the opposite of a smart beta strategy. In Section 4, we demonstrate a more appropriate approach. In Section 5, we show how portfolio level factor exposures calculated from stock level characteristics directly influence performance outcomes. In Section 6, we outline the dangers of not controlling portfolio factor exposures and, in Section 7, we solve the “mystery” of Malkiel’s monkey. In Section 8, we draw our conclusions.

2 Weighting schemes and factor exposures

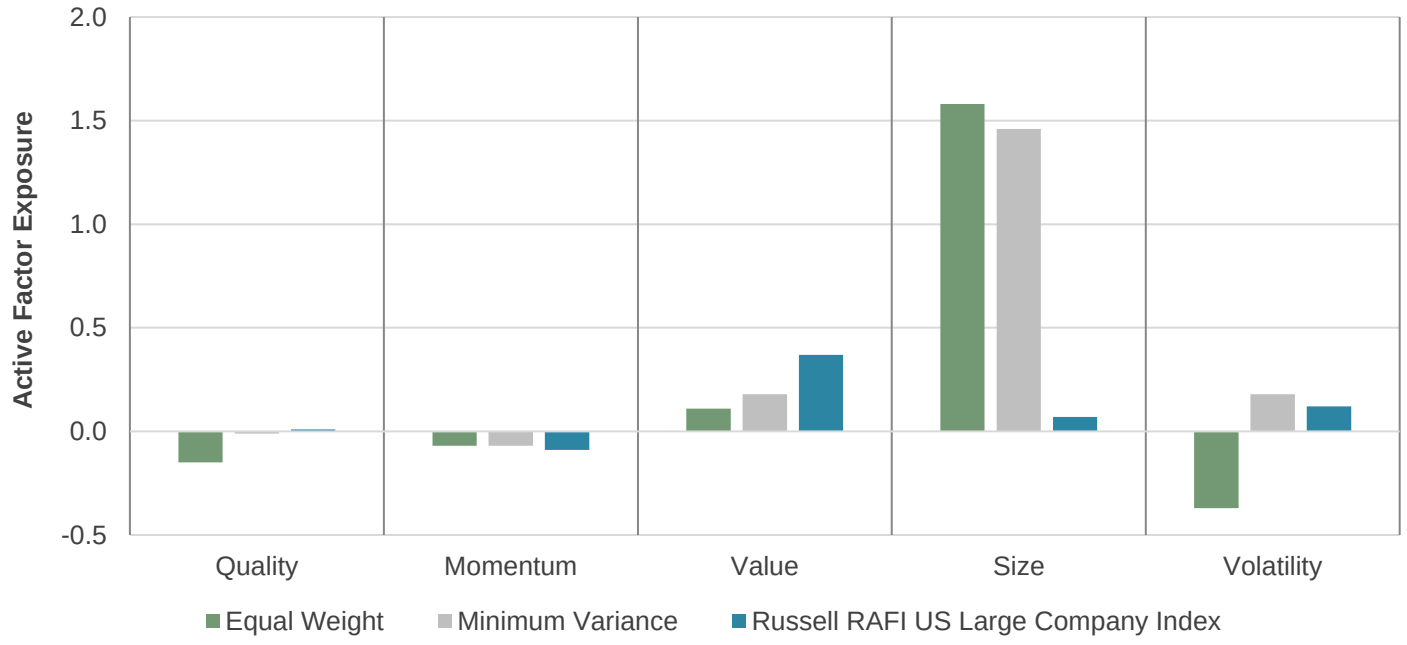
In both the Arnott and Amenc papers, the selection of a "heuristic" stock weighting scheme is portrayed as a neutral activity. However, the choice of weighting scheme has a profound effect on portfolio factor exposures and hence on performance outcomes. Weighting schemes, particularly "diversified" ones, frequently result in exposures to Size (small cap) and Value stocks.

To illustrate the point, we create Russell 1000 smart Beta portfolios employing a series of commonly used weighting schemes and examine the portfolio time-series average active factor exposures between December 1997 and March 2020. An equally-weighted portfolio is frequently used to create a well-diversified portfolio with small Size exposure. Figure 1 highlights that the (semi-annually rebalanced) equally-weighted portfolio has a significant Size factor and off-target exposures, such as negative exposures to Quality and Low Volatility[1], for example. Factor exposure is the weighted average of the stock factor Z-Scores. Active factor exposure is the difference between the portfolio's factor exposure and that of the benchmark.

Another popular alternatively weighted portfolio strategy is Minimum Volatility[2]. This is primarily used by investors wishing to have relatively low risk exposure to the equity market. Figure 1 shows that while the Russell 1000 Minimum Variance Index does exhibit Low Volatility exposure, it also has significant exposure to small capitalization stocks.

Fundamentally-weighted indexes are arguably one of the most familiar weighting schemes. The annually rebalanced Russell RAFI US Large Company Index exhibits strong levels of Value exposure as intended, but also displays small levels of positive exposure to Size and Low Volatility, and negative exposure to Momentum.

Figure 1: Russell 1000 Active factor exposures; equal, minimum variance and fundamental weighting schemes



Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 created for research purposes only. Please see the end for important legal disclosures.

[1] Factor definitions are those used in FTSE Global Factor Series. For further information see: https://research.ftserussell.com/products/downloads/FTSE_Global_Factor_Index_Series_Ground_Rules.pdf

[2] For further information see the FTSE Global Minimum Variance Index Series:

: https://research.ftserussell.com/products/downloads/FTSE_Global_Minimum_Variance_Index_Series.pdf

All three examples, therefore, display positive Value and Size exposure. However, we are not tempted to conclude that smart beta strategies by their very nature have a value and small cap bias. Indeed, we provide examples of smart beta indexes that do not exhibit these biases in Sections 3, 4 and 6.

Finally, it is worth noting that while all of these indexes are used to achieve factor exposure objectives, none were explicitly designed for that purpose. Equal weighting is designed to maximize the diversification of stock weights, Minimum Variance, to minimize portfolio volatility, and Fundamental weighting, to break the link between portfolio weights and prices by using company fundamentals to determine portfolio weights. It is, therefore, not surprising that the factor exposures of each index are many and varied.

