SOLACTIVE
German Index Engineering

(GDP WEIGHTED GOVERNMENT BOND INDICES)

IT'S THE ECONOMY, STUPID.

Fixed Income Index Engineering

White Paper

21 May 2019

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ABSTRACT

We analysed a GDP weighted strategy based on the Solactive Broad Global Developed Government Bond Index EUR TR over the period from 2008 to 2019. For this timeframe, the strategy is able to produce an annualized alpha of approx. 1% which is statistically significant at the 5% level. Furthermore, we show the analysed strategy's outperformance can't be explained by exposure to common risk factors such as credit and duration risk. While the interest rate risk is the key return driver of the analysed strategy, the outperformance can be attributed nearly equally to a superior country (interest rate risk) and currency allocation. We illustrate the counter-cyclical behavior of a GDP weighted strategy with the time varying exposure of the strategy to Portugal.

INTRODUCTION

In the last 17 years, Bond ETFs have seen a tremendous growth trajectory. In 2002, iShares launched the first 4 bond ETFs, all concentrating on the USD Market (Murphy, 2019). With their offering in the USD Treasury Market and the USD Corporate Investment Grade Market, iShares for the first time enabled their clients an uncomplicated access to one of the largest capital markets in the world via a single exchange traded security. According to a study from EY in 2017, the total assets under management for fixed income ETFs totaled to 3.5 trillion USD in 2016 and is expected to grow to 7.6 trillion USD in 2020 (EY, 2017).

Most bond indices follow a market cap weighting approach, meaning that the weight of a bond within a given index is determined by the product of a bond's price and amount outstanding. If one wants to measure the performance of a given debt market, this weighting method is correct, as it reflects the true performance of the market (Brown, 2002).

However, with the rise of investable market weighted security indices, the criticism of such indices and the assets tracking them has increased as well. Robert D. Arnott was among the first ones to voice his concerns about purely tracking market weighted security indices. In 2005, Arnott proposed fundamental index construction in a dedicated study. He argues that indices, which don't follow the pure market cap weighting scheme but other weighting approaches based on fundamental company data, are more mean-variance efficient (Arnott, Hsu, & Moore, 2005).

The main criticism of market weighted indices is that these indices are concentrated on expensive securities, which enjoyed price rallies in the past. This stands in strong contradiction to the contrarian or value investment approaches. While price rallies in bond prices also lead to an overweight of these bonds, the more dominant criterion of overconcentration is the amount of debt a company has issued. As a consequence, the most indebted companies usually have the highest weights in standard market cap weighted indices.

Fixed income investors are often concerned about the credit risk of borrowers. Naturally, the more debt an issuer has outstanding, the higher their credit risk should be, as it becomes less likely the issuer will be able to repay all her obligations. The desire of fixed income investors to encapsulate their capital in safe borrowers seems, to some extent, contradicting to the construction of pure market cap weighted bond indices. The overconcentration effect can be observed in all fixed income asset class from local currency sovereign debt to corporate issuers.

In this paper, we study a GDP Weighted Government Bond Index based on the Solactive Broad Global Developed Government Bond Index TR, which is Solactive's primary developed markets government bond benchmark index. Currently, the index includes 27 different countries. We find GDP weighting combines several benefits: investing in economies with stronger fundamentals, incorporating a liquidity factor (larger economies tend to have larger sovereign debt markets) as well as adding a counter-cyclical element to the weighting approach (Pimco, 2019).

We compare the GDP weighted approach on several risk metrics with the market cap weighted index. The analysed strategy generates an annualized alpha against the benchmark of approximately 1%, statistically significant at the

5% level, with a p-value of 0.036. It is notable that the strategy achieves this result even though it bears less exposure to credit and maturity risk than the benchmark index.

1 TRADITIONAL WEIGHTED SOVEREIGN BOND INDEX

Solactive constructed the Solactive Broad Global Developed Government Bond Index in 2018. It follows a standard market value weighted approach and holds a back-tested history until October 2008. The developed government bond index includes all liquid local currency bonds issued by central governments of countries, which are classified as developed market countries under Solactive's Fixed Income Country Classification schema. The index is calculated in Euro and contains no hedging of currency risks in its plain vanilla version. The series has several sub-indices based on ratings, geographical exposure, and currencies. Currently, the benchmark index includes 27 different countries and 1047 bonds[1].

As of January 2019, the following countries are represented in the index: the United States of America, Ireland, Canada, the United Kingdom, Germany, Italy, Spain, Belgium, France, Israel, the Slovak Republic, Portugal, New Zealand, Finland, Austria, Luxembourg, the Netherlands, Singapore, Australia, Switzerland, Denmark, Greece, Japan, Norway, Sweden, Slovenia and Cyprus.

1.1 DESCRIPTIVE STATISTICS

As mentioned before, the Solactive Broad Global Developed Government Bond Index includes 27 countries and 13 currencies. In the following graphs and tables, we show the various country and currency breakdowns of the index.

