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Identifying outperformance with the SDI Innovation Outlook score

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1. Introduction

Over the past few decades, many research papers have shown that patents are a leading indicator of future earnings growth and equity returns. However, there does not appear to be a consistent way of incorporating patent information, and there have been almost as many ways of measuring firms' patent portfolios as papers themselves. In December 2022, the Sustainable Development Investments Asset Owner Platform (SDI AOP) introduced a new, forward-looking metric called the SDI Innovation Outlook, which quantifies the alignment of a firm's patent portfolio with the UN Sustainable Development Goals (SDGs). This paper investigates the effectiveness of a proxy for the new SDI Innovation Outlook score in predicting equity returns and enabling the construction of outperforming portfolios.

The SDI Innovation Outlook score is based on patents that contribute positively to the SDGs, according to the SDI classification. The score considers a measure of a firm's patents that contributes to the SDGs relative to its overall patents. The score should prove very valuable in identifying firms that are investing to improve compliance with the SDGs, and should therefore assist in constructing Article 9 portfolios under the EU's Sustainable Finance Disclosure Regulation (SFDR). This paper focuses exclusively on the score's ability to identify firms with outperforming equity returns, and the effectiveness of using the score to construct outperforming portfolios.

Since an extensive history of the SDI Innovation Outlook score is not available, we utilized an SDI 3-year Outlook (3YO) score as a proxy. We reviewed the information contained in the 3YO score by considering both the information coefficient of the signal at different horizons and the information ratios of long-only portfolios constructed to maximize exposure to the signal. We tested these two measures of information over three different regions – the USA, Europe, and APAC, breaking these down further by market capitalization buckets.

We have shown that the information coefficients across various market segments do in fact appear to contain information that can be used to predict equity asset returns above and beyond that explainable by the factors in Qontigo's fundamental equity factor risk models. In addition, the signal is stronger at longer holding horizons. This is intuitive, since it is to be expected that realizing the financial benefits of patents will take time. We believe that this insight should ultimately be used to construct portfolios extracting the maximum information from the signal, though we did not consider this ourselves in the current paper.

Our tests of two different backtesting scenarios whose portfolios were constructed to maximize the 3YO score were even more conclusive. The first scenario was a factor-neutral strategy whose active returns were generated by the 3YO score as opposed to standard risk factors. The second scenario considered a strategy in which assets were grouped into ETF-like instruments based on their scores, with the investor investing only in these instruments. In both cases, we found that the optimized portfolios outperformed the corresponding market cap-weighted benchmarks in each of the nine different market segments considered. In some cases, this outperformance was also statistically significant.

The remainder of the paper provides the details of our tests. We describe the SDI Innovation Outlook score, the SDI 3-year Outlook score that we used as a proxy, and how the scores were used to construct our portfolios. Lastly, we illustrate how our portfolios, constructed using the 3YO score, outperformed their benchmarks from 2014 – 2022. We believe that the detailed description of our methodology and the results provide a good base from which to start constructing live portfolios utilizing the SDI Innovation Outlook score.

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2. The SDI Innovation Outlook proxy

The SDI Innovation Outlook is based on patents issued in the last ten years and also includes patent citations. Patents with larger numbers of citations are considered more impactful, or of a higher quality, and are therefore given greater weight.[1] Due to the ten-year history of historical patents required to construct the SDI Innovation Outlook score, it is difficult to construct a long history for the score. Aside from the lack of data, the UN SDGs were only introduced in 2015 and sustainability trends have also grown stronger over the last decade. We therefore based our analysis on the SDI 3-year Outlook ("3YO") – a rolling three-year window that serves as a proxy for the Innovation Outlook.[2] In other words, the 3YO adopts the same approach to processing patents as the full SDI Innovation Outlook score, but only considers patents issued in the last three years and does not consider patent citations. The full SDI Innovation Outlook score is therefore an extension of the shorter-term 3YO score considered here.

The 3YO score is similar to the Innovation Outlook score from a numerical perspective. The cross-sectional correlation between the two was slightly less than 97% on December 1, 2022.[3] We therefore feel comfortable that our analysis of the 3YO score will also apply to the actual Innovation Outlook score. In fact, we believe that the SDI Innovation Outlook signal will likely be even stronger, since it incorporates patent citations that should help to identify firms with stronger patent portfolios.

It is important to consider the universe of firms with scores so that we better understand how to handle them. The starting point for the SDI Innovation Outlook score (and the 3YO score) is the SDI Universe, which includes approximately 10,000 firms. A screening criterion is then applied to select only those companies that are listed on a global stock exchange. Firms in real estate and financial services are excluded. The same goes for companies that do not meet the criteria for reliability (i.e., not enough patents to make a reliable estimate) or representativeness (i.e., not enough patents relative to the firm's size). The resulting universe covers approximately 2,200 firms.

