Fundamental weighting schemes for Developed, Emerging and Frontier government bond markets

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Abstract

Along with the growing interest in valuation-indifferent-indexation, an increasing amount of literature has criticized the application of fundamental indexation in government bond markets. This study aims to investigate Arnott, Hsu, Li and Shepherd's (2010) valuation-indifferent indexation study in government bond markets, where their fundamentally weighted USD denominated Emerging market sovereign bond indices significantly outperform their market capitalization-weighted counterparts. The sample of this study is extended to local currency Developed market indices from 29 countries, local currency Emerging market indices from 23 countries and USD denominated Frontier market indices from 26 countries. The results imply that (1) there is no apparent trend in the outperformance of fundamental indices between Developed, Emerging and Frontier markets, showing evidence against the noise-in-price theorem which associates higher bid-ask spread markets with more negative noise (or higher outperformance possibility) (2) fundamental indexation significantly underperforms in a currency-hedged local currency government bond setting (3) the transaction cost difference between market-weighted and fundamental government bond indices is negligibly minor (4) term risk, default risk and the carry trade factor play a significant role in explaining the returns of the Developed and Emerging fundamental index samples but not the Frontier market sample.

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1. Introduction

1.1 The origins of Fundamental Indexation

A considerable amount of literature employs the assumption that market-capitalization weighted indices such as the S&P500, the FTSE100 and the NIKKEI225 are appropriate representatives of the CAPM market portfolio, which by definition is mean-variance optimal. Recent literature has however claimed that investors can achieve an improved risk-return profile through investing in fundamental indexation, a term coined by Arnott et al. (2005) which entails the weighting of stocks in an index based on fundamental values that are representatives of size. In his study covering equity indices, he used the factors of equity book value, gross sales, gross dividends, gross revenues and number of employees to replace market capitalization as a weighting method within an index. Through their research, they find that fundamental indices outperform their traditional cap-weighted counterparts by an annual average of 197bps, with a lower volatility and consequently an improved Sharpe ratio over 43 years. The theory has also been extended to stock markets outside the US (Arnott and West 2006) and to industry-specific applications (Hsu et al. 2010).

Arnott et al. (2008) explain this outperformance using the "Noisy Market Hypothesis", a term introduced by Siegel (2006) which argues that securities are subject to mispricing, therefore causing overvalued stocks to underperform in the long run and undervalued stocks to overperform. In the same context, it is derived that market capitalization weighted indices are overweight in overvalued securities and underweight in undervalued securities, posing an inherent performance drag; a hypothesis which by definition conflicts the "Efficient Market Hypothesis".

Despite the overall positive receipt of the theory, various criticisms on valuation-indifferent indexation stem from three main sides. Firstly, in addition to other criticisms, Blitz and Swinkels (2008) focus their research on proving that the outperformance of fundamental indexation is solely attributed to its correlation with value portfolios. They claim that the

factors that contribute to the outperformance of fundamental indices are commonly known risk factors that past literature has already covered. The authors demonstrate, that although fundamental indexing shows a significant alpha when no risk factors are taken into account in a single-factor regression, it has a large and highly significant exposure to the value and small capitalization factor. The same index's alpha then becomes minor and insignificant once included in the Fama and French 3-factor model. They therefore conclude that when common risk factors are taken into consideration, fundamental indexation gives no edge to investors and that the strategy is relatively inferior to other existing quantitative strategies.

Secondly, Perold (2007) emphasizes his research on the disproval of the inference that market-capitalization weighted indices constitute an inherent performance drag because they overweight overvalued companies and underweight undervalued ones. Through a model based on the random probability of pricing noise he explains that holding a stock in proportion to its capitalization weight does not change the likelihood that the stock will be undervalued or overvalued.

Lastly, both Perold (2007) and Blitz and Swinkels (2008) state that fundamental indexing does not represent a passive, buy-and-hold strategy. That's because a cap-weighted index setting requires no turnover when stock prices change, while in a fundamental index setting, a stock price change does not lead to a weight change. For this reason, fundamental indexing requires a rebalancing strategy which implies additional turnover, making the transaction cost differences between the two weighting strategies an important component of the analysis. As Perold (2007) noted, "the average investor who deviates from capitalization weights underperforms the market portfolio after fees and transaction costs".

1.2 The case of Fundamental Indexation in fixed-income markets

In response to these criticisms, Arnott et. al (2008) explain how size and value premiums and the outperformance of valuation indifferent indexation are very closely related terms of mispricing through their noise-in-price model. To add to the debate, Arnott, Hsu, Li and Shepherd (2010) showed that fundamentally indexed sovereign and corporate bonds outperformed their market capitalization weighted counterparts. The average annual

outperformance was estimated at 140 bps in the case of their USD Emerging Market sovereign bond indices, and GDP, population, energy consumption and land area were used as fundamental variables. Subsequently, they claim that the noise-in-price hypothesis gains credibility by an asset class where equity size and value premiums are not relevant. Shepherd (2011) confirms that the outperformance of fundamental indexes is ought to price corrections by comparing corporate US cap-weighted indices to their RAFI fundamentally weighted counterparts. De Jong and Wu (2014) extend the research to sovereign European bond markets and by solely using GDP to reweight the respective cap-weighted indices they find an 29bps annual outperformance of the fundamental index at the 95% confidence level.

Other than the Noisy Market Hypothesis, the outperformance of valuation-indifferent fixed income indices is also explained by Siegels' (2003) "bums problem". His theory follows the assumption that market cap weighted debt indices are going to underperform in the long run because they overweight debt loaded countries. This can be also provided as an explanation to why the outperformance of valuation indifferent bond indices can be mainly seen in times of financial distress when looking at the results of Shepherd (2011), De Jong (2014) and Bolla (2017).

Given that providers have already started offering fundamental government bond indices, such as the Citi RAFI Index series and the LOIM Global Government Index, the question of whether such a weighting strategy provides an investor a significant alpha is becoming increasingly important.

An opponent of the application of fundamental indexing in government bond markets, Bolla (2017) confirms the outperformance of several sovereign bond fundamental indexing approaches but finds that fundamental index returns are significantly exposed to various risk factors. More specifically, by including fixed annual transaction costs in the study, she provides evidence that the outperformance of fundamental indexation is explained by its exposure to the common risk factors of term, duration, convexity, liquidity and a carry trade portfolio.

Arnott et. al's (2010) study received recent criticism by Piljak and Swinkels (2017). By covering local currency Developed and Emerging market sovereign bonds and USD denominated Emerging and Frontier market sovereign bonds, their single-factor model results show significant positive excess returns for their Developed markets sample, but a significant exposure of this outperformance to standard equity and currency market factors. They conclude that the fundamental indices do not provide superior risk-return characteristics when compared to cap-weighted indices for local currency government bond markets and for currency-hedged local currency government bonds. (See Appendix A for a summary of Arnott et. al's (2010), Bolla's (2017) and Piljak & Swinkels' (2017) results)

1.3 The scope of this paper

The government bond indices covered in the analysis include: (1) local currency Developed market bonds, (2) local currency Emerging market bonds and (3) USD denominated Frontier market bonds. The theoretical framework behind fundamental indexation is tested by (1) Analyzing 3 markets with varying bid-ask spreads to test the validity of the noise-in price theory (2) Testing the applicability of fundamental indexation in a hedged and unhedged setting for Developed and Emerging markets (3) Providing information on the transaction cost difference between the two weighting methods through a portfolio rebalancing transaction cost model (4) Regressing the fundamental index returns against Fama and French's (1992) term risk and default risk bond factors and a carry trade portfolio.

The findings of this research suggest that (1) There is no pattern of outperformance/ underperformance as we move towards higher-bid-ask spread markets (2 and 4) In a single factor model setting, significant excess returns are present for fundamental indices over their market-weighted counterparts in the unhedged local currency Developed market bond sample and partly in the unhedged local currency Emerging market bond sample. For the Developed and Emerging market sample, the fundamental index returns are in majority significantly exposed to all three factors of term risk, default risk and the carry trade portfolio. Only the population and energy fundamental indices from the Emerging market sample retain their significantly positive alpha after the inclusion of the factors in the regression. The hedged sample for Developed markets shows significant underperformance

against its market-weighted counterpart when regressed against the abovementioned risk factors. Similarly, there is an overall decline in the alpha coefficients of the hedged Emerging market sample when the risk factors are taken into account. (3) The transaction cost difference between the two weighting methods varies between 0bps and 3bps with GDP, Energy and Trade Value being the fundamental categories with the highest annual turnover.

2. Data

2.1 Country Indices for Developed, Emerging and Frontier markets

Starting from the local currency Developed and Emerging market bonds, all the country indices are sourced from Merrill Lynch's "G0" series in USD, both in hedged and unhedged terms. Unhedged returns are converted into a given base currency (USD in this case) as follows:

$$CRR = \frac{FX_n}{FX_0} - 1$$

$$TRR_{converted} = [(1 + TRR_{local}) \times (1 + CRR)] - 1$$

Source: BoFA Merrill Lynch Bond Index Guide – 23 March 2016

Where:
CRR = currency return
FX_n = end-of-period FX rate (stated in terms of the number of units of the base currency per one unit of the currency of denomination of the bond)
FX_0 = beginning-of-period FX rate (stated in terms of the number of units of the base currency per one unit of the currency of denomination of the bond)
$TRR_{converted}$ = total return of the bond converted into the base currency unhedged
TRR_{local} = local total return of the bond

Instead of directly employing interest rate parity to calculate the difference between the forward exchange rate and the spot exchange rate, the currency hedged index returns hedge against currency fluctuations using 1-month forward contracts at market rates and hedging 100% of the index's market value. Hence, although interest rate differentials still play a role in explaining forward premiums, they are not always 100% based on them given

the existence of the Forward Premium Puzzle (Bansal & Dahlquist 2000). The returns are calculated as follows:

$$CRUTRR = CRR \times (1 + TRR_{local})$$

$$FCR = \frac{FWD_0}{FX_0} - 1$$

$$HR = H_{pct} \times (\mathrm{FCR} - \mathrm{CRR})$$

$$TRR_{hedged} = TRR_{local} + CRUTRR + HR$$

$$HIV_n = HIV_0 \times (1 + TRR_{hedged})$$

Source: BoFA Merrill Lynch Bond Index Guide – 23 March 2016

Where:
CRUTRR = currency return on unhedged local total return
FCR = forward contract return
FWD$_0$ = beginning-of-period forward rate (stated in terms of the number of units of the base currency per one unit of the currency of denomination of the bond)
HR = hedge return
H$_{pct}$ = percentage hedged
TRR$_{hedged}$ = total return hedged into the base currency
HIV$_n$ = closing hedged index value on day n
HIV$_0$ = closing hedged index value on prior month-end

The "G0" series country indices include bonds with at least 18 months to maturity at point of issuance, at least one year remaining to final maturity, a fixed coupon schedule and a varying minimum amount outstanding per country. In addition, the exclusion of bills, inflation-linked debt and strips also makes the between-country comparison more admissible since not all countries in the dataset issue such securities. The market weighted and fundamental indices are constructed based on Merrill Lynch's "Developed Markets Sovereign Bond Index (WSAV)" and "Emerging Markets Sovereign Bond Index (WSBV)" for Developed and Emerging markets respectively. In this way, this study benefits from the inclusion and exclusion criteria of the provider.

As for the USD denominated Frontier market bonds, all the country indices used are acquired from Merrill Lynch's "GD" series. The "GD" series country indices include bond indices that are a subset of the "BofA Merrill Lynch Emerging Markets External Sovereign Index", which contains Emerging market sovereign securities denominated in US dollars. Qualifying for inclusion requires a security to have at least 18 months to final maturity at the

time of issuance, at least one year remaining term to final maturity at the time as of the rebalancing date, a fixed coupon schedule and a minimum outstanding debt of 250 million USD. For Frontier markets, JP Morgan's "Next Generation Markets (NEXGEM)" country inclusion guidelines are used because BofA does not offer a Frontier markets index. The construction of the Frontier market indices is based on JP Morgan's country list at its launch on December 2011. Due to the index's recent launch and 10 years of backfill, the given returns can be prone to survivorship bias. However, this does not pose a major limitation given that this study focuses on the comparison of two weighting schemes and not in total returns. The same provider (BofA ML) is used for all the country indices at hand for the sake of comparability. Since different providers use varying criteria to include a bond in a country index, this paper considers important that all the bond indices examined follow the same inclusion criteria (see Appendix B for additional descriptions and factsheets of the mentioned indices).

Adjustments to the inclusion/exclusion of a few countries are made if (1) a country is included in two different market indices (Eg. Poland included in both the WSAV and WSBV- in which case they are placed in an index according to their risk rating on 31 May 2016) (2) a country with a high weighting has varying classification through the sample period (Eg. Argentina changed classification between EM to Frontier multiple times within the 2000-2016 period) (3) the index provider used does not offer bond indices of the country (Eg. Ethiopia government bond index not available in the ML index database but is part of NEXGEM).

Market data for all the index members has also been retrieved from Merrill Lynch on a monthly basis, including total returns, yields, years to maturity and bond ratings. Descriptive statistics of the data is given on Tables 1a, 1b and 1c for the Developed, Emerging and Frontier market country indices respectively. This study covers a worldwide scope of 29, 23 and 26 countries for Developed, Emerging and Frontier markets respectively. The issuers with the largest weightings are the US and Japan in the Developed markets, China and India in the Emerging Markets and El Salvador and Sri Lanka in the Frontier markets. The time periods covered in each index range from Jan 1990 to May 2016 for local currency Developed markets, Jun 2000 to May 2016 for local currency Emerging markets and July

2002 to May 2016 for USD denominated Frontier markets. That said, the inclusion date of a country within the index is based on the country index's launch date rather than the inclusion date in the market weighted index of the provider. Although using this approach could oppose certain criteria of inclusion (due to a bond risk rating change within the period), the layout of this research prioritizes a larger sample as it considers important testing the validity of fundamental indexation in different stages of the business cycle. The importance of this point can be understood after looking at the analyses of De Jong (2014) and Bolla (2017), which showed fundamental indices mainly outperforming their market-weighted counterparts during periods of economic recession. Except the longer time horizon, this method has the advantages of (1) a more diversified portfolio and (2) a lower turnover, making it more practically applicable (3) a lower possibility for survivorship bias. On the other hand, other practical limitations of this method that should be considered are (1) the fact that a country's debt might not be investible at the time and (2) ignores the manager's activity to remove a country from an index to adjust it to the client's risk-taking needs.

Table 1a: Local currency Developed market bond indices descriptive statistics since inception until May 2016

Country	Ticker	Inception Date	Rating	Monthly Return	Monthly Return H	StDev	StDev H	Maturity	Yield	Market Cap ($m)
Australia	G0T0	31/12/1985	AAA	0.81	0.48	3.60	1.39	5.83	5.24	74188
Austria	G0H0	31/08/1996	AA1	0.43	0.51	3.04	1.17	7.88	3.31	154891
Belgium	G0G0	31/01/1991	AA2	0.56	0.57	3.13	1.23	7.57	3.66	243144
Canada	G0C0	31/12/1985	AAA	0.66	0.56	2.57	1.44	9.33	3.97	204300
Cyprus	G0CY	31/07/2009	B1	0.15	0.26	6.82	5.56	4.67	7.81	2722
Denmark	G0M0	31/05/1989	AAA	0.67	0.54	3.06	1.35	7.40	3.62	83560
Finland	G0K0	31/08/1996	AA1	0.41	0.49	2.96	0.99	5.94	3.12	60519
France	G0F0	31/12/1985	AA2	0.71	0.57	3.15	1.20	7.98	3.52	659505
Germany	G0D0	31/12/1985	AAA	0.63	0.52	3.22	1.03	6.95	3.26	678308
Greece	G0GR	31/12/1997	CCC2	0.76	0.69	8.10	6.88	9.47	8.63	115358
Ireland	G0R0	31/05/1988	A2	0.67	0.61	3.75	2.07	7.87	4.60	46586
Israel	G0IS	31/12/2002	A1	0.82	0.43	2.79	1.07	5.59	4.28	33874
Italy	G0I0	30/11/1987	BBB2	0.65	0.60	3.52	1.43	7.10	4.63	695761
Japan	G0Y0	31/12/1985	A1	0.57	0.55	3.60	1.08	7.10	1.07	2700456
Latvia	G0LV	31/01/2014	A3	0.11	0.80	2.67	1.48	7.30	1.22	2507
Lithuania	G0LT	31/12/2014	A3	-0.16	0.34	2.82	1.25	5.81	0.51	3146
Luxembourg	G0LU	31/12/2008	AAA	0.21	0.42	2.89	0.98	6.11	1.53	5697
Netherlands	G0N0	31/12/1985	AAA	0.65	0.54	3.21	1.09	7.56	3.42	202021
New Zealand	G0Z0	31/12/1986	AA1	0.88	0.46	3.58	1.14	5.17	5.63	17802
Poland	G0PL	31/12/1997	A2	0.84	0.51	4.72	1.62	4.57	7.10	63630
Portugal	G0U0	30/09/1993	BB1	0.61	0.57	3.96	2.59	6.24	5.20	68330
Slovakia	G0SL	31/12/2003	A1	0.69	0.51	3.40	1.24	6.53	3.20	20638
Slovenia	G0SV	31/12/2007	BBB1	0.34	0.55	4.19	2.22	7.22	3.60	13483
South Korea	G0SK	30/06/2000	AA2	0.56	0.46	3.73	1.12	5.54	4.34	203074
Spain	G0E0	31/05/1992	BBB1	0.52	0.55	3.50	1.52	7.31	4.42	356517
Sweden	G0W0	31/07/1987	AAA	0.63	0.55	3.31	1.34	6.53	3.88	76633
Switzerland	G0S0	31/12/1985	AAA	0.63	0.51	3.51	1.03	8.05	2.15	48634
UK	G0L0	31/12/1985	AA1	0.72	0.53	3.24	1.77	11.68	4.39	632358
US	G0Q0	31/12/1980	AAA	0.57	0.57	1.37	1.37	8.16	3.66	3144461

Source: Merrill Lynch ML Index Database, Bloomberg

Note: The Return, Maturity, Yield and Market Cap statistics are calculated as averages of each country index since its inception. The standard deviation of the index's return is also calculated since inception. The Rating corresponds to the country index's risk rating on the 31st of May 2016, as seen in the ML index database (based on an average of Moody's, S&P and Fitch). Greece, Poland, South Korea and Poland were in the past included in the index but no longer are. Their inclusion was decided based on the Developed markets classification list provided by the FTSE, the S&P and the MSCI. Norway was excluded from the index due to its temporary unavailability in the ML index database.