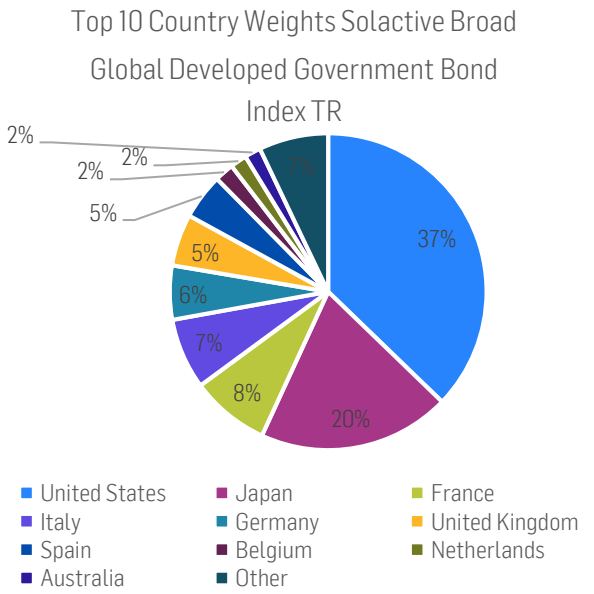

Figure 1: Country Weights Solactive Broad Global Developed Government Bond Index TR, Source: Solactive AG

As one clearly can see from the figure above, the market weighted sovereign bond index is heavily tilted towards the largest issuers of debt such as the United States, Japan, France, Italy and Germany. While one would expect that the United States of America and Japan are the countries with the highest weights in the index, it may come as a surprise that Italy owns a higher weight than Germany or the UK.

The currency exposure of the benchmark index is even more concentrated, with the top 3 currencies (USD, EUR and JPY) making up nearly 90% of the index as of January 2019.

Not only does the benchmark index include investment grade rated issuers it also contains sub-investment grade issuers. However, only two issuers are currently rated below investment grade (Greece and Cyprus). Approximately 55% of

[1] as of 01.01.2019

the index constituents fall within the AA rating bucket (AA+, AA and AA-).

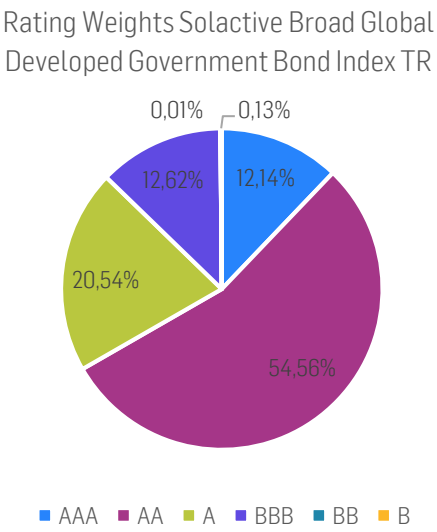

Figure 2: Rating Weights Solactive Broad Global Developed Government Bond Index TR, Source: Solactive AG

2 GDP WEIGHTED SOVEREIGN BOND INDEX

The analysed strategy is an alternative weighting approach to the Solactive Broad Global Developed Government Bond Index TR. The Solactive GDP Weighted Global Government Bond Index reweights all countries within the index based on their five-year average GDP relative to the five-year average GDP of all other index' countries. The weight of the bonds within each country is determined by the market capitalization of the instruments. GDP figures are collected from the World Bank. Specifically, we reference the GDP in constant 2010 U.S. dollar terms (World Bank Data I.D. = NY.GDP.MKTP.KD).

To prevent a look-ahead bias in our simulation, we have lagged published GDP figures of the World Bank. For all GDP figures, we assume the previous year's values to be published in September of the current year. This specifically means that in September 2017, we will use the GDP figures as of 2015 and from October 2017 onwards we will use the updated GDP figures as of 2016.

Formally, the following set of equations build the foundation of the country weights:

$$\text{Country Weight}_{i,t} = \frac{\text{Average GDP}_{i,n}}{\sum_{i=1}^{C} \text{Average GDP}_{i,n}} \quad (1)$$

$$\text{Average GDP}_{i,n} = \frac{1}{5}\sum_{l=0}^{4} \text{GDP}_{i,n-l} \quad (2)$$

where:
i = subscript for countries
t = date of effective weight
n = year of latest GDP figures available
l = number of years for average GDP calculation
C = number of countries

We study shows this weighting mechanism to be an effective way of incorporating all aspects of bond indexing. While it eliminates the largest flaw of market cap weighted bond indices (overweighting the most indebted countries), it still takes into consideration the size of a country as well as the single-issue size within the countries. The latter two points are crucial for the liquidity of the underlying instruments. While we accept the fact that the overall GDP is not the perfect indicator for a country's economic performance, we cannot rely solely on GDP growth or GDP per capita. These indicators could possibly overweight small countries such as Luxembourg, Norway, and Switzerland heavily. Typically, these governments have few debt outstanding, and therefore an index overweighting these countries could possibly run into liquidity problems. Secondly, weighting the bonds according to the market capitalization of a country's debt structure enables us to take into account the liquidity of single issues. Additionally, the market cap weighted approach within a country's debt structure allows us to capture the unique duration exposures of each country.

2.1 DESCRIPTIVE STATISTICS

To demonstrate the extent of how the GDP weighted approach differs from the market cap weighted approach, we again have calculated a current country weight split the same way we did for the abovementioned market cap weighted benchmark.

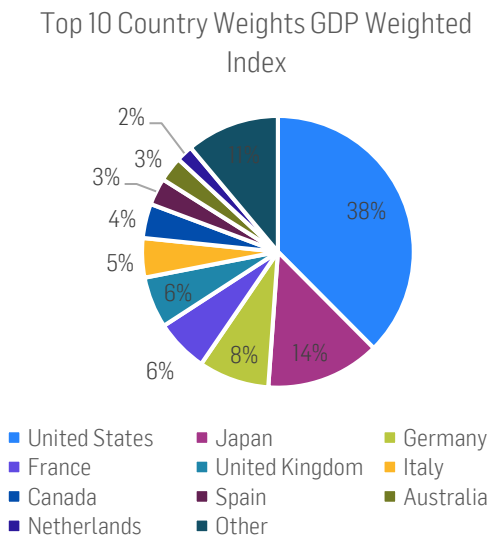

Figure 3: Country Weights GDP Weighted Index, Source: Solactive AG

Comparing the country weights to the market cap weighted index, we can spot some interesting facts. The weight of the United States does not change much, and the US by far still stays the largest issuer accounting for 38% of the GDP weighted index. We observe some of the largest absolute weight deviations from Japan (-6%), Italy (-2%), Canada (+3%), and Germany (+2%).