This paper uses the SDI 3-year Outlook label (3YO label), which is a categorization of the 3YO score, to break down our analysis. Each firm is assigned to one of the following categories based on its 3YO score:

- **"Innovator" if the 3YO score is ≥ 50**
- **"Developer" if 50 > 3YO score ≥ 10**
- **"Adopter" if 10 > 3YO score is > 0**
- **"Unclassified" if the asset does not have a 3YO score.**

Unclassified firms are assumed to have a score of zero. That is, they are treated as if they have zero patents contributing to the SDGs. This is described in more detail in the next section.

While scores and labels are provided at the level of the firms, our analysis is of the equity assets associated with these firms. Each asset receives a score and a label based on the score and label of the underlying firm. Multiple classes of equities associated with the same firm all receive the same score and label.

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[1] See https://www.sdi-aop.org/sdi-innovation-outlook-/ for a more detailed description of the score.

[2] SDI-AOP provided the SDI 3-year Outlook (3YO) to Qontigo for research purposes. The 3YO score is based on the ratio of a firm's SDI contributing patents to its total number of patents.

[3] We show a scatterplot of the SDI Innovation Outlook score and the 3YO score in the Appendix, Figure 8. The plot shows that while the correlation between the two scores is high, the scores do differ (substantially so for some firms).

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3. Methodology

For our analysis, we constructed market cap-weighted benchmarks by splitting the estimation universes used in Axioma's fundamental equity risk models into three buckets with an equal number of assets in each. We originally created families of Large, Mid, Small, and AllCap benchmarks for the United States (US), Europe (EU), and Asia-Pacific (AP) models, based on Axioma's fundamental equity risk models for the corresponding regions.[4] These are referred to as our "core benchmarks". In total, therefore, we constructed twelve different benchmarks for our analysis. However, we found that the core benchmarks for the Small market cap segments contained too few assets with a 3YO score greater than zero, so we excluded these from our analysis to produce a total of nine benchmarks. Please note, however, that the AllCap benchmarks still include the small cap segment.

Since the historical scores were constructed with assets for a single recent date, care must be taken to mitigate survivorship bias in our analysis. Take the example of biotechnology firms that produce large numbers of patents, all of which contribute to SDG 3 (Good Health and Well-Being) and hence to the 3YO score. Since we are considering firms that currently exist, and producing scores for those firms historically, portfolios constructed to maximize the 3YO score at a historical date will overweight assets that exist today and underweight assets that do not. This can create a significant bias and effectively assumes that we are able to predict which biotechnology stocks will be around years from now.

To prevent such potential survivorship bias, we constructed and utilized an eligible version of each of the benchmarks used in our analysis. These eligible benchmarks were constructed by considering the subset of those assets in our core benchmarks that are in the core benchmarks today. That is, the universe for an eligible benchmark on a given date was taken to be the intersection of assets in the core benchmark on that date and assets in the core benchmark today. The eligible benchmark was then reweighted based on the total market cap of the assets remaining in the eligible benchmark.

Note that eligible benchmarks can have assets that do not have 3YO scores, but this is consistent with the way in which the SDI Innovation Outlook score is constructed. This score was only provided for firms having patents, among other criteria; scores for other firms were implicitly treated as zeros. Firms that were ineligible (i.e., they were in the core benchmark but not the eligible benchmark) were dealt with separately. Exactly how eligible benchmarks and ineligible firms were handled in our analyses is described in the corresponding sections.

4. Information coefficients at different horizons

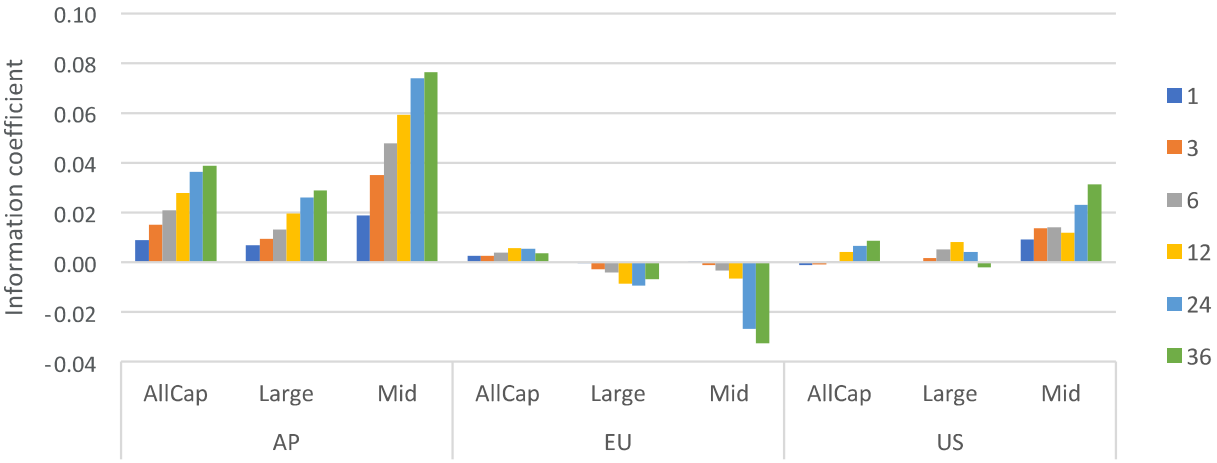
We started by looking at how much information was available in the 3YO score and where it lay. To do this, we considered the information coefficients of the 3YO score and the contributions to these coefficients, broken down into various categories. An information coefficient (IC) is the correlation between the signal – the 3YO score in our case – and asset returns. We wanted to consider the IC of the pure signal, i.e., the part of it that cannot be explained by risk factors. This means that our IC was actually the correlation between the signal that cannot be explained by risk factors and those asset returns that cannot be explained by risk factors. Details of the calculations can be found in the Appendix. All IC values discussed here were computed using the eligible benchmarks described in the previous section.

