

RESEARCH INSIGHTS
EDHEC

Contents

Targeting inflation risk in equity investing: Building dedicated portfolios from robust exposures	2
<i>Mikheil Esakia, Felix Goltz</i>	
Inflation-friendly equity indices: Robust tools for strategic asset allocation or tactical allocation choices	5
<i>Daniel Aguet, Dimitris Korovilas</i>	
A review of inflation-friendly equity strategies	11
<i>Dimitris Korovilas, Maurizio Luisi</i>	
The impact of intangibility and social distancing on the performance of rewarded factors since COVID-19	17
<i>Daniel Aguet</i>	
Financing the energy transition: What is the role of fossil fuel divestment?	21
<i>Erik Christiansen</i>	

Introduction

It is a great pleasure to introduce the latest Scientific Beta special issue of the Research Insights supplement to IPE.

In our first article, we look at how inflation risk can be targeted in equity investing and how dedicated portfolios can be built from robust exposures to inflation, with the aim of protecting investors from inflation surprises.

We introduce a new approach to overcome macroeconomic measurement challenges and construct dedicated equity portfolios that target desired exposures to surprises in inflation expectations. We present two families of inflation-friendly equity indices that can be employed either in a long-term strategic allocation or as a short-term tactical tool in a satellite allocation.

We then look at the small set of competitor inflation-sensitive strategies currently available in the marketplace. We review their main methodological choices and compare their quantitative profile relative to the Scientific Beta inflation indices.

In the area of factor investing, we review the performance of rewarded factors in the US market since 2020 through the lens of two important characteristics, which are intangibility and social distancing. These two characteristics were particularly important during the COVID crisis since lockdown measures affected companies with low intangible capital and companies that could not use teleworking to overcome social distancing measures. The losses incurred in 2020 are consistent with factor investing's risk-based rationale and should be expected by investors. The long-term reward of the consensus risk factors will not disappear in the future, and factor strategies, if properly designed, will be able to deliver their promise of long-term risk-adjusted outperformance.

Finally, turning to climate finance, we explore the role of fossil fuel divestment in financing the energy transition. We show that investors need to make clear distinctions between different types of fossil fuels as their stranding risk and the pace of their net zero consistent phase-out differ widely. We also illustrate the pitfalls of fossil fuel divestment by looking at the European Union's regulated Paris-Aligned Benchmarks (PAB).

We hope you will find the articles in the supplement useful and informative. We extend warm thanks to IPE for their partnership on the supplement.

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Targeting inflation risk in equity investing: Building dedicated portfolios from robust exposures

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We measure the inflation exposure of stocks using robust measures of return sensitivities in combination with automated analysis of risk disclosure texts

Reliable measurement requires forward-looking measures that reflect market participants' surprises with respect to inflation

Investors need to build dedicated portfolios to effectively target inflation exposure. Allocating across off-the-shelf building blocks like sector indices or style factors is too imprecise to deliver reliable results

Our approach can be used to design equity indices that protect investors from inflation surprises

Investors care how their equity portfolio is exposed to inflation risk. They are typically affected by inflation shocks outside their equity portfolio and wish to avoid dialling up such exposure when it comes to their equity investments. In addition, investment organisations spend significant resources to form views on future inflation. They need tools to translate these views into decisions about their equity portfolio.

This article presents a methodology developed in Esakia and Goltz (2022) that allows equity portfolios that target inflation exposure in the desired direction to be built, protecting investors from either positive or negative inflation shocks. We first discuss how to measure and target inflation exposures and then evaluate the out-of-sample reliability of this approach.

How to obtain a reliable measure of macro exposure

It has been documented that equity portfolios have substantial exposures to macroeconomic risks. In Amenc et al (2019), we analysed equity style factors and found that they did show substantial differences in their long-term exposures to different macroeconomic variables, after accounting for their exposure to the equity market factor. However, measuring these exposures reliably out of sample is not a piece of cake. Ang, Briere and Signori (2012) found that portfolios of stocks with the highest in-sample exposure to inflation could not provide any protection against inflation when going out of sample. In Esakia and Goltz (2022), we introduce an approach that allows exposures to a variety of macroeconomic state variables to be measured and portfolio exposure to such macro variables to be targeted. This approach relies on four important ingredients, discussed below.

Selecting forward-looking variables

As explained in Amenc et al (2019) and Esakia and Goltz (2022), using realised quantities of fundamental economic measures is not suitable when analysing movements in asset prices. In liquid markets, information is quickly reflected in prices. Financial assets that are claims for future cash flows depend on investors' expectations going forward. Therefore, looking at past realisations of economic variables does not allow the relationship between asset prices and economic conditions to be captured reliably. This is why we rely on macro state variables that are forward-looking and that incorporate available information fast. We primarily rely on nominal and inflation-protected

bonds data from the US. In particular, we use the difference between yields in 10-year Treasury Inflation-Protected Securities (TIPS) and 10-year nominal Treasury bonds. This measure is also called breakeven inflation, and it reflects the market expectations about long-term inflation. Our approach can be easily extended to other geographical areas and macro variables.

Surprises matter, not levels!

Another very important aspect of our methodology is to use surprises, or innovations, in expected inflation instead of levels. The value of stocks is not formally linked to the realisation of inflation, as opposed to inflation-linked bonds. Investors do not know what realised inflation will be in the future. The value of assets will reflect information that is known to investors today. As new information arrives, asset prices, including the stocks, will adjust accordingly. This is why we are interested in surprises, since the level of expected inflation that was fully anticipated by investors will not lead to different price reactions across stocks. Therefore, we will be measuring stocks' sensitivity to surprises in expected inflation, rather than levels of expected inflation.

To estimate anticipated changes in inflation, the standard approach is to use the vector auto-regressive model (VAR – see Campbell [1996], Petkova [2006] and Boons [2016]). A simpler approach is to use the first-order differences in a given macro variable. We choose first-order differences because in our setting it leads to similar results to using a VAR.

Robust statistical estimates

We take several important steps to ensure

that exposures estimated on past data stay reliable out of sample.

First, we use weekly frequency of observations. Levi and Welch (2017) show that using such higher-frequency data provides substantial improvements in accuracy of estimated betas compared to using monthly returns data. Having higher frequency leads to more observations, which helps to reduce estimation error. Therefore, we use weekly observations to estimate macro exposures with greater accuracy.

Second, we account for recent dynamics in macro betas while maintaining deep historical samples for estimation. Estimation problems face a basic trade-off between sample size and responsiveness to changes in exposures. Using historical data that is a decade old provides a large sample but ignores that firms might have drastically changed over this period. On the other hand, relying on a short time window, such as only the most recent year, will lead to imprecise estimates due to small sample size. We overcome this trade-off by using a long-term history of stock-level returns (20 years, if available) and attributing decreasing importance to observations as we go further back into history.

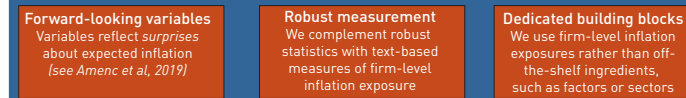
Third, we explicitly account for estimation risk at the firm level. Treating inflation exposures of identical magnitude for two stocks as equal would ignore estimation risk. Even if macro betas for two stocks are estimated to be identical in magnitude, they may differ in terms of the uncertainty around the point estimate. Therefore, we also account for the differences in uncertainty across stocks and adjust inflation exposures that are estimated imprecisely.

Text-based measure of macro exposures
Stock returns are noisy, and it is practically impossible to disentangle all their determinants. While our statistical approach does its best to capture the sensitivity of stock returns to inflation surprises, it still has obvious limitations. Therefore, we go beyond returns and look

1 10-K reports are specific to US companies. However, the methodology can be extended to other countries by looking at respective annual reports that legislation requires to be filled. It is also possible to rely on alternative source of text data. For example, transcripts of quarterly earnings calls could also be used to identify important risk factors for a given firm.

2 Our analysis focuses on inflation exposures. However, we have also studied the reliability of other macro exposures over a long-term period. In the following section, we show how our approach performs and how it compares with alternative approaches.

1. Process for creating macro exposure portfolios



for additional information to further improve the out-of-sample reliability of our inflation exposures. We do this by complementing our statistical estimates of macro exposures with the information from text data.

More specifically, we rely on the ‘risk factors’ section of firms’ annual 10-K filings that have been mandatory to disclose for public US firms since 2006.¹ The risk factors section should mention all key risk factors that may affect the firm. We use natural language processing techniques to come up with a score that indicates how important inflation risk is for a given firm. These techniques exploit the insight that the more often a given risk is discussed, the more likely it is that the firm is exposed to this risk. We use the text-based measures of exposures to complement the statistical measures when ranking stocks in our equity universe.

Overview of how we measure inflation exposure

Figure 1 summarises the process. The first ingredient of our methodology is to use surprises in forward-looking variables, such as breakeven inflation (BEI).² Second, we use a combination of statistical and text-based measures to define the stock-level macro exposures. Statistical estimates rely on surprises in forward-looking macro variables and employ various statistical adjustments to generate robust estimates. Text-based analysis allows us to add information beyond historical returns. Finally, we use stock-level inflation exposures to create

dedicated building blocks instead of allocating across existing ingredients, such as sector or factor portfolios.

Assessing the reliability of macro exposures estimates

We evaluate the reliability of macro exposure estimates by constructing mimicking portfolios. We buy stocks with the highest exposures to inflation (top 20%) and sell ones with the lowest inflation exposure estimates (bottom 20%). The equal-weighted long-short portfolio is formed each quarter and held until the next quarterly rebalancing. If our ex-ante estimates of exposure are reliable, the mimicking portfolio will have positive exposure ex-post.

It is worth highlighting the importance of using forward-looking variables. Figure 2 shows the realised macro betas of different macro variables using a naive estimation technique (ordinary least-squares estimates on monthly returns over the most recent five years). The mimicking portfolios have both statistically and economically weak exposures out of sample. The results suggest that mimicking portfolios formed on backward-looking variables do not come with positive exposure out of sample.

We now turn to analysing mimicking portfolios that use our robust statistical procedure complemented by textual analysis. Figure 3 highlights two important findings. First, using robust estimation techniques leads to significant improvements in realised exposures compared to the naive estimation

2. Out-of-sample exposures when using different macro variables

US, 30 June 1970–30 June 2022	Realised macro beta	t-statistic
<i>Using backward-looking variable and naive estimation technique</i>		
Industrial production	-0.08	-0.67
CPI	0.29	0.78

The realised macro exposures are estimated in a bivariate regression that include the market factor and the corresponding macro variable. Standard errors are adjusted for heteroskedasticity and autocorrelation following Newey-West (1987). We follow Andrews (1991) when determining data-dependent bandwidth/lag truncation parameters, which are estimated in a first-order autoregressive model (AR(1)) with a maximum likelihood method.

approach. The beta of a mimicking portfolio using a robust estimation is 4.48, which is statistically significant. Recall that when using a naive approach, we could only achieve insignificant beta of 1.89, as shown in the second row of figure 3. Secondly, even when relying on robust estimation techniques, using levels in expected inflation does not lead to reliable results. The last row of figure 3 shows that a mimicking portfolio that uses levels of expected inflation comes with negative out-of-sample exposure, albeit statistically insignificant. This finding is reassuring since the level of expected inflation is less relevant for asset prices than surprises.

To summarise, using naive estimation techniques or using the level of inflation leads to failure to measure exposures reliably. In contrast, applying robust estimation to surprises in BEI leads to exposures that remain reliable out of sample.

Using our firm-level estimates of macro exposure, we create stylised strategies that simply select 30% of the stocks with the highest or lowest exposures to expected inflation, and we weight them according to their market capitalisation. We refer to such strategies as macro-dedicated portfolios.

The alternative to going to stock level would be to use a set of existing portfolios and allocate across them based on the estimated inflation exposure. Investment practice often uses sector rotations or factor allocations to gain desired macro exposure, as opposed to directly selecting stocks. We provide a comparison with these alternative approaches to illustrate the importance of creating macro-dedicated portfolios. Note that sector and factor allocations will be based on our robust estimation method as well.