Countries	GDP Weight	Market Cap Weight
United States	37.54%	37.22%
Japan	13.59%	19.65%
France	6.29%	8.05%
Italy	4.68%	7.24%
Germany	8.41%	5.52%
United Kingdom	6.10%	5.29%
Spain	3.22%	4.65%
Belgium	1.15%	1.95%
Netherlands	1.98%	1.68%
Australia	2.97%	1.65%

Table 1: Comparison between GDP country weights and country weights based on market capitalization for the 10 largest countries by market capitalization, Source: Solactive AG

The overweight of countries with better fundamental economic data is also reflected in the index's rating distribution.

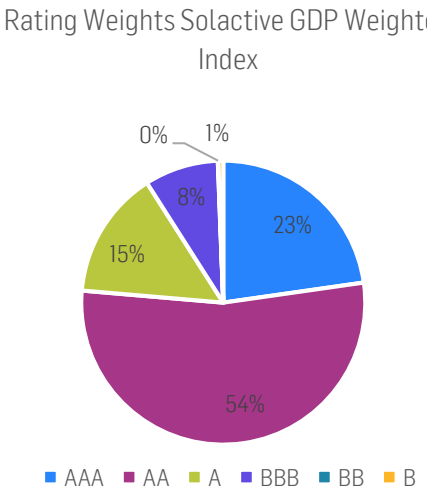

Figure 4: Rating Weights GDP Weighted Index, Source: Solactive AG

The GDP weighted strategy overweighs the AAA-rated segment while simultaneously underweighting the BBB and A segments. Thus, we show an outperformance of the GDP weighted strategy is not simply achieved by increasing the credit risk exposure.

In the next chapter we would like to shed some light on the historic compositions of both indices and examine developments in the country and rating exposures across time.

3 HISTORIC COMPARISON

When comparing the pure performance figures of both indices, we can conclude that the Solactive GDP Weighted Broad Global Government Bond Index outperforms its market cap weighted peer for the examined period between 31.10.2008 and 23.01.2019. The absolute cumulative outperformance is equal to 8.84% over this time period.

Descriptive Statistics

	Market Cap Weighted Index	GDP Weighted Index
Total Return	43%	52%
Annualized Return	3.61%	4.23%
Annualized Standard Deviation	7.27%	6.56%
Skewness	0.08	0.05
Excess Kurtosis	2.33	2.66

Table 2: Descriptive Statistics 2008 – 2019, Source: Solactive AG

During the period between 2008 and 2019, the GDP weighted version outperformed the market weighted version on both an absolute and as well on a risk-adjusted basis. As the GDP weighted strategy mimics a quality strategy in the sense that it tries to overweigh countries with better economic indicators, it should not come as a surprise that the GDP weighted version features a lower standard deviation.

The potential overlap of the GDP weighted index with a quality strategy might also explain the fact that the index isn't able to outperform the benchmark on a continuous basis. We illustrate this in the following two charts. Especially after the euro sovereign debt crisis (2010-2012), we observed the GDP weighted strategy to outperform its market value weighted peer. This arising difference in performance is intuitive. During the crisis, the economies of the most indebted countries took the most critical hits. Due to the non-market cap weighting, the most indebted countries had a comparatively low proportion in the GDP weighted index compared to market cap weighted indices.

On the other hand, we can see the GDP weighted strategy to underperform shortly after March 2015. This was the time when the public sector purchase programme (PSPP) was launched in Europe and the probability of another interest rate hike by the Fed tumbled. These developments lead to an appreciation of the Yen and a rally in Japanese government bonds. Due to high debt levels of the Japanese government the analysed strategy underweights Japan which explains the underperformance during this time period.

Figure 5: Simulated Index Levels Market Cap Weighted Index vs. GDP Weighted Index, Source: Solactive AG

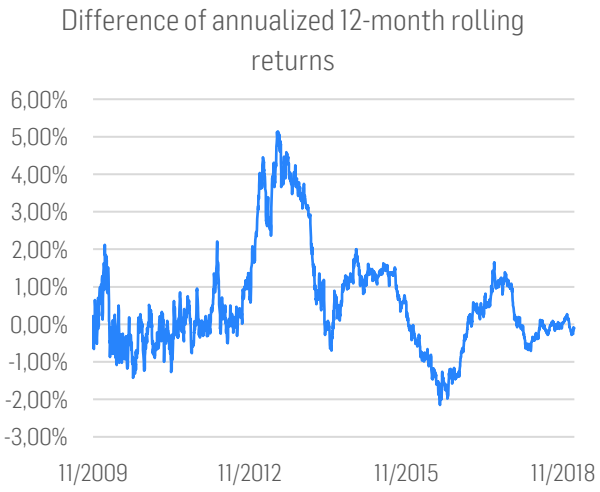

Figure 6: Difference of annualized 12-month rolling returns, Source: Solactive AG

To evaluate the robustness of the GDP weighted strategy, we have conducted a linear regression analysis to determine whether the analysed GDP weighted strategy is able to produce any significant alpha over the market cap weighted benchmark. In the following table, one can see that the GDP weighted strategy creates an annualized alpha of approximately 1%, which is statistically significant at the 5% level. Between 2008 and 2011, the strategy was not able to generate a positive alpha, which is statistically significant from zero. However, in the period starting in 2012, the strategy manages to generate a positive annualized alpha of approx. 1% with a p-value of 0.013.