[4] Qontigo's fundamental equity risk models contain a market intercept factor; a factor for each country, currency, and industry in the relevant region of the model; and a set of style factors including market sensitivity, dividend yield, earnings yield, growth, leverage, liquidity, medium-term momentum, profitability, size, value, and volatility.

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Figure 1 shows the average IC for each benchmark at various horizons. The IC values were computed over the assets in the eligible benchmark at each point in time and utilized the asset returns over the subsequent x months, where x is the specified horizon in months. The IC values were then averaged over all periods. The values were positive for most of the segments at various horizons – an impressive finding given the purity of the IC used in our calculations. This means that the 3YO score contained information above and beyond the risk factors, including the growth factor present in Qontigo's fundamental equity factor risk models. Not surprisingly, the ICs tend to increase in strength as the horizon increases. This is consistent with the belief that it takes time for patents to translate into financial success and to increase the market value of a firm's equity.

Figure 1: Average information coefficients at different horizons (subsequent months).

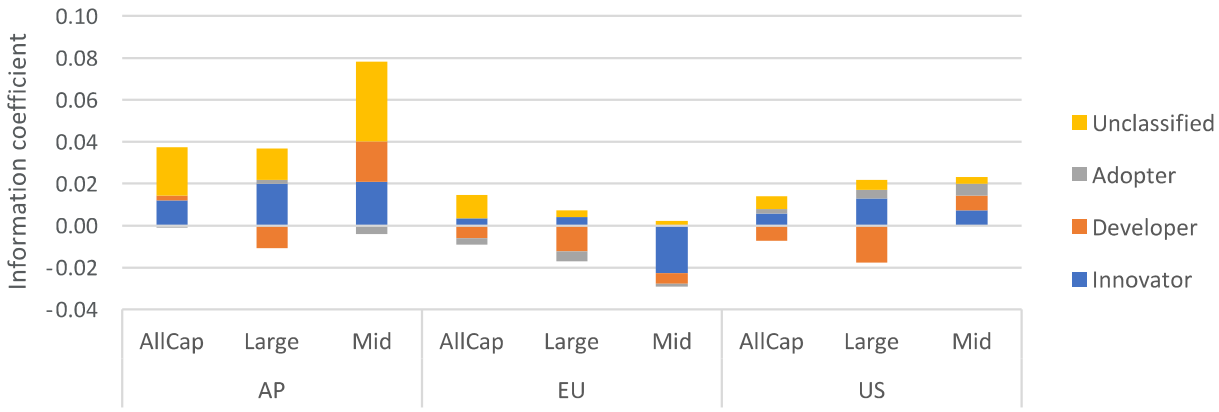


Source: Qontigo.

Figure 2 decomposes the 24-month ICs by the 3YO label described earlier. These IC contributions were computed by breaking down the inner product in the numerator of the IC calculation by disjoint sets (utilizing the labels here). Note that the positive contributions from the Unclassified category do not mean that these assets performed well. In fact, it means the opposite. The score of each Unclassified asset is zero (at least prior to purifying), so the underweighting of these assets together with the relatively lower asset returns of the Unclassified assets led to a positive contribution to the IC, as was to be expected. Similarly, the contribution from the Innovator group was consistently positive except for the EU mid-cap segment, which had the greatest 3YO score. However, when combined with the relatively larger asset returns, the contribution to the Innovator class was positive again.

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Figure 2: Average information coefficient contributions by 3YO label.



Source: Qontigo.