The first approach that we compare with allocates equal weights across two out of six equity factor portfolios with the most desirable exposure to expected inflation shocks. The factor portfolios considered are mid-cap, value, high momentum, low volatility, high profitability, and low investment. Single factor portfolios select 30% of the stocks with the highest factor scores and cap-weights them. We refer to such strategies as a factor allocation. The second approach allocates across sectors following the TRBC classification. Three out of 10 cap-weighted sectors with the most desired inflation exposures are allocated

3. Out-of-sample exposure to breakeven inflation with different estimation approaches

US, 30 March 2002–30 June 2022	Realised macro beta	t-statistic
Breakeven inflation surprises (robust estimation)	4.48	2.73
Breakeven inflation surprises (naive estimation)	1.89	1.26
Breakeven inflation level (robust estimation)	-0.04	-0.32

The realised exposures are estimated to the same variable that was used during the estimation. Levels refer to absolute values of breakeven inflation, surprises refer to innovations over a lag of one period. Robust measurement uses weekly frequency, weighted least-squares, 20-year calibration window, Bayesian shrinkage; and complements this with textual analysis. Naive measurement uses monthly data, ordinary least squares, and a five-year calibration window. Standard errors are adjusted for heteroskedasticity and autocorrelation following Newey-West (1987). We follow Andrews (1991) when determining data-dependent bandwidth/lag truncation parameters, which are estimated in a first-order autoregressive model [AR(1)] with a maximum likelihood method.

4. Different approaches to targeting inflation exposure

US, 30 March 2002–30 June 2022	Positive inflation exposure	Negative inflation exposure	Differences in macro exposures
Macro dedicated portfolios	2.56**	-1.16**	3.70**
Factor allocation	1.68**	0.17	1.50*
Sector allocation	3.13**	2.25**	0.87

The realised macro exposures are estimated in a bivariate regression that includes the market factor and innovations in breakeven inflation. Macro-dedicated portfolios select 30% of the stocks with the most desired inflation exposures. Factor allocation selects two out of six equity style factor portfolios (cap-weighted 30%). Sector allocation selects three out of 10 sector indices (TRBC sectors). Standard errors are adjusted for heteroskedasticity and autocorrelation following Newey-West (1987). We follow Andrews (1991) when determining data-dependent bandwidth/lag truncation parameters, which are estimated in a first-order autoregressive model [AR(1)] with a maximum likelihood method. Statistical significance is indicated by a single asterisk (*) for results that are significant on a 5% basis, and double asterisks (**) for results that are significant on a 1% basis.

equal weight in a portfolio. We refer to such strategies as a sector allocation.

Figure 4 provides the analysis of realised macro exposures of different equity portfolios. The results suggest that macro-dedicated portfolios constructed from stock-level data achieve out-of-sample realised exposures that are in line with the target. For example, a portfolio that targets positive inflation exposure has a realised beta of 2.56, while a portfolio that targets negative exposure to inflation has a beta of -1.16.

The results are different for factor or sector allocations. The realised exposures of expected inflation shocks are always positive, even when the factor or sector allocation targets negative inflation exposure. Moreover, the differences between portfolios that target opposite inflation exposures are weak and much smaller than differences between betas of macro-dedicated portfolios.

Overall, our results clearly indicate that selecting stocks based on their macro exposures leads to more consistent exposures out of sample. This may not be surprising as sectors or factors were not designed to proxy inflation risk, while this is exactly the case for macro-dedicated

portfolios. Indeed, reliable measurement of macro exposures is key to allow such portfolios to be created.³

Conclusion

Reliable measurement of macro exposures allows us to create dedicated macro portfolios that come with strong exposure to a given macro variable. The success of our methodology relies on the use of a forward-looking proxy for inflation surprises, robust measurement of stock-level exposures, and construction of dedicated portfolios that exploit information at stock level. Our approach leads to more reliable measurement of inflation exposure than alternative approaches commonly used in the industry. Our macro-dedicated portfolios come with more consistent out-of-sample exposures to inflation surprises than sector or factor allocation strategies.

This methodology can be used to design indices that help investors to position for inflation shocks. Possible applications include designing narrow indices with strong conditionality to inflation, broad indices that extract the equity premium while tilting inflation exposure in the targeted direction or

³ Esakia and Goltz (2022) report similar benefits of robust estimation and dedicated portfolios when considering other forward-looking macro variables such as the term spread, default spread and short-term interest rates.

overlay strategies that help protect a multi-factor portfolio against inflation shocks.

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Inflation-friendly equity indices:

Robust tools for strategic asset allocation or tactical allocation choices

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In the current unstable macroeconomic environment, investors are actively seeking the right equity tools to protect their portfolio or to take advantage of unexpected inflation shocks

In order to fill a gap in terms of inflation-friendly equity solutions provided to investors, Scientific Beta offers a new approach to overcome macroeconomic measurement challenges and construct dedicated equity portfolios that target desired exposures to surprises in inflation expectations

In this article, we present two families of inflation-friendly equity indices that can be employed either in a long-term strategic allocation or as a short-term tactical tool in a satellite allocation

Furthermore, we illustrate their benefits for investors with two concrete investment cases

Two dedicated inflation-friendly indices

The inflation-friendly equity indices designed by Scientific Beta employ the methodology developed in Esakia and Goltz (2022) for robust measurement of macroeconomic exposures in equity portfolios. This methodology relies on two pillars that we summarise below.

First, the methodology employs the breakeven inflation rate¹ as the relevant inflation variable that is reactive enough, or sufficiently forward-looking, to capture changes in investors' expectations contemporaneously with equity returns. The second key aspect of the methodology is that it uses unexpected changes, also referred to as surprises, innovations or shocks. By measuring expected inflation in terms of surprises, we can identify stocks that provide protection against inflation changes that are not anticipated by investors.

Then, a robust statistical approach estimates stock-level inflation exposures while controlling for broad market exposure. Complementing the statistical approach, a text-based measure is used

that goes beyond returns and looks for additional information to further improve the out-of-sample reliability of exposures to inflation surprises. The final measure of inflation exposure is the average of the cross-sectional rank of the statistical and text-based measures, whereby a higher rank indicates higher exposure to inflation risk (and vice versa).²

Using this robust measurement of inflation exposure, we can then design dedicated inflation-friendly equity indices with the objective of being used as a core

¹ Breakeven inflation is derived from observable prices of the relevant government bond markets such that they reflect investors' expectations about inflation over the next 10 years. In the case of US indices, it is calculated as the difference between the yield of 10-year US Treasury Inflation-Protected Securities (TIPS) and 10-year US Treasury securities. In the case of Developed indices, a G7 breakeven inflation proxy rate is computed by GDP weighting the individual G7 country breakeven rates using 10-year maturities.

² The text-based metric relies on the risk factors section of US firms' annual 10-K filings. As a result, it forms part of the estimation methodology only for the US indices and not for the Developed region where similar information is not available.

allocation, namely inflation-tilted benchmark indices, or as a satellite allocation, namely inflation bet indices.³

Characteristics of inflation-tilted benchmark indices

We design two dedicated inflation-tilted benchmark indices, the Inflation+ and the Inflation- indices, which tilt stock weights in the reference cap-weighted index towards stocks with a positive or negative exposure respectively to expected inflation surprises. The indices target three objectives:

- Provide a substitute to the cap-weighted benchmark while maintaining a high level of investability;
- Capture the equity risk premium without targeting long-term outperformance;
- Provide the desired conditionality with inflation by offering positive or negative exposure to breakeven inflation surprises, while maintaining a reasonable tracking error with the cap-weighted benchmark.

These objectives are achieved by ultimately weighting the stocks in the reference cap-weighted index proportionally to the product of an inflation-exposure score and their free-float market-capitalisation weight.

As shown in figure 1, inflation-tilted benchmark indices exhibit statistically significant out-of-sample exposures to breakeven inflation surprises. The Inflation+ index has a positive exposure, which means that its relative returns are driven by positive (upwards) inflation shocks, while the Inflation- index has a negative exposure, which means that its relative returns are driven by negative (downwards) inflation shocks.

A main highlight of the inflation-tilted benchmark indices is that they deliver conditional outperformance over the cap-weighted benchmark during the relevant inflation surprise regimes. In figure 2, we define as positive (negative) inflation regimes, the top (bottom) quartiles of weekly inflation innovations defined as changes in the 10-year breakeven inflation rate. Both Inflation+ and Inflation- indices delivered outperformance during their desired exposure-tilted inflation regime, with annualised relative performances of 8.86% and 4.90%

³ Results presented in this article are based on a long-term track record dataset spanning more than 40 years of data for the US market or over 30 years for the Developed region. Regarding the availability of long-term data for breakeven inflation during periods that Treasury Inflation-Protected Securities did not exist, we follow the design of a long-term proxy for expected inflation surprises as described in Esakia and Goltz (2022).

1. Inflation-tilted benchmark exposure to breakeven inflation surprises

EDHEC Risk Long-Term Track Record	US		Developed	
	Inflation+	Inflation-	Inflation+	Inflation-
Breakeven inflation	0.77	-0.77	1.13	-0.70
T-stat	5.24	-5.85	3.63	-2.76

The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. The realised macro exposures are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and weekly inflation innovations, defined as changes in the 10-year breakeven inflation (BEI) rate. The statistics in bold are statistically significant at a 95% level.

2. Inflation-tilted benchmark indices' risk-adjusted performance

EDHEC Risk Long-Term Track Record	US			Developed		
	# of regimes	Inflation+	Inflation-	# of regimes	Inflation+	Inflation-
Weekly breakdown inflation innovations						
Negative inflation surprises	545	-4.75%	4.90%	417	-3.91%	3.05%
Stable inflation	1,096	-0.33%	0.21%	835	-0.28%	-0.05%
Positive inflation surprises	551	8.86%	-7.87%	418	11.94%	-8.48%
Macro spread	-	13.61%	-12.77%	-	15.86%	-11.53%
Monthly realised CPI changes						
Negative inflation surprises	126	-3.07%	2.76%	96	-3.63%	2.61%
Stable inflation	252	0.51%	-0.46%	191	0.99%	-0.94%
Positive inflation surprises	126	3.02%	-2.57%	96	4.78%	-3.70%
Macro spread	-	6.09%	-5.33%	-	8.42%	-6.31%

The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. Outperformance figures are computed as annualised relative performance of inflation indices compared to the CW index in top (positive surprise) and bottom (negative surprise) quartiles of either weekly inflation innovations, defined as changes in the 10-year breakeven inflation rate, or monthly realised changes in CPI (final estimate of US consumer price index for all urban consumers for US indices, GDP-weighted G7 consumer price index proxy for Developed indices). Macro spread is the difference in returns between positive and negative inflation surprise regimes. Macro spreads in bold are statistically significant at a 95% level based on a Welch's t-test.

in the US (11.94% and 3.05% in Developed) respectively for the Inflation+ and Inflation- indices, a result that confirms the ability of the indices to deliver conditional performances in line with positive and negative inflation surprise regimes in the market.

As a complement, we performed the same conditional analysis but using the US consumer price index for all urban consumers (US CPI) regarding the US indices or a GDP-weighted G7 consumer price index (G7 CPI) proxy for the Developed indices respectively, with CPI considered a common measure of inflation used in the industry. We define positive (negative) inflation surprises regimes as the top (bottom) quartiles of monthly realised changes in CPI. We underscore that the conditional behaviour of the inflation-tilted benchmark indices goes in the same direction as when using breakeven inflation rates, even if condi-

tional outperformance and macro spreads are slightly lower. This highlights the robustness of our methodology whatever the definition of the inflation regimes used.

In line with the rest of their objectives, the inflation-tilted benchmark indices are also able to deliver risk-adjusted performance in line with the cap-weighted index over longer time horizons. As we can see from figure 3, the Sharpe ratio for the US Inflation+ and Inflation- indices is 0.43 and 0.46 respectively, very close to the metric of 0.45 for the broad cap-weighted benchmark. The same holds for the developed market where the Inflation+ and Inflation- indices exhibit a Sharpe ratio of 0.40 and 0.35 respectively, again close to that of the broad cap-weighted benchmark (0.39). Furthermore, the Inflation indices provide the desired conditionality with respect to expected inflation while maintaining reasonable

tracking error with the cap-weighted benchmark (3.4% and 3.1% respectively for the Inflation+ and Inflation- indices in the US or 3.0% and 2.5% respectively in Developed).