3 Upside-down portfolios and factor exposure

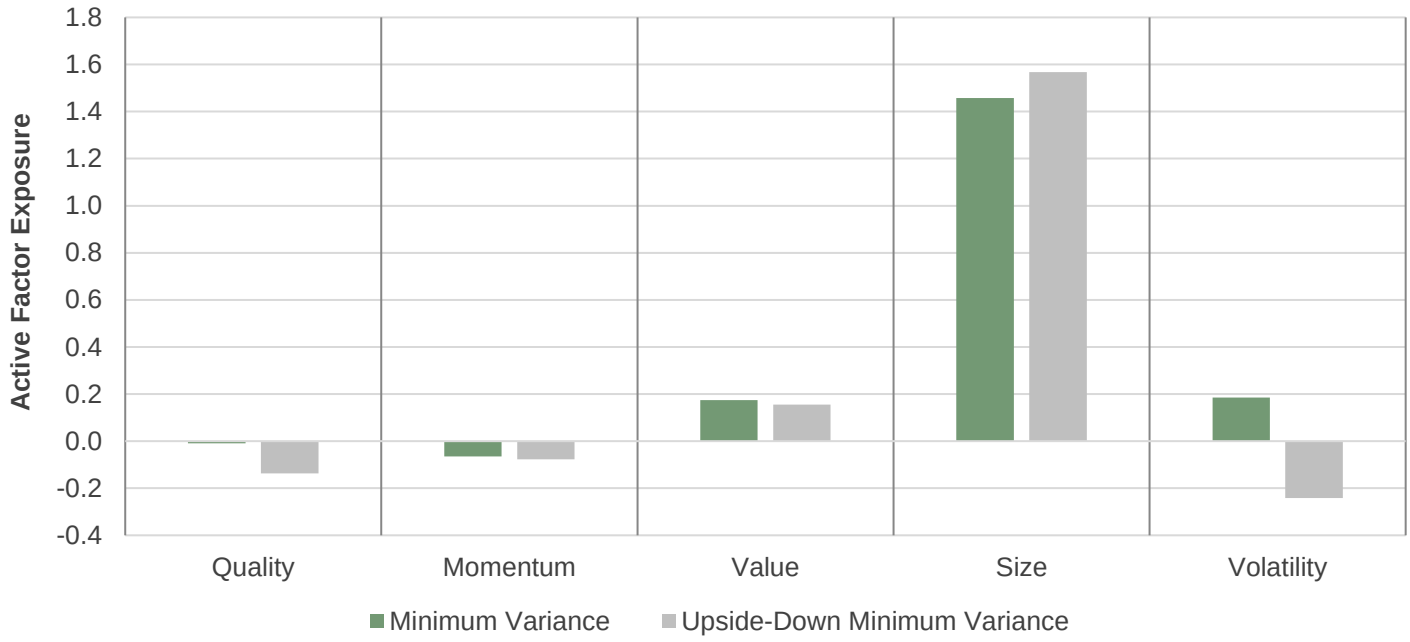
Arnott et al invert the weights of a number of smart beta strategies to determine strategies with the “opposite investment beliefs.” They note that the resulting “upside-down” portfolios share the same small Size and Value exposures of the original smart beta strategies. Correctly, they conclude that this is the primary reason for the outperformance of both the smart beta and upside-down portfolios.

However, as we noted in the previous section, these portfolios were not designed primarily with factor exposure objectives in mind. Hence, it is unsurprising that a simple inversion of each strategies’ portfolio weights does not necessarily result in the opposite investment strategy. Indeed, Amenc et al [3] provide a simple example of this; inversion of the weights of an equal-weighted strategy results in exactly the same portfolio, displaying the same factor exposure profile, including the well-known exposure to small capitalization stocks.

For a less trivial example, consider the Russell 1000 Minimum Variance Index and its upside-down counterpart created by taking the reciprocal of the weights of the original minimum variance portfolio. That is, we transform the (non-zero) weights W to $1/\mathrm{W}$ and then normalize the result so that they sum to one.

The active factor exposures of the minimum variance index and its upside-down counterpart are presented in Figure 2.

Figure 2. Active exposures: Russell 1000 Minimum Variance Index and upside-down portfolio



Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 created for research purposes only. Please see the end for important legal disclosures.

All factor exposures remain broadly the same, with the exception of the Low Volatility exposure, which is now negative. In particular, both the Russell 1000 Minimum Variance Index and its upside-down counterpart both exhibit positive Size and Value exposures. Clearly, while this portfolio may represent the opposite investment strategy in one sense, it does not represent the opposite set of factor beliefs, which would presumably involve inverting all factor exposures.

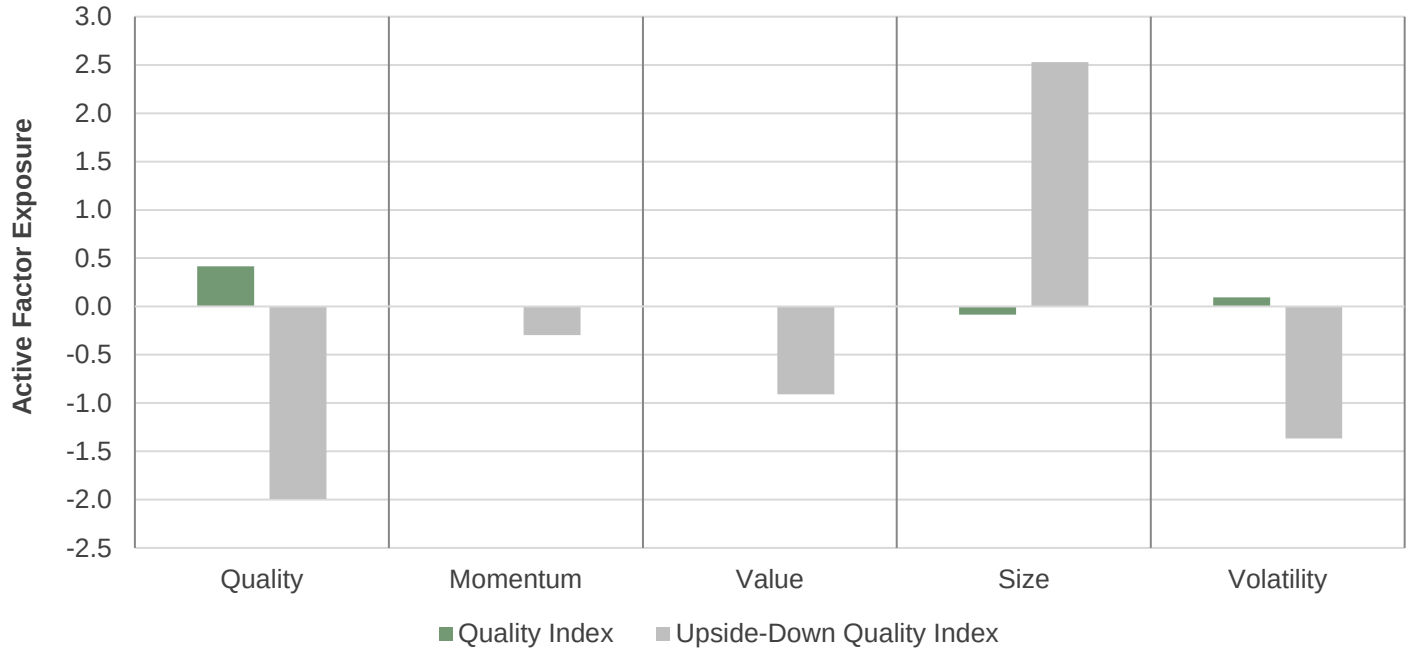
Even in the case where the initial smart beta strategy has only one dominant factor exposure, weight inversion does not achieve the opposite factor strategy. In order to see this, consider a Russell 1000 Quality Index created using a single factor tilt of the form:

$$W_Q = W_M \times S(Z_{Quality}) \quad (1)$$

where W_M is a vector of market capitalization weights (one element for each stock) of the Russell 1000 index, $S(Z_{Quality})$ is set of positive scores that vary monotonically with the Quality factor Z-Scores, $Z_{Quality}$ (see [5] for a detailed description of the tilt construction). We now compare the active exposures of this Quality Index to its upside-down counterpart.

Figure 3 reveals that the semi-annually rebalanced Quality tilt index is relatively pure, with small exposures to all factors apart from the targeted Quality exposure. A natural assumption is that the inverse strategy would exhibit negative Quality exposure and relatively small exposures to other factors. Figure 3 confirms that the upside-down portfolio does indeed exhibit negative exposure to Quality, but also displays a strong positive exposure to Size and large negative exposures to Momentum, Value and Low Volatility. We conclude that the Size exposure of the upside-down portfolios is not a consequence of the factor exposures of the original portfolio, but most likely results from the nature of the weight inversion. Clearly, this is not the opposite strategy to the Quality index, which presumably consists of an index with a negative Quality orientation and little or no exposure to any other factor.

Figure 3: Active exposures: Russell 1000 Quality Index and upside-down portfolio



Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 created for research purposes only. Please see the end for important legal disclosures.

In summary, inverting the weights of a smart beta portfolio may result in the inversion of some of its factor exposures, but frequently results in a portfolio with a strong Size and Value bias. Therefore, it does not follow that weight inversion also results in the inversion of the original investment beliefs. If a smart beta portfolio expresses a set of factor exposure objectives, then inverting those exposure objectives, rather than the portfolio weights, is the appropriate means of creating an upside-down portfolio to reflect the inverted investment beliefs. In the next Section, we demonstrate one approach to creating such portfolios.

4 Inverting factor exposure beliefs

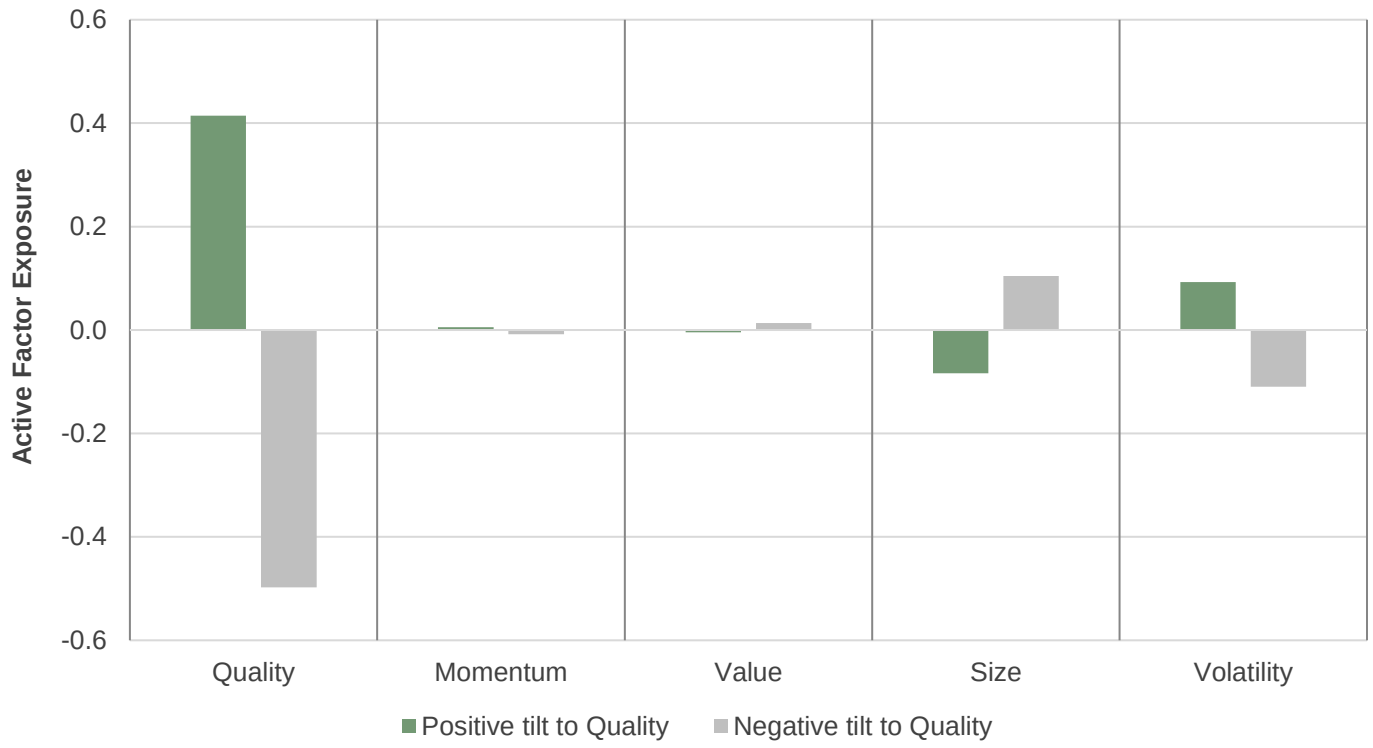
In section 3, we demonstrated that inverting a set of smart beta portfolio weights does not result in a strategy with an inverted set of investment beliefs, primarily because weight inversion does not result in the inversion of factor exposure outcomes.