5. Optimized portfolios

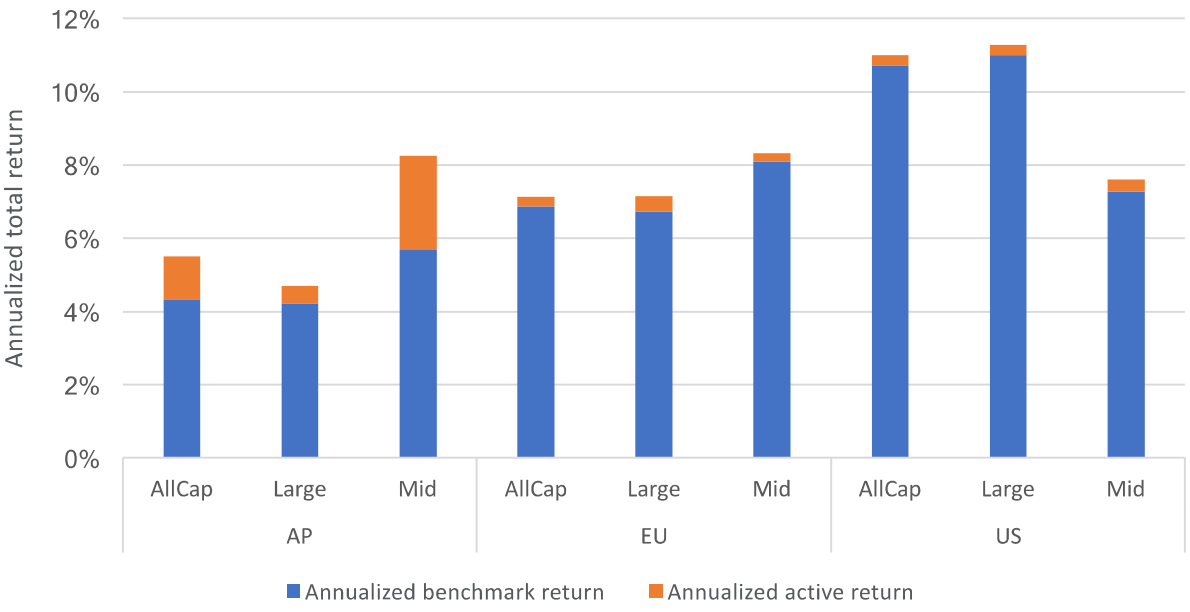
After discovering that the 3YO score appears to contain information across most geographies and capitalization segments, we wanted to consider how portfolios that are constructed using the signal perform. To do this, we first considered a simple strategy that maximizes the 3YO score, with the predicted tracking error against the underlying benchmark being at most one percent and with zero active exposures to all risk factors in the Axioma medium-horizon fundamental risk model for the corresponding region. This means that the signal ultimately being bet on is pure (since it is neutral to risk factors) and implementable (since it is constructed in a long-only portfolio). In addition, we constrained active positions in all "ineligible" assets to zero. That is, we allowed active positions only in those assets that were in the eligible benchmark. This constraint was adopted to mitigate survivorship bias in our optimized backtests.

We ran nine different backtests, one for each size-region combination, in the same way as when considering the information coefficients. We rebalanced the portfolios monthly from January 2014 through November 2022. The annualized active return was positive in each of the nine backtests. Figure 3 breaks down the annualized total returns into an annualized benchmark return and annualized active return for each backtest. Annualized active returns are particularly large in the Asia-Pacific region. The consistency of performance suggests that the 3YO score may be a true alpha-generating signal.

To show the statistical significance of the backtests, we have provided the information ratios for each of the backtests in Figure 4. The blue bars show the information ratios, whereas the annualized active return is statistically significant at the 95% level in those cases in which the information ratio is greater than the dashed orange line. In other words, the annualized active returns are statistically significant for two out of the nine backtests. As with the information coefficients, we can see that the 3YO score is stronger in the Asia-Pacific region across all market cap segments. More detailed backtest summary statistics are provided in Table 1 in the Appendix.