Table 1b: Local currency Emerging market bond indices descriptive statistics since inception until May 2016

Country	Ticker	Inception Date	Rating	Monthly Return	Monthly Return H	StDev	StDev H	Maturity	Yield	Market Cap ($m)
Brazil	G0BR	31/12/2005	BB2	0.86	0.40	5.46	1.67	3.57	12.25	113835
Chile	G0CL	31/12/2009	AA3	0.20	0.23	3.26	1.02	5.68	4.99	9746
China	G0CN	31/12/2004	AA3	0.56	0.43	1.17	1.06	8.48	3.37	610744
Colombia	G0CO	31/12/2010	BBB1	-0.10	0.33	4.91	1.45	6.33	6.40	55348
Czech	G0CZ	31/12/1997	AA3	0.83	0.57	3.96	1.18	5.89	3.96	25342
Egypt	G0EG	31/12/2010	B3	0.46	-0.84	2.65	2.33	3.82	14.29	41717
Hong Kong	G0HK	30/06/2000	AA1	0.26	0.30	0.95	0.92	4.00	1.84	9081
Hungary	G0HU	31/12/1997	BB1	0.67	0.37	5.91	1.95	4.87	6.81	32056
India	G0IN	31/12/1998	BBB3	0.40	0.19	3.02	1.59	10.20	7.64	358742
Indonesia	G0ID	31/12/2004	BBB3	0.79	0.63	5.95	3.52	10.04	9.25	47628
Malaysia	G0MY	31/12/2005	A2	0.30	0.23	2.69	0.82	5.90	3.65	104863
Mexico	G0MX	31/12/2001	A3	0.41	0.41	3.77	1.56	7.99	6.88	93967
Morocco	G0MA	31/12/2010	BBB3	0.25	0.13	2.15	0.63	6.17	3.93	26719
Nigeria	G0NG	31/12/2011	B1	0.82	0.12	4.11	3.36	7.29	13.44	18810
Peru	G0PE	31/12/2011	A3	0.13	0.15	3.54	2.56	13.68	5.72	12376
Philippines	G0PH	31/12/2004	BBB2	1.10	0.78	3.18	2.07	8.73	6.14	41963
Romania	G0RO	31/12/2011	BBB3	0.31	0.43	3.15	0.79	3.74	4.16	16409
Russia	G0RU	31/12/2005	BBB3	0.15	0.11	6.61	2.82	6.94	8.17	48211
Singapore	G0SP	30/06/2000	AAA	0.41	0.27	2.18	1.02	6.45	1.91	46739
South Africa	G0SA	31/12/1997	BBB2	0.38	0.25	5.90	2.05	9.86	8.23	64739
Thailand	G0TH	31/12/2002	A3	0.54	0.29	2.59	1.68	8.06	3.64	58761
Turkey	G0TR	31/12/2004	BBB3	0.55	0.26	5.50	2.33	3.31	12.11	50501
Vietnam	G0VN	30/09/2014	BB3	0.18	0.15	1.20	0.67	4.62	5.76	17704

Source: Merrill Lynch ML Index Database, Bloomberg

Note: The Return, Maturity, Yield and Market Cap statistics are calculated as averages of each country index since its inception. The standard deviation of the index's return is also calculated since inception. The Rating corresponds to the country index's risk rating on the 31st of May 2016, as seen in the ML index database (based on an average of Moody's, S&P and Fitch). The countries excluded from the original index (WSBV) and kept in the (WSAV) are South Korea, Poland and Israel. Their market classification was decided based on the Emerging market lists provided by the FTSE, the S&P and the MSCI. Taiwan was removed because it was not available as a separate country in the World Bank database.

Table 1c: USD Frontier market bond indices descriptive statistics since inception until May 2016

Country	Ticker	Inception Date	Rating	Return (monthly)	StdDev (monthly)	Maturity	Yield	Market Cap ($m)
Angola	GDAO	31/08/2012	B2	0.49	2.72	5.67	6.51	1253
Armenia	GDAM	01/04/2014	B1	0.37	2.13	6.67	6.41	879
Belarus	GDBY	01/08/2010	B3	0.92	4.86	3.50	9.59	1417
Belize	GDBZ	01/12/2012	CC	1.07	6.80	22.79	9.27	361
Bolivia	GDBO	01/10/2010	BB3	0.66	1.98	8.53	5.02	916
Costa Rica	GDCR	01/07/2002	BB2	0.56	2.06	8.37	5.72	1615
Dominican Rep.	GDDO	01/09/2001	BB2	0.97	4.85	9.53	8.58	2506
Ecuador	GDEC	01/02/1995	B3	0.79	7.32	11.55	11.33	2165
El Salvador	GDSV	01/04/2004	B1	0.64	3.71	17.10	7.25	3742
Gabon	GDGA	01/12/2007	B1	0.70	5.30	7.82	6.88	1152
Georgia	GDGE	01/04/2008	BB3	0.83	4.23	5.97	7.27	520
Ghana	GDGH	01/10/2007	B3	0.79	5.78	7.38	8.28	1279
Guatemala	GDGT	01/07/2002	BB2	0.69	2.24	11.92	6.15	1176
Honduras	GDHN	01/05/2013	B2	0.86	3.07	7.93	7.19	971
Iraq	GDIQ	01/01/2006	B3	0.79	5.22	16.79	8.85	2101
Ivory Coast	GDCI	01/03/1998	B1	-0.16	9.59	17.61	3.44	757
Jamaica	GDJM	01/05/2001	B3	0.98	3.27	11.75	8.69	2350
Kenya	GDKE	14/06/2014	B1	0.13	2.12	7.63	6.79	2637
Mongolia	GDMN	01/12/2012	B3	0.16	3.51	6.49	7.46	1362
Mozambique	GDMZ	01/04/2012	CCC3	-0.30	3.10	6.10	8.09	373
Pakistan	GDPK	01/12/1999	B2	1.06	4.48	6.93	10.49	1392
Paraguay	GDPY	01/01/2013	BB2	0.50	2.11	15.16	5.16	1207
Senegal	GDSN	01/05/2011	B1	0.70	2.95	8.01	7.01	744
Sri Lanka	GDLK	01/10/2007	B1	0.83	5.55	5.70	7.60	2798
Tunisia	GDTN	01/04/2002	B1	0.52	1.95	5.69	5.40	579
Zambia	GDZM	01/09/2012	B2	-0.10	4.14	9.10	7.93	1506

Source: Merrill Lynch Index Database, Bloomberg

Note: The Return, Maturity, Yield and Market Cap statistics are calculated as averages of each country index since its inception. The standard deviation of the index's return is also calculated since inception. The Rating corresponds to the country index's risk rating on the 31st of May 2016, as seen in the ML index database (based on an average of Moody's, S&P and Fitch). The countries excluded from the original index (NEXGEM) and kept in the (WSAV) include Vietnam and Egypt. Their market classification was decided based on the Frontier market lists provided by the FTSE, the S&P and the MSCI. Ethiopia is excluded due to its non-availability in the ML index database. Argentina is excluded due to its varying classification in the time period concerned and also JP Morgan's decision to remove the country from the index in January 2016 (http://www.reuters.com/article/us-argentina-index-jpmorgan-idUSKCN0V61E6).

2.1 Fundamental variables

The fundamental variables chosen to reweight the market capitalization weighted indices are similar to Arnott et al. (2010) with the introduction of one additional variable: (1) gross

domestic product (GDP), (2) the square root of land area, (3) population, (4) energy consumption and (5) global trade value which is defined by the imports plus the exports of a country and represents an alternative proxy to GDP. Its correlation with GDP for the countries included in the analysis is 0.900, 0.728 and 0.778 for Developed, Emerging and Frontier markets respectively. It can represent a variable which signifies the fundamental importance of a country in international trade. Taking into account gender inequality and working regulation differences especially between Frontier market countries, Labor Force was also considered as a proxy for population, but the correlation between Labor Force and Population was 0.998, 0.992 and 0.962 for Developed, Emerging and Frontier markets respectively – therefore making its separate analysis from population nugatory. All factor data is obtained from the World Bank database on a yearly frequency and covers the whole period of the analysis – 1985 to 2015 (for more details on the data extracted from the World Bank, see Appendix C). For the sake of comparability with Arnott et al. (2010)'s study, the fundamental weighting scheme will be based on 5 year rolling averages of the fundamental factors (See Appendix E for a graphical representation of the performance of each fundamental index).

The average weighting of each country through the sample period measured by the above fundamental factors is displayed in the Tables 2a, 2b and 2c for Developed, Emerging and Frontier markets respectively. It can be seen that the weights can greatly vary with the change of the fundamental weighting factor, giving credibility to the argument made by various academics that using one factor to measure economic size can lead to misleading results (Jalan 1982, Downes 1988 and Read 2001).

Table 2a: Developed market average country weights of fundamental indices

Country	Population	Area	Energy	GDP	Trade Value	Average	Market Value
Australia	2.2%	16.5%	2.3%	2.0%	1.8%	4.9%	0.7%
Austria	0.9%	1.6%	0.6%	0.9%	1.8%	1.2%	1.1%
Belgium	1.2%	1.0%	1.2%	1.1%	3.6%	1.6%	2.3%
Canada	3.4%	18.7%	5.3%	3.2%	5.1%	7.2%	2.4%
Cyprus	0.1%	0.5%	0.0%	0.1%	0.1%	0.2%	0.0%
Denmark	0.6%	1.2%	0.4%	0.8%	1.5%	0.9%	0.9%
Finland	0.6%	3.3%	0.7%	0.6%	0.9%	1.2%	0.5%
France	6.9%	4.4%	5.4%	6.5%	7.8%	6.2%	6.6%
Germany	9.2%	3.5%	7.5%	9.1%	12.9%	8.4%	7.1%
Greece	1.1%	2.0%	0.6%	0.6%	0.7%	1.0%	1.0%
Ireland	0.4%	1.6%	0.3%	0.4%	1.5%	0.8%	0.4%
Israel	0.7%	0.8%	0.4%	0.5%	0.7%	0.6%	0.2%
Italy	6.5%	3.3%	3.6%	5.4%	6.0%	4.9%	6.1%
Japan	14.2%	3.6%	10.5%	16.8%	9.0%	10.8%	25.1%
Latvia	0.2%	1.4%	0.1%	0.1%	0.1%	0.4%	0.0%
Lithuania	0.3%	1.4%	0.1%	0.1%	0.3%	0.4%	0.0%
Luxembourg	0.1%	0.3%	0.1%	0.1%	0.8%	0.3%	0.0%
Netherlands	1.8%	1.2%	1.6%	1.9%	5.4%	2.4%	2.2%
New Zealand	0.4%	3.1%	0.3%	0.3%	0.4%	0.9%	0.2%
Poland	4.0%	3.1%	2.0%	0.9%	1.3%	2.3%	0.4%
Portugal	1.1%	1.8%	0.5%	0.5%	0.8%	0.9%	0.5%
Slovakia	0.5%	1.2%	0.4%	0.2%	0.6%	0.6%	0.1%
Slovenia	0.2%	0.8%	0.1%	0.1%	0.3%	0.3%	0.1%
South Korea	4.9%	1.8%	4.3%	2.4%	4.1%	3.5%	1.2%
Spain	4.6%	4.1%	2.5%	3.0%	3.5%	3.5%	2.8%
Sweden	1.0%	4.0%	1.1%	1.2%	2.1%	1.9%	1.0%
Switzerland	0.8%	1.2%	0.6%	1.3%	3.0%	1.4%	0.5%
UK	6.7%	2.9%	4.7%	6.3%	8.0%	5.7%	5.7%
US	31.3%	18.4%	46.8%	36.6%	21.1%	30.8%	32.7%

Source: World Bank Database

Note: In the above table the average weight of a country in each fundamental index is shown. The average weight is calculated through the timeline covered by the index (Jan 1990 to May 2016), or since the country index's inception date, if launched after Jan 1990. Some indices might be temporarily withdrawn from the index and then rejoin it once they are re-launched due to a possible repayment of its total bond obligation. This implies that for several countries (mostly in the Frontier markets), part of the series will be equal to 0, adversely affecting the average weight but not entirely reflecting its fundamental factor.

Table 2b: Frontier market average country weights of fundamental indices

Country	Population	Area	Energy	GDP	Trade Value	Average	Market Value
Angola	4.1%	9.4%	3.8%	7.5%	11.7%	8.1%	2.6%
Armenia	0.5%	1.3%	0.7%	0.7%	0.8%	0.6%	1.4%
Belarus	2.0%	5.3%	8.4%	5.1%	10.2%	5.8%	4.4%
Belize	0.1%	1.2%	0.0%	0.1%	0.2%	0.1%	0.7%
Bolivia	1.9%	8.6%	1.9%	1.8%	2.1%	3.8%	1.8%
Costa Rica	1.2%	4.8%	1.7%	4.1%	5.6%	2.8%	6.7%
Dom. Republic	2.6%	4.7%	3.1%	6.1%	7.1%	4.1%	9.3%
Ecuador	3.9%	10.7%	4.8%	7.6%	6.9%	6.0%	13.9%
El Salvador	1.7%	3.1%	1.9%	3.2%	3.7%	2.2%	17.9%
Gabon	0.3%	7.3%	0.7%	1.5%	2.0%	1.9%	4.0%
Georgia	0.9%	3.7%	1.1%	1.2%	1.6%	1.2%	1.9%
Ghana	5.4%	7.0%	2.3%	2.9%	3.5%	3.8%	3.8%
Guatemala	3.7%	7.0%	3.6%	5.2%	5.3%	4.2%	5.5%
Honduras	1.4%	2.7%	1.3%	1.2%	2.1%	1.4%	1.8%
Iraq	7.1%	11.1%	11.6%	12.8%	16.2%	11.5%	8.4%
Ivory Coast	4.4%	7.6%	3.4%	2.5%	3.4%	3.8%	5.3%
Jamaica	0.7%	2.2%	1.6%	2.0%	3.1%	1.6%	11.0%
Kenya	7.4%	5.8%	5.1%	3.3%	2.7%	4.8%	4.2%
Mongolia	0.5%	10.1%	1.2%	0.7%	1.2%	3.9%	2.8%
Mozambique	4.4%	6.7%	2.6%	0.9%	1.4%	3.4%	1.5%
Pakistan	42.7%	18.6%	32.4%	20.8%	11.1%	25.6%	6.1%
Paraguay	1.2%	5.1%	1.3%	1.7%	2.5%	2.2%	2.1%
Senegal	2.7%	4.8%	1.1%	1.1%	1.3%	1.8%	1.8%
Sri Lanka	4.6%	3.7%	3.2%	4.8%	4.3%	3.6%	7.8%
Tunisia	3.1%	10.0%	4.1%	6.5%	9.9%	5.7%	5.2%
Zambia	2.7%	7.2%	2.3%	1.7%	1.9%	3.3%	2.8%

Source: World Bank Database

Note: In the above table the average weight of a country in each fundamental index is shown. The average weight is calculated through the timeline covered by the index (Jan 1990 to May 2016), or since the country index's inception date, if launched after Jan 1990. Some indices might be temporarily withdrawn from the index and then rejoin it once they are re-launched due to a possible repayment of its total bond obligation. This implies that for several countries (mostly in the Frontier markets), part of the series will be equal to 0, adversely affecting the average weight but not entirely reflecting its fundamental factor.

Table 2c: Emerging market average country weights of fundamental indices

	Population	Area	Energy	GDP	Trade Value	Average	Market Value
Brazil	5.2%	13.3%	5.1%	11.7%	4.4%	7.9%	5.5%
Chile	0.4%	3.6%	0.6%	1.3%	1.4%	1.5%	0.4%
China	36.2%	15.2%	45.3%	34.1%	26.9%	31.5%	32.2%
Colombia	1.2%	4.3%	0.6%	1.6%	1.0%	1.7%	2.1%
Czech Rep.	0.4%	2.7%	2.3%	2.5%	3.2%	2.2%	2.4%
Egypt	2.1%	4.0%	1.4%	1.2%	1.0%	1.9%	1.5%
Hong Kong	0.3%	0.3%	0.7%	5.0%	17.6%	4.8%	1.0%
Hungary	0.4%	2.9%	1.4%	1.9%	2.9%	1.9%	3.0%
India	47.5%	17.4%	25.5%	16.8%	7.2%	22.9%	31.8%
Indonesia	6.4%	6.8%	4.3%	4.0%	3.3%	5.0%	2.6%
Malaysia	0.7%	2.6%	1.5%	1.6%	4.4%	2.2%	5.4%
Mexico	4.1%	10.8%	6.7%	15.1%	10.5%	9.4%	6.3%
Morocco	0.8%	2.7%	0.3%	0.5%	0.7%	1.0%	1.0%
Nigeria	4.0%	3.8%	2.2%	1.9%	1.4%	2.7%	0.7%
Peru	0.7%	4.4%	0.3%	0.8%	0.7%	1.4%	0.4%
Philippines	2.4%	2.7%	0.9%	1.3%	1.7%	1.8%	1.9%
Romania	0.5%	1.9%	0.6%	1.0%	1.1%	1.0%	0.6%
Russia	3.9%	18.8%	14.6%	9.7%	7.6%	10.9%	2.6%
Singapore	0.2%	0.3%	1.2%	3.0%	13.3%	3.6%	4.7%
South Africa	2.0%	10.6%	6.3%	4.7%	3.1%	5.3%	8.3%
Thailand	2.3%	4.9%	3.3%	3.0%	5.1%	3.7%	4.1%
Turkey	1.9%	4.3%	2.1%	5.0%	3.7%	3.4%	2.7%
Vietnam	2.1%	2.2%	1.0%	0.7%	1.9%	1.6%	0.6%

Source: World Bank Database

Note: In the above table the average weight of a country in each fundamental index is shown. The average weight is calculated through the timeline covered by the index (Jan 1990 to May 2016), or since the country index's inception date, if launched after Jan 1990. Some indices might be temporarily withdrawn from the index and then rejoin it once they are re-launched due to a possible repayment of its total bond obligation. This implies that for several countries (mostly in the Frontier markets), part of the series will be equal to 0, adversely affecting the average weight but not entirely reflecting its fundamental factor.