However, there is a simple mechanism for inverting a set of factor investment beliefs; using a tilt approach, it is possible to tilt both towards and *away* from a factor of interest. By way of illustration, we examine the Russell 1000 and apply the FTSE Russell tilt methodology[3] to create separate semi-annually rebalanced portfolios to achieve positive and negative active exposure to Quality. The latter is achieved by changing the sign of the Quality factor Z-score in the scoring function of equation (1), so that:

$$W_{-Q} = W_M \times S(-Z_{Quality}) \quad (2)$$

Figure 4 shows average active factor exposures of the resulting portfolios. The active Quality exposure is almost identically equal and opposite; even the small off-target exposures share this property. This is a pervasive feature of the tilt approach employed and is a direct result of the correlation[4] between factor Z-scores.

Figure 4: Average active factor exposure: Russell 1000 positive and negative Quality tilts



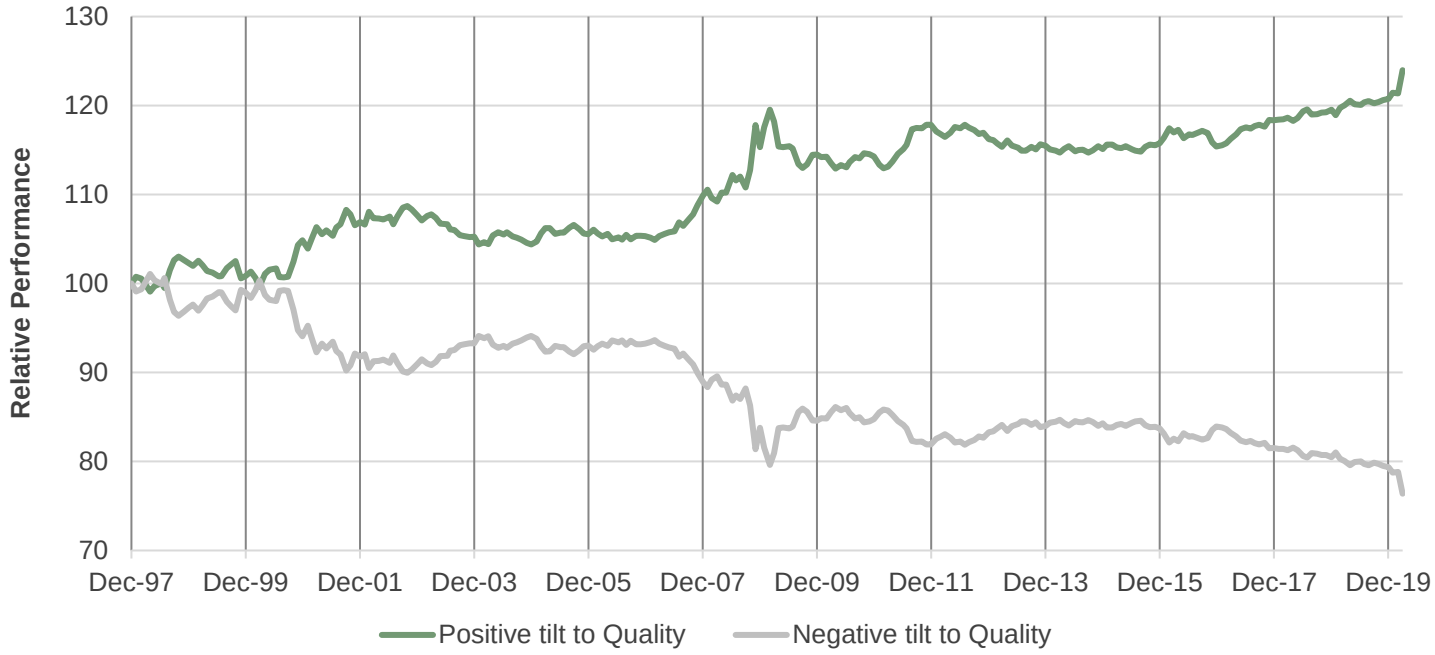
Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 created for research purposes only. Please see the end for important legal disclosures.

[3] For more detail see FTSE Russell publication Multi-factor indexes: The power of tilting.
https://content.ftserussell.com/sites/default/files/research/multi-factor-indexes--the-power-of-tilting-final.pdf.

[4] This can be demonstrated using similar reasoning to that used in FTSE Russell publication The size exposure spectrum and factor tilts.
https://content.ftserussell.com/sites/default/files/research/The-Size-Exposure-Spectrum-and-Factor-Tilts.pdf.

Figure 5 shows the striking result of this symmetry; almost mirror-image relative performance compared to the Russell 1000 for the period December 1997 to March 2020. This is compelling evidence that the performance of these “opposite indexes” is primarily driven by their opposite factor exposures.

Figure 5: Relative performance: Russell 1000 positive and negative Quality tilts



Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 created for research purposes only. Please see the end for important legal disclosures.

This intuitive and symmetric behavior is reflected in the outcomes of other single and multiple factor indexes constructed using the factor tilt methodology [5]. Indeed, all factor exposures can be set to pre-specified values, be they positive or negative, using the factor tilt methodology. This is the basis of the FTSE Russell’s Target Exposure methodology [11].