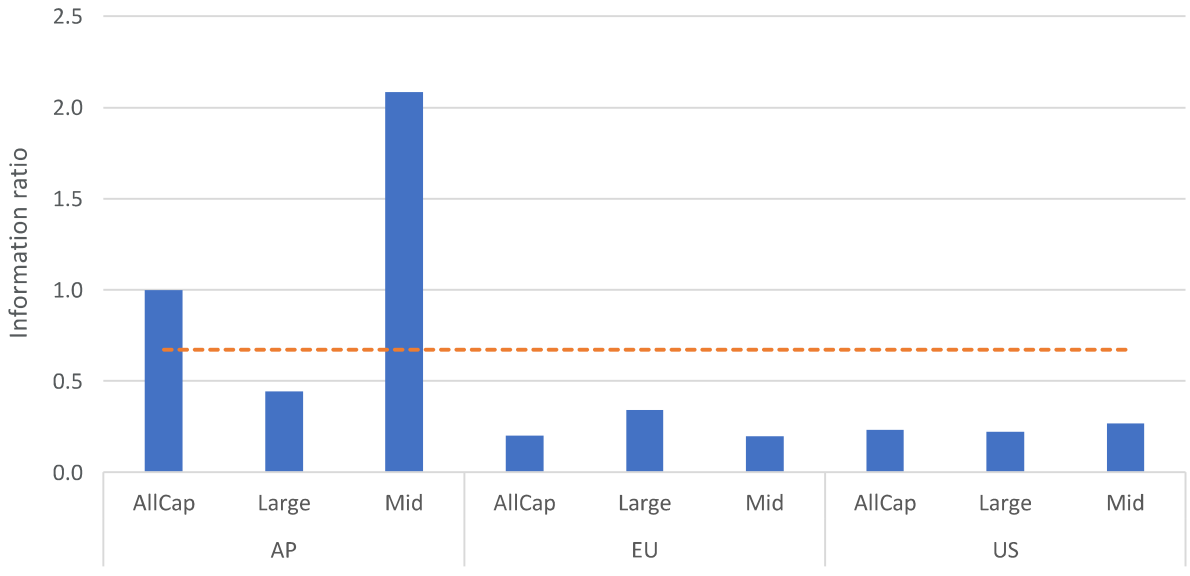
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Figure 3: Annualized total returns of optimized strategies.



Source: Qontigo.

Figure 4: Information ratios of optimized strategies.

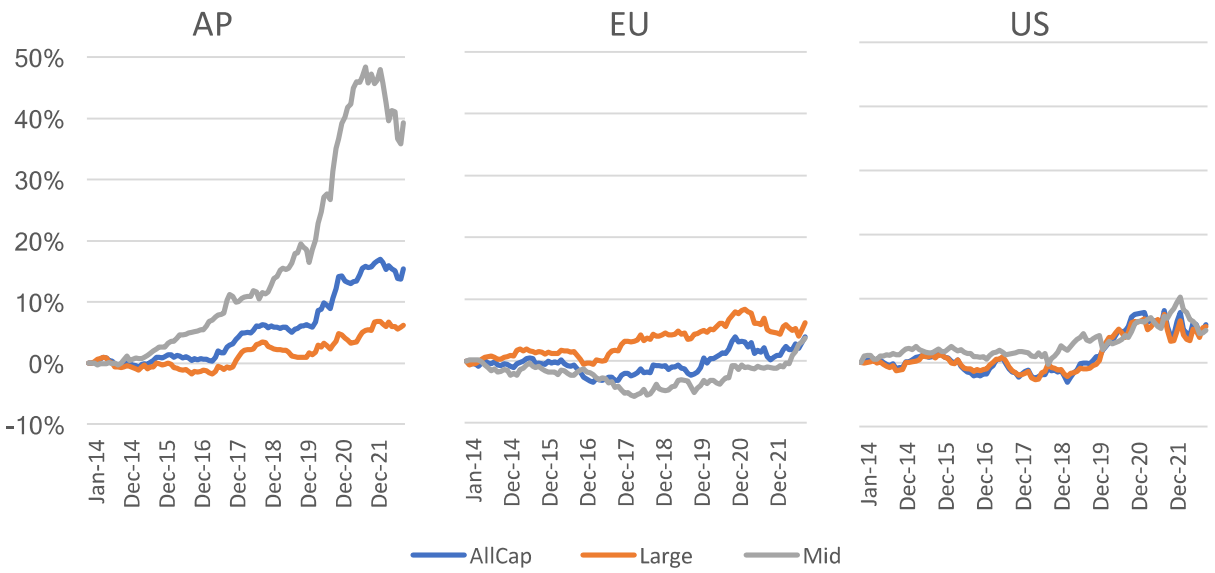


Source: Qontigo.

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The cumulative active returns for each of the optimized strategies are shown in Figure 5. This reveals that the active returns were particularly strong in the most recent three-year period for many of the benchmarks, but that there was a downtrend in the mid-cap segment of the AP and US regions in 2022. This is particularly impressive given the under-performance of growth stocks in 2022 which we would expect to be related to companies with stronger patent portfolios. However, our portfolios were constructed to be neutral to all risk factors, including the growth factor present in Qontigo's fundamental equity risk models. Consequently, these active returns are in excess of all risk factors and supports the hypothesis that this the information in the 3YO score contains excess information.

Figure 5: Cumulative active returns of optimized strategies.