3. Methodology

3.1 Index-building

Fundamental indexation for bonds will be explained in an algebraic manner (Fisher et. Al 2015). Firstly, the weight of a country's bond index (W_i) is equal to the fundamental variable's value of that country (F_i) divided by the sum of all fundamental variable values of the countries included in the index.

$$W_i = \frac{F_i}{\sum_{i=1}^{N} F_i}$$

The return of the fundamental bond index (R_{FI}) is therefore equal to the sum of the country bond index weights multiplied by their respective total return.

$$R_{FI} = \Sigma_{i=1}^{N} \frac{F_{i,t-1}}{\Sigma_{i=1}^{N} F_{i,t-1}} \times R_{i,t}$$

The way this method differs from market capitalization weighting is that the fundamental variables (F_i) are replaced with the market value of a security and that the weight of a security changes along with its price (instead of changing yearly when fundamental factor values change).

In a similar way-doing as Arnott et. Al (2010), the five-year rolling averages of each country's fundamental factors will be used for building the index weights in order to promote stability in the index prices and in an effort to minimize transaction costs caused by high turnover. For example, for the year 1990, the fundamental factor average between 1985-1989 will be used. Likewise, the rebalancing frequency will be set to one year. Six fundamentally weighted indices will be created, one for each of the factors and one by taking the average country weight of all the 5 factors combined.

3.2 Transaction costs

Previous literature (Perold 2007) has noted how fundamental indexation does not closely reflect a passive investing method due to the additional transaction costs incurred when the index is rebalanced annually to reflect the fundamental factor changes.

Given that the "new country inclusion" transaction costs are shared between the two weighting methods, only the annual rebalancing transaction costs are of interest. The annual transaction costs will be estimated by first calculating the sum of the absolute weight changes in the annual rebalancing process (turnover) and then multiplying the result by an assumed markup:

$$TC = (\Sigma_{i=1}^{N} |\Delta w|) \times \mathrm{m}$$

Where:

TC = Total annual transaction cost

Δw = Country bond index weight change from Dec of year t to January of year t+1

m = Assumed mark-up representing bid-ask spread

The assumed markup aims to approach the bid-ask spread, while not taking into account brokerage costs, given that they are of little importance for institutional investors. The data for the bid-ask spreads for Developed and Emerging markets is drawn from the IMF study "Market Liquidity – Resilient or fleeting" (2015), while the bid-ask spread data for Frontier markets is sourced from Piljak and Swinkels' study "Frontier and Emerging government bond markets" (2015). A limitation of this method is that it treats buying and selling transactions equally. However, past studies follow similar methodologies for transaction cost models for portfolio rebalancing purposes (Yoshimoto 1994 and Fang, Lai, Wang 2006).

The assumed markups based on the bid-ask spread data in Appendix D are 0.25% for Developed markets, 0.50% for Emerging markets and 1.00% for Frontier markets. An illustration of the average annual transaction costs and turnover per market and per factor is given in Table 3. The average annual transaction costs are 0 bps for Developed markets, 1 bps for Emerging markets and 2 bps for Frontier markets. Through all categories, the highest turnover is expressed by the GDP and Trade Value indices and the lowest is expressed by the Area and Population indices. The results show that the transaction costs are indeed negligibly minor, implying that they do not greatly differ between the two weighting methods. Despite that, they will still be included in the analysis for the sake of comparability.

Table 3 - Average annual transaction costs and turnover per market and factor

Developed markets			Emerging markets			Frontier markets		
Indices	Turnover	Costs	Indices	Turnover	Costs	Indices	Turnover	Costs
Population	0.44%	0.00%	Population	0.40%	0.00%	Population	0.46%	0.00%
Area	0.01%	0.00%	Area	0.00%	0.00%	Area	0.02%	0.00%
GDP	2.41%	0.01%	GDP	3.89%	0.02%	GDP	2.86%	0.03%
Energy	0.65%	0.00%	Energy	1.97%	0.01%	Energy	1.74%	0.02%
Trade	1.65%	0.00%	Trade	3.71%	0.02%	Trade	3.17%	0.03%
Composite	1.03%	0.00%	Composite	2.00%	0.01%	Composite	1.65%	0.02%

Note: The calculation of the annual transaction costs and turnover excludes weight changes caused by inclusions, if the inception dates of the country indices coincide with the rebalancing date (1st of January). The turnover calculation entails the sum of the absolute weight changes of each country per year, with respect to the change of its fundamental factor. The annual turnover and transaction costs for the composite indices are calculated by the average of the annual transaction cots of the fundamental indices in the same year, in the same market.

3.3 Table construction

The monthly alphas, betas and T-statistics on tables 4 to 6 are calculated using a single factor model. The risk-free rate is taken from Fama and French's global factor database and the market return represents the market weighted counterpart of the fundamental index. The regression for the alpha calculation looks as following:

$$R_{FI} - r_f = a + \beta(R_m - r_f) + \varepsilon$$

The returns and standard deviations are calculated based on the annual return of the indices. The Sharpe ratio is calculated using the average excess return of the fundamental index over the risk-free rate (from the FF global factor database). The Tracking Error represents the standard deviation of the annual excess returns (R_E) and the Information Ratio (IR) represents the average annual excess return divided by the Tracking Error:

$$IR = \frac{\sum_{i=1}^{N}(R_E)}{N} \div \sqrt{\frac{\sum_{i=1}^{N}(R_E - \overline{R_E})}{N}} \quad where \;\; R_E = R_{FI} - R_m$$

3.4 Additional analysis

After comparing the results found for the indices at hand, three main pillars of additional analysis will be undertaken to test and explain the significance of the overperformance of the fundamentally built indices. Firstly, for the local currency indices, the theory will be tested in both a hedged and unhedged setting. This measure will put aside the effect of currency fluctuations and interest rate differentials. Secondly, the difference in the nature of the excess returns in each market will be commented on, since Arnott et al. (2008) have claimed through their noise-in-price model that small cap securities (defined as low- market capitalization stocks) are more likely to incur negative noise. As stated by Blume and Straughbaug (1983) (the incubators of the noise in price theory as referenced by Arnott et al. 2008) higher bid-ask spreads explained 50% of the size effect and a big part of the return derived from their noise-in-price model. Hence, if the market outperformance of the fundamental indices in the high bid-ask spread markets is relatively higher, the noise-in-price theory will be confirmed. Thirdly, after receiving the results from the above analyses, the fundamental indices will be regressed against the Fama and French bond factors term risk and default risk (Fama and French 1996) including a carry factor to test how much of the return can be explained by common risk factors.

The first factor is TERM, a proxy for the risk that arises from unexpected interest rate changes (calculated by the difference between the BofA ML 10+ Year Global Government Index (W9G1) and the one-month US Treasury bill sourced from the FF database). The return on the 1-month US Treasury Bills, can be explained as the general level of expected returns for bonds, so the difference between the actual bond returns the following month reflects the deviation of long term bond returns from expected bond returns due to unexpected interest rate changes.

The second term is DEF, or default risk, as a proxy for changes in economic conditions (calculated by the difference between the Global Government Bond Index II (W0G1) and the BoFA ML Global Corporate Index (G0BC)). A different government bond index is chosen here than in the case of the TERM factor because of the similar maturity and country inclusion between the W0G1 and G0BC and the unavailability of a direct corporate bond counterpart

of the W9G1 in the ML index database (See Appendix B for index description and factsheets). Given that shifts in economic conditions impact corporate bond default rates more than in government bonds, the change in the return spread between the two can be a reliable proxy to reflect different stages of a business cycle. These two indices are suitable for this factor because they both include local currency denominated debt and cover similar countries. In addition, they use the same bond inclusion criteria as the country indices analyzed in this study. A limitation of using these two indices to calculate the DEF factor is that the G0BC index only goes back until January 1997. Before that date, the BofA ML US Corporate Index (C0A0) is used as the corporate bond index, since before 1997 the factor only applies to the Developed market indices, which heavily weighted the US at the time (US average market capitalization weight of 43.0% between Jan 1990 and Dec 1996 vs 28.9% average weight between Jan 1997 and May 2016 in WSAV).

Given that this sample includes local currency bond indices, currency fluctuations can play an important part in the variation of returns. For this reason, the Deutsche Bank G10 Harvest Index (Bloomberg code: DBHVG10U) will be used as a carry factor to reflect the returns of a carry strategy. This index represents the return of being long in the 3 highest-yielding currencies while being short in the 3 lowest-yielding currencies within the G10 currency universe. The index is rebalanced quarterly and it uses the 3-month Libor rate to rank the currencies.

The abovementioned three factors constitute the following equation:

$$R_F - r_f = \ a + \beta(R_M - r_f) + tTERM + \ dDEF + cCAR + \varepsilon$$

4. Results

4.1 Index performance – single factor model

In tables 4 to 6, the results for all 3 fundamentally weighted portfolios are presented and compared to their market value weighted counterparts. Looking at the fundamentally

weighted composites of each market, the Developed markets section shows a significant monthly alpha of 5bps (85% confidence level), while the Emerging and Frontier indices show an insignificant 5bps and 2bps monthly alpha respectively. In terms of average annual excess returns, the Developed market fundamental composite expresses a 58bps annual excess return, while the Emerging and Frontier market fundamental composite indices show annual excess returns of 39bps and -13bps respectively.

Table 4a: Developed market fundamental indices - based on BofA ML WSAV (Jan 1990 - May 2016)

	Return	Standard Deviation	Sharpe Ratio	Alpha	T-statistic	Beta	Excess Return	Tracking Error	Information Ratio
Population	6.96	7.46	0.90	0.05	1.50	0.98	0.59	2.20	0.27
Area	7.50	9.00	0.81	0.10	1.42	0.93	1.13	4.38	0.26
Energy	6.74	6.50	1.00	0.07	3.05	0.84	0.37	1.98	0.19
GDP	6.58	6.89	0.92	0.03	1.36	0.95	0.21	1.62	0.13
Trade value	6.98	8.43	0.80	0.02	0.43	1.08	0.60	3.17	0.19
Composite	6.95	7.54	0.89	0.05	1.50	0.96	0.58	2.34	0.25
Market weighted	6.37	7.45	0.83	-	-	-	-	-	-

Note: In the above table, "Return" is calculated by taking the average of the index's annual return. "Standard Deviation" is calculated by calculating the standard deviation of the annual return of the index. "Sharpe Ratio" is calculated using the average annual excess return of the index over the risk free rate sourced from the FF database and "Standard Deviation". "Alpha", "T-statistic" and "Beta" is calculated using the single factor market model. "Excess Return", "Tracking Error" and "Information Ratio" are based on the difference between the return of the fundamental indices and the market weighted index.

Starting from the unhedged Developed market fundamental index in table 4a, the significant alpha (at the 85% confidence level) of a monthly 5bps expressed by the composite is mainly driven by the Energy and Area portfolios. All fundamentally weighted portfolios except Trade value and Area express a higher Sharpe ratio than the market composite. Likewise, all of the fundamental indices express positive annual excess returns and the composite shows a tracking error of 2.34 and an information ratio of 0.25. Given both the IR and Sharpe Ratio results, the fundamentally weighted indices can be interpreted as a risk-return superior choice against the market-weighted benchmark when adjusted for risk. As seen in Appendix A, the superiority of the Developed market fundamental indices in terms of Sharpe Ratio, Alpha and Excess Returns is in-line with Swinkels and Piljak (2017) and Bolla (2017). In addition, across both studies, Area seems to represent a very strong fundamental factor by

always ranking among the top 2 outperforming fundamental indices in terms of alpha and excess returns.

Table 4b: Developed market fundamental indices hedged - based on BofA ML WSAV (Jan 1990 - May 2016)

	Return	Standard Deviation	Sharpe Ratio	Alpha	T-statistic	Beta	Excess Return	Tracking Error	Information Ratio
Population	6.63	4.62	1.39	-0.01	-1.19	1.06	0.10	0.72	0.14
Area	6.64	5.33	1.20	-0.02	-1.09	1.08	0.10	1.32	0.08
Energy	6.52	4.75	1.32	-0.04	-1.80	1.10	-0.02	1.22	-0.01
GDP	6.58	4.54	1.40	-0.02	-1.62	1.08	0.04	0.82	0.05
Trade value	6.64	4.66	1.38	-0.02	-1.61	1.09	0.11	0.86	0.13
Composite	6.60	4.75	1.34	-0.02	-1.74	1.09	0.07	0.80	0.08
Market weighted	6.54	4.49	1.40	-	-	-	-	-	-

Note: In the above table, "Return" is calculated by taking the average of the index's annual return. "Standard Deviation" is calculated by calculating the standard deviation of the annual return of the index. "Sharpe Ratio" is calculated using the average annual excess return of the index over the risk free rate sourced from the FF database and "Standard Deviation". "Alpha", "T-statistic" and "Beta" is calculated using the single factor market model. "Excess Return", "Tracking Error" and "Information Ratio" are based on the difference between the return of the fundamental indices and the market weighted index.

Comparing table 4a with table 4b, results greatly differ in the hedged sample of the Developed market bonds. All fundamentally weighted portfolios show a negative alpha over their market weighted equivalent, with 4 out of 6 being significant at >85% confidence level. As for excess returns, the results are mixed, with the fundamentally weighted composite showing a 7bps annual excess return, which is notably lower than the 58bps annual excess return of the unhedged version of the composite index. In addition, the Sharpe Ratio of the market weighted portfolio is higher than all of its fundamentally weighted counterparts, standing at 1.40, and the information ratio of the fundamentally weighted composite stands very low at 0.08. The significance of the negative alphas as well as the lower IR and Sharpe Ratios, show that fundamental indexation in Developed markets underperforms in a local currency hedged setting, hinting that currency factors may play an important explanatory factor for the outperformance shown in table 4a.

Table 5a: Emerging market fundamental indices - based on BofA ML WSBV (Jun 2000 - May 2016)

	Return	Standard Deviation	Sharpe Ratio	Alpha	T-statistic	Beta	Excess Return	Tracking Error	Information Ratio
Population	8.32	6.77	1.21	0.11	1.70	0.92	0.88	2.49	0.35
Area	8.35	10.17	0.81	-0.04	-0.40	1.24	0.90	4.59	0.20
Energy	8.25	7.47	1.09	0.11	1.93	0.91	0.80	2.29	0.35
GDP	7.57	7.19	1.03	0.04	0.60	0.95	0.12	3.21	0.04
Trade value	6.69	5.96	1.10	0.03	0.52	0.82	-0.76	3.86	-0.20
Composite	7.83	7.24	1.06	0.05	0.94	0.97	0.39	2.40	0.16
Market weighted	7.45	7.52	0.97	-	-	-	-	-	-

Note: In the above table, "Return" is calculated by taking the average of the index's annual return. "Standard Deviation" is calculated by calculating the standard deviation of the annual return of the index. "Sharpe Ratio" is calculated using the average annual excess return of the index over the risk free rate sourced from the FF database and "Standard Deviation". "Alpha", "T-statistic" and "Beta" is calculated using the single factor market model. "Excess Return", "Tracking Error" and "Information Ratio" are based on the difference between the return of the fundamental indices and the market weighted index.

Moving to the Emerging market fundamental indices and starting from the unhedged ones in table 5a, although excess returns are present, they are significant at the 90% level only in the case of Population and Energy. Referring to the same two indices, they show fair annual excess returns of 88bps and 80bps respectively, with the composite standing at an excess return of 39bps over the market weighted index. This result is nearly in-line with Piljak and Swinkels' (2017) Emerging market unhedged sample, where Population and Energy also express relatively higher and significant alphas and a higher excess return. However, unlike Piljak & Swinkels' (2017) study, Argentina, a heavily weighted country, is not included in the sample so the results of this study can also act as a robustness check of their results. As for the Sharpe ratios, the fundamental indices are all risk-return superior except in the case of the Area index, which is ought to volatile Russia's heavy weighting in the specific fundamental factor. Although the energy and population fundamental indices come with the very high information ratios of 0.35 when compared to Developed markets (composite IR of 0.25), the rest of the Emerging markets fundamental indices are not superior to any Developed market fundamental category in terms of IR. Overall, these results come against Arnott et. al's (2010) sample of USD denominated Emerging market sovereign bonds, since they show significant outperformance in all categories at a 95% confidence level. This could be ought to the difference in the sample period (Jan 1997-Dec 2009 vs July 2000-May 2016)

and currency denomination (local currency vs USD) but still hints the unreliability of the strategy for Emerging markets.