Regression Results 2008 - 2019

	Coefficients	Standard Error	t Stat	P-value
Alpha	1.02%	0.000019	2.087	0.03697
Beta	0.8764	0.0042115	208.1	0

Table 3: Regression Results 2008 - 2019, Source: Solactive AG

Compared to the benchmark, this outperformance cannot be explained by taking on additional credit risk. As the historic rating distribution shows, the GDP weighted index constantly invests in higher credit quality borrowers. Especially the allocation to the AAA and AA+ bucket is considerably higher in the GDP weighted version than in the market cap weighted benchmark. For historic rating distributions, please refer to the appendix.

Similarly, increasing maturity risk cannot explain the outperformance, since, for most parts of the examined period, the GDP weighted index has a lower average time to maturity than the benchmark. Up to 2010, the GDP weighted index features an only slightly higher average time to maturity. In subsequent periods, this trend reverses and the GDP weighted version has a considerably smaller average time to maturity.

If one looks at the average duration, which is arguably a better indicator for interest rate risk than maturity, one can see that the GDP weighted index continuously has a lower duration than the market cap weighted benchmark. We can see the same underlying trend in both duration figures which is slowly rising over time. This can be attributed to lower interest rates which encourages countries to issuer longer dated debt.

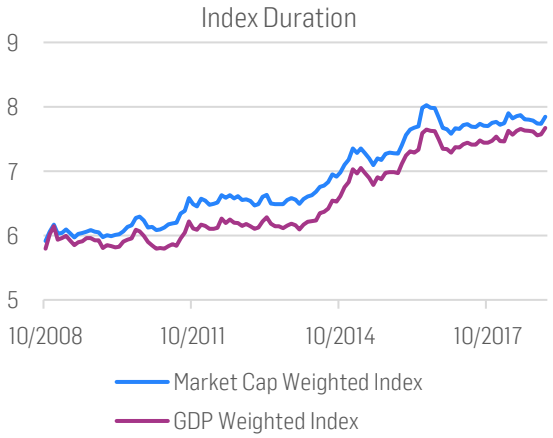

Figure 7: Index Durations, Source: Solactive AG

As with any strategy that deviates from the market cap weighted benchmark, excess turnover is always an issue. As we are taking the five-year average of a country's GDP figures, the

country weights remain relatively stable, in fact, more stable than in the market cap weighted benchmark. Nonetheless, we rebalance the portfolio every month, so country weights match their GDP target weights and bond weights equal their market cap weight within a country's debt structure. Two-way turnover in excess of the benchmark is on average 1.41% per month. Given the stable country weights, one could argue a quarterly or even semiannual rebalancing cycle would be sufficient for the index. As turnover is not significant higher and to allow for better comparison we decided not to deviate from the benchmark in this matter.

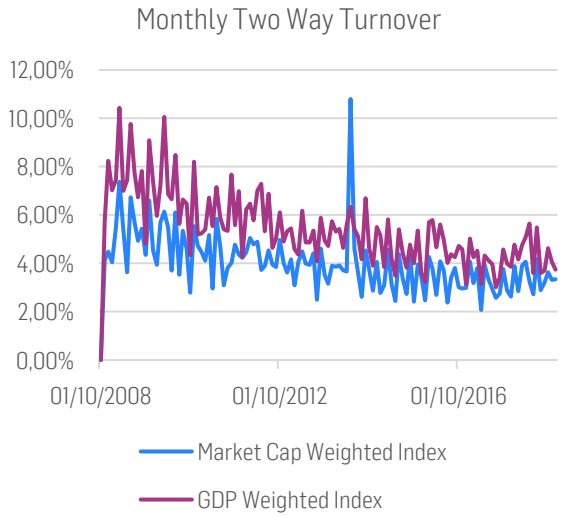

Figure 8: Monthly Two-Way Turnover for GDP Weighted and Market Cap Weighted indices, Source: Solactive AG

These findings lead us to conclude that the index's outperformance stems mostly from a superior country allocation. Especially in times of downturns, we find the GDP weighted approach to be far more robust. We believe that countries with a higher GDP feature better fundamental economic data, which subsequently leads to a better performance of the local currency sovereign bond market. Another possible source of outperformance versus the benchmark originates from active currency risks that we are taking within the GDP weighted approach. Since countries with larger GDP figures typically feature higher economic growth, their currencies tend to appreciate. Therefore, an investor in those currencies will experience a profit based on currency holdings.

In the next chapter, we would like to examine to what extent the outperformance can be explained by a superior country selection and/or active currency risk-taking.

4 PERFORMANCE ANALYSIS

As laid out before, the outperformance can't be explained by exposure to credit risk or maturity risk alone. As the two potential sources for outperformance versus the benchmark, we suspect the active weights within countries and currencies. First, we have calculated indices eliminating the currency effects on the GDP weighted and the market cap weighted indices entirely. This was done by subtracting the daily returns of a currency index from the bond index returns. The weights of the currencies were determined once a month in accordance with the rebalancing of the bond indices. Formally speaking, the returns on the currency index can be calculated using the following formula:

$$\text{Currency Index Return}_t = \sum_{i=1}^{n} w_{i,R} * cr_{i,t} \qquad (3)$$

where:
i = subscript for currencies
w = weight of currency
R = last rebalancing date
cr = currency return
n = number of currencies

Comparing the two country-risk-only indices allows us to extract the return differential, which is purely based taking idiosyncratic country interest rate risk.

Since the GDP weighted index outperforms the GDP weighted country-risk-only index, we can

conclude that bearing currency risk is rewarded by achieving higher returns.