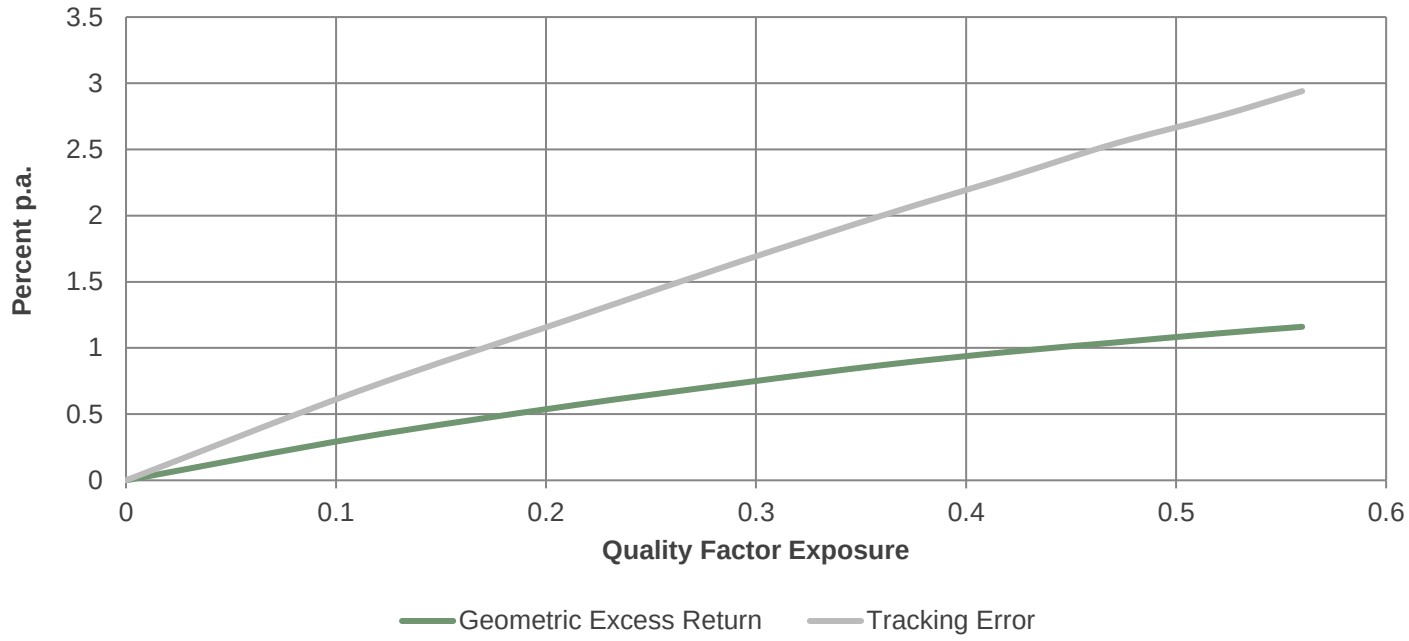
5 Factor exposure and performance outcomes

In this section, we assess the statement made in [2]; that smart beta strategies have approximately the same return, which has very little to do with “stated investment beliefs”. Here, we demonstrate that important performance outcomes of a diversified portfolio are related to the total size of factor exposure derived from stock level estimates, that is, weighted average Z-Scores. In contrast, some academics have appeared to question whether such exposure measures have any influence on portfolio performance [7].

Using the factor tilt methodology [5], we create Russell 1000 Quality portfolios, with varying levels of active exposure to Quality. This is achieved by raising the score in equation (1) to different powers. The greater the power (or “tilt strength,”) the greater the active exposure. In other respects, these portfolios are similar; other factor exposures are small as we saw earlier, and importantly they remain suitably diversified, all with Effective N greater than 60% that of the benchmark. This allows us to demonstrate the effect of different levels of factor exposure on portfolio outcomes.

Figure 6 demonstrates that the excess return and tracking error associated with these portfolios increases with factor exposure in almost a linear fashion, with the result that the information ratios are similar and in the range 0.4 - 0.5. This result is as expected—one can choose the level of exposure consistent with either a performance objective or tracking error budget but, increasing the exposure to a single metric cannot change its information content.

Figure 6: Factor exposure, excess return and tracking error: Russell 1000 Quality tilt portfolios



Source: FTSE Russell. Monthly data from December 1997 to March 2020. Index based on Russell 1000 using a tilt to the Quality factor, created for research purposes only. Please see the end for important legal disclosures.

Tracking error and excess return are related to levels of active factor exposure. That “heuristically” weighted smart beta benchmarks perform similarly is merely a reflection that they introduce similar factor exposures irrespective of the factor objective. To do this more systematically, it requires a mechanism that allows the precise control of portfolio level active factor exposures. FTSE Russell’s Target Exposure methodology [11] is one such mechanism.

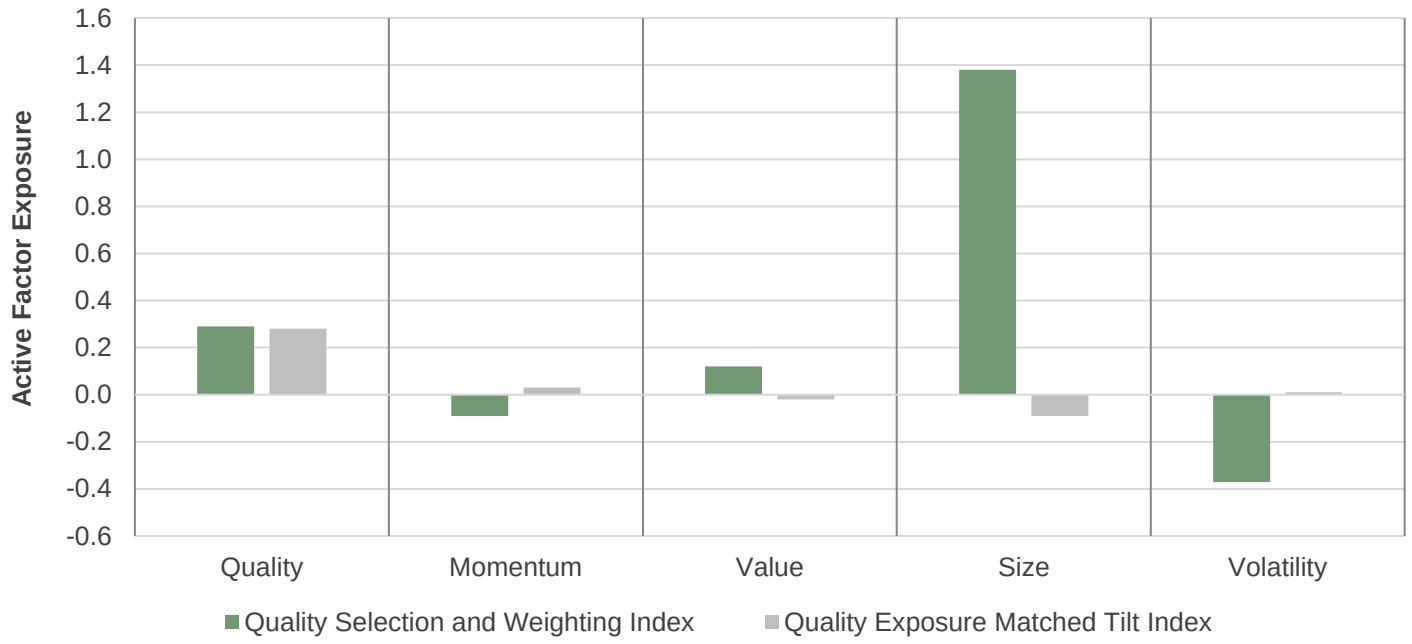
6 The importance of portfolio construction

A striking aspect of the debate outlined in the introduction to this paper is the question of whether all smart beta portfolios (and their inverses) necessarily have a small Size and Value factor exposures. We have seen in Sections 3 and 4 that it is relatively easy to construct portfolios that do not have significant Size and Value exposures using a factor tilting approach. Indeed, in order to counter Arnott's claims, Amenc et al find it necessary to construct "score weighted" portfolios, as their standard "diversified multi-strategy weighting scheme" methodology provides insufficient control over factor exposure outcomes. The "score weighted" portfolios used are essentially the same as the tilt portfolios we introduced earlier.