Table 5b: Emerging market fundamental indices hedged - based on BofA ML WSBV (Jun 2000 - May 2016)

	Return	Standard Deviation	Sharpe Ratio	Alpha	T-statistic	Beta	Excess Return	Tracking Error	Information Ratio
Population	5.66	4.91	1.13	-0.01	-0.17	1.13	0.38	1.47	0.26
Area	5.28	5.36	0.96	0.01	0.22	0.96	0.00	2.94	0.00
Energy	5.54	4.78	1.13	0.03	0.94	0.96	0.26	2.07	0.12
GDP	5.44	4.54	1.17	0.05	1.52	0.90	0.16	1.69	0.10
Trade value	5.07	3.96	1.25	0.07	1.81	0.70	-0.20	1.88	-0.11
Composite	5.40	4.54	1.16	0.03	1.12	0.93	0.12	1.58	0.08
Market weighted	5.28	4.80	1.07	-	-	-	-	-	-

Note: In the above table, "Return" is calculated by taking the average of the index's annual return. "Standard Deviation" is calculated by calculating the standard deviation of the annual return of the index. "Sharpe Ratio" is calculated using the average annual excess return of the index over the risk free rate sourced from the FF database and "Standard Deviation". "Alpha", "T-statistic" and "Beta" is calculated using the single factor market model. "Excess Return", "Tracking Error" and "Information Ratio" are based on the difference between the return of the fundamental indices and the market weighted index.

Consistent with the results discussed in tables 4a and 4b, the overall performance of the indices has diminished when interest rate differences and currency fluctuations are taken into consideration, especially when looking at excess returns (composite of 12bps vs 39bps in unhedged sample). However, it's worthy to note the exception of the Trade Value and GDP indices, which showed improved results compared to their unhedged equivalents, possibly hinting how currency risk negatively affected these fundamental categories. No other fundamental category expresses significant outperformance, although excess returns remain positive in majority. As previously noted, the majority of the Information and Sharpe ratios stand at an inferior position than their unhedged equivalent, implying that fundamental indexation does not give a reliable and consistent edge to an Emerging markets local currency bond investor who hedges against currency risk.

Table 6: Frontier market fundamental indices - based on JPM NEXGEM (Jul 2002 - May 2016)

	Return	Standard Deviation	Sharpe Ratio	Alpha	T-statistic	Beta	Excess Return	Tracking Error	Information Ratio
Population	9.23	9.06	1.01	0.03	0.18	0.97	0.33	7.63	0.04
Area	8.43	8.06	1.03	-0.05	-0.44	0.96	-0.46	4.91	-0.09
Energy	8.85	8.36	1.05	0.04	0.27	0.89	-0.05	6.29	-0.01
GDP	8.78	7.95	1.09	0.03	0.32	0.88	-0.12	4.29	-0.03
Trade value	8.52	7.43	1.13	0.04	0.52	0.84	-0.38	4.20	-0.09
Composite	8.77	7.88	1.10	0.02	0.16	0.91	-0.13	5.19	-0.03
Market weighted	8.90	8.71	1.01	-	-	-	-	-	-

Note: In the above table, "Return" is calculated by taking the average of the index's annual return. "Standard Deviation" is calculated by calculating the standard deviation of the annual return of the index. "Sharpe Ratio" is calculated using the average annual excess return of the index over the risk free rate sourced from the FF database and "Standard Deviation". "Alpha", "T-statistic" and "Beta" is calculated using the single factor market model. "Excess Return", "Tracking Error" and "Information Ratio" are based on the difference between the return of the fundamental indices and the market weighted index.

Lastly, looking at the results of the USD denominated Frontier market bonds in table 6, all the fundamental indices have a better risk-return profile than the respective market-weighted index shown by their high Sharpe ratios. However, no clear inferences can be made from the data on the alphas of the Frontier market indices, as none of the fundamental categories expresses a significant outperformance/ underperformance. Although insignificant, the fundamental categories express in majority negative excess returns with Area reaching an annual -46bps. Given the negative excess returns, almost all information ratios also stand at a negative, although not indicating consistency due to their low value. An important reason of why the results shown above are largely insignificant is the lack of a larger sample, making this part of the results worthy to be revisited in the future.

4.2 Outperformance testing

To further scrutinize what causes excess returns, the fundamental indices of Developed and Emerging markets will be regressed against term, default and a carry trade portfolio along with their market weighted counterparts. These factors constitute the below equation:

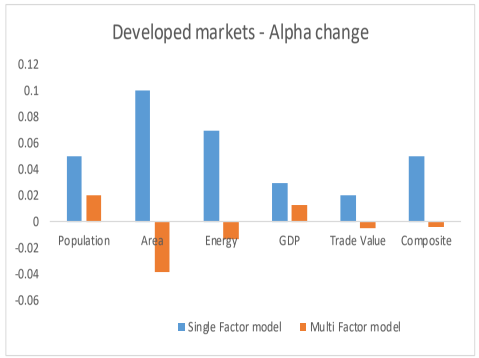
$$R_F - r_f = a + \beta(R_m - r_f) + dDEF + tTERM + cCAR + \varepsilon$$

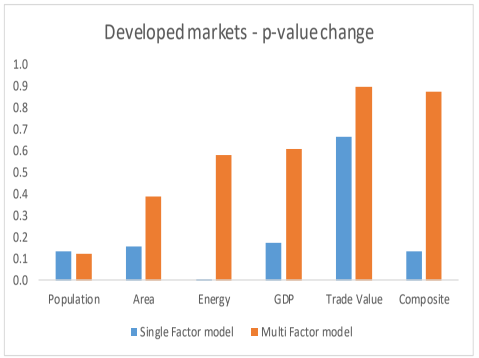
Table 7: Regression results of fundamental indices on common risk factors of term risk, default risk and carry trade risk

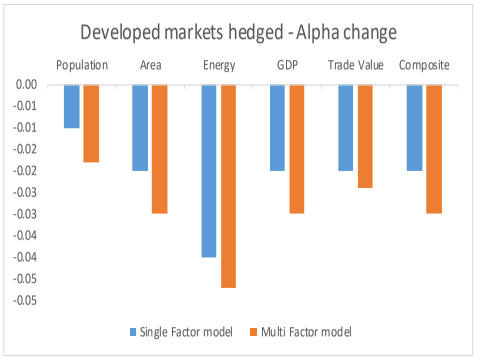
	Unhedged	Alpha	Beta	TERM	DEF	CAR	**Hedged**	Alpha	Beta	TERM	DEF	CAR
Developed markets	Population	0.020	1.129***	-0.097***	0.147***	0.101***	Population	-0.018*	0.801***	0.137***	0.012	-0.010**
		(0.1224)	(0.0000)	(0.0092)	(0.0040)	(0.0000)		(0.0938)	(0.0000)	(0.0000)	(0.5679)	(0.0483)
	Area	-0.038	1.289***	-0.160***	0.428***	0.259***	Area	-0.030	0.792***	0.149***	0.046	-0.019**
		(0.3921)	(0.0000)	(0.0022)	(0.0000)	(0.0000)		(0.1321)	(0.0000)	(0.0000)	(0.2603)	(0.0286)
	Energy	-0.013	0.727***	0.118***	0.123***	0.058***	Energy	-0.047***	0.518***	0.286***	0.018	-0.023***
		(0.5827)	(0.0000)	(0.0001)	(0.0095)	(0.0000)		(0.0047)	(0.0000)	(0.0000)	(0.5098)	(0.0027)
	GDP	0.013	1.018***	-0.479	0.100**	0.051***	GDP	-0.030**	0.692***	0.196***	-0.017	-0.015***
		(0.6101)	(0.0000)	(0.1854)	(0.0286)	(0.0021)		(0.0190)	(0.0000)	(0.0000)	(0.3928)	(0.0078)
	Trade value	-0.005	1.340***	-0.188***	0.174***	0.154***	Trade value	-0.024*	0.843***	0.136***	-0.015	-0.011*
		(0.9001)	(0.0000)	(0.0002)	(0.0053)	(0.0000)		(0.0601)	(0.0000)	(0.0000)	(0.4485)	(0.0688)
	Composite	-0.004	1.101***	-0.075**	0.194***	0.125***	Composite	-0.030**	0.729***	0.181***	0.009	-0.016***
		(0.8745)	(0.0000)	(0.0448)	(0.0004)	(0.0000)		(0.0117)	(0.0000)	(0.0000)	(0.7017)	(0.0075)
Emerging markets	Population	0.144**	0.995***	-0.071***	0.016	-0.056**	Population	0.214	1.185***	-0.068***	0.002	-0.007
		(0.0221)	(0.0000)	(0.0026)	(0.6740)	(0.0131)		(0.5157)	(0.0000)	(0.0030)	(0.9388)	(0.3487)
	Area	-0.076	1.120***	0.011	0.066	0.166***	Area	-0.045	0.921***	0.040*	0.162***	0.072***
		(0.4205)	(0.0000)	(0.7480)	(0.4577)	(0.0025)		(0.2606)	(0.0000)	(0.0655)	(0.0000)	(0.0000)
	Energy	0.113**	0.915***	-0.049**	-0.115*	0.056	Energy	0.021	1.185***	-0.068***	0.002	-0.007
		(0.0450)	(0.0000)	(0.0478)	(0.0989)	(0.1215)		(0.5157)	(0.0000)	(0.0030)	(0.9388)	(0.3487)
	GDP	0.016	0.874***	0.014	0.029	0.097***	GDP	0.012	0.860***	0.040***	0.063*	0.035***
		(0.7793)	(0.0000)	(0.5951)	(0.6381)	(0.0035)		(0.7020)	(0.0000)	(0.0032)	(0.0658)	(0.0040)
	Trade value	-0.028	0.677***	0.115***	0.019	0.112***	Trade value	0.016	0.586***	0.131***	0.049	0.025***
		(0.6342)	(0.0000)	(0.0006)	(0.7806)	(0.0000)		(0.6124)	(0.0000)	(0.0000)	(0.1997)	(0.0038)
	Composite	0.034	0.916***	0.004	0.003	0.075*	Composite	0.007	0.907***	0.227**	0.056**	0.031***
		(0.4861)	(0.0000)	(0.8452)	(0.9561)	(0.0590)		(0.8238)	(0.0000)	(0.0336)	(0.0367)	(0.0083)
Frontier markets	Population	0.022	0.782***	0.192**	0.675**	0.017						
		(0.8976)	(0.0000)	(0.0312)	(0.0238)	(0.8442)						
	Area	0.021	0.850***	0.015	0.167	0.053						
		(0.7816)	(0.0000)	(0.6802)	(0.2240)	(0.1931)						
	Energy	0.047	0.737***	0.116	0.482*	0.073						
		(0.7460)	(0.0000)	(0.1463)	(0.0885)	(0.3569)						
	GDP	0.052	0.788***	0.056	0.290	0.059						
		(0.5827)	(0.0000)	(0.2693)	(0.1056)	(0.2641)						
	Trade value	0.075	0.772***	-0.002	0.179	0.073*						
		(0.3426)	(0.0000)	(0.9532)	(0.1684)	(0.0943)						
	Composite	0.043	0.786***	0.075	0.359*	0.055						
		(0.6866)	(0.0000)	(0.1684)	(0.0736)	(0.3400)						

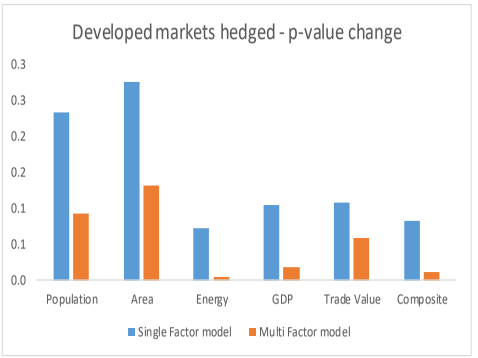
Notes: ***= significant at the 1% level, **= significant at the 5% level, *= significant at the 10% level. Exact p-value denoted below the coefficients. The table above reflects the multifactor regression results for all three different markets and a correlogram of the factors used. The monthly index returns minus the risk free rate are regressed on the term (TERM), default (DEF) and carry trade (CAR) risk factors. All regressions employ HAC standard errors. For Developed markets, the regression covers the time-frame between April 1993 and May 2016. For Emerging markets, the regression covers the returns of each fundamental index since its inception, namely June 2000 to May 2016. For Frontier markets, the regression covers the returns of each fundamental index since its inception, namely July 2002 to May 2016. See Appendix F for a correlogram of the independent variables used in the regression.

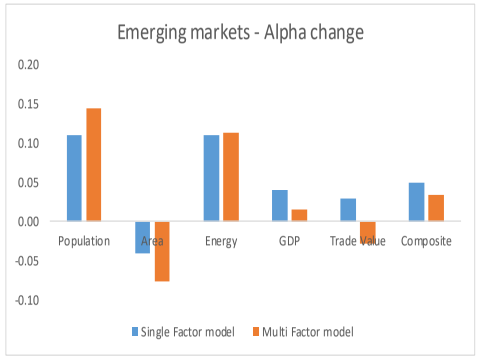
Table 8: Illustration of alpha change from the single-factor to the multi-factor model

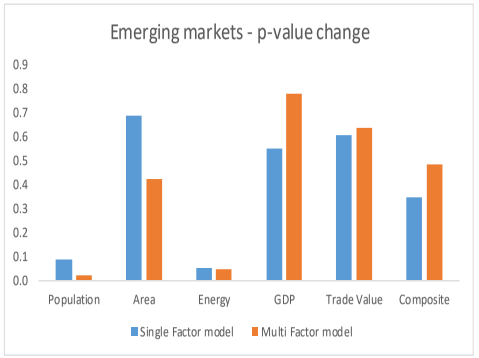


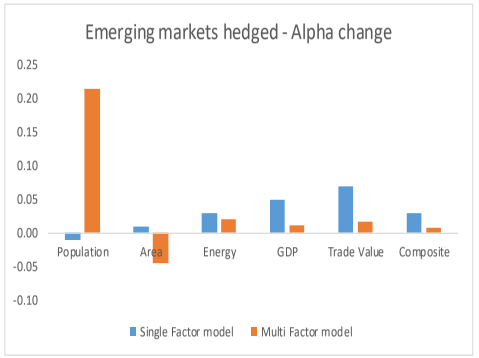


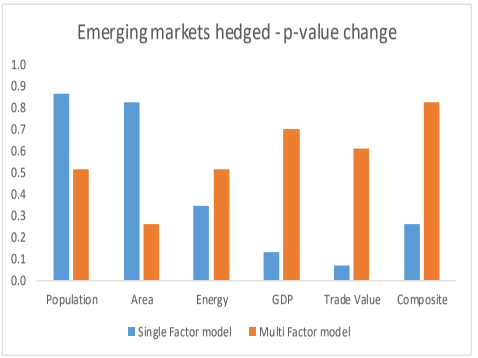


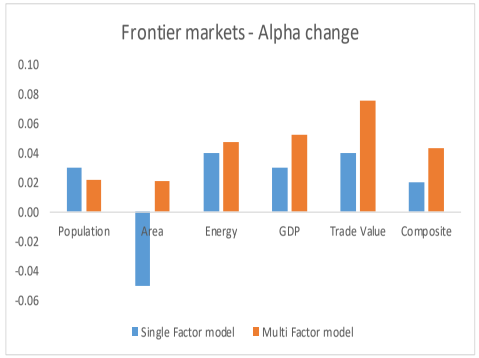


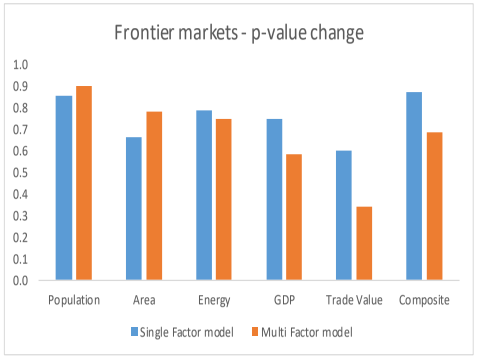












Note: In these tables, a clearer view of how the inclusion of the common risk factors affected the fundamental indices' alpha is reflected by showing their coefficient and p-value levels before (blue) and after (orange) their inclusion. Different scales focus on the are employed in each graph in order to directional difference rather than the numerical one.

In table 7, the relationship between the bond market risk factors TERM, DEF and CAR and the fundamental indices is shown. Starting off from the unhedged Developed market sample, it is seen that all three factors play a greatly significant role in explaining the previously seen excess returns and significant alphas, now being negative and insignificant. Also looking at table 8, almost every single fundamental index has a lower alpha with a higher p-value after the risk factors were included in the model. As for the alpha changes in the hedged version of the Developed market indices shown in table 8, all the fundamental index alphas show a lower and more significant value, confirming the fact that the fundamental indexing strategy is much less potent in a currency-hedged setting.

Looking at the Emerging markets sample in table 7, the population and energy indices' alphas were improved after the inclusion of the risk factors. Looking at Bolla's (2017) Initial risk factor regression results in Appendix A, the fundamental factors of population and energy were also the only ones that retained their positive and significant alphas (significant at the 10% level) after the inclusion of several risk factors. However, after including the factors of convexity and liquidity risk into her analysis, both the energy and population indices' alphas were not significantly different from 0. As far as the other 3 fundamental indices are concerned, the state of their alphas worsened both in terms of coefficient and significance, as seen in table 8. The hedged sample results of the Emerging markets show that all fundamental indices except population express a lower alpha in the multi-factor model when compared to the single factor model, while p-value results seem mixed, although still insignificant. In both Emerging market samples, the common risk factors are less potent in explaining the outperformance of fundamental indices when compared to the Developed market samples, but in majority, they still play a significant role in explaining the returns of these indices.

Lastly, in the Frontier markets, the returns of the fundamental indices do not seem to be greatly exposed to the common risk factors the analysis. Although the default factor is significant in 3 of the 5 fundamental indices, the other two factors show weak evidence in explaining the variation of the returns. The results in table 8 are also mixed, with most alphas still remaining insignificantly different from zero.

5. Conclusion

This paper contributes to existing literature on fundamental indexation in bond markets in four ways: (1) by examining differences in the strategy's potency in three different markets (2) by including transaction costs in the analysis (3) by testing the fundamental indexing strategy's performance for hedged bond indices and (4) by running the fundamental index returns against the Fama and French bond risk factors default risk and term risk, as well as the carry trade factor. Compared to the closely related studies of Bolla (2017) and Piljak and Swinkels (2017), this study contributes through the inclusion of a dynamic transaction cost model, the extension of the data to an alternative provider as well as different index compositions, the confirmation of their results through the use of strictly bond-related common risk factors and the reference and analysis of results from multiple studies on the topic.