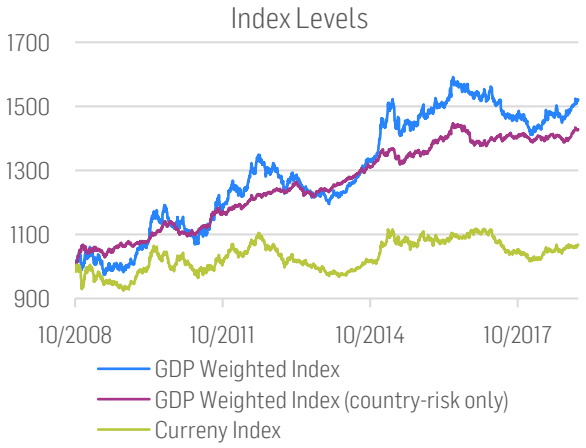

Figure 9: Index Level of unhedged GDP weighted index, country hedged GDP weighted index and currency index only, Source: Solactive AG

From the chart above, we can see that a large part of the outperformance is driven by taking active risks within the country selection. Past annualized performance of the GDP weighted strategy has been 4.23%, while the country-risk-only version had an annualized past performance of approx. 3.6%. The hypothetical currency-only index showed an annualized returned of 0.64%.

We have computed the same statistics for the benchmark index. It is interesting to note that, using the GDP weighted approach, the currency part of the total return has increased most.

Past Annualized Performance		
	GDP Weighted Strategy	Market Cap Weighted Benchmark
Total Return	4.23%	3.61%
Country Return	3.59%	3.30%
Currency Return	0.64%	0.33%

Table 4: Past Annualized Performance of GDP Weighted Strategy and Market Cap Weighted Benchmark, Source: Solactive AG

Next, we would like answer to the question whether active positions in idiosyncratic country risks or active currency risks are the main driver of the outperformance. To answer this question, we compare the GDP weighted country-risk-only strategy with the country-risk-only market cap weighted benchmark index as well as the market cap weighted currency index vs. the GDP weighted currency strategy.

Annualizing the daily return differences between the GDP weighted strategy and the market cap weighted benchmark index yields in an outperformance of approx. 5.5% for the total return versions. Annualizing the daily return differences for the country-risk-only versions leads to an annual outperformance of 2.9%. Similarly, the GDP weighted currency index outperforms the market cap weighted currency index by 2.6%.

Annualized Performance Difference	
GDP Weighted Index - Market Cap Weighted Index	
Total Return	5.50%
Country Return	2.90%
Currency Return	2.60%

Table 5: Annualized Performance Difference between daily GDP weighted strategy returns and daily market cap weighted benchmark returns, Source: Solactive AG

Plotting the 250-day trailing return differences for total return, country-risk-only return, and currency returns leads to the following conclusions:

1. Outperformance due to idiosyncratic country risk is much less volatile than the outperformance due to active currency risk.
2. Outperformance due to idiosyncratic country risk and active currency risk are approximately equal.

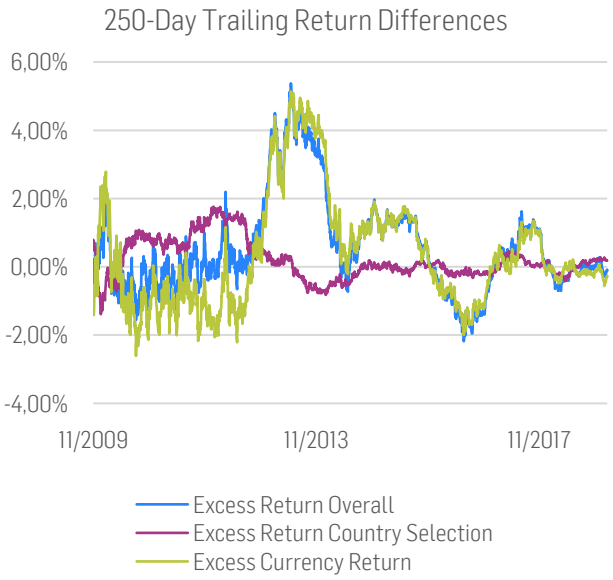

Figure 10: 250-Day Trailing Return Differences, daily return differences are computed by subtracting the market cap weighted return from the GDP weighted daily return. Source: Solactive

Given the high level of the excess currency returns we propose to use a currency hedged version of the GDP weighted index as an underlying for any investment product.

In a separate exercise, we have tried to identify the impact of the active weights per country on the performance of the GDP weighted index. For this process, we have calculated the active weight for each country in the active index and the excess return of the country's local currency bond market over the market cap weighted benchmark index. Unsurprisingly, most of the outperformance is driven by underweighting Japan over the entire time period. Japan's local currency bond market has performed poorly. Due to its large issuance of new debt, Japan has a considerably lower weight in the GDP weighted index compared to the market cap weighted index.

Continuously underweighting the Italian sovereign debt market as well as relatively high exposure to the Australian government debt over time achieves a considerable outperformance.

An interesting case is Portugal. In the chart below, we have plotted the 12-month average active weight of Portugal in the GDP weighted strategy as well as the annualized 12-month average excess return of the local currency Portuguese sovereign debt market.