Benefits of inflation-tilted benchmark indices in a core allocation

For an investor with liabilities linked to inflation (proxied by 10-year constant maturity Treasury Inflation-Protected Securities), positive inflation surprises will correspond to an increase in the present value of future liabilities. Hence, replacing the cap-weighted benchmark with the Inflation+ index in a multi-asset portfolio composed of bonds and equities might prove beneficial to improve its funding ratio, namely the relative performance of the multi-asset portfolio to the liabilities. In figure 4, we compare the conditional funding ratio of the multi-asset portfolio including the cap-weighted benchmark or the Inflation+ index in periods of positive inflation surprises. We clearly see the improvement in the conditional funding ratio between the two multi-asset portfolios, as depicted by the excess funding ratio line, which is very stable through time, and represents a conditional excess surplus of 3.9% annualised (see figure 5).

Moreover, as seen in figure 5, the average volatility of the surplus is very similar between both portfolios. Hence, the investor will benefit from a stronger surplus per unit of volatility (of the surplus) in these regimes of positive inflation surprises. Finally, we emphasise that extreme levels of the conditional funding ratio or volatility of the funding ratio are reduced when using the Inflation+ index. These conditional improvements are due to the good conditional properties and ‘cap-weighted like’ characteristics of the Inflation+ index.

Characteristics of inflation bet indices

With a different objective in mind and to serve the needs of the satellite part of investors’ allocations, we design two dedicated inflation bet indices, the Inflation Bet+ and Inflation Bet- indices. In the context of the satellite portfolio, investors are not expecting access to the broad equity premium over the long term or to obtain the Sharpe ratio offered by the typical cap-weighted benchmark. Instead, the objective is to gain maximal sensitivity with respect to positive or negative inflation surprises regimes and benefit from one’s views.

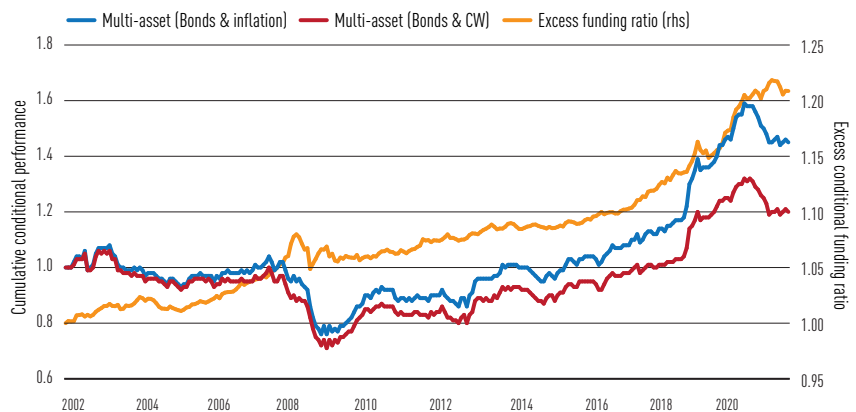
As a result, the objective of the inflation bet indices is to maximise the

3. Inflation-tilted benchmark indices’ risk-adjusted performance

EDHEC Risk Long-Term Track Record	US			Developed		
	CW	Inflation+	Inflation-	CW	Inflation+	Inflation-
Annualised returns	12.17%	12.29%	12.05%	8.48%	9.11%	7.79%
Annualised volatility	17.76%	18.92%	16.98%	15.22%	16.32%	14.88%
Sharpe ratio	0.45	0.43	0.46	0.39	0.40	0.35
Maximum drawdown	55.5%	57.3%	56.0%	56.95%	57.48%	58.08%
Annualised relative returns	-	0.13%	-0.11%	-	0.63%	-0.69%
Annualised tracking error	-	3.41%	3.07%	-	2.97%	2.53%
Information ratio	-	0.04	n/r	-	0.21	n/r

The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. All statistics are annualised.

4. Funding ratio of multi-asset portfolios in positive inflation regimes



The analysis is based on weekly US dollar total returns from 31 December 2001 to 31 December 2021. Liabilities are proxied with 10-year constant maturity Treasury Inflation-Protected Securities and bonds are proxied with 10-year constant maturity treasury securities. The funding ratio is computed as the difference in performance between the multi-asset portfolio and the liabilities only in weeks of positive inflation surprises, where they are defined as top quartiles of breakeven inflation surprises.

5. Conditional funding ratio statistics of multi-asset portfolios in positive inflation regimes

EDHEC Risk US Long-Term Track Record	Multi-asset with CW	Multi-asset with Inflation+	Difference
31 Dec 2001–31 Dec 2021			
Annualised funding ratio	3.74%	7.67%	+105%
Extreme 5% funding ratio	-0.50%	-1.93%	-19%
Volatility of funding ratio	12.3%	12.6%	+2%
Extreme 5% volatility of funding ratio	18.1%	17.7%	-2.5%
Funding ratio to volatility	0.30	0.61	+101%

The analysis is based on daily US dollar total returns from 31 December 2001 to 31 December 2021. Liabilities are proxied with 10-year constant maturity Treasury Inflation-Protected Securities and bonds are proxied with 10-year constant maturity treasury securities. The funding ratio is computed as the difference in performance between the multi-asset portfolio and the liabilities only in weeks of positive inflation surprises, where they are defined as top quartiles of breakeven inflation surprises. Extreme 5% statistics are computed using 1-year rolling window with daily steps. Extreme 5% funding ratio corresponds to the lowest 5% rolling funding ratio. Extreme 5% of volatility of funding ratio corresponds to the highest 5% rolling volatility of the funding ratio.

sensitivity to breakeven inflation surprises. Using these indices, investors should expect strong outperformance in cases where breakeven realisations match prior forecasts. Conversely, portfolio losses should be anticipated if the initial investment was targeting the opposite direction of the realised inflation shocks.

To achieve these objectives, the inflation bet indices are constructed by ranking stocks by inflation score exposure, selecting the top and bottom 50 US stocks (200 for Developed) respectively for the two indices and equally weighting the selected securities to avoid concentration issues.

As shown in figure 6, the Inflation Bet+ indices exhibit very strong and statistically significant exposure to positive breakeven inflation surprises. In fact, the exposure for US is about 4.4 (4.5 in Developed) times higher than the exposure offered by the Inflation+ index. Similarly, the US Inflation Bet- index exhibits an exposure to breakeven inflation that is about 2.2 (2.4 in developed) times higher than the exposure of the Inflation- index.

In addition, the inflation bet indices offer much stronger conditional outperformance over the cap-weighted benchmark during the relevant inflation surprise regimes compared to the inflation-tilted benchmark indices. In figure 7, we observe that the US Inflation Bet+ index displays annualised relative performance of +32.97% (+62.33% for Developed) during positive inflation regimes, which highlights its ability to offer very strong protection to investors in periods of unexpected rising inflation. Similarly, the US Inflation Bet- index is outperforming the benchmark by 16.35% (6.26% for Developed) during periods of negative inflation surprises. These figures are approximately 3.7 and 3.3 times higher for the US market (5.2 and 2.1 times higher for the Developed market) than the equivalent outperformance figures for inflation-tilted benchmark indices. Finally, whether we use weekly breakeven inflation innovations or monthly realised changes in CPI, this has no impact on the conclusion of the analysis as the conditional behaviour of the inflation bet indices goes in the expected direction. This highlights the robustness of our methodology.

The strong conditionality profile of inflation bet indices comes with some costs. In effect, as seen in figure 8, they exhibit considerable tracking error, since the Inflation Bet+ index comes with a tracking error of 11.34% while the Inflation Bet- index shows a tracking

6. Inflation bet indices' exposure to inflation surprises

EDHEC Risk Long-Term Track Record	US		Developed	
	Inflation Bet+	Inflation Bet-	Inflation Bet+	Inflation Bet-
Breakeven inflation	3.40	-1.73	5.11	-1.67
T-stat	5.45	-3.62	3.39	-1.95

The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. The realised macro exposures are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and weekly inflation innovations, defined as changes in the 10-year breakeven inflation (BEI) rate. The statistics in bold are statistically significant at a 95% level.

7. Inflation bet indices' conditional relative performance

EDHEC Risk Long-Term Track Record	US		Developed			
	# of regimes	Inflation Bet+	Inflation Bet-	# of regimes	Inflation Bet+	Inflation Bet-
Weekly breakdown inflation innovations						
Negative inflation surprises	545	-19.76%	16.35%	261	-15.96%	6.26%
Stable inflation	1,096	-1.95%	-1.27%	522	-0.20%	-0.75%
Positive inflation surprises	551	32.97%	-17.80%	261	62.33%	-12.84%
Macro spread	-	52.73%	-34.15%	-	78.29%	-19.10%
Monthly realised CPI changes						
Negative inflation surprises	123	-15.33%	6.30%	60	-11.83%	3.25%
Stable inflation	246	0.38%	-0.74%	119	-0.15%	1.59%
Positive inflation surprises	123	11.25%	-5.13%	60	17.95%	-6.43%
Macro spread	-	26.58%	-11.43%	-	29.77%	-9.69%

The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. Outperformance figures are computed as annualised relative performance of inflation indices compared to the CW index in top (positive surprise) and bottom (negative surprise) quartiles of either weekly inflation innovations, defined as changes in the 10-year breakeven inflation rate, or monthly realised changes in CPI (final estimate of US consumer price index for all urban consumers for US indices, GDP-weighted G7 consumer price index proxy for Developed indices). Macro spread is the difference in returns between positive and negative inflation surprise regimes. Macro spreads in bold are statistically significant at a 95% level based on a Welch's t-test.

8. Inflation bet indices' risk-adjusted performance

EDHEC Risk Long-Term Track Record	US			Developed		
	CW	Inflation Bet+	Inflation Bet-	CW	Inflation Bet+	Inflation Bet-
Annualised returns	12.17%	10.47%	12.19%	8.53%	8.66%	8.67%
Annualised volatility	17.76%	22.91%	16.27%	16.42%	22.08%	17.57%
Sharpe ratio	0.45	0.28	0.49	0.45	0.34	0.42
Maximum drawdown	55.5%	67.1%	62.9%	56.95%	66.2%	63.98%
Annualised relative returns	-	-1.70%	0.02%	-	0.13%	0.13%
Annualised tracking error	-	11.34%	8.89%	-	9.32%	6.50%
Information ratio	-	n/r	0.00	-	0.01	0.02

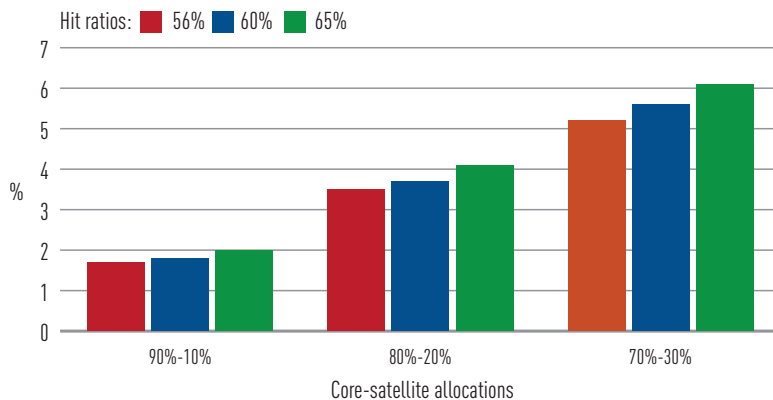
The analysis is based on weekly US dollar total returns from 31 December 1979 for the EDHEC Risk US Long-Term Track Record or 31 December 1989 for the EDHEC Risk Developed Long-Term Track Record to 31 December 2021. All statistics are annualised.

error of 8.89% that is much larger compared to the inflation-tilted benchmark indices. Moreover, the inflation bet indices do not necessarily capture the long-term equity premium and can exhibit much larger volatility than the cap-weighted benchmark.