Many factor and smart beta commercial products [12, 13] can be characterized as being constructed by a "selection and weighting" approach. Broadly, this consists of selecting some proportion of stocks with the highest factor values and then overlaying a portfolio-weighting scheme. We have shown elsewhere [6, 10, 11] that a common problem with this approach is that the factor exposures arising from the "selection" process may be dominated by those that arise from the "weighting" mechanism. This is particularly the case for multiple "diversified" weighting schemes; combinations of weighting schemes such as equal weight, risk weight, maximum Sharpe Ratio or maximum decorrelation, inevitably lead to significant Size and Value exposures, irrespective of whether they are desired or not.

We illustrated this construction technique by creating a semi-annually rebalanced Quality portfolio consisting of the top 50% of stocks in the Russell 1000 with highest Quality scores and weighting them equally. This is essentially a proxy for the "diversified multi-strategy weighting scheme," where the factor is Quality [9]. The time-averaged active factor exposures are presented in Figure 7 as green bars.

Chart 7: Active factor exposures: Russell 1000 Quality selection and weighting & tilt portfolios

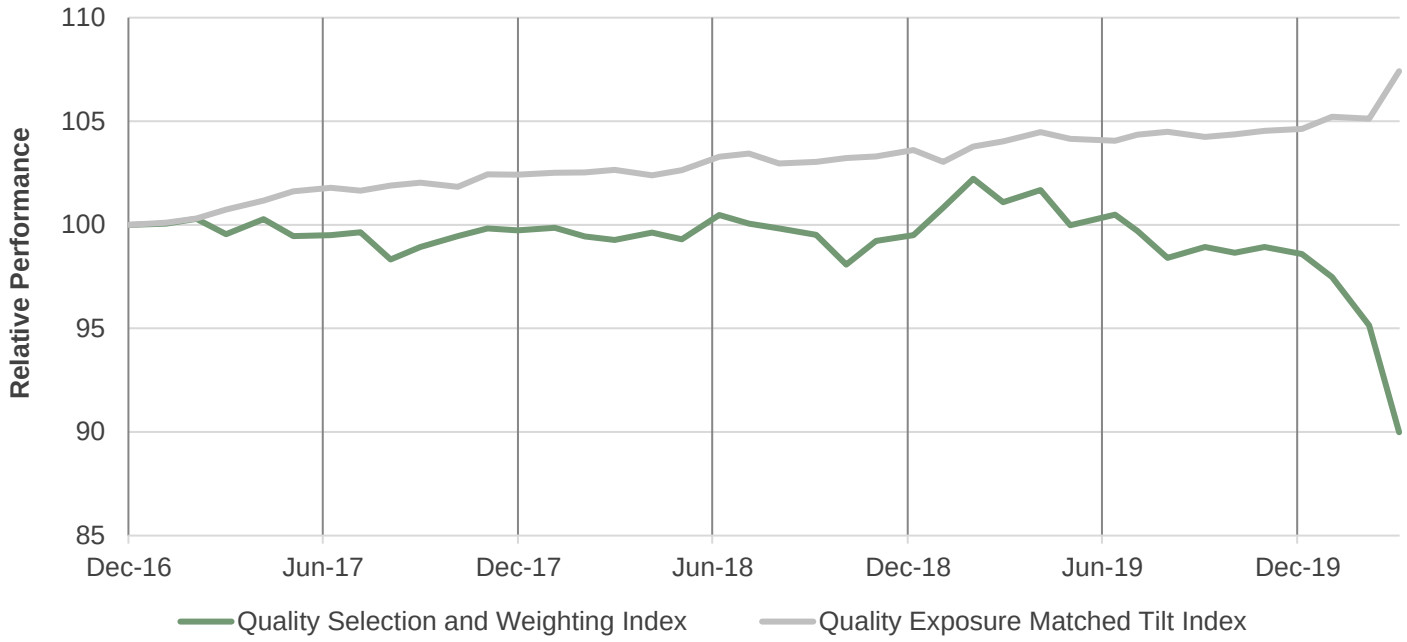


Source: FTSE Russell. Monthly data from June 2011 to March 2020. Index based on Russell 1000 using a selection and weighting methodology on the basis to the Quality factor, created for research purposes only. Please see the end for important legal disclosures.

The off-target exposures from this methodology are clear and, in particular, we observe the Size and Value exposures that Arnott suggested are pervasive to smart beta strategies. However, we can also create a portfolio using the factor tilting techniques set out earlier by choosing the tilt strength to achieve identical levels of active Quality exposure at each rebalance. The active exposures of this portfolio are shown by the grey bars in Figure 7. This relatively simple construction approach yields the sought-after Quality exposure, but does not introduce significant off-target exposures to Size and Value.

One might argue that the additional Size and Value exposures are beneficial if positive return premia are associated with such exposures. However, their inclusion should be a conscious decision. If Quality is being employed specifically for its downside protection properties, then additional uncontrolled exposures to Size and Value may undermine those properties. Figure 8 shows the relative performance of each portfolio between December 2016 and March 2020. The Quality tilt portfolio does exactly what it is supposed to do during the crisis period of the first quarter of 2020—it outperforms the market. In contrast, the Quality Selection and Weighting portfolio underperforms the Russell 1000 as a result of the incidental off-target exposures to Size and Value and negative exposure to Low Volatility.

Figure 8: Relative performance: Russell 1000 Quality selection and weighting & tilt portfolios



Source: FTSE Russell. Monthly data from December 2016 to March 2020. Index based on Russell 1000 using a selection and weighting and tilt methodologies on the basis to the Quality factor, created for research purposes only. Please see the end for important legal disclosures.