Based on the four main points, and given the results: (1) The performance of the fundamental indexation strategy does not seem to improve in markets with higher bid-ask spreads. Shepherd (2012) clarifies that uncertainty about default risk and inflation rates are the primary source of inefficiencies that drive the outperformance of Fundamental indexation. In addition, Straughbaug (1983) claims that higher bid-ask spreads are an important factor that causes negative noise (and therefore future outperformance). Given that higher uncertainty about both macroeconomic and microeconomic factors is partly reflected through lower bond ratings and also seeing that the situation does not improve when the bid-ask spreads increase, the results of this study go against the noise-in price theory as formed by Straughbaug (1983) and Arnott et. al (2008). (2) By employing a portfolio rebalancing transaction model, it was found that transaction costs for government bond fundamental indices barely differ when compared to their market-weighted counterparts. (3) The performance of fundamental indexing diminishes when local currency bonds are hedged against currency risk, mainly seen by the significant negative alphas in the Developed markets results section. (4) After regressing the returns of the fundamental indices against common risk factors, it was found that Developed and Emerging market fundamental indices are significantly exposed to term risk, default risk and the carry trade

portfolio, although no such risk exposure was found in Frontier markets. Overall, although some significant outperformance is seen in the single factor model, a great majority of it disappears when common risk factors are added in the regression. This study therefore concludes that fundamental indexation does not provide an investor a consistent and significant alpha when employed in local currency government bond markets.

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7. Appendix

Appendix A – Results of papers relevant to this study

Bolla 2017 - Citigroup WGBI - Jan 1991 to Dec 2014

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	p-value
Population	6.50%	0.73%	6.63	0.58	2.02	0.86	0.04
Area	7.00%	1.22%	7.40	0.59	4.19	1.45	0.10
Energy	6.31%	0.54%	5.59	0.65	1.94	1.10	0.00
GDP	6.17%	0.40%	6.24	0.56	1.35	0.62	0.01
Composite	6.50%	0.72%	6.30	0.61	2.05	1.01	0.01
Market value	5.78%		6.62	0.47			

Piljak Swinkels 2017 - LC Investment grade sample - Barclays Global Treasury Index - hedged Jan 1987 - Dec 2015

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	6.20%	0.03%	3.30	0.89	0.80	0.01	0.09
Area	6.02%	-0.15%	4.06	0.68	2.07	-0.42	-1.08
Energy	6.16%	-0.01%	3.51	0.83	0.93	-0.20	-1.13
GDP	6.22%	0.05%	3.36	0.88	0.61	-0.06	-0.51
Composite	6.11%	-0.05%	3.53	0.81	1.07	-0.22	-1.07
Market value	6.17%		3.19	0.92			

Piljak Swinkels 2017 - LC Investment grade sample - Barclays Global Treasury Index - unhedged Jan 1987 - Dec 2015

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	6.79%	0.65%	7.03	0.50	2.43	0.75	1.64
Area	6.98%	0.84%	7.55	0.49	6.27	1.74	1.57
Energy	6.50%	0.36%	5.99	0.54	2.43	0.87	2.23
GDP	6.64%	0.50%	6.58	0.51	1.54	0.68	2.44
Composite	6.74%	0.60%	6.46	0.54	3.27	1.08	1.89
Market value	6.14%		6.81	0.42			

Piljak Swinkels 2017 - LC Emerging market sample - Barclays EM LGUI - hedged Jul 2008 - Dec 2015

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	3.14%	-0.31%	3.22	0.94	0.96	-0.78	-2.26
Area	2.01%	-1.44%	4.21	0.45	3.78	-0.51	-0.35
Energy	2.79%	-0.67%	2.66	1.01	1.37	-0.15	-0.29
GDP	3.33%	-0.12%	2.84	1.13	1.48	0.24	0.43
Composite	2.68%	-0.78%	2.98	0.86	1.85	-0.32	-0.45
Market cap	3.45%		2.72	1.23			

Piljak Swinkels 2017 - LC Emerging market sample - Barclays EM LGUI - unhedged Jul 2008 - Dec 2015

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	4.46%	1.21%	7.60	0.57	2.72	1.72	1.96
Area	1.14%	-2.12%	12.52	0.08	7.59	-2.70	-0.98
Energy	3.47%	0.21%	7.29	0.21	3.04	0.86	0.93
GDP	3.65%	0.39%	8.46	0.42	2.40	0.56	0.64
Composite	2.99%	-0.27%	8.87	0.32	3.55	-0.11	-0.08
Market value	3.25%		8.55	0.37			

Piljak Swinkels 2017 - USD Frontier market sample - JP Morgan NEXGEM - unhedged Jan 2002 - Dec 2015

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	10.45%	0.07%	10.83	0.84	5.95	2.26	1.61
Area	11.39%	1.00	10.88	0.92	5.03	2.87	2.44
Energy	10.88%	0.50	10.19	0.94	5.44	2.90	2.47
GDP	11.19%	0.80	11.03	0.89	4.21	2.37	2.40
Composite	10.87%	0.49	10.66	0.90	4.65	2.40	2.29
Market value	10.38%		12.62	0.72			

Arnott et. al 2010 - USD Emerging market sample - Merrill Lynch USD EM Sovereign Plus index - Jan 1997 - Dec 2009

	Return	Excess return	Volatility	Sharpe Ratio	Tracking Error	Alpha (annualized)	T-statistic
Population	11.24%	0.43	10.18	0.79	8.00	3.44	2.09
Area	13.10%	2.30	13.38	0.74	5.63	3.18	2.10
Energy	13.31%	2.50	13.28	0.76	7.87	4.04	1.95
GDP	11.47%	0.67	10.53	0.79	6.36	3.07	2.36
Composite	12.23%	1.43	11.72	0.77	6.64	3.38	2.14
Market value	10.80%		13.87	0.55			

Bolla 2017 - Initial risk factor regression

	Benchmark	Single factors				Multi factors	Equally weighted
	Market value weighted	GDP weighted	Population weighted	Land area weighted	Energy weighted	Composite weighted	
Annualized alpha	1.03%	1.35%	1.47%*	1.24%	1.29%*	1.36%*	1.42%
	(0.2879)	(0.1073)	(0.0772)	(0.1995)	(0.0725)	(0.0890)	(0.2142)
Market return	-9.17%***	-6.74%***	-4.01%**	6.56%***	-4.99%***	-2.48%	-2.10%
	(0.0000)	(0.0002)	(0.0359)	(0.0030)	(0.0019)	(0.1619)	(0.4267)
SMB	-4.75%	-5.01%	-4.42%	3.55%	-3.79%	-2.63%	-2.44%
	(0.1987)	(0.1446)	(0.1796)	(0.2422)	(0.1495)	(0.3669)	(0.6032)
HML	-1.42%	-0.41%	1.62%	5.13%*	0.10%	1.51%	6.53%*
	(0.6274)	(0.8683)	(0.5377)	(0.0627)	(0.9637)	(0.5292)	(0.0867)
TERM	52.48%***	51.07%***	50.08%***	51.31%***	54.64%***	51.71%***	46.14%***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DEFAULT	95.61%***	90.50%***	96.68%***	92.94%***	75.68%***	89.11%***	134.03%***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Adj. R square	66.15%	70.28%	72.14%	72.76%	74.72%	74.47%	70.39%
Paired t-test p-value	n/a	(0.2397)	(0.2417)	(0.7704)	(0.4620)	(0.3944)	(0.5549)

Notes: ***/**/* denotes significance at the 1% / 5% / 10% level. The table shows the multifactor regression results of the regression setting similar to Arnott et al. (2010). The monthly index returns minus the risk free rate are regressed on several risk factors: (1) the Fama and French equity market excess returns, (2) the Fama and French equity risk factor SMB (size), (3) the Fama and French equity risk factor HML (book to market), (4) the bond risk factor TERM and (5) the bond risk factor DEFAULT. The paired t-test investigates whether the difference between the abnormal return (alpha) of the indices (fundamentally and equally weighted indices) and the benchmark (market value weighted index) is significantly different from zero. The OLS regressions include a variance-covariance estimation based on Newey and West (1987) and are based on monthly data points. The regressions analyze the time period from January 1991 to December 2014 and use 288 data points for each setting. Values in brackets represent p-values.

Appendix B – Descriptions and factsheets of indices used (all sourced from the ML index database)

a) WSAV

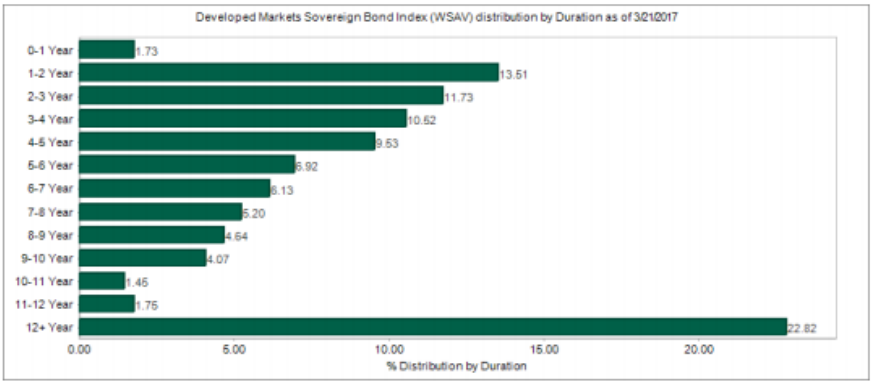
The BofA Merrill Lynch Developed Markets Sovereign Bond Index (WSAV)

The BofA Merrill Lynch Developed Markets Sovereign Bond Index is a subset of The BofA Merrill Lynch World Sovereign Bond Index including all securities with a country of risk that is a member of the FX G10, all Western European countries, and territories of the U.S. and Western European countries. The FX G10 includes all Euro members, the US, Japan, the UK, Canada, Australia, New Zealand, Switzerland, Norway and Sweden.

Index distribution by Duration	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	17	448,289.586	1.73437	0.91	0.02	0.39	1	-0.063	0.029
1-2 Year	137	3,490,982.419	13.50609	1.54	0.21	0.63	9	-0.050	0.056
2-3 Year	111	3,031,925.285	11.73007	2.53	0.30	0.77	12	-0.079	0.113
3-4 Year	95	2,718,300.482	10.51670	3.53	0.37	0.92	12	-0.156	0.105
4-5 Year	88	2,463,460.906	9.53076	4.49	0.43	1.03	19	-0.298	0.093
5-6 Year	74	1,788,978.072	6.92129	5.52	0.38	1.16	27	-0.442	0.119
6-7 Year	69	1,585,125.922	6.13262	6.47	0.40	1.19	23	-0.540	0.085
7-8 Year	59	1,343,297.236	5.19702	7.53	0.39	1.25	34	-0.576	0.150
8-9 Year	52	1,198,899.962	4.63837	8.49	0.39	1.20	27	-0.805	0.128
9-10 Year	49	1,052,987.521	4.07385	9.40	0.38	1.01	43	-0.937	0.134
10-11 Year	25	373,701.268	1.44579	10.49	0.15	1.26	52	-0.934	0.029
11-12 Year	25	453,017.284	1.75266	11.50	0.20	1.08	52	-1.067	0.164
12+ Year	257	5,898,498.189	22.82041	18.06	4.12	1.69	19	-1.373	0.008
Grand Total	**1,058**	**25,847,464.133**	**100.00000**	**7.74**	**7.74**	**1.12**	**20**	**-0.584**	**0.080**

Developed Markets Sovereign Bond Index (WSAV) - distribution characteristics as of 3/21/2017

Bank of America Merrill Lynch

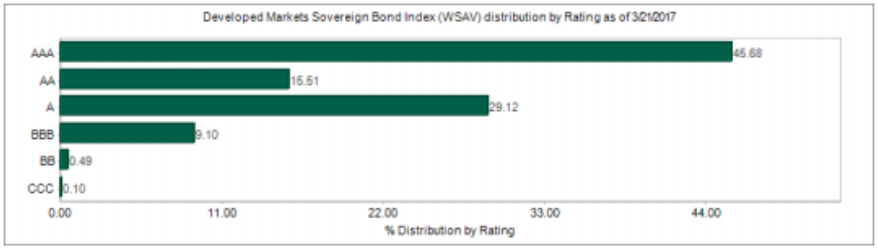


Index distribution by Currency	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
Australian Dollar	21	333,276.282	1.28940	6.28	0.08	2.49	-0	-0.230	-0.033
Canadian Dollar	34	337,237.509	1.30472	6.69	0.09	1.36	-1	-0.290	0.006
Danish Krone	8	97,206.268	0.37608	8.77	0.03	0.47	1	-1.776	0.042
Euro	376	6,423,633.599	24.85208	7.37	1.83	0.91	80	-1.385	0.255
Japanese Yen	274	7,382,493.409	28.56177	9.24	2.64	0.19	-0	-0.123	0.003
New Zealand Dollar	8	42,187.167	0.16322	5.06	0.01	2.69	-2	0.357	-0.007
Norwegian Krone	7	45,147.785	0.17467	5.05	0.01	1.17	-1	-0.222	-0.012
British Pound	41	1,704,274.570	6.59359	11.55	0.76	1.12	-2	-0.927	0.103
Swedish Krona	9	74,979.973	0.29009	6.52	0.02	0.41	0	-1.403	0.002
Swiss Franc	20	82,756.747	0.32017	11.84	0.04	0.14	0	-2.119	-0.028
U.S. Dollar	260	9,324,270.824	36.07422	6.19	2.23	1.94	-0	-0.335	0.025
Grand Total	**1,058**	**25,847,464.133**	**100.00000**	**7.74**	**7.74**	**1.12**	**20**	**-0.584**	**0.080**

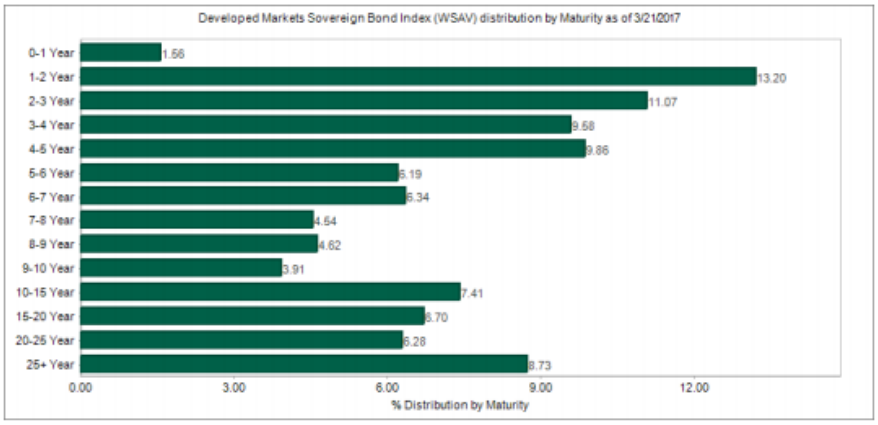
Developed Markets Sovereign Bond Index (WSAV) - distribution characteristics as of 3/21/2017

Bank of America Merrill Lynch

Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	434	11,806,458.077	45.67743	6.43	2.94	1.69	0	-0.521	0.027
AA	162	4,009,505.237	15.51218	9.45	1.47	0.88	27	-1.266	0.156
A	304	7,525,900.482	29.11659	9.21	2.68	0.20	1	-0.147	0.009
BBB	121	2,353,166.801	9.10405	6.78	0.62	1.41	143	-1.192	0.343
BB	16	126,316.300	0.48870	5.85	0.03	2.57	269	0.406	1.763
CCC	21	26,117.236	0.10104	8.65	0.01	7.63	732	-1.107	0.768
Grand Total	**1,058**	**25,847,464.133**	**100.00000**	**7.74**	**7.74**	**1.12**	**20**	**-0.584**	**0.080**



Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	15	403,611.417	1.56151	0.91	0.01	0.35	0	N/A	N/A
1-2 Year	134	3,412,247.901	13.20148	1.51	0.20	0.62	8	-0.049	0.054
2-3 Year	103	2,862,463.024	11.07444	2.46	0.27	0.75	12	-0.070	0.107
3-4 Year	85	2,477,356.398	9.58452	3.39	0.33	0.85	12	-0.156	0.090
4-5 Year	87	2,548,116.020	9.85828	4.29	0.42	1.02	16	-0.225	0.112
5-6 Year	70	1,599,245.890	6.18724	5.23	0.32	1.07	20	-0.423	0.075
6-7 Year	67	1,638,504.399	6.33913	6.10	0.39	1.24	27	-0.465	0.119
7-8 Year	47	1,173,331.879	4.53945	7.07	0.32	1.00	26	-0.578	0.100
8-9 Year	51	1,193,109.070	4.61596	8.02	0.37	1.09	31	-0.674	0.145
9-10 Year	47	1,011,553.041	3.91355	8.82	0.35	1.21	32	-0.719	0.158
10-15 Year	116	1,916,398.296	7.41426	10.61	0.79	1.14	43	-0.884	0.122
15-20 Year	83	1,731,818.447	6.70015	14.97	1.00	1.11	28	-1.019	0.020
20-25 Year	58	1,623,304.223	6.28032	16.77	1.05	2.20	25	-1.481	-0.011
25+ Year	95	2,256,404.128	8.72969	21.94	1.92	2.03	14	-1.752	0.003
Grand Total	**1,058**	**25,847,464.133**	**100.00000**	**7.74**	**7.74**	**1.12**	**20**	**-0.584**	**0.080**



b) WSBV

The BofA Merrill Lynch Emerging Markets Sovereign Bond Index (WSBV)

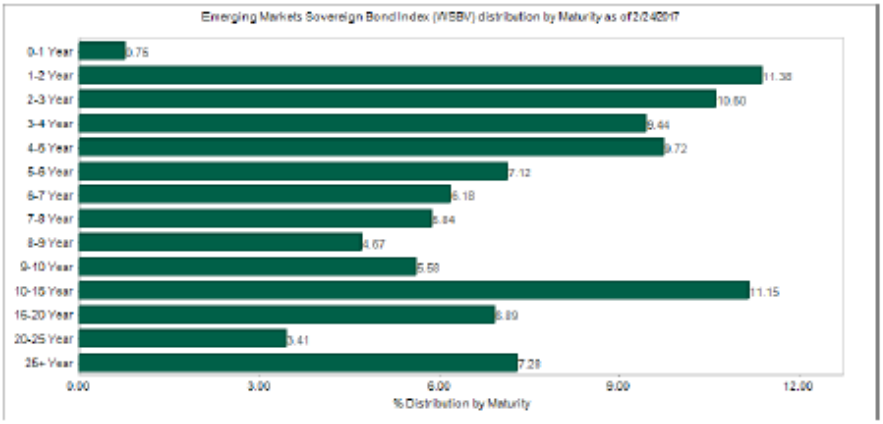
The BofA Merrill Lynch Emerging Markets Sovereign Bond Index is a subset of The BofA Merrill Lynch World Sovereign Bond Index excluding all securities with a country of risk that is a member of the FX G10, all Western European countries, and territories of the U.S. and Western European countries. The FX G10 includes all Euro members, the US, Japan, the UK, Canada, Australia, New Zealand, Switzerland, Norway and Sweden.