Benefits of inflation bet indices in a core-satellite tactical allocation

We show below how an investor with a long-term strategic allocation to a cap-weighted benchmark can improve its conditional performance in periods of positive inflation surprises by tactically

9. Relative performances with regard to core in positive inflation surprises regimes



The analysis is based on daily US dollar total returns from 31 December 1979 to 31 December 2021. Conditional relative performance figures are computed as cumulative relative performance of the different portfolios in excess of the CW index in top (positive surprise) quartiles of weekly inflation innovations. Innovations are computed as weekly changes in the 10-year breakeven inflation rate. Hit ratios are expressed as a percentage of weeks of correct forecasts of positive inflation surprises over a given year (ie, 56% is equivalent to 29 weeks out of 52).

allocating to the Inflation Bet+ index in a core-satellite tactical allocation. Under the case study, the investor, without any view on inflation surprises, is only fully invested in the cap-weighted index, but they can make tactical bets to benefit from possible positive inflation surprises by allocating funds to the Inflation Bet+ index. When the investor forecasts a positive inflation surprise for a given week, 10% (or 20% or 30%) of the portfolio is allocated to the satellite Inflation Bet+ index and the remaining 90% (or 80% or 70%) to the core cap-weighted equity index. Otherwise, if no positive inflation surprise is expected, 100% of the portfolio is allocated to the core cap-weighted equity index. We use hit ratios of 56% (correctly predicting positive inflation surprises 29 out of 52 weeks), 60%

⁴ We follow the methodology in Amenc, Goltz and Grigoriu (2010) and assume a positive inflation forecasting ability, namely correctly forecasting positive inflation surprises, by the investor for a certain number of weeks per year. To evaluate the performance of this approach, for each portfolio allocation, we simulate 10,000 scenarios for the period from January 1979 to December 2021 using the EDHEC Risk US Long-Term Track Record dataset.

(31 out of 52 weeks) and 65% (34 out of 52 weeks).

Looking at figure 9, we observe that the conditional relative performances of the core-satellite portfolios during positive inflation surprise regimes improve as the satellite allocation in the Inflation Bet+ index increases from 10% to 20% and finally to 30% under all different hit ratio scenarios.⁴ Similarly, higher hit ratios translate to better conditional returns during positive inflation surprise regimes. At the same time, the unconditional risk-adjusted performances of the overall portfolio are not materially affected, since the long-term Sharpe-ratio of the different portfolios (nine hit ratio/core-satellite combinations) are in the range of 0.47–0.50 when the long-term Sharpe ratio of the cap-weighted benchmark is at 0.48.

These results show that investors with marginal forecasting ability with respect to breakeven inflation innovations, in the range of 55% to 65% hit ratios, would be able to achieve strong outperformance potential during positive inflation surprise regimes, relative to a standard core cap-weighted allocation by using the Inflation Bet+ indices. At the same time,

their long-term unconditional risk-adjusted performance would not be compromised.

A novel approach to protecting equity portfolios from inflation

Scientific Beta has designed a novel approach to construct two families of inflation-friendly equity strategies that offer protection from inflation surprises. These portfolios are created with the purpose of serving a core-satellite investment framework, where the core represents investors' strategic long-term allocation, while the satellite represents tactical deviations with respect to this allocation.

On one side, the inflation-tilted benchmark indices are created with the objective of delivering 'market-like' characteristics, such as capturing the long-term equity premium, with the additional feature of inflation protection in the form of conditional outperformance over the cap-weighted benchmark during positive or negative inflation surprise regimes. Hence, they are designed to be ideal candidates for cap-weighted index replacement in a long-term strategic allocation to provide protection against inflation surprises.

On the other hand, the main objective of the inflation bet indices is to offer strong sensitivity to positive or negative inflation surprise regimes for investors who wish to take tactical bets on inflation. We have showed that even with weak forecasting skills, investors can use inflation bet indices in a tactical core-satellite allocation and improve their conditional performance in the resulting portfolio in periods of positive inflation surprise while conserving long-term risk-adjusted performance in line with the cap-weighted benchmark.

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To Have a Real Impact on the Climate, It's Perhaps Time to Change Benchmark

Many institutional investors have set out the same objective as a priority: the fight against climate change.

Today, this objective is being translated into engagements on the alignment of their portfolio as part of the net-zero investment framework.

Naturally, the powers of persuasion of the engaged investors will be more effective if the companies and their management understand that their response to climate demands will have consequences on the attractiveness of their stocks. The voice of investors is ultimately all the stronger if their investments are consistent with their engagements.

Unfortunately, it must be acknowledged that this consistency is rarely found in the benchmarks that are representative of portfolio alignment strategies. The vast majority of climate alignment benchmarks display sharp reductions in carbon intensity or temperature at the global portfolio level, but this greening of the portfolio does not correspond to consistent investments at the stock level. As such, stocks that correspond to climate deteriorators see their weights increase.

To tackle these limitations of traditional climate benchmarks, which are the fruit of a mix-up between climate and financial considerations, Scientific Beta has built the first pure climate benchmarks, which have the weights of the stocks in the portfolio depend solely on their climate performance and the alignment engagements taken by the companies.

With the Scientific Beta Climate Impact Consistent Indices, investors bolster the potential for successful real-world engagement by putting their money where their mouths are.

For more information on the Scientific Beta Climate Impact Consistent Indices, please contact Mélanie Ruiz on +33 493 187 851 or by e-mail to melanie.ruiz@scientificbeta.com.



www.scientificbeta.com/green

As of July 31, 2022, the Scientific Beta indices corresponded to USD 52.47bn in assets under replication. Scientific Beta signed the United Nations-supported Principles for Responsible Investment (PRI) on September 27, 2016. Today, Scientific Beta is devoting more than 40% of its R&D investment to Climate Investing and more than 45% of its assets under replication refer to indices with an ESG or Climate flavour. As a complement to its own research, Scientific Beta supports an important research initiative developed by EDHEC on the subjects of ESG and climate investing and cooperates with V.E and ISS ESG for the construction of its ESG and climate indices.

A review of inflation-friendly equity strategies

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Following the recovery from the COVID-19 crisis, inflation has emerged as a significant portfolio risk facing investors

Scientific Beta has designed two families of inflation-friendly equity indices that are able to protect investors' portfolios against rising inflation

The first family, termed inflation-tilted benchmark indices, is comprised of the Inflation+ and Inflation- indices, which are ideal candidates to replace an equity cap-weighted benchmark in a core allocation for investors who wish to protect their portfolio against inflation surprises

The second family, termed inflation bet indices, covers the Inflation Bet+ and Inflation Bet- indices which are well suited for the satellite part of investors' portfolios

In this article, we look at the small set of competitor inflation-sensitive strategies currently available in the marketplace. We review their main methodological choices and compare their quantitative profile relative to the Scientific Beta inflation indices

Following the recovery from the COVID-19 crisis, inflation has emerged as a significant portfolio risk facing investors. Using Treasury Inflation-Protected Securities (TIPS) to fully hedge inflation risk has a high opportunity cost. Instead, investors can turn to their equity portfolio to provide some protection against inflation surprises. Equities are a natural candidate to provide some protection and, unlike

commodities, equities also offer a positive long-term risk premium.

Scientific Beta has designed two families of inflation-friendly equity indices that are able to protect investors' portfolios against rising inflation. Their design is based on the methodology developed in Esakia and Goltz (2022).

The first family, termed inflation-tilted benchmark indices, comprises the Inflation+ and Inflation- indices, which are ideal candidates to replace a cap-weighted equity benchmark in a core allocation for investors who wish to protect their portfolio against inflation surprises. They are designed to deliver the equity market risk premium over the long term while offering the desired conditionality with inflation by offering positive or negative exposure to breakeven inflation surprises, respectively, via reasonable tracking error with the cap-weighted benchmark. This type of index is therefore a good substitute for a cap-weighted index as a benchmark that is representative of the equity asset class for a long-term investor who has liabilities that are exposed to inflation risk. This asset liability management (ALM) approach differs from an asset management (AM) approach that has the sole objective of maximising the Sharpe ratio of the equity investment in an unconditional way.

The second family, termed inflation bet indices, covers the Inflation Bet+ and Inflation Bet- indices, which are well suited for the satellite part of investors' portfolios. These indices enable investors to take tactical bets and generate potential short-term outperformance in regimes of positive or negative breakeven inflation surprises. Their design aims to maximise the exposure to positive or negative breakeven inflation surprises. Using these indices as a satellite allocation, investors can implement their views on future realisation of inflation and generate outperformance relative to the core cap-weighted benchmark allocation. This

involves a conditional approach to performance in a classic asset management context in which the CIO wishes to transform their views, on inflation in this instance, into additional performance.

Other providers of indices and active portfolio strategies have also designed equity strategies targeting inflation. In this article, we look at the small set of competitor inflation-sensitive strategies currently available in the marketplace. We review their main methodological choices and compare their quantitative profile relative to the Scientific Beta Inflation Indices.

Design of competitor inflation strategies

In addition to the Scientific Beta inflation indices, there is only a handful of equity inflation-friendly strategies currently offered by competitors and these are listed in figure 1. Furthermore, figure 2 provides an overview of the index construction methods for this selection of inflation-friendly equity products.

Looking at the methodology of the competitor strategies, it is important to note that they all target inflation in a single direction, that of protecting against positive inflation shocks. Scientific Beta, in its capacity as an index provider, aims to provide investors with solutions covering all relevant investment scenarios and as a result, it offers inflation-friendly equity indices that target inflation

1. Inflation-friendly equity strategies

Name	Provider
Scientific Beta Inflation+/- index	Scientific Beta
Scientific Beta Inflation Bet+/- index	Scientific Beta
MSCI USA Inflation Sentiment Select 100 index	MSCI
MSCI USA Inflation Sensitivity Select 50 index	MSCI
Fidelity Stocks for Inflation Factor index	Fidelity

2. Methodology overview of equity inflation-friendly portfolios

Category	Methodology	Inflation score	Universe	Stock weighting scheme
Scientific Beta Inflation+/- index	Stocks ranked by Inflation score and weights are tilted relative to their market capitalisation.	A regression analysis identifies the sensitivity of stocks to changes in breakeven inflation, while controlling for market exposure of individual stocks and accounting for both time variation and uncertainty in exposure. Breakeven inflation is measured as the difference between the yield of 10-year US Treasury Inflation-Protected Securities (TIPS) and 10-Year US Treasury securities in the case of US indices, or GDP weighting individual G7 country 10-year breakeven inflation rates in the case of Developed indices. Regarding the US indices, the statistical approach is also complemented (equally weighted) by a textual analysis which looks at the risk factors section of US firms' annual 10-K filings to measure exposure as the frequency of mentions related to inflation.	US or Developed (large and mid-cap)	Inflation score tilting around market capitalisation weights
Scientific Beta Inflation Bet+/- index	Stocks ranked by Inflation score and top 50 (US) or top 200 (Developed) are selected	As above	As above	Equal weighting subject to liquidity rules
MSCI USA Inflation Sentiment Select 100 index	Stocks ranked by Inflation score and top 100 are selected	A regression analysis assesses the sensitivity of stocks to inflation separately on five variables employed to capture inflation innovations which are then combined for a final score: a) changes in five-year breakeven inflation, b) gold price changes, c) oil price changes, d) indicator on Fed's concern with inflation relative to unemployment and e) indicators whether an increase or decrease in inflation is expected. Regressions include an interaction term with inflation attention (defined based on proprietary textual analysis).	US (large and mid-cap)	Equal weighting
MSCI USA Inflation Sensitivity Select 50 index	Stocks ranked by Inflation score and top 50 are selected	As above	As above	As above
Fidelity Stocks for Inflation Factor index	Factor targeting strategy (size, value, momentum, quality) with additional tilting of sectors based on inflation sensitivity.	Sectors under the energy, materials, consumer staples, healthcare, real estate, utilities sectors and some industrials and communication services sub-sectors receive an overweight relative to the benchmark, whereas sectors such as information technology, financials, consumer discretionary and remaining companies under industrials and communication services receive an underweight.	Top 1,000 US companies by market cap	Factors score weighting

sensitivity in either positive or negative inflation shocks to suit all investment needs. Furthermore, and unlike competitor products which cover only a specific region, Scientific Beta is offering its suite of inflation-friendly indices for both US and developed world universes, thus extending the available solutions to investors to cover protection for both US and global inflation.