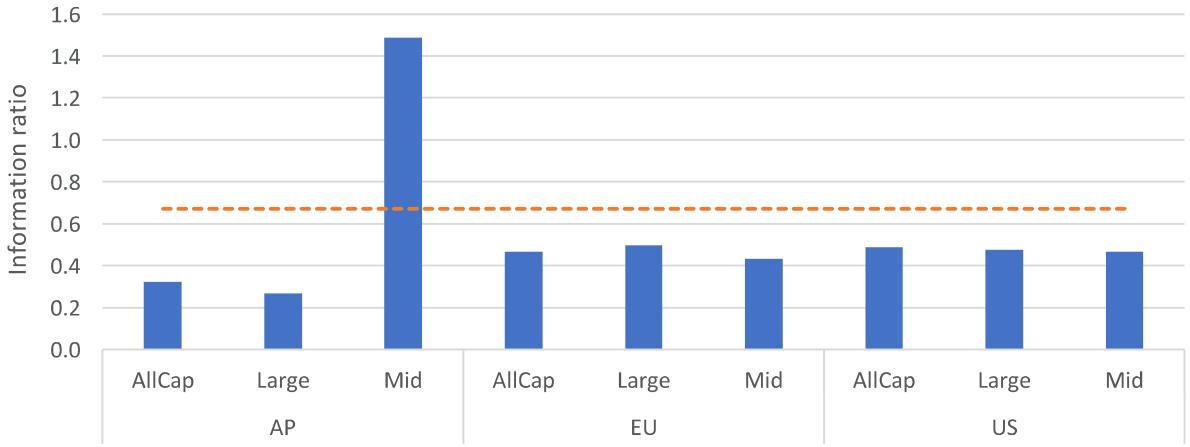
Source: Qontigo.

We considered one more very simple backtesting strategy that simulates investing in ETFs, with each ETF being a market cap-weighted version of our core benchmarks and with segmentation using the 3YO labels described earlier. Specifically, we constructed segments for each core benchmark by restricting the assets to the Unclassified and Ineligible sets mentioned earlier and to the Innovator, Developer, and Adopter 3YO labels. Each core benchmark was divided into these five segments and then rescaled so that the weights totaled 100%. The strategy then invested in the five composite assets associated with the benchmark rather than in individual equities. We did not force the portfolio to have zero active exposures to risk factors in this case. We maximized the 3YO score, restricted the tracking error against the core benchmark to one percent at most, and restricted the active positions in the Ineligible segment to zero. In other words, we used the zero active exposure to Ineligible ETFs to ensure that the ultimate exposure of each ineligible asset equaled that of the benchmark.

The information ratios for the optimized composite backtest are given in Figure 6. In this case, only one backtest – the Asia-Pacific mid-cap segment – had a statistically significant information ratio. The information ratios for all other segments were more consistent, ranging from 0.27 to 0.5. Unlike the previous strategy that invested in individual equities and constrained active risk exposures to zero, these optimized portfolios could take active positions in industries, countries, and styles. However, we expected such exposures to be small due to the cap on the predicted tracking error. We therefore believe that most of the return is still driven by the portfolio tilts on the 3YO score.

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Figure 6: Information ratios of optimized composite strategies.



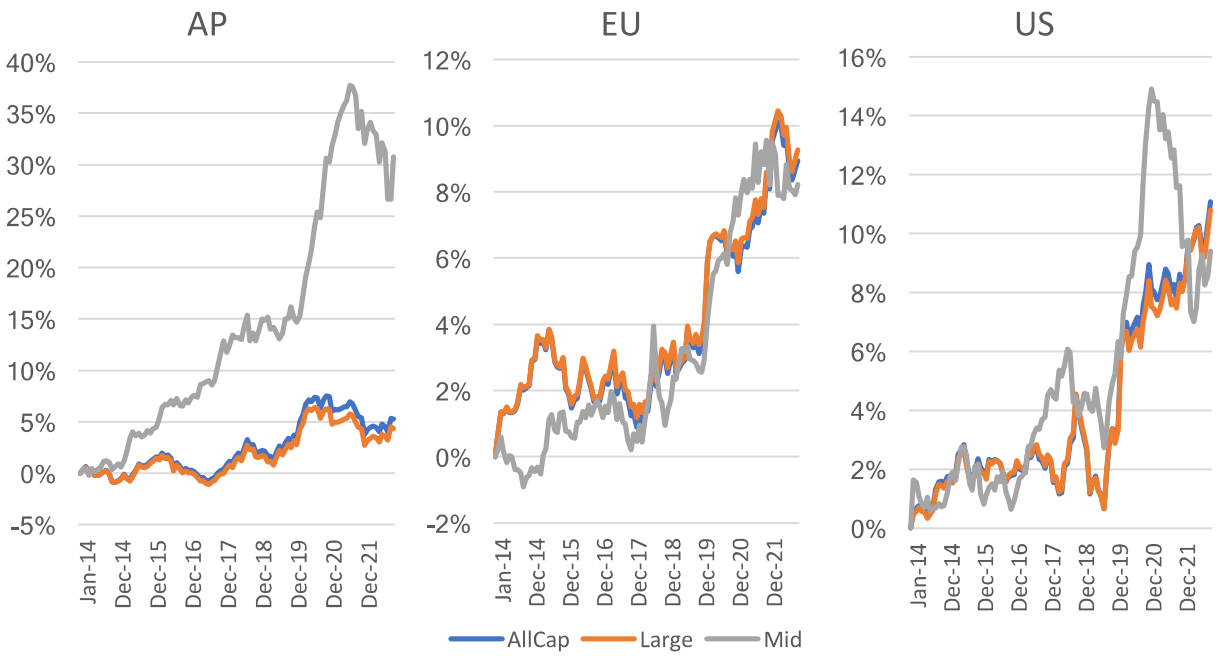
Source: Qontigo.