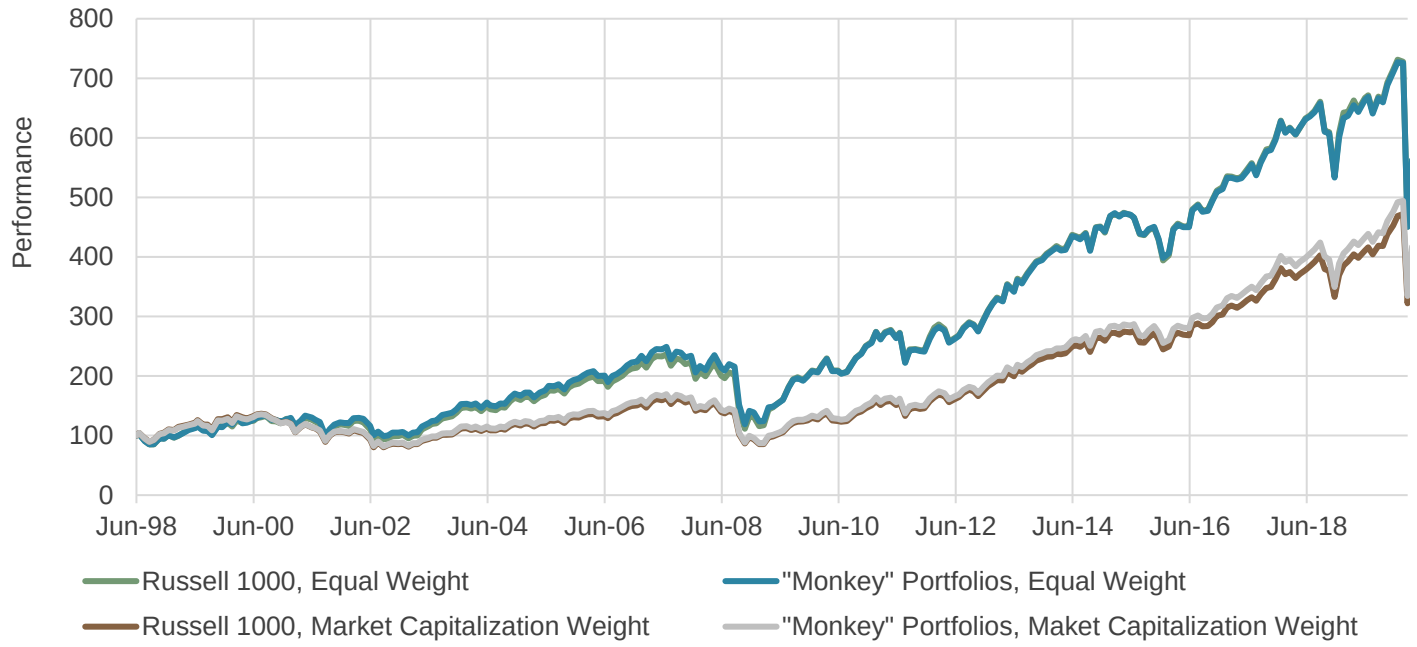
7 Monkey portfolios

Finally, we comment on the surprising investment success of Malkiel's monkey. However admirable the monkey's ability to throw darts, like Arnott et al, we assume that he has no real stock picking talent. The key, here, is that, while the monkey selects the stocks, it does not choose the weighting scheme. The seemingly innocent decision that we should equal weight the stocks has profound implications. Suppose instead that we decided to weight stocks in proportion to their market capitalization. What would we then observe?

To investigate this, we simulate the "monkey investment" process by randomly selecting 100 stocks from the Russell 1000 universe each June for the period 1998 to 2019. We then create two separate portfolios by weighting the selected stocks equally and in proportion to their capitalization weights. We repeat this exercise hundred times and calculate the average performance across each set of one hundred portfolios.

Figure 9 shows the total return performance of these portfolios in USD. For comparison, we also include the Russell 1000 equally weighted (consisting of the entire Russell 1000 universe) and Russell 1000 capitalization weighted benchmarks.

Figure 9: Performance: Russell 1000 monkey portfolios, equal and market capitalization weighted Indexes

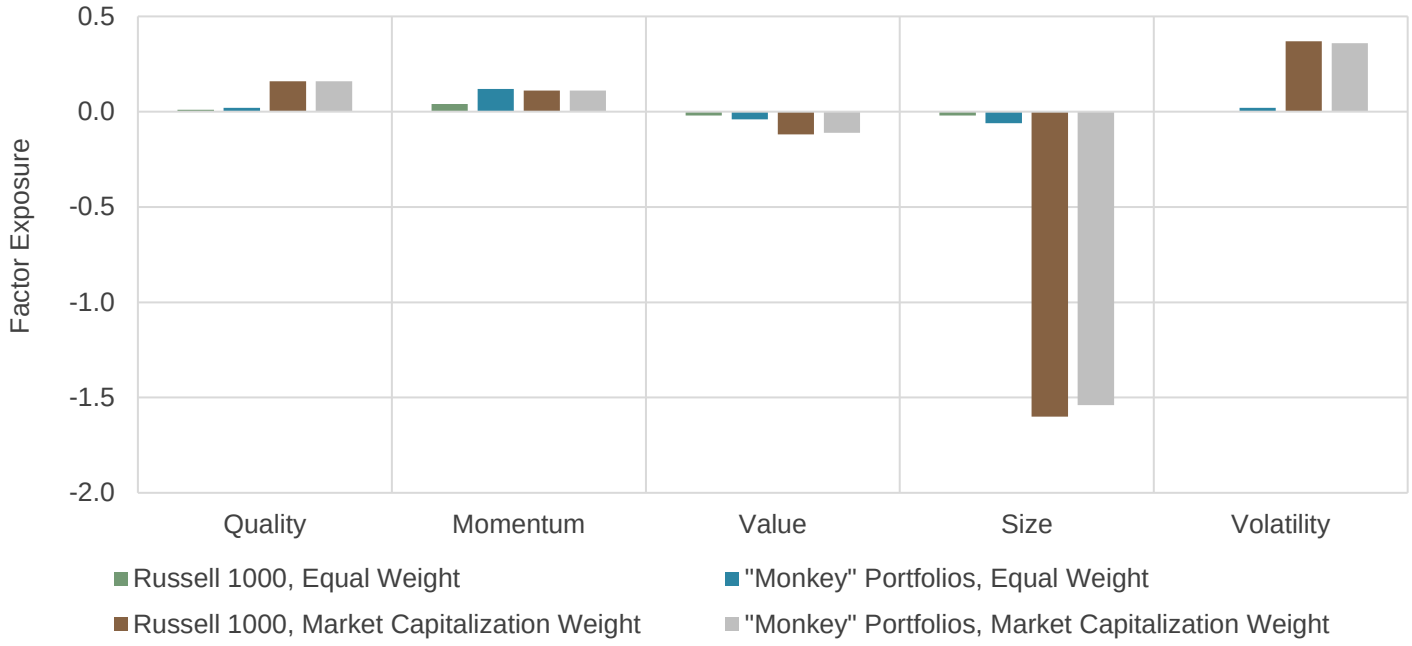


Source: FTSE Russell. Monthly data from June 1998 to March 2020. Index based on Russell 1000 using random selection of 100 stocks, created for research purposes only. Please see the end for important legal disclosures.