Another important point to highlight is that Scientific Beta has designed its suite of inflation-friendly equity strategies in a way that separately satisfies the needs of the core and the satellite parts of investors' allocations. This avoids the one-size-fits-all approach of competitor strategies.

Going into more detail regarding the design choices, we see a disparity in methodological approaches. MSCI offers two strategies which are variations of the same methodology with just a different portfolio size with respect to the inflation-based stock selection. Nevertheless, the number of stocks selected remains very similar between the two strategies as both target a narrow selection relative to the available universe. This questions the need for both being offered to investors at the same time. In terms of the inflation score model selected, we can see that sensitivity to breakeven inflation is only one out of five variables used, which potentially diminishes its relevance to the

final model. In fact, what investors are looking for with regards to inflation protection is sensitivity to inflation expectations, which are well expressed in the market via the breakeven inflation measure. In addition, the choice of oil as a relevant variable could be justified as representing a reasonable proxy for energy prices (one of three main components for a consumer price index, a common metric of inflation in the market) but equally the choice of gold cannot be similarly justified.

Next, the Fidelity index is primarily a multi-factor strategy with inflation sensitivity only added to the portfolio construction via a sector-tilting approach. In fact, it has been common practice for investment managers to rely mainly on off-the-shelf building blocks, such as sectors or style factors, to manage exposure to macroeconomic risk. However, such building blocks have never been designed to efficiently target macro risks. Instead, our approach utilises stock-level information to build dedicated portfolios that emphasise the most relevant stocks with respect to inflation sensitivity. Esakia and Goltz (2022) discuss this point in more detail and show numerically that dedicated macro strategies come with stronger and more consistent realised exposures than allocation approaches that use sectors or factors as building blocks.

In what follows, we compare the performances of the inflation-friendly strategies that target positive unexpected inflation shocks, ie, the Scientific Beta Inflation+ and Inflation Bet+ indices, and the set of competitor strategies. We acknowledge that this selection of inflation-friendly equity strategies follows different stock selection schemes, inflation sensitivity metrics, and weighting schemes; however, they share the same explicit objective of targeting positive exposure to unexpected inflation shocks.

Inflation is difficult to assess unequivocally and there is no unique measure of it; on the contrary there are various metrics to account for inflation (inflation surveys, breakeven inflation rates, CPI headline, CPI core, etc), which may or may not reflect the practices of those investing in assets and the strategies designed to provide inflation protection. Despite inflation being complex to measure, we need to specify an ex-ante inflationary regime rule to evaluate the conditional performance of these inflation-friendly portfolios. Ultimately, what matters for equity prices is what market participants deem to be the most appropriate measure; hence, we settle on two alternative measures of inflation surprises that will be used to assess the conditional performances of alternative inflation-friendly

portfolios: weekly breakeven inflation (BED)¹ rate innovations and monthly realised CPI changes.² The results presented here are generally robust under the two different definitions of inflation expectations selected.

Comparative analysis of Scientific Beta and competitor inflation strategies regarding investors' core allocation

In this section, we compare the performances of the inflation-friendly strategies that target positive unexpected inflation shocks in a core asset allocation setting – ie, the Scientific Beta Inflation+ index, and the Fidelity Stocks for Inflation index.

Under the core allocation, investors' equity portfolios may already come with substantial exposures not only to stock market risk, but also to broader macro-economic risks, such as inflation risk. Such implicit exposures will not necessarily align with what an investor would target when considering macroeconomic risk exposures explicitly. If an investor is already exposed to a given macroeconomic risk outside their equity allocation, the total portfolio will not be well diversified and will suffer losses if a given macroeconomic risk materialises. For example, the inflation-linked liabilities of a pension fund will increase with rising inflation. Holding stocks with negative exposure to inflation will lead to poor diversification and greater capital at risk during times of positive inflation shocks. Therefore, any inflation-friendly index designed to form part of an investor's core allocation should be able to deliver the desired conditionality with inflation by offering positive or negative exposure to breakeven inflation surprises, respectively, via reasonable tracking error with the cap-weighted benchmark.

In order to start analysing these strategies, figure 3 compares the unconditional exposure to inflation surprises for these two inflation-friendly strategies over their available sample, which spans the period from December 1995 to December 2021. As reported, both indices considered exhibit statistically significant out-of-sample exposures to inflation shocks measured as weekly breakeven inflation surprises or monthly realised

¹ Breakeven inflation rates are derived from observable market prices as the difference between the yield of 10-year US Treasury Inflation-Protected Securities (TIPS) and 10-Year US Treasury Securities. This difference reflects investors' expectations about inflation over the next 10 years.

² The CPI used here refers to the final estimate of the US Consumer Price Index for All Urban Consumers.

3. Indices' exposure to inflation surprises

US LTTR (R/\$) 31 Dec 1995–31 Dec 2021	EDHEC Risk US LTTR Inflation+	Fidelity Stocks for Inflation index
<i>Inflation shocks measured as weekly breakeven inflation innovations</i>		
Weekly breakeven inflation	0.65	1.17
T-stat	(2.10)	(2.34)
<i>Inflation shocks measured as monthly realised CPI changes</i>		
Monthly realised CPI changes	0.99	1.75
T-stat	(3.39)	(6.28)

The analysis is based on weekly US dollar total returns from 31 December 1995 to 31 December 2021. The realised inflation exposures measured as breakeven inflation are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and weekly inflation innovations, defined as changes in the 10-year breakeven inflation rate. The realised inflation exposures measured as realised CPI changes are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and monthly inflation innovations, defined as monthly realised CPI changes. Statistics in bold are statistically significant at a 95% level. Indices used are the EDHEC-Risk US LTTR Inflation+, the EDHEC-Risk US LTTR Cap-Weighted and the Fidelity Stocks for Inflation index.

4. Conditional outperformance during weekly breakeven inflation surprises regimes

US LTTR (R/\$) 31 Dec 1995–31 Dec 2021	# regimes (weeks)	EDHEC Risk US LTTR Inflation+	Fidelity Stocks for Inflation index
<i>Relative performance to cap-weighted index in different regimes (weekly breakeven inflation innovations)</i>			
Negative inflation surprises	316	-3.45%	1.53%
Stable inflation	709	0.16%	1.66%
Positive inflation surprises	332	11.28%	-0.39%
Macro spread	-	14.73%	-1.92%
Macro spread/TE	-	3.92	-
Macro spread/1Y rolling relative returns worst 5%	-	3.04	-
Macro spread/3Y rolling relative returns worst 5%	-	9.00	-
<i>Relative performance to cap-weighted index in different regimes (monthly realised CPI changes)</i>			
Negative inflation surprises	106	-2.70%	-1.64%
Stable inflation	145	1.76%	0.74%
Positive inflation surprises	61	6.16%	9.24%
Macro spread	-	8.86%	10.88%
Macro spread/TE	-	2.36	1.99
Macro spread/1Y rolling relative returns worst 5%	-	1.83	0.85
Macro spread/3Y rolling relative returns worst 5%	-	5.42	1.20

The analysis is based on daily US dollar total returns from 31 December 1995 to 31 December 2021. Outperformance figures are computed as annualised relative performance of inflation indices compared to the CW index in top (positive surprise) and bottom (negative surprise) quartiles of weekly inflation innovations defined as changes of the 10-year breakeven inflation rate or monthly realised CPI changes; regimes are defined over the period 31 December 1979 to 31 December 2021. Macro spread is the difference in returns between positive and negative inflation surprise regimes. Indices used are the EDHEC-Risk US LTTR Inflation+, the EDHEC-Risk US LTTR Cap-Weighted and the Fidelity Stocks for Inflation index.

CPI changes. The indices analysed have a positive unconditional exposure, which means that their relative returns are driven by positive (upwards) inflation shocks.

However, we can start to see some differences when we look more closely at a conditional relative performance analysis of the strategies under consideration, as shown in figure 4, and at their deviations relative to the cap-weighted

benchmark, as depicted in figure 5.

The Scientific Beta Inflation+ benchmark-tilted index achieves strong outperformance relative to the cap-weighted benchmark in positive inflation surprise regimes, whether BEI or CPI-defined. This is achieved while the index maintains relatively low tracking error versus the cap-weighted benchmark, measured at 3.76%, as we can see from figure 5.

5. Inflation-friendly indices' deviations relative to the cap-weighted benchmark

US LTR (R/\$) 31 Dec 1995–31 Dec 2021	EDHEC Risk US LTR Inflation+	Fidelity Stocks for Inflation index
Annualised tracking error	3.76%	5.47%
1Y rolling relative returns worst 5%	-4.85%	-12.77%
3Y rolling relative returns worst 5%	-1.64%	-9.08%

The analysis is based on daily US dollar total returns from 31 December 1995 to 31 December 2021. Indices used are the EDHEC-Risk US LTR Inflation+, the EDHEC-Risk US LTR Cap-Weighted and the Fidelity Stocks for Inflation index.

Overall, as we can see from figure 4, the Inflation+ index delivers a strong macro spread per unit of tracking error when measured against regimes defined based on breakeven inflation innovations, which demonstrates that it offers good conditionality to inflation surprises while maintaining 'cap-weight-like' characteristics. When inflation regimes are measured according to CPI, the macro spread per unit of tracking error for the Scientific Beta Inflation+ index is 2.36, which is about 20% higher than the Fidelity Stocks for Inflation index. Similarly, measuring the macro spread per unit of worst relative returns shows that the Scientific Beta Inflation+ index again has the better ratio between the two indices.

In summary, the Scientific Beta Inflation+ index shows a stronger profile regarding sensitivity to inflation (measured by the macro spread) relative to both average (measured by the tracking error) and extreme (measured by one-year and three-year worst relative returns) measures of deviations relative to the cap-weighted benchmark. As a result, this makes the Inflation+ index a strong candidate for investors' core allocation to replace a traditional cap-weighted benchmark with an asset that retains 'cap-weight-like' characteristics while delivering strong conditionality with inflation by offering positive exposure to breakeven inflation surprises.

Comparable analysis of Scientific Beta and competitor inflation strategies regarding investors' satellite allocation

In this section, we compare the inflation-friendly strategies that target positive unexpected inflation shocks in a satellite asset allocation setting, ie, the Scientific Beta Inflation Bet+ index, the MSCI Inflation Sentiment Select 100 index and the MSCI Inflation Sensitivity Select 50 index.

Regarding the satellite part of the

allocation, investors aim to explore their views on future economic conditions and gain additional performance if their predictions materialise. For instance, a portfolio manager expecting upward changes to inflation will be able to add returns if their satellite allocation includes a portfolio with strong positive inflation exposure ahead of such conditions being realised in the market.

Figure 6 allows us first to compare the unconditional exposure to inflation surprises for the satellite inflation-friendly strategies offered by Scientific Beta and MSCI over the overlapping sample available across these indices, ie, a period of nearly 10 years, from December 2012 to June 2022.

As shown in figure 6, all three inflation-friendly indices considered exhibit statistically significant out-of-sample exposures to inflation shocks measured as weekly breakeven inflation surprises or monthly realised CPI changes. The indices analysed have positive unconditional exposure, which means that their relative returns are driven by positive (upwards)

inflation shocks; among the indices compared, the Scientific Beta Inflation Bet+ index exhibits the strongest out-of-sample exposure to inflation surprises, with a beta to weekly breakeven inflation innovations of about 12.12, which is roughly 33% higher than the beta measured for the MSCI Inflation Select 50 index, which is the next most inflation-sensitive strategy in the competitors pool. These results, and the relative magnitudes, are consistent also when comparing the betas to inflation shocks measured as monthly realised CPI changes.

Next, figure 7 depicts a conditional relative performance analysis of the strategies under consideration. We see that the Scientific Beta Inflation Bet+ index offers much stronger conditional outperformance over the cap-weighted benchmark during the relevant inflation surprise regimes compared to the competitors' strategies. It displays an annualised relative performance of +80.62% during positive inflation regimes, defined using weekly breakeven inflation innovations, which highlights its ability to offer very strong protection to investors in periods of unexpected rising inflation.

In fact, the Inflation Bet+ index shows conditional outperformance over the cap-weighted benchmark during positive inflation surprise regimes that is about 1.5 and 1.2 times stronger than the MSCI Inflation Select 100 and the MSCI Inflation Select 50 indices respectively. The difference is robust when you compare their performance during CPI-based positive inflation regimes with 1.8 and 1.2 times stronger relative outperformance to the cap-weighted benchmark than that provided by the two MSCI indices respectively.