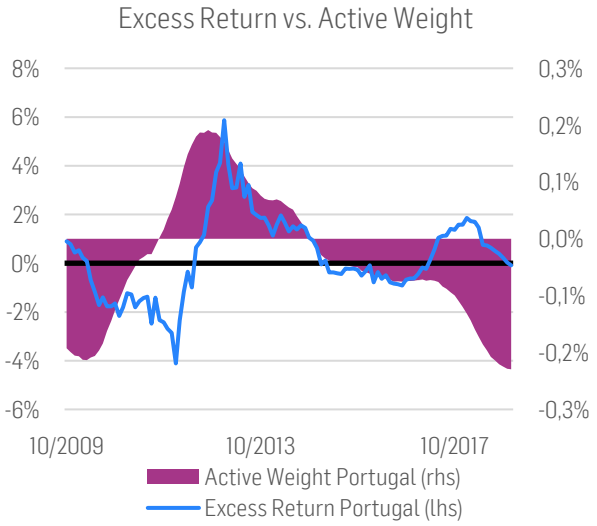

Figure 11: Excess Returns vs. Active Weight of Portugal against market cap weighted benchmark index, Source: Solactive AG

During the European sovereign debt crisis, until mid-2011, the GDP weighted strategy would have underweighted Portugal. Interestingly, the subsequent overweighting does not result from an increase in the weight within the GDP weighted index. It is rather driven by a sharp reduction in the weight in the market cap weighted index. Just as bond prices started to tumble, the GDP weighted index increased its relative allocation to cheap Portuguese debt. During much of the period, where the Portuguese debt market outperformed the benchmark, the GDP weighted index carried a relative overweight in Portuguese debt.

As Portuguese debt prices recovered, its country weight in the market cap weighted strategy increased, leading to a relative underweighting of Portugal's debt within the GDP weighted strategy.

5 CONCLUSION

We can conclude that a simple GDP weighted strategy in the developed sovereign bond market is able to outperform a standard market cap weighted index on both an absolute and a risk-adjusted basis. The results show that the annualized average return was increased from 3.82% to 4.36%, while decreasing the volatility from 7.27% to 6.56%. The outperformance cannot be linked to common risk factors such as duration and credit risk. Additionally, we find the outperformance arises from both taking active country (interest rate) risk as well as taking active currency risk. While in both strategies the idiosyncratic country risk is the predominant return driver, it is surprising that the outperformance of the GDP weighted strategy stems nearly equally from the currency and the country risk factors. A currency hedged GDP weighted strategy is able to outperform a market cap weighted equivalent.

In a one-factor regression model, ranging from 2008 – 2019, and with the market cap weighted sovereign bond index as the only independent variable, the GDP weighted strategy is able to produce a positive annualized alpha of approximately 1% with a p-value of 0.03697.

As expected, the GDP weighted strategy demonstrates a similar behavior as a quality strategy, performing better in risk-averse market situations. This could be clearly observed in the time period around the European sovereign debt crisis between 2010 and 2012. As with most rules-based investment strategies, there are prolonged period of times where such strategies underperform the benchmark. For the analysed strategy this is especially the case between 2015 and 2016.

We believe that a GDP weighted fixed income index is a valuable addition to the current offering of sovereign bond indices. Due to its superior performance in periods of stress, it should offer a higher degree of diversification to investors' portfolios. Additionally, this index can be utilized as a base index for more sophisticated multi-factor strategies with the aim to boost returns further.