The cumulative active returns for the optimized composite strategies are given in Figure 7. In this case, the mid-cap segments of the AP and US regions were volatile and showed declines in the last 1.5 years, though they still significantly outperformed the benchmark over the entire backtest period. In all other cases, the cumulative active return was either relatively flat or even increased. Given the general performance of tech stocks in 2022, the performance of these strategies in recent months seems to further validate the information in the 3YO score.[5]

[5] For example, the NASDAQ 100 index (a technology-heavy US index) was down 32% in 2022, while the S&P 500 was down 18%. In other words, technology underperformed the broader large cap index. One might expect the outperformance of our portfolios that tilted on the 3YO score to be due to overweighting technology assets. If that were the case, we would have expected our portfolio to underperform in 2022. However, our cumulative active return for US large caps actually increased. This means that our portfolio outperformed even in 2022 when technology stocks did so poorly, and that there is therefore more to the 3YO score than just betting on growth firms.

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Figure 7: Cumulative active returns of optimized composite strategies.



Source: Qontigo.

6. Summary and conclusions

Based on the analysis presented in this paper, the SDI 3-year Outlook score offers information in excess of that present in existing risk factors. By looking at information coefficients at varying horizons, we saw that the signal grew stronger as the investment horizon increased (at least up to the maximum horizon considered (36 months)). Moreover, when we decomposed the information coefficients by their 3YO labels, we saw that the stronger contributions were due to the large 3YO scores associated with the Innovator label, while the zero scores were associated with the Unclassified label. In other words, the information seems to be stronger at both ends of the spectrum of 3YO scores.

We then looked at backtests, in which optimized portfolios were constructed monthly from January 2014 to November 2022 for each of our nine benchmarks. We found that the annualized active returns were positive in all nine cases. This is particularly interesting given that the information coefficients were negative in some cases, and in particular for the European mid-cap segment. The information ratios were statistically significant for two of the nine cases. The consistency of the relative performance across both market cap segments and regions further validates our hypothesis that the 3YO score contains information for predicting future asset returns, and may therefore be a true alpha-generating signal.

Lastly, we constructed composite assets representing the market cap-weighted segments of our core benchmarks, based on the 3YO scores. We ran optimized backtests in which portfolios were constructed by investing exclusively in five composite assets. This strategy is meant to simulate a scenario in which an investor could build a portfolio of ETFs constructed using the 3YO score segments. We found that the optimized strategies again outperformed the benchmark in each of the nine region/capitalization scenarios tested.