6. Indices' exposure to inflation surprises

US (R/\$) 31 Dec 2012–30 June 2022	SciBeta Inflation Bet+	MSCI Inflation Select 100 index	MSCI Inflation Select 50 index
<i>Inflation shocks measured as weekly breakeven inflation innovations</i>			
Weekly breakeven inflation	12.12	8.14	9.11
T-stat	(5.01)	(5.91)	(6.25)
<i>Inflation shocks measured as monthly realised CPI changes</i>			
Monthly realised CPI changes	5.76	3.27	4.42
T-stat	(5.17)	(4.65)	(5.28)

The analysis is based on weekly US dollar total returns from 31 December 2012 to 30 June 2022. The realised inflation exposures measured as breakeven inflation are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and weekly inflation innovations, defined as changes in the 10-year breakeven inflation rate. The realised inflation exposures measured as realised CPI changes are estimated in a bivariate regression that includes the market factor (excess return above the risk-free rate) and monthly inflation innovations, defined as monthly realised CPI changes. Statistics in bold are statistically significant at a 95% level. Indices used are the SciBeta US Inflation Bet+, the SciBeta US Cap-Weighted, the MSCI USA Inflation Sentiment Select 100 index and the MSCI USA Inflation Sensitive Select 50 index.

7. Conditional outperformance during weekly breakeven inflation surprises regimes

US (R/US\$) 31 Dec 2012–30 June 2022	# regimes (weeks)	SciBeta Inflation Bet+	MSCI Inflation Select 100 index	MSCI Inflation Select 500 index
<i>Relative performance to cap-weighted index in different regimes (weekly breakeven inflation innovations)</i>				
Negative inflation surprises	100	-26.16%	-16.80%	-19.12%
Stable inflation	296	-2.77%	-6.94%	-6.83%
Positive inflation surprises	99	80.62%	54.85%	69.32%
Macro spread	-	106.78%	71.65%	88.43%
<i>Relative performance to cap-weighted index in different regimes (monthly realised CPI changes)</i>				
Negative inflation surprises	42	-21.67%	-11.23%	-14.28%
Stable inflation	50	9.76%	-1.27%	2.08%
Positive inflation surprises	22	19.54%	10.87%	15.77%
Macro spread	-	41.21%	22.10%	30.05%

The analysis is based on daily US dollar total returns from 31 December 2012 to 30 June 2022.

Outperformance figures are computed as annualised relative performance of inflation indices compared to the CW index in top (positive surprise) and bottom (negative surprise) quartiles of weekly inflation innovations defined as changes of the 10-year breakeven inflation rate or monthly realised CPI changes; regimes are defined over the period 31 December 1979 to 30 June 2022. Macro spread is the difference in returns between positive and negative inflation surprise regimes. Indices used are the SciBeta US Inflation Bet+, the SciBeta US Cap-Weighted, the MSCI USA Inflation Sentiment Select 100 index and the MSCI USA Inflation Sensitive Select 50 index.

This analysis highlights that the Inflation Bet+ index can be a very useful tool for tactical asset allocation decisions when the investor's goal is to gain maximal sensitivity with respect to inflation surprises regimes and benefit from one's views. The Inflation Bet+ index is indeed an index whose objective is to maximise the sensitivity with respect to breakeven inflation surprises. Using this index, investors should

expect to outperform a passive cap-weighted benchmark allocation in cases where breakeven inflation realisations match prior forecasts. As we can see from figure 7, its higher sensitivity and better relative outperformance to the cap-weighted benchmark, compared to competitor strategies, means that an investor could potentially require fewer correct forecasts when it comes to positive inflation surprises to realise the

same outperformance potential.

Conclusion

In this article, we have compared the available set of competitor and Scientific Beta inflation-friendly equity indices both from an index design point of view and through the lens of a comparative performance analysis.

Scientific Beta is offering investors two families of inflation-friendly equity strategies that offer protection against inflation regarding both positive and negative inflation surprises. These strategies serve the needs of a core-satellite investment framework, where the core represents investors' strategic long-term allocation, while the satellite represents tactical deviations with respect to this allocation. Instead, competitor inflation strategies seem to have been created with the approach of one-size-fits-all. In addition, their sensitivity is only targeting protection against positive inflation surprises, leaving investors without the necessary tools to cover all different investment scenarios. Finally, a conditional performance analysis highlights the superiority of the Scientific Beta strategies in serving the objectives of inflation protection in both a core and satellite investment framework.

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The impact of intangibility and social distancing on the performance of rewarded factors since COVID-19

Daniel Aguet, Deputy CEO & Index Director, Scientific Beta

We review the performance of rewarded factors in the US market since 2020 through the lens of two important characteristics, which are intangibility and social distancing

These two characteristics were particularly important during the COVID crisis, since lockdown measures affected companies with low intangible capital and companies that could not use teleworking to overcome social distancing measures

The losses incurred in 2020 are consistent with factor investing's risk-based rationale and should be expected by investors

The long-term reward of the consensus risk factors will not disappear in the future, and factor strategies, if properly designed, will be able to deliver their promise of long-term risk-adjusted outperformance

Factor strategies are appealing for investors because they provide exposures to rewarded risk factors in addition to the market risk and hence are a source of superior risk-adjusted performance over the long term compared to cap-weighted benchmarks. There is a limited set of consensus rewarded risk factors that are backed by academic research. Their long-term reward is justified by economic rationale. Investors require compensation for additional risks brought by factor exposures in bad times

when assets that correspond to a given factor tilt tend to provide poor payoffs (see Cochrane [2005]). The COVID crisis was a good illustration of the materialisation of these additional risks, such as the cost of reversibility, for the value factor. In effect, value firms did underperform growth firms during the pandemic because they are made up of assets in place that are costly to reverse. They were not capable of adapting their business to the lockdown measures imposed and their stock price fell dramatically relative to growth stocks.

Factor risk premia exhibit short-term variations that can be linked to the business cycle or macroeconomic conditions (Amenc et al [2019]) and their performance can be negative for a long period of time (Harvey [1989], Asness [1992]). By seeking exposures to all rewarded factors, investors can smooth out variations in premia and improve the robustness of the outperformance of their factor strategies. This explains the success of multi-factor strategies over time.

However, in recent years, factor strategies have disappointed by failing to provide consistent outperformance, especially during the COVID crisis. The investment community blamed the underperformance of risk factors to explain the poor performance of multi-factor strategies. Many articles have been written about the death of the size or value factors. However, these criticisms are not consistent with the risk-based rationale of factor investing and the time-varying nature of factor rewards.

In this article, we review the performance of rewarded factors in the US market since 2020 through the lens of two important characteristics, which are

intangibility and social distancing. These two characteristics were particularly important during the COVID crisis, since lockdown measures affected more companies with low intangible capital and relying on tangible assets to generate their cash flows, and companies that could not use teleworking to overcome social distancing measures and continue their activities.

Rewarded risk factors recovered after extreme performance in 2020

There is a set of six consensus-based long/short (L/S) rewarded risk factors backed by academic research, namely size, value, momentum, low volatility, high profitability and low investment. In figure 1, we show their annual performance from 2020 to 2022 (up to June).

First, we underline that out of the six L/S factors, four, namely the value, low investment, size and low volatility factors, had negative performance in 2020, ranging from -22.6% for value to -4.7% for size. The performance of the value, low investment and low volatility factors was extreme compared to historical standards. In effect, if we look at the value factor, we see that its -22.6% loss in 2020 was below the worst 5% one-year rolling return computed over a 45-year sample, which stands at -19.1%. This demonstrates how strong the impact of the COVID crisis and the lockdown measures was on these three factors. Conversely, the momentum and high profitability factors were the main beneficiary of the crisis since they had positive performance in 2020, +13.2% and +11.4% respectively. Not surprisingly, the average performance of the six L/S factors in 2020 was negative by -5.5%. This performance might seem relatively

1. Performance of US L/S risk factors from 2020 to June 2022

US risk factors	Size	Value	Momentum	Low volatility	High profitability	Low investment	Average L/S factors
2022	2.2%	12.5%	7.4%	4.6%	-9.8%	12.3%	5.0%
2021	4.9%	8.0%	-22.2%	8.6%	1.4%	7.3%	1.5%
2020	-4.7%	-22.6%	13.2%	-16.4%	11.4%	-16.2%	-5.5%
Worst 5% 1-year return	-19.9%	-19.1%	-14.7%	-15.7%	-14.3%	-7.1%	-2.0%
Best 5% 1-year return	17.9%	55.4%	20.4%	27.5%	36.0%	21.2%	20.5%

The size factor is the return series of an equal-weighted portfolio that is long small market cap stocks and short the top 30% stocks (large market cap stocks) sorted on market capitalisation in descending order. The value factor is the return series of an equal-weighted portfolio that is long the top 30% stocks (value stocks) and short the bottom 30% stocks (growth stocks) sorted on book-to-market value in descending order. The momentum factor is the return series of an equal-weighted portfolio that is long the winner stocks and short the loser stocks. The winner stocks (inversely the loser stocks) are defined as the top 30% (inversely the bottom 30%) of stocks, sorted on the past 104 weeks' compounded returns excluding the most recent month, in descending order. The volatility factor is the return series of an equal-weighted portfolio that is long the bottom 30% stocks (low volatility stocks) and short the top 30% stocks (high volatility stocks) sorted on past volatility in descending order. The profitability factor is the return series of an equal-weighted portfolio that is long the top 30% stocks (high profitability stocks) and short the bottom 30% stocks (low profitability stocks) sorted on gross profitability in descending order. The investment factor is the return series of an equal-weighted portfolio that is long the bottom 30% stocks (low investment stocks) and short the top 30% stocks (high investment stocks) sorted on two-year asset growth in descending order. All L/S factors are market beta neutralised quarterly using ex-post CAPM beta over the quarter. The average L/S factors is an equally-weighted portfolio of the six L/S factors rebalanced daily. The worst/best 5% 1-year return corresponds to the 5th and 95th percentile of 1-year rolling return with a weekly step over a 45-year period, from 31 December 1974 to 31 December 2019.

dramatic consequences for the economy. Industries were not affected in the same ways; some were almost completely shut down, like airline companies, while others were favoured, like online retailers, thanks to surging demand. Companies with high intangible assets and relying mostly on their intellectual property to generate their revenues were less impacted than companies relying on hard assets such as plants or production equipment, which had to shut down their activities almost entirely. Similarly, companies which were less affected by social distancing measures because they were able to operate their activities remotely have been less impacted than companies which were unable to implement teleworking to continue their activities.

To understand the impact of these two characteristics on rewarded factors, we first analyse the performance of two long/short portfolios that go long companies with the lowest intangible assets or teleworkability scores and short companies with high intangible assets or teleworkability scores. We observe in figure 3 that the performance of the two long/short portfolios was very similar over the sample analysed, which indicates that intangibility and social distancing

modest, compared to the losses of the other rewarded factors like value, but it was nonetheless extreme when compared to historical standards, since it is well below the worst 5% one-year rolling return of -2.0%.

During the subsequent years, the average performance of L/S factors was driven by the strong rebound of the same factors that suffered in 2020. Indeed, value had the strongest rebound with a performance of 8.0% in 2021 and 12.5% in 2022, followed by low investment, low volatility and size. Conversely, the momentum and high profitability factors, which benefited from the COVID crisis in 2020, had a reversal in performance. Momentum had an extreme loss of -22.2% in 2021 and high profitability lost -9.8% in 2022 after gaining only 1.4% in 2021. Hence, the performance of the L/S factor portfolio was up by 1.5% in 2021 and 5% in 2022, which corresponds to a full recovery of the loss incurred in 2020.

To conclude on this performance analysis, we underscore that although the average performance of rewarded risk factors was negative in 2020, led by the extreme loss of the value, low investment, and low volatility factors, rewarded factors rebounded in the subsequent years and recovered fully, on average, from their 2020 losses.