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APPENDIX

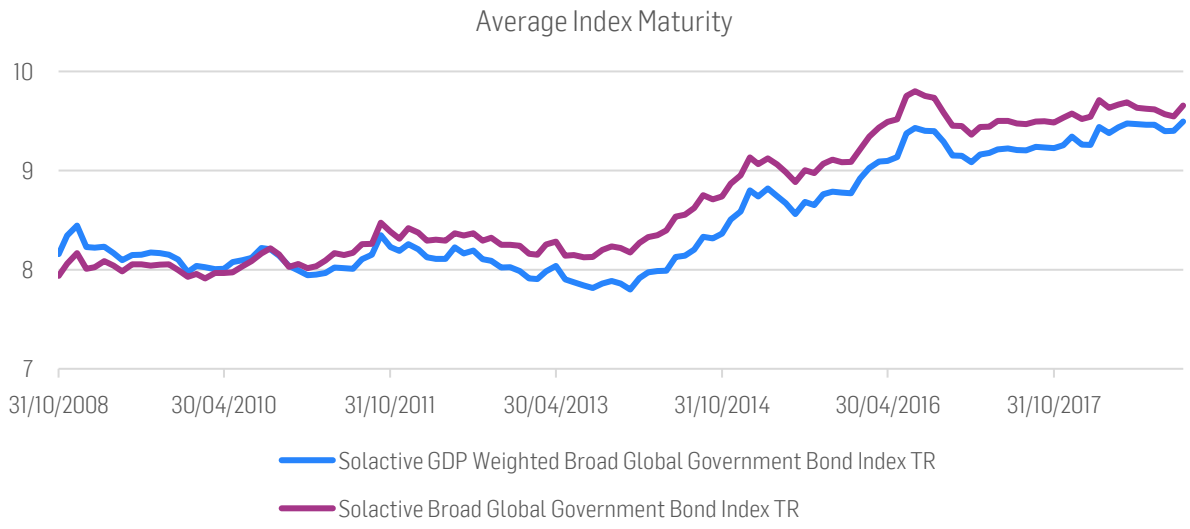

Figure 12: Average Index Maturity, Source: Solactive AG

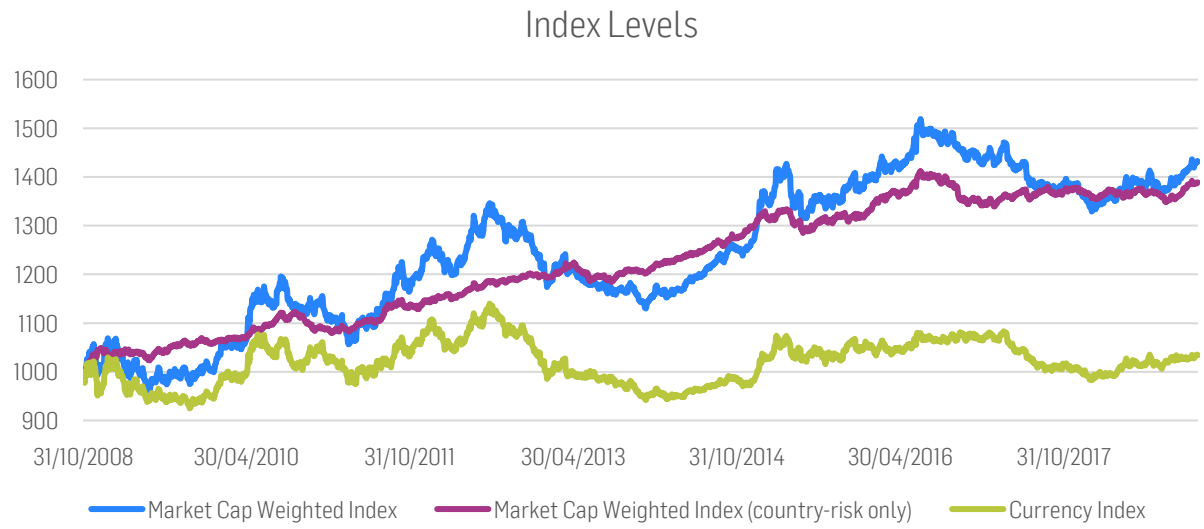

Figure 13: Index Levels for Market Cap Weighted benchmark as well as a country-risk only index and the currency index, Source: Solactive AG

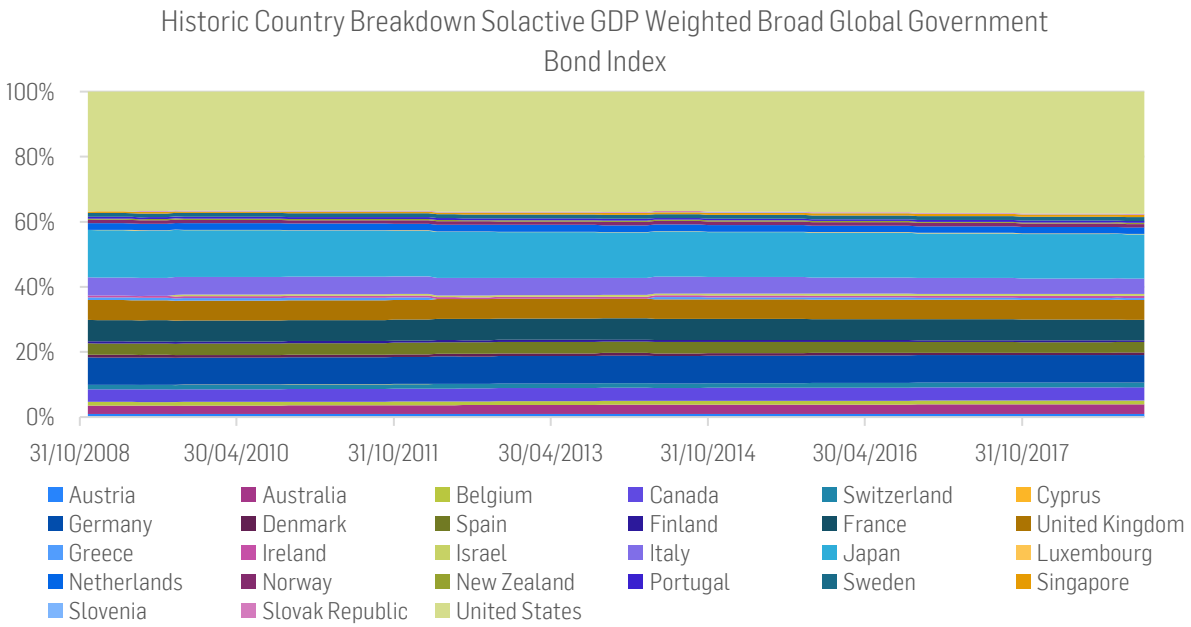

Figure 14: Historic Country Breakdown Solactive GDP Weighted Broad Global Government Bond Index, Source: Solactive AG