Inception date: December 31, 2005

The BofA Merrill Lynch World Sovereign Bond Index (WSOV)

The BofA Merrill Lynch World Sovereign Bond Index is designed to track the performance of sovereign debt publicly issued and denominated in the issuer's own domestic currency. In order to be included in the Index, a country (i) must have at least $10 billion (USD equivalent) outstanding face value of Index qualifying debt (i.e., after imposing constituent level filters on amount outstanding, remaining term to maturity, etc.); and (ii) must have at least one readily available, transparent price source for its securities. Qualification with respect to country size criteria is determined annually based on information as of June 30th, but does not take effect until September 30th. Conversion of local currency outstanding face value into USD terms is based on the average of the previous 12 month-end exchange rates up to and including the June 30th evaluation date. Euro sovereigns are treated as a group with respect to the minimum size requirement. To qualify as a Euro sovereign a country must be a Euro member as of the first of the month. For example, a country joining the EMU on January 1 would be treated as part of the Euro group for the December 31 rebalancing.

Index distribution by Currency	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
Brazilian Real	15	223,584.062	5.41703	3.05	0.17	9.82	-3	2.570	0.035
Chilean Peso	17	15,986.620	0.38733	5.69	0.02	3.87	3	0.400	-0.152
Col. Peso	13	58,503.260	1.41743	4.80	0.07	6.54	-1	0.320	0.001
Czech Koruna	16	42,260.008	1.02388	5.76	0.06	0.33	2	-1.017	-0.083
Egyptian Pound	53	36,428.546	0.88260	2.53	0.02	16.91	-3	2.567	-0.064
Hong Kong Dollar	36	11,444.893	0.27729	3.46	0.01	1.20	0	0.517	-0.020
Hungarian Forint	15	39,581.205	0.95898	4.20	0.04	1.74	-1	-0.042	-0.117
Indian Rupee	75	700,419.303	16.96987	6.43	1.09	7.16	1	-2.293	-0.031
Indonesia Rupiah	40	116,980.638	2.83423	6.15	0.17	7.66	-1	1.049	0.019
Israeli Shekel	13	60,166.015	1.45771	5.52	0.08	1.28	-1	0.277	0.052
South Korean Won	38	446,305.629	10.81317	7.49	0.81	1.97	-0	-0.010	-0.004
Mexican Peso	16	117,797.310	2.85401	5.40	0.15	7.18	-1	1.395	0.002
Moroccan Dirham	42	27,756.819	0.67250	5.26	0.04	2.90	-0	0.313	-0.093
New Turkish Lira	19	67,734.294	1.64108	3.26	0.05	10.62	1	1.278	0.003
Nigerian Naira	14	17,684.636	0.42847	4.00	0.02	16.15	3	1.420	-0.231
Pakistan Rupee	13	20,769.233	0.50320	3.13	0.02	6.70	0	0.443	-0.009
Peru Nuevo Sol	9	18,399.351	0.44578	7.91	0.04	5.89	0	0.155	0.086
Philippines Peso	46	73,395.936	1.77825	7.29	0.13	4.31	2	0.158	-0.139
Polish Zloty	18	97,382.545	2.35940	4.30	0.10	2.81	-0	0.354	0.001
Renminbi	154	1,241,142.924	30.07062	6.73	2.02	3.17	0	-0.027	-0.015
Malaysian Ringgit	72	128,612.229	3.11604	5.32	0.17	3.87	-2	0.590	0.001
Romanian Leu	10	19,305.551	0.46774	4.16	0.02	2.66	2	0.517	-0.121
Russian Ruble	23	55,861.838	1.35343	4.05	0.05	8.39	2	-0.175	0.050
Singapore Dollar	20	69,795.704	1.69102	6.45	0.11	1.78	0	1.011	-0.022
South African Rand	15	88,645.726	2.14772	7.37	0.16	8.95	-1	1.142	-0.062
Sri Lankan Rupee	41	19,733.192	0.47810	3.99	0.02	12.31	-5	0.390	0.027
Taiwanese Dollar	104	177,654.526	4.30424	9.28	0.40	1.09	-0	0.439	0.001
Thailand Baht	33	106,382.321	2.57745	8.43	0.22	2.58	1	0.538	0.120
Vietnamese Dong	84	27,713.440	0.67145	4.16	0.03	5.08	-1	1.202	-0.053
Grand Total	**1,064**	**4,127,427.755**	**100.00000**	**6.28**	**6.28**	**4.78**	**-0**	**-0.040**	**-0.013**

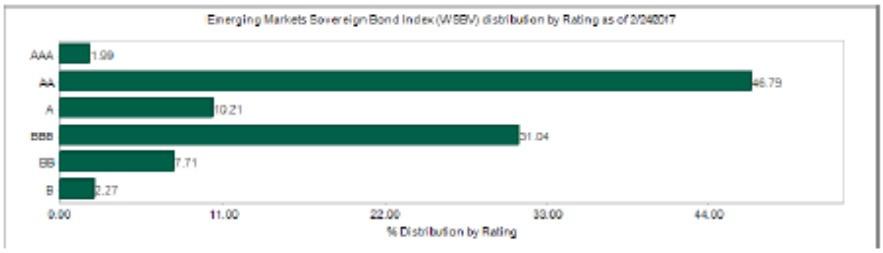


Index distribution by Duration	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	27	52,051.836	1.26112	0.71	0.01	4.62	1	0.445	0.070
1-2 Year	154	519,620.626	12.58945	1.48	0.19	4.73	-1	0.439	0.026
2-3 Year	143	476,744.424	11.55064	2.49	0.29	4.49	1	0.288	-0.034
3-4 Year	149	510,280.936	12.36317	3.46	0.43	4.66	0	0.405	-0.053
4-5 Year	102	435,695.540	10.55610	4.44	0.47	4.84	-1	0.341	-0.054
5-6 Year	89	411,240.426	9.96360	5.45	0.54	5.08	-0	0.363	0.073
6-7 Year	67	346,058.266	8.38436	6.49	0.54	5.41	-2	-0.325	0.202
7-8 Year	56	260,484.220	6.31105	7.57	0.48	4.95	1	-0.207	0.069
8-9 Year	56	280,314.128	6.79150	8.45	0.57	5.02	-1	-0.567	-0.046
9-10 Year	43	170,798.451	4.13813	9.53	0.39	5.98	-1	-0.712	-0.143
10-11 Year	30	144,993.902	3.51294	10.62	0.37	6.15	2	-0.825	0.090
11-12 Year	26	91,118.808	2.20764	11.46	0.25	4.64	1	-2.010	-0.209
12+ Year	122	428,026.191	10.37029	16.79	1.74	3.25	2	-0.489	-0.115
Grand Total	**1,064**	**4,127,427.755**	**100.00000**	**6.28**	**6.28**	**4.78**	**-0**	**-0.040**	**-0.013**

Emerging Markets Sovereign Bond Index (WSBV) - distribution characteristics as of 2/24/2017

Bank of America Merrill Lynch

Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	20	82,121,034	1.98964	5.48	0.11	1.82	0	1.011	-0.022
AA	365	1,931,359,537	46.79330	7.10	3.32	2.64	0	0.003	-0.014
A	128	421,308,736	10.20754	5.26	0.54	4.28	-1	0.685	0.012
BBB	312	1,280,967,769	31.03550	6.41	1.99	6.51	0	-1.018	-0.023
BB	118	318,028,084	7.70524	3.20	0.25	9.58	-2	2.177	0.020
B	121	93,642,596	2.26879	3.27	0.07	13.71	-2	1.344	-0.065
Grand Total	**1,064**	**4,127,427,755**	**100.00000**	**6.28**	**6.28**	**4.78**	**-0**	**-0.040**	**-0.013**

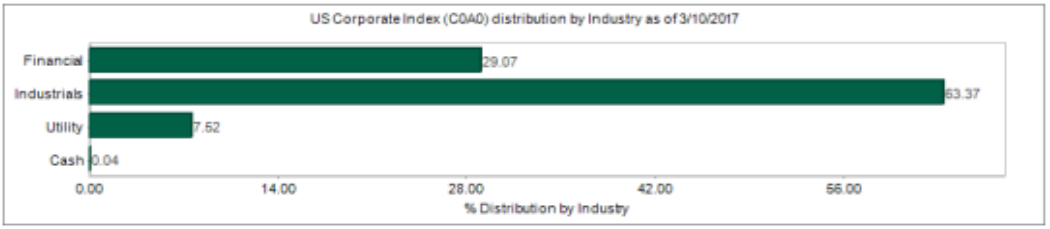


Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	12	30,800,067	0.74623	0.53	0.00	3.91	-2	N/A	N/A
1-2 Year	135	469,529,219	11.37583	1.39	0.16	4.76	-1	0.447	0.037
2-3 Year	130	437,499,946	10.59982	2.31	0.24	4.18	0	0.289	-0.029
3-4 Year	109	389,456,692	9.43582	3.14	0.30	4.54	1	0.437	-0.062
4-5 Year	117	401,313,437	9.72309	3.96	0.39	4.05	-0	0.226	-0.094
5-6 Year	62	294,018,534	7.12353	4.67	0.33	4.99	-1	0.467	0.056
6-7 Year	64	254,957,659	6.17716	5.47	0.34	4.38	-0	0.219	0.093
7-8 Year	46	240,861,031	5.83562	5.90	0.34	5.36	-0	0.520	0.191
8-9 Year	39	192,597,204	4.66628	6.97	0.33	4.60	-1	-0.210	0.095
9-10 Year	46	230,375,155	5.58157	7.34	0.41	5.44	-4	0.215	0.135
10-15 Year	120	460,195,759	11.14970	8.82	0.98	5.12	1	-0.746	-0.146
15-20 Year	77	284,470,181	6.89219	11.16	0.77	5.70	0	-1.228	-0.201
20-25 Year	35	140,854,150	3.41264	13.57	0.46	5.17	0	-0.666	0.291
25+ Year	72	300,498,721	7.28053	16.82	1.22	4.72	3	-0.939	-0.142
Grand Total	**1,064**	**4,127,427,755**	**100.00000**	**6.28**	**6.28**	**4.78**	**-0**	**-0.040**	**-0.013**

c) C0A0

The BofA Merrill Lynch US Corporate Index (C0A0)

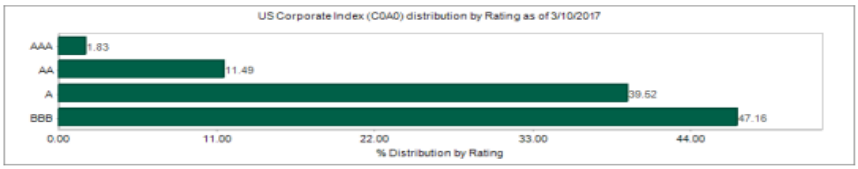
The BofA Merrill Lynch US Corporate Index tracks the performance of US dollar denominated investment grade corporate debt publicly issued in the US domestic market. Qualifying securities must have an investment grade rating (based on an average of Moody's, S&P and Fitch), at least 18 months to final maturity at the time of issuance, at least one year remaining term to final maturity as of the rebalancing date, a fixed coupon schedule and a minimum amount outstanding of $250 million. Original issue zero coupon bonds, 144a securities (with and without registration rights), and pay-in-kind securities (including toggle notes) are included in the index. Callable perpetual securities are included provided they are at least one year from the first call date. Fixed-to-floating rate securities are included provided they are callable within the fixed rate period and are at least one year from the last call prior to the date the bond transitions from a fixed to a floating rate security. Contingent capital securities ("cocos") are excluded, but capital securities where conversion can be mandated by a regulatory authority, but which have no specified trigger, are included. Other hybrid capital securities, such as those issues that potentially convert into preference shares, those with both cumulative and non-cumulative coupon deferral provisions, and those with alternative coupon satisfaction mechanisms, are also included in the index. Equity-linked securities, securities in legal default, hybrid securitized corporates, eurodollar bonds (USD securities not issued in the US domestic market), taxable and tax-exempt US municipal securities and DRD-eligible securities are excluded from the index.



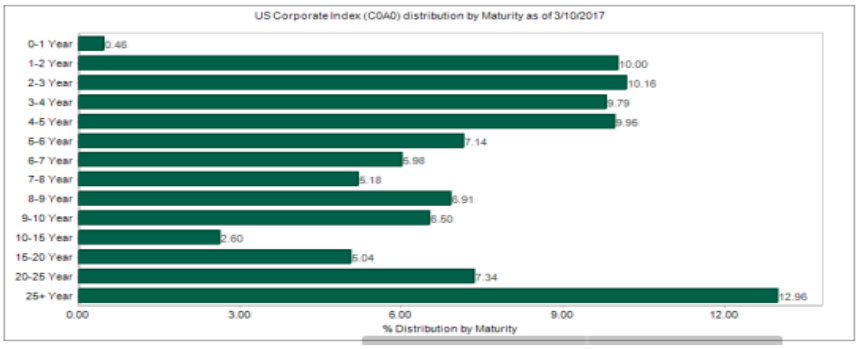
US Corporate Index (C0A0) - distribution characteristics as of 3/10/2017

Bank of America Merrill Lynch

Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	98	109,333.959	1.82577	9.62	0.18	3.16	70	-1.961	0.029
AA	670	688,333.475	11.49452	6.35	0.73	2.87	74	-1.303	-0.014
A	2,781	2,366,592.570	39.51988	6.87	2.72	3.22	98	-1.403	-0.002
BBB	3,705	2,824,100.005	47.15982	7.02	3.31	3.86	154	-1.442	-0.003
Grand Total	7,254	5,988,360.009	100.00000	6.93	6.93	3.48	121	-1.420	-0.003



Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	32	27,279.344	0.45554	0.85	0.00	1.54	49	N/A	N/A
1-2 Year	754	598,542.016	9.99509	1.42	0.14	1.95	68	-0.157	0.081
2-3 Year	712	608,419.615	10.16004	2.35	0.24	2.30	76	-0.314	0.087
3-4 Year	663	586,296.908	9.79061	3.28	0.32	2.70	88	-0.537	0.055
4-5 Year	687	595,794.235	9.94921	4.09	0.41	3.00	97	-0.829	-0.048
5-6 Year	534	427,555.462	7.13978	4.92	0.35	3.32	110	-1.001	-0.028
6-7 Year	455	358,228.779	5.98208	5.60	0.34	3.56	121	-1.116	0.021
7-8 Year	408	309,924.751	5.17545	6.39	0.33	3.77	132	-1.346	-0.023
8-9 Year	447	413,604.846	6.90681	7.15	0.49	3.86	133	-1.519	-0.010
9-10 Year	432	389,220.872	6.49962	7.94	0.52	3.91	134	-1.783	-0.070
10-15 Year	209	155,805.333	2.60180	8.61	0.22	4.47	183	-1.795	0.075
15-20 Year	388	302,050.340	5.04396	11.64	0.59	4.63	177	-2.294	0.241
20-25 Year	542	439,541.519	7.33993	13.00	0.95	4.75	176	-2.591	0.166
25+ Year	991	776,095.991	12.96008	15.63	2.03	4.76	165	-3.371	-0.298
Grand Total	7,254	5,988,360.009	100.00000	6.93	6.93	3.48	121	-1.420	-0.003



d) W0G1

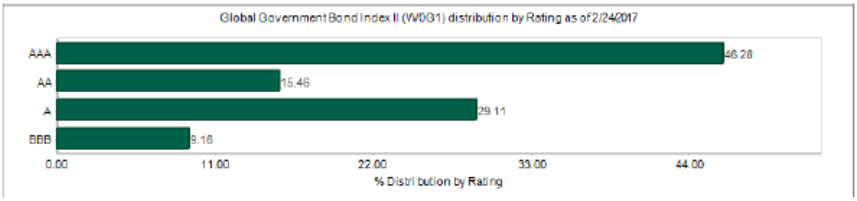
The BofA Merrill Lynch Global Government Index (W0G1)

The BofA Merrill Lynch Global Government Index tracks the performance of publicly issued investment grade sovereign debt denominated in the issuer's own domestic currency. In order to qualify for inclusion in the Index, a country (i) must be a member of the FX-G10 or Western Europe; (ii) must have an investment grade foreign currency long-term sovereign debt rating (based on an average of Moody's, S&P and Fitch); (iii) must have at $50 billion (USD equivalent) outstanding face value of Index qualifying debt (i.e., after imposing constituent level filters on amount outstanding, remaining term to maturity, etc.) to enter the Index; (iv) must have at least $25 billion (USD equivalent) in outstanding face value of Index qualifying debt in order to remain in the Index; (v) must be available to foreign investors; and (vi) must have at least one readily available, transparent price source for its securities. The FX-G10 includes all Euro members, the US, Japan, the UK, Canada, Australia, New Zealand, Switzerland, Norway and Sweden. Euro sovereigns are treated as a group with respect to minimum size requirements but each member country is evaluated individually with respect to rating criteria. To qualify as a Euro sovereign a country must be a Euro member as of the first of the month. For example, a country joining the EMU on January 1 would be treated as part of the Euro group for the December 31 rebalancing. Qualification with respect to all country criteria other than rating is determined annually based on information as of June 30th, but does not take effect until September 30th. Conversion of local currency outstanding face value into USD terms is based on the average of the previous 12 month-end exchange rates up to and including the June 30th evaluation date. Qualification with respect to country rating criteria is determined monthly based on information available as of the third business day before the last business day of the month and takes effect on each month-end rebalancing date. Qualifying securities must meet established local currency size filters.