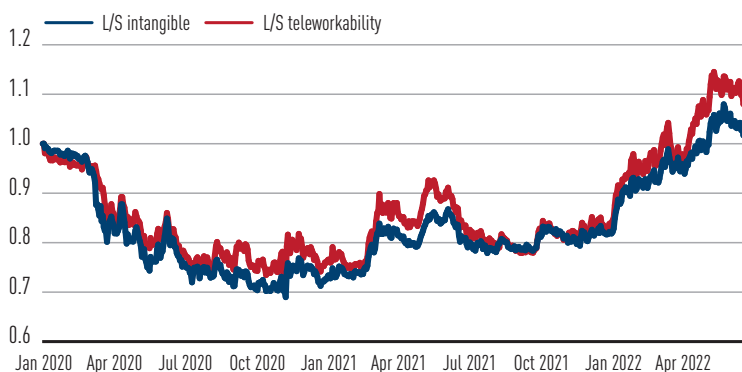
The importance of intangibility and social distancing characteristics
In this section, we look at two characteristics, namely intangibility and social

distancing, to understand the performance of rewarded risk factors observed over the recent period. The COVID crisis was such an unexpected event that it had

2. Measurement of intangibility and social distancing characteristics

Intangibility	Social distancing
Intangibility is defined as total intangible assets/total assets. Total intangible assets are defined as the sum of recorded intangible assets and unrecorded intangible assets as measure in Amenc et al (2020).	We use a teleworkability score as defined in Koren and Peto (2020) to measure social distancing. The score is based on the affected share of employment.

3. Relative performance of low intangible and least teleworkable companies



The L/S intangible portfolio is constructed by selecting 30% firms with the lowest intangible to total asset ratio for the long branch and 30% firms with the highest intangible to total asset ratio for the short branch. The L/S teleworkability portfolio is constructed by selecting 30% firms with the lowest teleworkability score for the long branch and 30% firms with the highest teleworkability score for the short branch. L/S portfolios are rebalanced every quarter and are dollar neutral. The universe is the SciBeta US.

characteristics reacted very similarly to the pandemic shock and the subsequent crisis recovery. We underline that companies with low intangible assets or low teleworkability scores were hurt by COVID restrictions such as lockdown measures much more strongly than companies with high intangible assets or high teleworkability scores. This is clear during the first wave of COVID in February and March 2020, since both low intangible and the least teleworkable companies underperformed high intangible and most teleworkable companies by roughly 15% in only a few weeks. The underperformance of low intangible or the least teleworkable companies lasted all of 2020 and only started to recover by mid-2021 as soon as the vaccine started to be administered massively to populations and restrictions were removed by governments. A strong rebound of low intangible and the least teleworkable companies from the beginning of 2022 enabled a full performance recovery.

In figure 4, we analyse the long-term correlation between the two L/S portfolios based on intangibility and social distancing characteristics and rewarded risk factors. Both the value and high profitability factors stand out since they exhibit the strongest average correlation to both characteristics. The positive correlation for the value factor and the intangibility characteristic is not surprising. Value companies have high book-to-price and hence tend to have low intangible assets. The positive correlation with the teleworkability portfolio indicates that value companies are less teleworkable than growth companies. The high profitability factor has a negative correlation to both intangibility and social distancing characteristics. This means that highly profitable companies tend to have high intangible assets and that their activities can be run via teleworking.

In figure 5, we show the results of a regression analysis of each rewarded risk factor to both L/S portfolios based on intangibility and teleworkability characteristics over the period 2020 to June 2022. Results are very similar whatever the characteristics used as the dependent variable in the regression. First, we highlight that the R2 of the regression is very strong for the value, high profitability and low investment factors. This means that more than 50% of the variability of these three rewarded factors was explained by the two characteristics over the sample analysed. Second, we underscore that except for the low volatility factor, all rewarded factors have statistically significant exposure to intangibility and social distancing characteristics. As

4. Correlation of L/S intangible and L/S teleworkability with L/S rewarded risk factors

US L/S risk factors	Size	Value	Momentum	Low volatility	High profitability	Low investment
L/S intangible	0.16	0.56	-0.22	-0.03	-0.65	0.25
L/S teleworkability	0.14	0.52	-0.22	0.08	-0.54	0.34

The correlation analysis is done from June 2002 to June 2022 using US dollar daily total returns.

5. Regression analysis of L/S rewarded factors

US L/S risk factors	Size	Value	Momentum	Low volatility	High profitability	Low investment
L/S intangible						
Exposure	0.38	0.61	-0.54	-0.10	-0.47	0.40
T-stat	7.63	13.38	-4.29	-1.69	-15.29	12.91
R2	20.4%	60.0%	24.3%	1.3%	58.0%	49.4%
Teleworkability						
Exposure	0.33	0.52	-0.51	-0.06	-0.38	0.37
T-stat	7.43	18.66	-4.75	-1.05	-17.61	22.07
R2	20.6%	58.1%	28.8%	0.6%	50.2%	55.7%

The analysis is done using daily US dollar total returns from 31 December 2019 to 30 June 2022. We run a bivariate regression with the market factor and one characteristic as the dependent variables. Standard errors are adjusted for HAC. Bold statistics are statistically significant at a 5% level.

expected, value had a positive exposure, while high profitability had a negative one. This is in line with the long-term correlation analysis. For the other rewarded factors, we see that momentum had a negative exposure, while size and low investment had a positive one.

In figures 6 and 7, we analyse the overlap between the stock composition of the L/S rewarded factors and the L/S intangible and teleworkability portfolios. The overlapping analysis allows a cross-sectional comparison that is useful to measure the similarity between the rewarded factors and intangibility and social distancing characteristics at a given point in time, like the first quarter of 2020, that a correlation or regression analysis cannot provide. If the overlap is close to 0%, it means that the stock composition between factor selections and characteristics is completely different and that there is no link between them. Conversely, if the overlap is close to 100%, it means that both factor selection and characteristics are composed of the same stocks, which means that they convey the same information and risks.

First, we can confirm the strong relationship between the value and high profitability factors and the intangibility and social distancing characteristics. Indeed, we observe that over the sample from 2002 to 2022, the value selection had a 47% overlap with the low intangible portfolio and 39% with the least telework-

able portfolio, which is much stronger than the overlap of the growth selection (17% and 25% for the low intangible and least teleworkable portfolios respectively). Conversely, the high profitability selection had a 72% overlap with the high intangible portfolio and 36% with the most teleworkable portfolio relatively to the low profitability selection (4% and 22% for the high intangible and most teleworkable portfolios respectively).

Second, during the first quarter of 2020, all four factors that had losses in 2020, namely size, value, low volatility and low investment, had a stronger overlap between stocks composing their long branch and the low intangible or least teleworkable portfolios than stocks making up their short branch. Conversely, the momentum and high profitability factors, which had positive performance in 2020, had a higher overlap between stock composing their long branch with the high intangible or most teleworkable portfolios than stocks composing their short branch. This underscores the importance of the intangibility and social distancing characteristics in explaining the performance of rewarded factors in 2020.

To conclude this section, we emphasise the strong link between some rewarded factors and intangibility and social distancing characteristics since 2020. For three of them, namely value, high profitability and low investment, their

6. Overlap between factor selection and low or high intangible portfolios

US factor selections	% of overlap between factor selection and low intangible portfolio			% of overlap between factor selection and high intangible portfolio		
	2021-22	Q1 2020	2002-22	2021-22	Q1 2020	2002-22
Small cap	28%	30%	30%	31%	28%	31%
Large cap	29%	23%	27%	29%	32%	28%
Value	46%	46%	47%	13%	11%	12%
Growth	18%	15%	17%	48%	50%	46%
High momentum	31%	23%	27%	32%	38%	33%
Low momentum	32%	34%	31%	28%	23%	28%
Low volatility	25%	48%	37%	26%	21%	29%
High volatility	38%	18%	26%	30%	36%	30%
High profitability	11%	11%	5%	65%	63%	72%
Low profitability	52%	49%	46%	8%	5%	4%
Low investment	32%	27%	29%	25%	26%	28%
High investment	20%	21%	27%	37%	33%	30%

The table is based on quarterly data. The overlap analysis compares the stocks in each factor selection and the low or high intangible portfolios. The overlap ranges between 0% and 100%. For the 2002-22 and 2021-22 columns, we report the average quarterly overlaps.

7. Overlap between factor selection and least or most teleworkable portfolios

US factor selections	% of overlap between factor selection and least teleworkable portfolio			% of overlap between factor selection and most teleworkable portfolio		
	2021-22	Q1 2020	2002-22	2021-22	Q1 2020	2002-22
Small cap	35%	31%	32%	28%	26%	29%
Large cap	22%	23%	25%	35%	39%	33%
Value	42%	38%	39%	19%	20%	23%
Growth	23%	21%	25%	40%	38%	34%
High momentum	28%	24%	28%	38%	40%	35%
Low momentum	32%	36%	34%	29%	19%	27%
Low volatility	19%	44%	35%	31%	19%	21%
High volatility	43%	22%	30%	32%	38%	35%
High profitability	20%	26%	25%	41%	38%	36%
Low profitability	45%	38%	42%	20%	21%	22%
Low investment	35%	31%	30%	22%	28%	27%
High investment	18%	22%	27%	43%	37%	36%

The table is based on quarterly data. The overlap analysis compares the stocks in each factor selection and the least and most teleworkable portfolios. The overlap ranges between 0% and 100%. For the 2002-22 and 2021-22 columns, we report the average quarterly overlaps.

role, in particular during the most intense periods of the COVID crisis, like February to March 2020. However, this role was less significant and less stable than for the other rewarded factors.

Factor investing is not dead

2020 was an annus horribilis for rewarded risk factors due to extreme market conditions following the COVID crisis. Nonetheless, they recovered from their losses in less than one and a half years. Intangibility and social distancing characteristics played a key role in explaining the short-term performance of rewarded factors, especially for value, high profitability and low investment. However, the losses incurred in 2020 are consistent with factor investing's risk-based rationale and should be expected by investors. In effect, investors are rewarded over the long term because it is a compensation for the additional risks that they are taking by being exposed to these factors in bad times. Moreover, the reward of risk factors is expected to vary and to be driven by macroeconomic cycles, hence there is no reason to expect them to deliver steady outperformance year after year like a coupon-paying bond would. Therefore, the long-term reward of the consensus risk factors will not disappear in the future, and factor strategies, if properly designed, will be able to deliver their promise of long-term risk-adjusted outperformance.

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performance and risks were mainly driven by the two characteristics, as demonstrated by the regression or portfolio

composition overlap analysis. For the other rewarded factors, intangibility and social distancing characteristics played a

Financing the energy transition:

What is the role of fossil fuel divestment?

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Withdrawing capital from companies that produce fossil fuels can be justified both by the wish of investors to avoid exposure to stranding risk, and by the goal of incentivising these companies to transform their business models by modifying their cost of capital.

In the first part of this article, we show that, for both motivations, investors need to make clear distinctions between different types of fossil fuels as their stranding risk and the pace of their net-zero consistent phase-out differs widely. Immediate and indiscriminate divestment from all fossil fuels will not help tackle climate change and it may even be counterproductive.

In the second part, we illustrate the pitfalls of fossil fuel divestment by looking at the European Union's regulated Paris Aligned Benchmarks (PAB). These exclude companies that represent almost 40% of global renewables-based electricity. The regulation also permits even more dramatic underfunding of power companies, as its anti-greenwashing constraints are toothless in avoiding sector-weighting biases.

While PAB compliance enables investors to claim an official Paris alignment label, and while their returns looked promising when oil prices were falling, investors should be aware of the explicit and implicit consequences of adopting the PAB-regulated fossil fuels requirements.

Fossil fuels: why, what and when to divest?

Fossil fuels are the major source of greenhouse gases (GHGs) and the reduction in the use (and leakage) of fossil fuels plays a key role in net-zero trajectories: "In modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, the global use of coal, oil and gas in 2050 is projected to decline with median values of about 95%, 60% and 45% compared to 2019" (IPCC [2022]). These numbers also show the need to distinguish between the three main types of fossil fuels. Coal is the top culprit, primarily because coal has about twice the carbon emissions for the same electricity output as natural gas (US EIA [2020]). While the sale of electric cars is already picking up fast in some markets, internal combustion engines will continue to play a role, especially in long-distance transport, even in 2050. Petroleum derivatives will also continue to be an input in the chemicals and materials industries. Hence the 60% decline in the use of oil is less steep than the 95% for coal. Nevertheless, within oil production there are stark differences between conventional and various unconventional sources. For tar sands, different studies have estimated that well-to-tank emissions are from 56% to 156% higher compared to conventional oil extraction, depending on the type of pit and extraction method (Mui et al [2010]). In particular, for natural gas the declines would be sharper in scenarios where carbon capture and storage (CCS) processes are not put in place, with median values of about 70%. Hence, the continued use of natural gas depends largely on CCS deployment, which has until now proved challenging.