Clearly, the equally-weighted monkey portfolio outperforms its capitalization-weighted counterpart. However, neither of their performances deviates significantly from their respective Russell 1000 equal and capitalization weighted benchmark, indicating that our monkey does not possess any stock picking skill.

The explanation for this is provided in Figure 10, where we show the absolute factor exposures of both the monkey portfolios and the equal and capitalization-weighted Russell 1000.

Figure 10: Absolute factor exposures: Russell 1000 monkey portfolios, equal and market capitalization weighted indexes



Source: FTSE Russell. Monthly data from June 1998 to March 2020. Index based on Russell 1000 using random selection of 100 stocks, created for research purposes only. Please see the end for important legal disclosures.

The equal-weighted monkey portfolio benefits from the small cap premium arising from an increased exposure to Size compared to the capitalization-weighted monkey portfolio. Indeed, the absolute factor exposures of the equal (capitalization) weighted monkey portfolio are similar to those of the equal (capitalization) weighted Russell 1000. This is unsurprising, as in the limit, the average factor exposures, performance and weightings of each monkey portfolio must converge to those of the respective equal or capitalization-weighted benchmark.

The mystery of the outperformance of the monkey portfolio is simply a consequence of the active Size exposure of the equally-weighted monkey portfolio. This arises directly from the weighting scheme chosen, as opposed to any stock picking skill the monkey may have. Indeed, we could have chosen to weight the monkey portfolios by inverse stock volatility and then expressed “surprise” that the monkey was producing portfolios with a low volatility orientation.

8 Conclusion

In this note, we have demonstrated that the use of “heuristic” smart beta weighting schemes frequently introduces uncontrolled and potentially undesired factor exposures. Typically, those exposures are to small Size and Value. This reflects the fact that such weighting schemes are often not explicitly designed with factor exposure objectives in mind, but rather aim to reduce risk or enhance levels of diversification.

Inversion of a set of portfolio weights, either arithmetically or geometrically, does not result in the parallel inversion of an investment strategy, at least in the sense of factor beliefs. Moreover, it frequently retains the same small Size and Value biases of the original smart beta weighting scheme.

We have shown it is possible to invert factor exposures in a controlled way, using an appropriate portfolio construction technique such as factor tilting. Generalizing this approach to multiple factors with variable tilt strengths permits the control of both on and off-target factor exposures and leads to the creation of pure (multi) factor indexes [11].

We have also demonstrated that such an approach can also target different levels of factor exposure and, therefore, that not all smart beta portfolios are the same in their performance outcomes; higher factor exposure results in higher levels of tracking error and excess return.

Finally, we have seen that selecting a set of stocks is only meaningful if one also specifies how those stocks should be weighted. Indeed, for such “selection and weighting” portfolios, we have demonstrated that the weighting schemes introduce factor exposures that can potentially dominate performance outcomes. This is particularly the case if stock selection expresses particularly weak investment beliefs, or in the case of our monkey, no beliefs at all.

In summary, index construction methodologies that employ heuristic stock weighting schemes do not permit precise control of factor exposures. They, therefore, are unable to target specific intentional factor exposures or to create indexes which correspond to the inversion of a set of investment beliefs.

9 References

[1] Johnson, B., Bryan, A. and McCullough, A., Morningstar's Active/Passive Barometer, *Morning Star Manger Research*, August 2018.

[2] Arnott, R., Hsu, J., Kalesnik, V. and Tindall, P., "The Surprising Alpha From Malkiel's Monkey and Upside-Down Strategies", *The Journal of Portfolio Management*, Vol. 39, Number 4, Summer 2013.

[3] Amenc, N., Goltz, F. and Lodh. A., "Smart Beta Is Not Monkey Business", *Journal of Index Investing*, Vol. 6, No. 4, 2016.

[4] Malkiel, B., *A Random Walk Down Wall Street*, New York: W. W. Norton & Company, Inc., 2007.

[5] FTSE Global Factor Index Series Ground Rules, FTSE Russell, March 2020.

[6] Factor investing considerations – Questions and Answers, FTSE Russell, November 2019.

[7] Amenc, N., Goltz, F. and Sivasubramanian, S., "Multifactor Index Construction: A Skeptical Appraisal of Bottom-Up Approaches". *The Journal of Index Investing*, Vol. 9, No. 1, p6-p17, 2018.

[8] Amenc, N., Ducoulombier, F., Esakia, M., Goltz, F. and Sivasubramanian, S. "Accounting for Cross-Factor Interactions in Multifactor Portfolios without Sacrificing Diversification and Risk Control", *Journal of Portfolio Management*, Special Issue, 2017.

[9] Amenc, N., Ducoulombier, F., Goltz, F., Lodh, A. and Sivasubramanian, S., "Diversified or Concentrated Factor Tilts," The Journal of Portfolio Management, Vol. 42, No. 2, p64-p76, 2016.

[10] Factor Indexes and Factor Exposure Matching: Like for Like Comparisons, FTSE Russell Research, 2018. https://www.ftserussell.com/sites/default/files/factor-indexes-and-factor-exposure-matching-like-for-like-comparisons_0.pdf

[11] Target Exposure: Investment applications and solutions, FTSE Russell Research, 2020.

[12] RAFI Indices: Methodology & Standard Treatment, Research Affiliates, 2020.

[13] Aguet, D., Amenc, N., Goltz, F. and Lodh, A., "Scientific Beta Multi-Beta Multi-Strategy Solution Benchmarks", Scientific Beta, 2018.

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