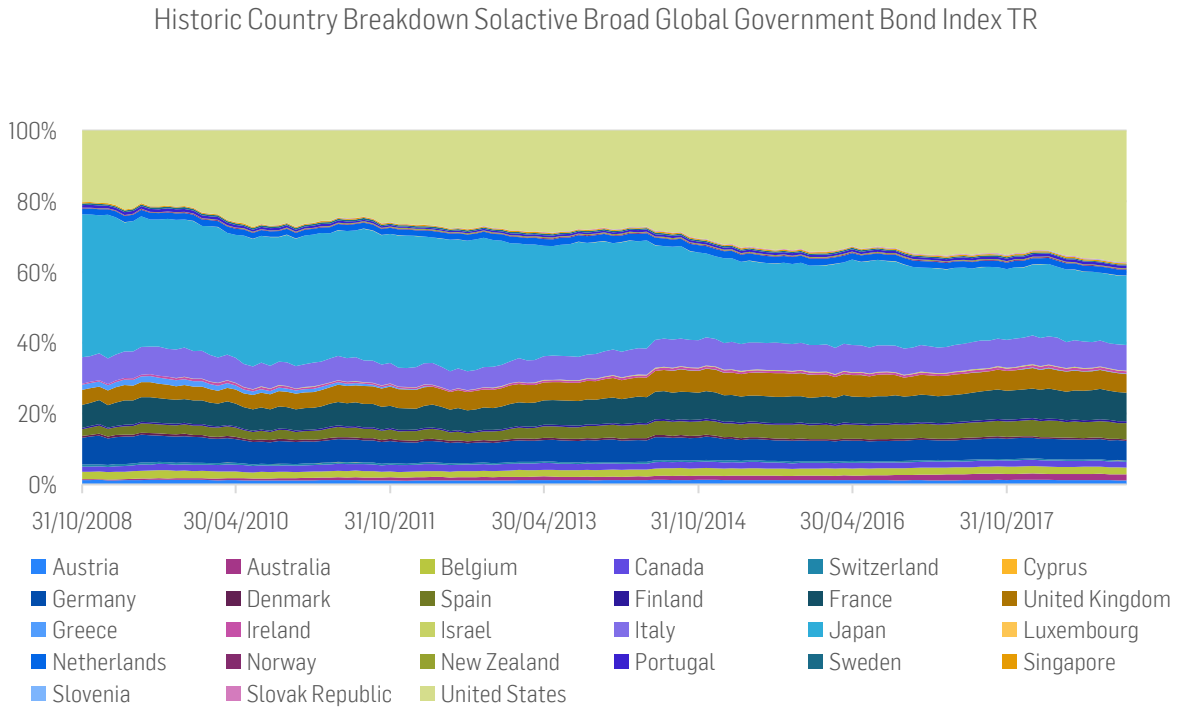

Figure 15 Historic Country Breakdown Solactive Broad Global Government Bond Index TR, Source: Solactive AG

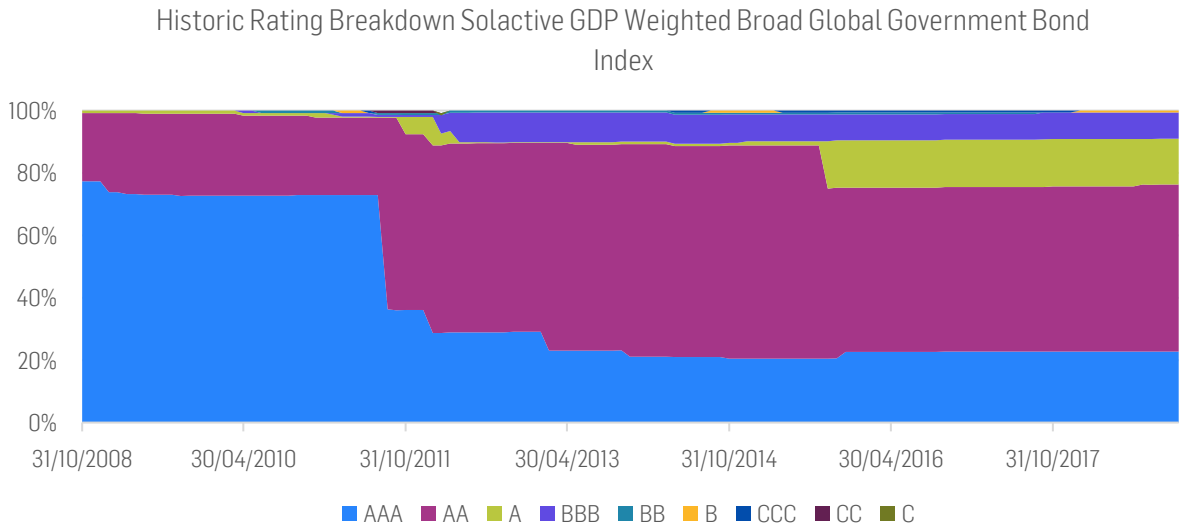

Figure 16: Historic Rating Breakdown Solactive GDP Weighted Broad Global Government Bond Index, Source: Solactive AG

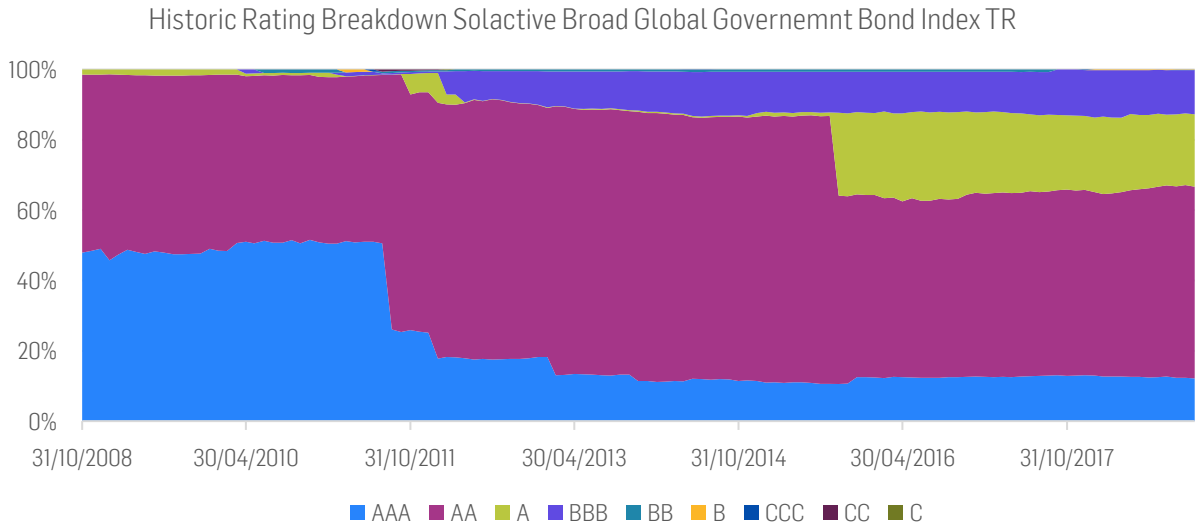

Figure 17: Historic Rating Breakdown Solactive Broad Global Government Bond Index TR, Source: Solactive AG

DISCLAIMER

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All numbers are calculated by Solactive as of Q1 2019.

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