These differences across fossil fuels explain why coal and tar sands are the two priorities of net-zero-committed investors. The two main net-zero investment

frameworks, those of the Net Zero Asset Owner Alliance (NZAOA) and the Paris Aligned Investment Initiative (PAII), indeed single them out. The NZAOA has published a position paper on coal (NZAOA [2020]). The PAII's Net Zero Investment Framework (PAII [2021]) recognises the potential role of divestment, while naming and shaming coal and tar sands. Under their reasoning, immediate divestment from fossil fuels, in particular coal and tar sands, can be justified for financial risk management purposes. Indeed, "coal assets are projected to be at risk of being stranded before 2030, while oil and gas assets are projected to be more at risk of being stranded toward mid-century" (IPCC [2022]). Not only is the stranding risk of coal more acute in terms of time horizon, but also in terms of magnitude. For example, "Around 80% of coal, 50% of gas, and 20% of oil reserves are likely to remain unextractable under 2°C constraints" (McGlade and Ekins [2015]; Pellegrini et al [2020]).

Beyond protecting the divestor from stranding risk, fossil fuel divestment may also contribute to the transition away from fossil fuels. Divestment influences a company's activity by increasing its cost of capital. This has been shown not only in economic models (Heinkel et al [2001], Pastor et al [2020]), but also in empirical studies, eg, Rohleder et al (2022) find that "divested firms experiencing a stock price decline subsequently reduce their carbon emissions compared to non-divested firms". A well-thought-out fossil fuel divestment policy thus contributes to the fight against climate change.

The costs of climate change mitigation have a modest impact on the total economic output that investors ultimately rely on to honour their liabilities. For 2°C scenarios the "average reduction in annual global GDP growth over 2020-2050 is 0.04–0.09 percentage points" and these modest costs are estimated "without

accounting for the economic benefits of mitigation action” (IPCC [2022]). Moreover, beyond the mean economic outcome, climate change mitigation may help reduce the risks to economic output, hopefully avoiding some of the worst results: “climate change threatens, in the most extreme scenarios, to return us economically whence we came,” as Nordhaus eloquently phrased it (2019). At a modest cost (or even gain) to the economy, investors who contribute to the fight against climate change help reduce the financial risks facing all investors, including themselves.

The unintended consequences of Paris-Aligned Benchmarks

Investors thus have sound reasons to implement investment strategies that include discerning and escalating fossil fuel divestment components. Unfortunately, in practice, many climate-labelled products marketed to investors would lead them to divest, partly or entirely, from fossils companies in ways that will fail to have the desired impact and may even be utterly counterproductive. A case in point is the EU-regulated Paris-Aligned Benchmarks (PAB). While they have several flaws (Ducoulombier [2020]), we will now concentrate on those linked to the financing of the energy transition.

Inadvertently pulling the plug on electric utilities

To carry the officially sanctioned PAB label, indices are required to immediately implement a number of exclusions related to fossil fuel production and distribution. The regulation may at first glance seem to make a relevant distinction between the three main types of fossil fuels, coal, oil, and gas,¹ as the exclusion thresholds of 1%, 10% and 50% of revenues respectively indicate a consistent hierarchy. However, in practice, all companies in the fossil fuel sector in the Scientific Beta Global universe of mid and large cap companies end up being excluded from PAB-compliant indices.

In that regard, an undesirable consequence of the PAB-related fossil fuel exclusions is that many of the affected companies are also significant players in renewable energies: for example, the excluded fossil fuels companies generate 7.4% of the revenues from renewables-based electricity² of all companies in the Scientific Beta developed markets universe. In emerging markets, these excluded companies stood for a full 38.6% of renewable electricity revenues.

The PAB requirements include another fossil-related criterion, namely that companies “that derive 50% or more of their revenues from electricity generation

1. Share of total renewable electricity revenues generated by PAB-excluded companies

Share of renewable electricity revenues generated by companies excluded by the different PAB fossil fuels exclusion criteria	Developed markets	Emerging markets	Global markets
No more than 1% of revenues from coal, 10% from oil, 50% from gas	7.4%	38.6%	14.1%
No more than 50% of revenues from electricity generation with a GHG intensity of more than 100g CO ₂ e/kWh	29.3%	29.3%	29.3%
All four of the above PAB fossil fuels screening criteria (screening criteria may overlap for the same company)	32.8%	46.4%	35.8%

Scientific Beta universes as at the end of June 2022. Renewable electricity revenues sourced from ISS ESG. The shares are computed as the sum of revenues from renewable electricity generated by excluded companies, divided by the same revenues for all companies in the respective Scientific Beta universes. Revenues are trailing twelfth months for the period ending 31 March 2022.

with a GHG intensity of more than 100g CO₂e/kWh” be excluded. In practice, electric utilities relying on unabated fossil fuels for most of their activity are to be shunned. However, these excluded utilities are also significant players in renewable electricity, representing 29.3% of revenues from renewables-based electricity in both the developed and emerging markets universes.

All in all, as shown in figure 1, the PAB fossil screens lead to the withdrawal of funding for companies representing about 35.8% of the renewable electricity generated in a global listed equity universe. This tightening of funding increases the cost of capital of these companies and hampers their ability to pursue further investments in renewable energies.

While these counterproductive effects are a direct consequence of the fossil-screening requirements of the regulation, these requirements also allow for greenwashing. The regulation imposes a 7% annual decarbonisation pathway for PAB indices and, to address greenwashing concerns, this pathway towards net-zero emissions must not be achieved by simply removing capital from carbon-intensive sectors. To ensure PAB indices “provide a realistic image of the real economy, including of sectors that should actively reduce GHG emissions to make the objectives of the Paris Agreement attainable, the exposure of those benchmarks to those sectors should not be less than the exposure of their underlying investable universe”.³

The view that decarbonising portfolios through sector reallocations has no positive impact is supported by academic research: Landier and Lovo (2021) analyse mechanisms of impact in a theoretical model and show that an ESG fund “that just defines its strategy as a cross-sector capital allocation has no impact on social welfare”. The Institutional Investors Group on Climate Change also recognises that one of the disadvantages of strategies focusing on portfolio-level self-decarbonisation goals is that they “may incentivise investors to achieve emissions reductions through re-allocating capital to lower carbon sectors”. Instead, it underlines that its “Net Zero Investment Framework promotes real decarbonisation through tilting portfolios to best performers within a sector or an industry as well as through the emissions reductions achieved by assets themselves” (IIGCC [2021]).

However, the greenwashing constraint in the PAB regulation, which prohibits the underweighting of high-climate-impact sectors in aggregate – as opposed to sector by sector – is far from being effective. In a paper on detecting greenwashing in climate investing strategies (Amenc, Goltz and Liu [2021]), we show that typical methodologies used to construct climate indices lead to a drastic reduction in the capital allocation to the electric utilities sector. As demonstrated in figure 2, whether the portfolios are built by tilting (over and underweighting stocks, relative to a standard cap-weighted benchmark, based on their carbon intensity measures) or by

1 Cf. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R1818>. “Administrators of EU Paris-Aligned Benchmarks shall exclude all of the following companies from those benchmarks: Article 12 (d) companies that derive 1% or more of their revenues from exploration, mining, extraction, distribution or refining of hard coal and lignite; (e) companies that derive 10% or more of their revenues from the exploration, extraction, distribution or refining of oil fuels; (f) companies that derive 50% or more of their revenues from the exploration, extraction, manufacturing or distribution of gaseous fuels.”

2 Wind, solar, hydro, geothermal and biomass.

3 Cf. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R1818>.

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optimisation (using a portfolio optimiser to achieve an average carbon intensity reduction while minimising tracking error with respect to a standard cap-weighted benchmark), the outcome is a severe reduction in the weighting of electric utilities. Moreover, imposing the aggregate sector constraint of the PAB requirements has almost no effect on this problem.

Betting on falling fossil prices

It should perhaps come as no surprise that investors who divest from companies that sell fossil fuels fare better when fossil prices are declining. We can illustrate this effect specifically for the fossil fuel exclusions of the PAB regulation by comparing the oil price exposure of two different versions of the Scientific Beta Climate Impact Consistent (CIC) indices. These climate indices aim at incentivising all companies to align on net-zero trajectories by allocating capital based on each company's climate performance relative to their industry peers. While the EU PAB-compliant version applies all the EU-mandated fossil-fuel screens, the standard CIC version targets coal and tar sands.⁴ As shown in figure 3, while the standard version, which avoids sector weight distortions, is not significantly exposed to the ups or downs of oil prices, the PAB version of the indices clearly gain in bear markets for oil prices. When analysing the performances – and risks – of climate strategies, investors need to account for their implicit exposures to factors influencing stock price movements.

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⁴ The screening criteria for coal and tar sands in CIC indices are as follows: Ownership of (thermal) coal reserves; >5% of revenues from coal; >20% of power generation capacity from coal, with phase-out by 2030/2040 in developed markets/emerging markets; absolute coal-fuelled power production volumes (5GW/10GW in DM/EM) except for companies having a 1.5°C science-based target; Companies excluded by the Norwegian Government Pension Fund for unacceptably high carbon emissions (tar sands); >10 % of revenues from tar sands.

2. Representation of the electricity sector by strategy type

	Tilting strategies	Optimisation strategies
Unconstrained strategies		
Electricity sector absolute active weight	-2.2%	-2.5%
Electricity sector relative active weight	-81.0%	-90.5%
Strategies with aggregate constraint on high-climate-impact sectors		
Electricity sector absolute active weight	-2.2%	-2.4%
Electricity sector relative active weight	-79.0%	-89.4%

We report results for each strategy type, averaging across the eight different climate scores we maintain. Our results thus provide a complete picture across the eight climate metrics. We note that results align very closely across the eight metrics so that averaging does not hide relevant information. We assess impact consistency measures once a year in June from 2011 to 2020 and report the average value. We thus provide a view on impact consistency observed on average over one decade. Electricity sector is from the Scientific Beta climate impact sector classification. Note: index products may deviate from stylised strategies in important ways. Results derived for stylised strategies may not be applicable to index products, in particular in the case where index products employ additional constraints or rules which are not accounted for in the stylised strategies.

3. Oil price exposure of two versions of Climate Impact Consistent (CIC) indices

Scientific Beta Developed, June 2013–June 2022	CIC	CIC EU PAB
Unexplained	-0.19%	0.60%
Equity beta	1.05	1.05
Oil beta	0.00	-0.02
R2	98.8%	98.5%
t-stat unexplained	-0.32	0.91
t-stat beta	66.29	84.81
t-stat oil	0.25	-4.78
Positive oil return	-0.10%	-1.35%
Negative oil return	-0.64%	2.85%
Oil return spread	0.54%	-4.19%

The regression analysis is computed on weekly US dollar total returns from 21 June 2013 to 30 June 2022. Exposures are obtained using an OLS regression based on weekly returns. Equity beta is the SciBeta Developed Cap-Weighted index. The oil beta is the ICE-Brent Crude Oil Continuous obtained from Datastream (LLCCS00). Standard errors are corrected for heteroskedasticity and autocorrelation. The conditional analysis is computed on daily US dollar total returns from 21 June 2013 to 30 June 2022. Positive/negative oil return regimes correspond to months with positive/negative oil returns. Oil return spread is the difference between positive and negative oil return regimes. For the conditional analysis, returns of CIC and CIC EU PAB are market beta neutralised ex-post on the full sample before the analysis to remove the market effect. Indices used are the SciBeta Developed Climate Impact Consistent index (CIC) and the SciBeta Developed Climate Impact Consistent EU PAB Compliant index (CIC EU PAB). Bold values are statistically significant at 5%.

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