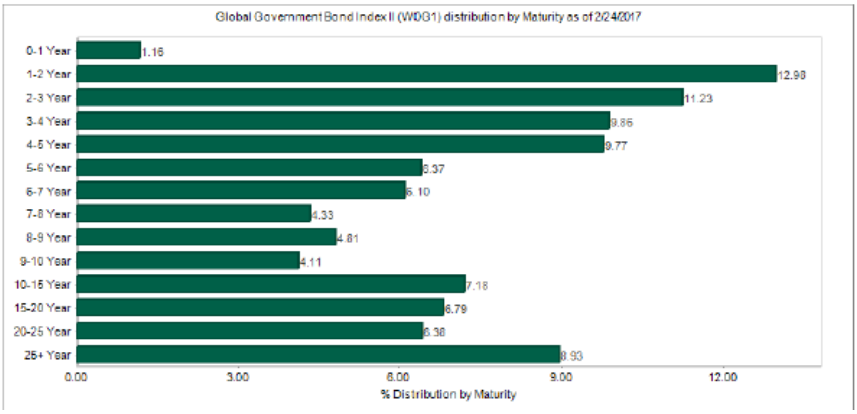
Global Government Bond Index II (W0G1) - distribution characteristics as of 2/24/2017

Bank of America Merrill Lynch

Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	424	11,818,545.851	46.27535	6.46	2.99	1.56	0	0.872	-0.023
AA	150	3,947,808.921	15.45759	9.58	1.48	0.77	32	1.898	-0.398
A	305	7,435,035.974	29.11178	9.22	2.68	0.20	1	0.125	-0.018
BBB	122	2,338,222.193	9.15528	6.76	0.62	1.33	161	0.106	-1.551
Grand Total	**1,001**	**25,539,612.939**	**100.00000**	**7.77**	**7.77**	**1.02**	**20**	**0.741**	**-0.222**



Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	11	297,444.132	1.16464	0.82	0.01	0.57	12	N/A	N/A
1-2 Year	131	3,314,412.949	12.97754	1.45	0.19	0.54	9	0.092	-0.046
2-3 Year	102	2,867,322.597	11.22696	2.40	0.27	0.67	15	0.212	-0.086
3-4 Year	86	2,519,445.256	9.86485	3.35	0.33	0.76	13	0.327	-0.130
4-5 Year	83	2,494,128.385	9.76573	4.27	0.42	0.93	18	0.457	-0.160
5-6 Year	66	1,626,901.288	6.37011	5.18	0.33	0.96	21	0.614	-0.228
6-7 Year	59	1,557,111.186	6.09685	6.10	0.37	1.11	23	0.689	-0.263
7-8 Year	43	1,105,107.566	4.32703	7.02	0.30	0.90	29	0.731	-0.308
8-9 Year	47	1,229,435.463	4.81384	7.91	0.38	0.96	30	0.909	-0.316
9-10 Year	46	1,049,918.047	4.11094	8.81	0.36	1.03	36	0.898	-0.385
10-15 Year	103	1,834,861.216	7.18437	10.56	0.76	1.00	39	0.949	-0.418
15-20 Year	80	1,733,876.942	6.78897	14.91	1.01	1.05	30	1.023	-0.319
20-25 Year	52	1,629,012.108	6.37837	16.79	1.07	2.08	22	1.670	-0.421
25+ Year	92	2,280,635.803	8.92980	22.02	1.97	1.93	13	2.059	-0.249
Grand Total	**1,001**	**25,539,612.939**	**100.00000**	**7.77**	**7.77**	**1.02**	**20**	**0.741**	**-0.222**



e) W9G1

The BofA Merrill Lynch 10+ Year Global Government Index (W9G1)

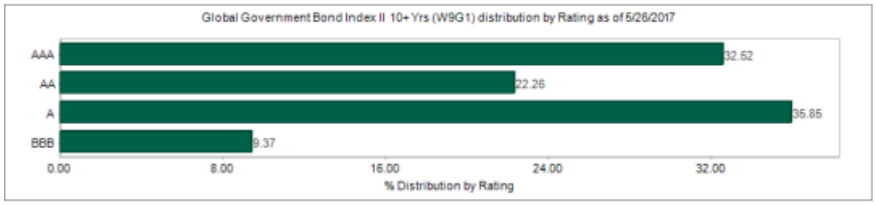
The BofA Merrill Lynch 10+ Year Global Government Index is a subset of The BofA Merrill Lynch Global Government Index including all securities with a remaining term to final maturity greater than or equal to 10 years.

Inception date: December 31, 1985

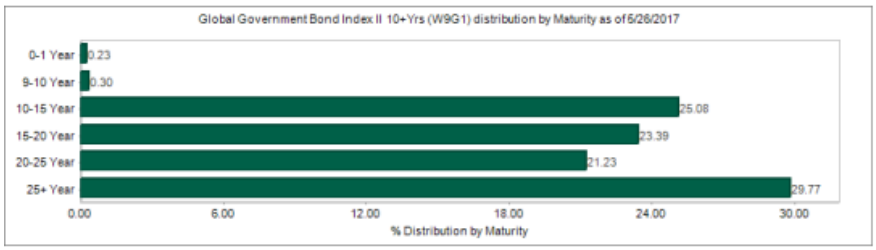
Global Government Bond Index II 10+ Yrs (W9G1) - distribution characteristics as of 5/26/2017

Bank of America Merrill Lynch

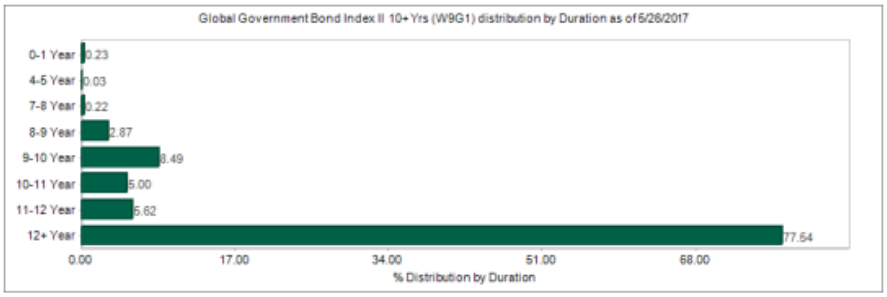
Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	99	2,572,961.902	32.52043	16.19	5.27	2.31	0	0.622	0.107
AA	61	1,761,167.649	22.25992	16.76	3.73	1.39	18	1.100	0.700
A	137	2,836,075.954	35.84600	17.16	6.15	0.47	1	-0.140	0.066
BBB	38	741,627.960	9.37365	12.86	1.21	2.46	176	2.026	2.575
Grand Total	**335**	**7,911,833.465**	**100.00000**	**16.36**	**16.36**	**1.46**	**21**	**0.579**	**0.448**



Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	0	18,394.552	0.23249	0.00	0.00	0.62	0	N/A	N/A
9-10 Year	2	23,738.160	0.30003	9.51	0.03	1.30	96	N/A	N/A
10-15 Year	109	1,984,173.952	25.07856	10.56	2.65	0.93	33	0.440	0.495
15-20 Year	81	1,850,194.623	23.38516	14.89	3.48	1.01	22	0.392	0.488
20-25 Year	50	1,679,742.541	21.23076	16.92	3.59	2.01	18	0.697	0.456
25+ Year	93	2,355,589.638	29.77299	22.18	6.60	1.88	12	0.753	0.372
Grand Total	**335**	**7,911,833.465**	**100.00000**	**16.36**	**16.36**	**1.46**	**21**	**0.579**	**0.448**

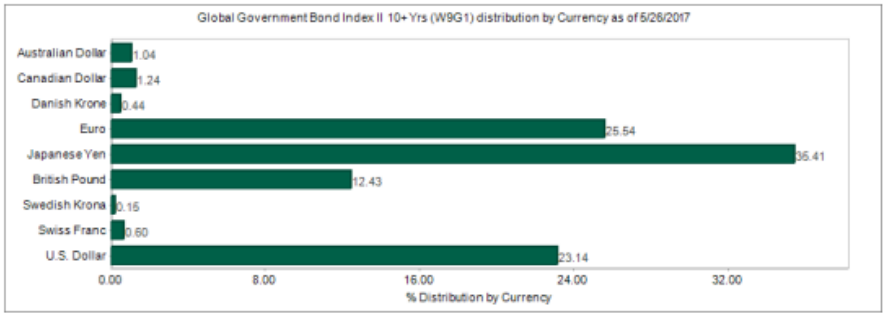


Index distribution by Duration	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	0	18,394.552	0.23249	0.00	0.00	0.62	0	N/A	N/A
4-5 Year	1	2,449.395	0.03096	4.53	0.00	3.41	174	0.715	0.846
7-8 Year	2	17,739.632	0.22422	7.88	0.02	2.03	2	0.877	-0.026
8-9 Year	9	226,932.556	2.86827	8.55	0.25	1.23	36	0.517	0.375
9-10 Year	36	671,726.215	8.49015	9.46	0.80	1.19	48	0.753	0.686
10-11 Year	20	395,460.210	4.99834	10.58	0.53	1.02	37	0.359	0.374
11-12 Year	18	444,373.308	5.61657	11.59	0.65	1.01	41	0.608	0.865
12+ Year	249	6,134,757.598	77.53901	18.20	14.11	1.56	15	0.577	0.406
Grand Total	**335**	**7,911,833.465**	**100.00000**	**16.36**	**16.36**	**1.46**	**21**	**0.579**	**0.448**



Index distribution by Currency	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
Australian Dollar	9	81,983.862	1.03622	11.67	0.12	2.73	-1	2.048	-0.007
Canadian Dollar	9	98,246.293	1.24176	15.24	0.19	1.91	-0	1.522	-0.035
Danish Krone	2	35,175.751	0.44460	16.02	0.07	1.12	0	-1.784	-0.011
Euro	102	2,021,042.822	25.54456	14.29	3.65	1.59	84	0.954	1.612
Japanese Yen	129	2,801,453.853	35.40840	17.19	6.09	0.46	0	-0.151	0.050
British Pound	23	983,373.858	12.42915	17.98	2.23	1.51	-3	1.247	-0.005
Swedish Krona	3	11,900.131	0.15041	15.03	0.02	1.24	-0	1.168	0.075
Swiss Franc	12	47,756.406	0.60361	17.33	0.10	0.20	1	-0.469	0.035

Index distribution by Currency	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
U.S. Dollar	46	1,830,900.488	23.14129	16.75	3.88	2.78	0	0.893	0.123
Grand Total	**335**	**7,911,833.465**	**100.00000**	**16.36**	**16.36**	**1.46**	**21**	**0.579**	**0.448**



Index distribution by Industry	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
Sovereign	***335***	***7,893,438.914***	***99.76751***	***16.39***	***16.36***	***1.46***	***21***	***0.579***	***0.448***
Cash	***0***	***18,394.552***	***0.23249***	***0.00***	***0.00***	***0.62***	***0***	***0***	***0***
Grand Total	**335**	**7,911,833.465**	**100.00000**	**16.36**	**16.36**	**1.46**	**21**	**0.579**	**0.448**

f) G0BC

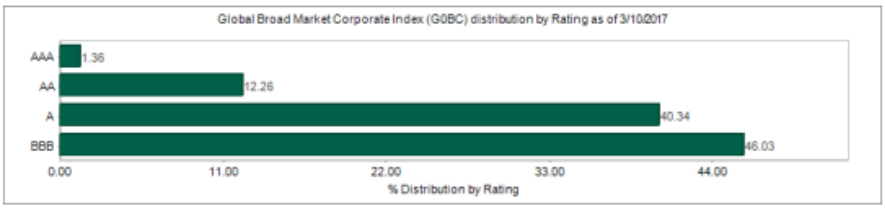
The BofA Merrill Lynch Global Corporate Index (G0BC)

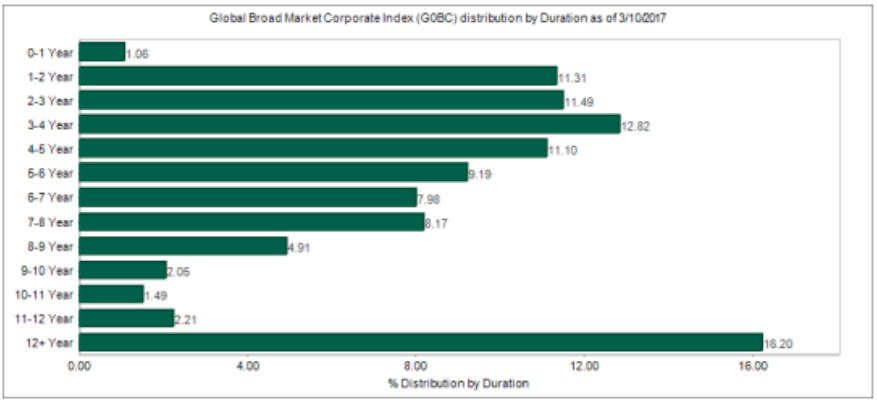
The BofA Merrill Lynch Global Corporate Index tracks the performance of investment grade corporate debt publicly issued in the major domestic and eurobond markets. Qualifying securities must have an investment grade rating (based on an average of Moody's, S&P and Fitch), at least 18 months to final maturity at the time of issuance, at least one year remaining term to final maturity as of the rebalancing date and a fixed coupon schedule. Qualifying currencies and their respective minimum size requirements (in local currency terms) are: AUD 100 million; CAD 100 million; EUR 250 million; JPY 20 billion; GBP 100 million; and USD 250 million. Original issue zero coupon bonds and pay-in-kind securities, including toggle notes, also qualify for inclusion. Callable perpetual securities qualify provided they are at least one year from the first call date. Fixed-to-floating rate securities also qualify provided they are callable within the fixed rate period and are at least one year from the last call prior to the date the bond transitions from a fixed to a floating rate security. Contingent capital securities ("cocos") are excluded, but capital securities where conversion can be mandated by a regulatory authority, but which have no specified trigger, are included. Other hybrid capital securities, such as those issues that potentially convert into preference shares, those with both cumulative and non-cumulative coupon deferral provisions, and those with alternative coupon satisfaction mechanisms, are also included in the index. Equity-linked securities, securities in legal default, hybrid securitized corporates, taxable and tax-exempt US municipal securities and DRD-eligible securities are excluded from the index.