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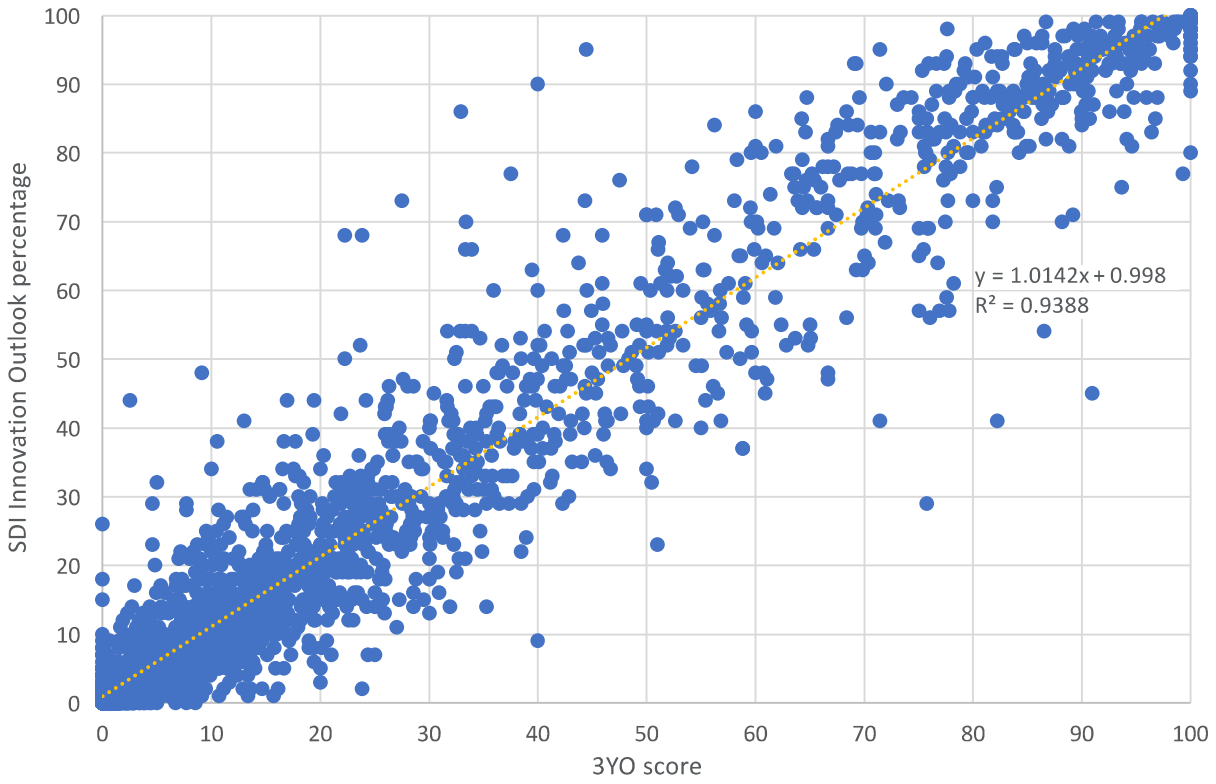
In summary, we demonstrated that utilizing the information in the 3YO score can lead to outperformance. Because the SDI Innovation Outlook score is highly correlated with the 3YO score utilized here, we feel confident that the information in the 3YO score will also apply to the SDI Innovation Outlook score itself. In fact, since the latter contains patents over a longer horizon and incorporates patent citations so as to weight "important" patents more heavily, we expect that the actual signal will perform even better in practice than the 3YO score.

7. Appendix

7.1 The SDI 3-year Outlook (3YO) score versus the SDI Innovation Outlook percentage

The scatterplot below shows the SDI 3-Year Outlook (3YO) score versus the SDI Innovation Outlook percentage for December 1, 2022. The regression line between the two scores shows an r-squared value of 0.9388, indicating the strong relationship between them. At the same time, the scatterplot shows that, while they are highly correlated, they do differ substantially for some firms.

Figure 8: SDI Innovation Outlook Score vs 3YO score.



Source: Qontigo.

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7.2 Computing the information coefficient

This paper computes the information coefficient as the correlation between that portion of the signal that cannot be explained by risk factors and the portfolio of asset returns that cannot be explained by risk factors.

Let r be the vector of asset returns, α be the vector representing the signal (3YO score), and X be the $n \times k$ matrix of risk exposures where n is the number of assets and k is the number of risk factors. Then consider the following two regression equations that explain the asset returns and the signal, respectively, by risk factors:

$$r = Xf + \varepsilon$$

$$\alpha = Xs + u$$

where ε and u are the portions of the asset returns and signal not explained by the risk factors. Both regressions are weighted by the inverse of the specific risk matrix from the corresponding equity risk model. We can then compute the information coefficient as the correlation between u and ε:

$$IC = \frac{u^T \varepsilon}{\|u\| \|\varepsilon\|}$$

Table 1: Summary backtest statistics of optimized portfolios.

Region/ benchmark	Annualized portfolio return	Annualized benchmark return	Annualized active return	Annualized active risk	Information ratio	Average monthly two-way turnover	Average SDI 3-Year Outlook score	Average active SDI 3-Year Outlook score
AP								
AllCap	5.52%	4.33%	1.18%	1.19%	1.00	11.0%	22.2	14.6
Large	4.70%	4.21%	0.49%	1.12%	0.44	12.3%	20.5	12.5
Mid	8.26%	5.67%	2.58%	1.24%	2.08	25.7%	16.1	12.9
EU								
AllCap	7.13%	6.88%	0.26%	1.27%	0.20	11.4%	24.3	12.0
Large	7.15%	6.74%	0.41%	1.20%	0.34	12.9%	23.4	10.2
Mid	8.32%	8.10%	0.22%	1.14%	0.20	23.0%	11.4	7.9
US								
AllCap	11.01%	10.71%	0.29%	1.26%	0.23	10.7%	21.8	11.0
Large	11.27%	11.00%	0.27%	1.23%	0.22	12.4%	20.5	9.3
Mid	7.60%	7.28%	0.32%	1.20%	0.27	22.6%	14.2	8.5

Source: Qontigo.

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8. Contacts and further information

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