Global Broad Market Corporate Index (G0BC) - distribution characteristics as of 3/10/2017

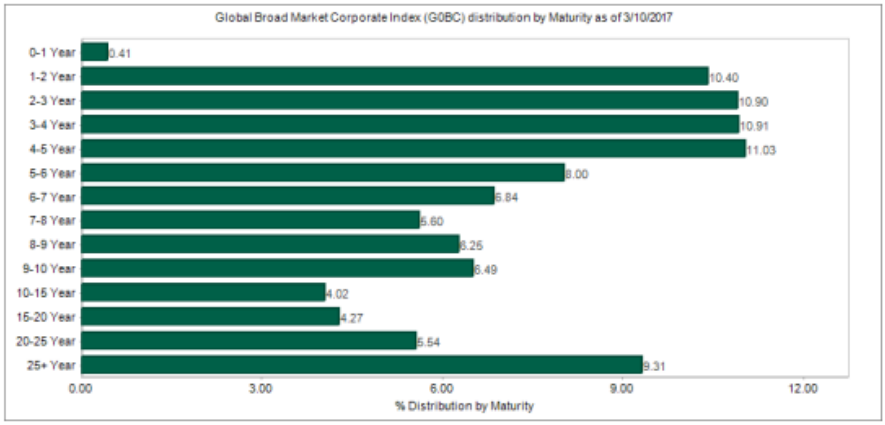
Bank of America Merrill Lynch

Index distribution by Rating	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
AAA	115	127,849.961	1.36462	9.45	0.13	2.87	67	-1.929	0.061
AA	1,376	1,148,849.428	12.26232	6.01	0.74	2.17	73	-1.134	0.043
A	5,137	3,779,781.679	40.34376	6.41	2.59	2.54	101	-1.201	0.078
BBB	6,054	4,312,455.383	46.02929	6.52	3.00	3.18	154	-1.220	0.116
Grand Total	**12,682**	**9,368,936.452**	**100.00000**	**6.45**	**6.45**	**2.80**	**122**	**-1.211**	**0.091**



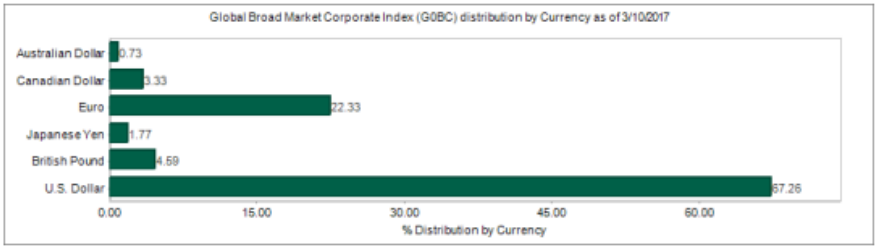


Index distribution by Maturity	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	48	38,870.456	0.41489	0.82	0.00	1.48	57	N/A	N/A
1-2 Year	1,432	974,540.244	10.40182	1.43	0.15	1.51	77	-0.120	0.066
2-3 Year	1,441	1,021,311.334	10.90104	2.36	0.26	1.80	85	-0.267	0.084
3-4 Year	1,363	1,022,273.904	10.91131	3.29	0.36	1.98	95	-0.464	0.094
4-5 Year	1,320	1,033,288.859	11.02888	4.15	0.46	2.34	108	-0.760	0.052
5-6 Year	980	749,870.220	8.00379	5.00	0.40	2.47	116	-0.983	0.068
6-7 Year	864	640,729.661	6.83887	5.78	0.40	2.67	127	-1.139	0.121
7-8 Year	709	525,055.953	5.60422	6.59	0.37	2.96	136	-1.311	0.167
8-9 Year	720	585,962.228	6.25431	7.26	0.45	3.37	140	-1.439	0.138
9-10 Year	766	608,075.891	6.49034	8.17	0.53	3.29	137	-1.699	0.141
10-15 Year	550	377,098.044	4.02498	9.42	0.38	3.20	159	-1.688	0.361
15-20 Year	567	400,321.834	4.27286	11.94	0.51	4.18	167	-2.163	0.298
20-25 Year	692	519,444.476	5.54433	13.14	0.73	4.56	174	-2.400	0.203
25+ Year	1,230	872,093.349	9.30835	15.69	1.46	4.65	164	-3.181	-0.223
Grand Total	**12,682**	**9,368,936.452**	**100.00000**	**6.45**	**6.45**	**2.80**	**122**	**-1.211**	**0.091**



Index distribution by Duration	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
0-1 Year	137	99,608.062	1.06317	0.91	0.01	1.53	77	-0.058	0.079
1-2 Year	1,547	1,059,827.977	11.31215	1.52	0.17	1.57	80	-0.132	0.068
2-3 Year	1,523	1,076,101.827	11.48585	2.50	0.29	1.87	89	-0.288	0.093
3-4 Year	1,569	1,201,240.543	12.82153	3.51	0.45	2.12	101	-0.547	0.076
4-5 Year	1,347	1,040,299.281	11.10371	4.49	0.50	2.43	112	-0.838	0.071
5-6 Year	1,147	861,436.275	9.19460	5.49	0.50	2.69	123	-1.092	0.081
6-7 Year	995	747,301.006	7.97637	6.50	0.52	3.07	138	-1.271	0.146
7-8 Year	961	765,564.778	8.17131	7.47	0.61	3.30	143	-1.492	0.156
8-9 Year	586	460,189.847	4.91187	8.39	0.41	3.19	135	-1.742	0.141
9-10 Year	280	192,456.784	2.05420	9.46	0.19	2.83	145	-1.820	0.327
10-11 Year	212	139,673.526	1.49082	10.50	0.16	3.40	164	-1.679	0.544
11-12 Year	292	207,498.225	2.21475	11.54	0.26	4.40	197	-1.987	0.441
12+ Year	2,086	1,517,738.320	16.19969	14.72	2.38	4.45	159	-2.885	-0.046
Grand Total	**12,682**	**9,368,936.452**	**100.00000**	**6.45**	**6.45**	**2.80**	**122**	**-1.211**	**0.091**

Index distribution by Currency	#	FullVal	%Full Val	Eff Dur	Contr EffDur	Eff Yld	OAS	TRR%MTD	ExRtn%MTD
Australian Dollar	341	67,943.502	0.72520	3.44	0.02	3.50	126	-0.407	0.165
Canadian Dollar	885	311,600.415	3.32589	6.20	0.21	2.69	120	-0.771	0.144
Euro	2,450	2,091,799.074	22.32696	5.33	1.19	1.00	121	-0.999	0.340
Japanese Yen	525	166,231.877	1.77429	4.30	0.08	0.26	39	-0.084	0.002
British Pound	702	429,945.931	4.58906	8.60	0.39	2.51	145	-0.581	0.218
U.S. Dollar	7,779	6,301,415.652	67.25860	6.78	4.56	3.48	123	-1.386	-0.001
Grand Total	**12,682**	**9,368,936.452**	**100.00000**	**6.45**	**6.45**	**2.80**	**122**	**-1.211**	**0.091**

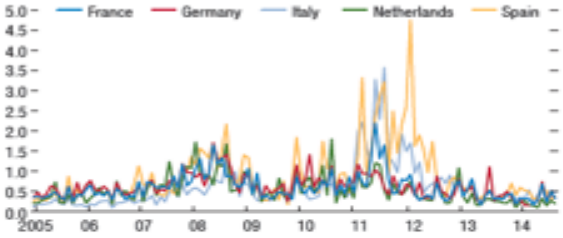


Appendix C - Descriptions of fundamental factors extracted from the World Bank

Indicator Name	Definition	Source
Population, total	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.	(1) United Nations Population Division. World Population Prospects, (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Report (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.
Surface area (sq. km)	Surface area is a country's total area, including areas under inland bodies of water and some coastal waterways. Although Arnott et al's methodology of taking the square root of this factor to avoid the "Russia problem" was considered, the absolute value of it will be used instead since the square root will lead to a more equal-weighted sample, which this paper considers unfair given that all the other factors are taken in absolute values.	Food and Agriculture Organization, electronic files and web site.
Energy use (kg of oil equivalent per capita)*population	Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.	IEA Statistics © OECD/IEA 2014 (http://www.iea.org/stats/index.asp), subject to https://www.iea.org/t&c/termsanddconditions/
GDP (current US$)	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.	World Bank national accounts data, and OECD National Accounts data files.
Imports of goods and services (current US$)	Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in current U.S. dollars.	World Bank national accounts data, and OECD National Accounts data files.
Exports of goods and services (current US$)	Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in current U.S. dollars.	World Bank national accounts data, and OECD National Accounts data files.

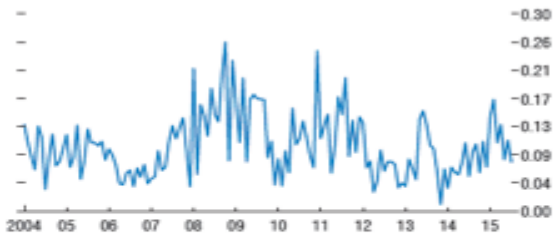
Appendix D – Transaction costs and bid-ask spreads

Bid-ask spreads for European sovereign bonds (percent) (IMF 2015)



Note: The figure shows the effective spread of a two-year on-the-run government bond for the following countries: France, Germany, Italy, Netherlands, and Spain.

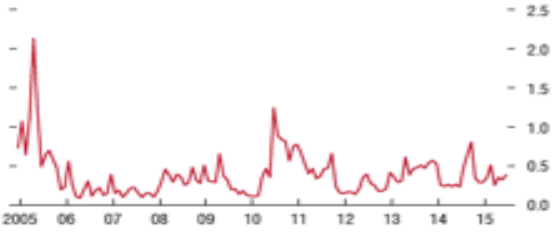
Estimated bid-ask Spreads for US treasuries (percent) (IMF 2015)



Note: Bid-ask spread, as a percent of price, for on-the-run 10-year U.S. Treasury bonds, estimated using the high-low spread suggested by Corwin and Schultz (2012).

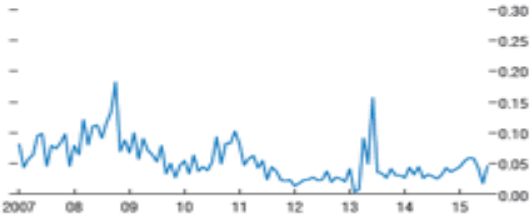
JPM Nexgem and EMBI bid-ask spreads (Piljak & Swinkels 2015)

Estimated EM bid-ask spread for EM bonds (percent) (IMF 2015)



Note: Bid-ask spread, as a percent of price, for local currency government bonds from Brazil, India, Indonesia, South Africa, and Turkey, with a maturity of at least five years, estimated using the high-low spread suggested by Corwin and Schultz (2012).

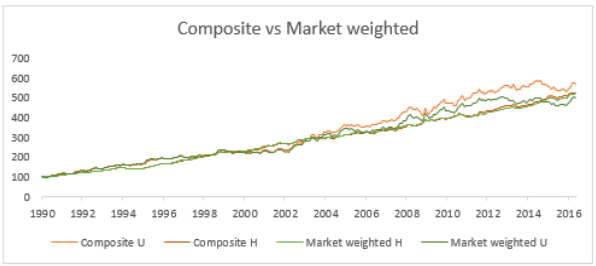
Bid-ask spread for Japanese government bonds (percent) (IMF 2015)

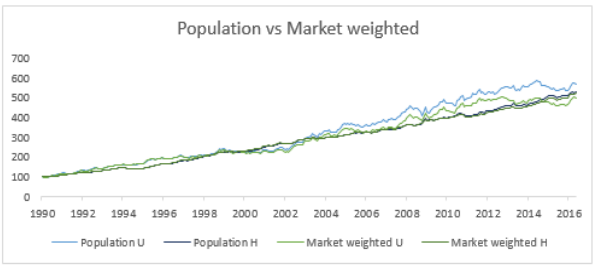


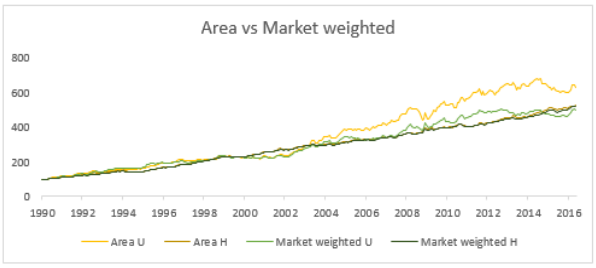
Note: Bid-ask spread, as a percent of price, for on-the-run 10-year Japanese government bonds estimated using the high-low spread suggested by Corwin and Schultz (2012).

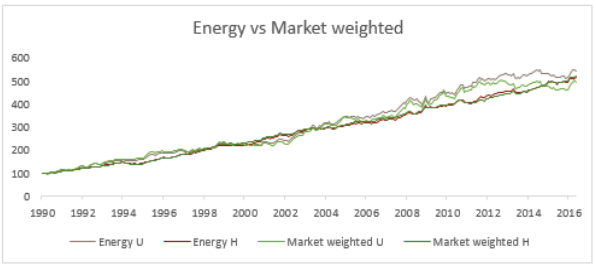
Appendix E – Index performance graphs

Developed markets



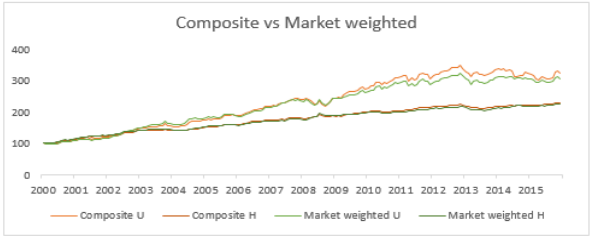


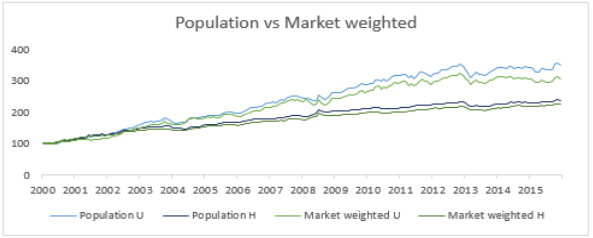


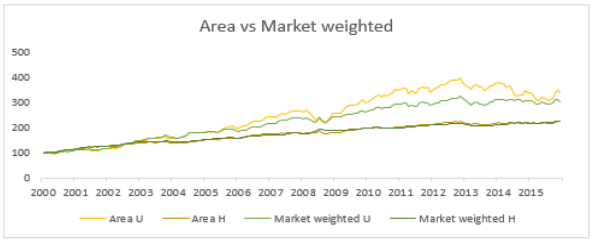


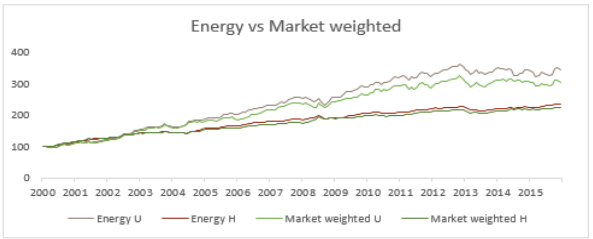
Note: The above graphs reflect the performance of each of the fundamental indices when compared to its market-weighted counterpart, including the additional transaction costs for the fundamental indices

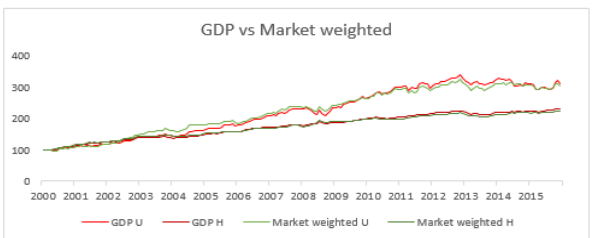
Emerging markets

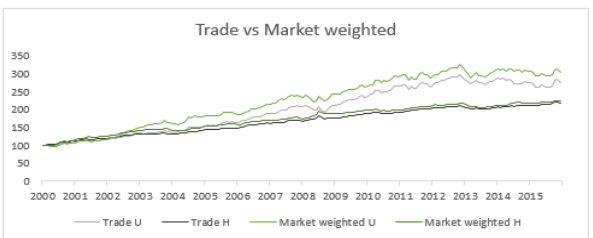






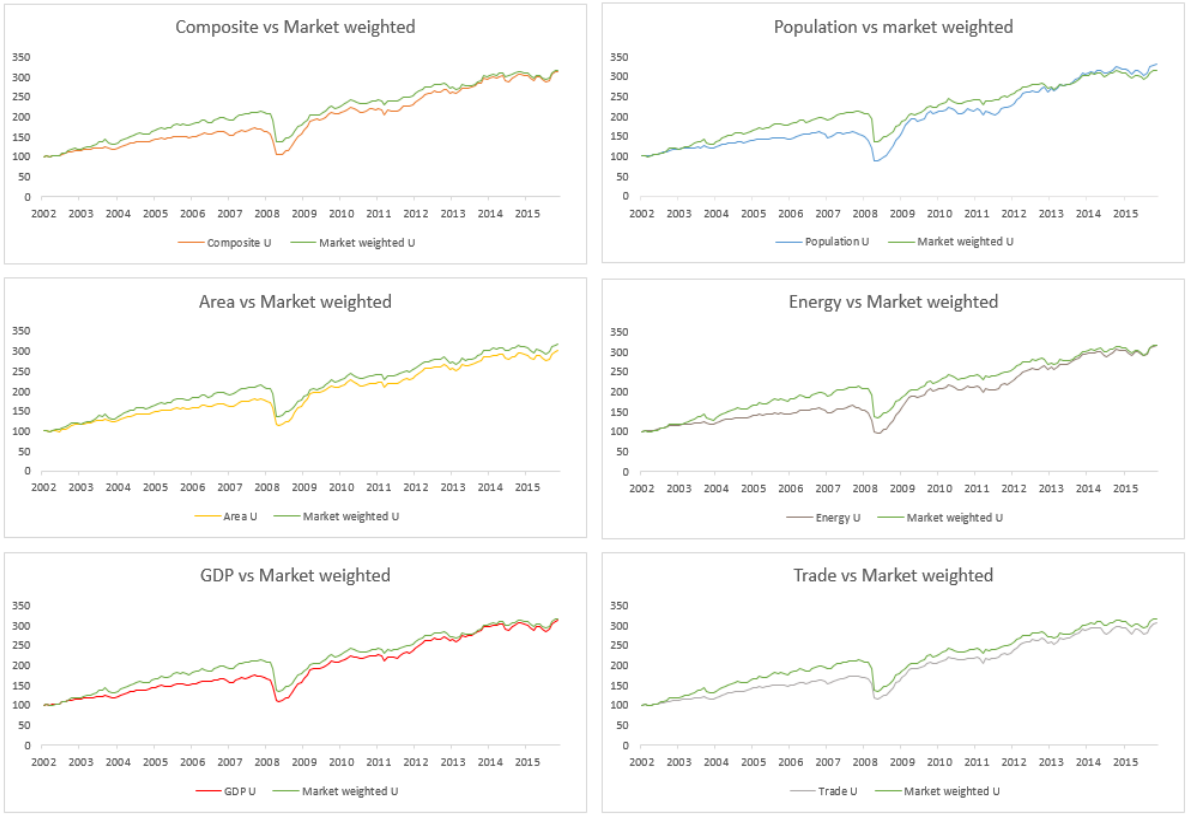






Note: The above graphs reflect the performance of each of the fundamental indices when compared to its market-weighted counterpart, including the additional transaction costs for the fundamental indices

Frontier markets



Note: The above graphs reflect the performance of each of the fundamental indices when compared to its market-weighted counterpart, including the additional transaction costs for the fundamental indices

Appendix F – Multi-factor regression correlogram

	Rm U	Rm H	Term U	Term H	Def U	Def H	Carry
Rm U	1	0.53	0.89	0.50	-0.39	0.13	0.08
Rm H	0.53	1	0.77	0.92	-0.11	-0.06	-0.04
Term U	0.89	0.77	1	0.81	-0.24	0.14	-0.01
Term H	0.50	0.92	0.81	1	-0.09	-0.02	-0.06
Def U	-0.40	-0.11	-0.24	-0.09	1	0.74	0.50
Def H	0.13	-0.06	0.14	-0.02	0.74	1	0.37
Carry	-0.08	-0.04	-0.01	-0.06	0.49	0.37	1