EUROPEAN BOND ETFs - TRACKING ERRORS AND SOVEREIGN DEBT CRISIS

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ABSTRACT

We examine tracking errors and performance of 31 European bond exchange traded funds (ETFs) during 2007-2010. On average, ETFs outperform their respective benchmarks. Our findings, contradicts recent results from international equity markets that suggest ETFs' underperformance. The average over-performance during the sample period varies from 10 basis points to 27 basis points. Notable the over-performance is more pronounced for funds which employ physical replication. All sample ETFs have statistically significant average (mean) tracking errors at 1% level of significance. The results also suggest that that (more volatile) higher maturity segments have typically higher levels of tracking error. In particular, funds with heavy the exposure to the riskiest sovereign issuers exhibit different performance in comparison with funds that exclude the risky issuers. In the environment of widening sovereign CDS spreads and divergent yield trends, understanding selection rules of a benchmark index is, therefore, crucial for understanding fund performance.

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1. Introduction

Recent introduction of the electronic trading platforms made the sovereign debt market of the Euro zone countries much more efficient and led to the possibility of creation of investible debt indices. The indices are based upon realized transactions in real time electronic trading and as a result, index values more fully reflect the market consensus. On the demand side, lower advisory management fees and relatively poor performance of active bond managers contributed to the recent popularity of bond indexing strategies. The significant increase in market activities resulted in several families of indices and related ETFs that comprehensively cover sovereign debt of the Euro zone countries. During 2007-2008 the funds have been one of the best-performing segments of the European ETF market, providing investors with safer options to the equity market. The sovereign debt market of the Euro zone countries, however, has been under intense scrutiny since the inception of the world financial crisis in 2008.[1] The bonds, previously perceived by the market as almost riskless are now seen as a mixed interest rate and credit risk product. In post-Greek debt crisis period, markets penalize fiscal imbalances much more strongly (Attinasi et al., 2009). Price elasticity of deficit differentials (in terms of GDP), for example, has

[1] We take end of 2008 as a beginning of the EU sovereign debt crisis. Since then, several EU governments implemented various measures aiming to stabilize their troubled financial systems which was further followed by the divergence in the credit spreads of EU countries. The crisis culminated in late 2009 with Greek sovereign debt crisis.

increased 3-4 times while price elasticity of differentials in the level of debt (as a fraction of the GDP) has increased around 7-8 times during the post-Lehman crisis period (Schuknecht et al., 2010).

Despite the increasing popularity of ETFs, there are relatively few research papers studying them.[2] Furthermore, from investors' point of view the analysis of ETF tracking errors remains widely misunderstood and frustrating process.[3] Notable most of the studies examine equity related ETFs. For example, Amenc and Goltz (2009) study the role of European ETFs in providing investor exposure to various asset classes.[4] Rompotis (2008) shows that German equity ETFs slightly underperforms underlying indices. The tracking error is directly related to risk, bid-ask spreads and management fees. Blitz et al., (2010) compare Europe-listed index mutual funds and index ETFs that offer exposure to global equity markets. The authors report that, on average, ETFs underperform their benchmarks.

In this paper we analyze the tracking errors and performance of the sample of European bond ETFs during 2007-2010. We conjecture that changes due to recent financial crisis may have changed relative importance of the risk factors and

[2] By the mid 2009, there were 753 registered European exchange traded funds (ETFs) with assets under management (AUM) of over US$ 183 billion. The proportion of the fixed income ETFs in the total ETF assets grew from 5% in 2003 to more than 25% in 2009. Calculations by authors based on data from *ETF Landscape - Industry Review*, Barclays Global Investors, August 2009.
[3] As cited in Flood, C., ETF tracking errors can 'mislead', Financial Times, 5th October 2010.
[4] The investigation is based on the large survey by the Edhec Institute (2009).

affect the performance and tracking errors of the ETFs.The effect is expected to be associated with the composition of indices and country exposure. In particular we expect significant association of ETF's tracking errors and increase in credit default swap (CDS) spreads. In other words funds with highest exposure to sovereign debt of countries experiencing highest increase in CDS are likely to have the highest tracking errors. We also examine how different fund characteristics (replication method, maturity, and fund composition) affect tracking errors of ETF funds. We conjecture significant differences in tracking quality across physically and synthetically replicated ETFs. To the best of our knowledge this is the first study to examine European sovereign debt ETFs.

The results of our research shed more light on the existence and determinants of tracking errors, thus providing valuable insights for index fund and ETFs investors. On average, ETFs outperform their respective benchmarks. Our findings contradict recent results from international equity markets that suggest ETFs' underperformance. The average over-performance during the sample period varies from 10 basis points to 27 basis points. Notable the over-performance is more pronounced for funds which employ physical replication. All sample ETFs have statistically significant average (mean) tracking errors at 1% level of significance. The results also suggest that that (more volatile) higher maturity segments have typically higher levels of tracking error. In particular, we

show that selection rules can result in significantly different returns for two similarly structured indices. For example, sample funds with the exposure to the riskiest sovereign issuers perform differently in comparison with funds that exclude the risky issuers. In the environment of widening sovereign CDS spreads and divergent yield trends, understanding selection rules of a benchmark index is, therefore, crucial for understanding fund performance.

The remainder of the paper is organized as follows. In Section 2 we present characteristics of the European sovereign debt indices and ETFs. Section 3, describes the data and methodology. The results are discussed in section 4. Finally, we conclude in section 5.

2. Characteristics of Euro zone sovereign bond indices and ETFs

2.1. Bond indices

Unlike equity indices, fixed income indices are more complex as bonds are typically not traded on organized exchanges. Each index family is created by an institution who then licenses the index to an investment bank or a brokerage house. The dominant providers of Euro zone sovereign debt indices are: Barclays Capital, International Index Company (IIC), EuroMTS, and Deutsche Borse.

Between them they provide leading families of indices such as: Barclays Term, Markit iBoxx, eb.rexx and EuroMTS (See Table 1).

Barclays Capital pioneered the concept of a *term index*. In contrast to standard market indices, term indices have stricter inclusion criteria regarding both the original time to maturity and remaining time to maturity. They include only bonds with remaining time to maturity near to their original time to maturity, rather than selecting all bonds in an index maturity range. As a result, term indices have very similar yields, duration and risk/return characteristics to standard maturity-based indices but are more compact and more liquid.

International Index Company (IIC) develops and runs the Markit iBoxx bond indices. A distinctive feature of iBoxx bond indices is a multi-contributor real-time pricing (i.e. pricing that takes into account price information from multiple trading platforms) (See Table 1). iBoxx also calculates and publishes consolidated bond prices once per minute each trading day. iBoxx indices track the overall exposure to Euro zone sovereign debt market. [5] The weight of a single Euro zone country in an iBoxx Liquid Sovereign Capped index is capped at 20%.

Insert Table 1 about here

[5] For more details about Markit iBoxx Liquid and Liquid Capped indices see http://indices.markit.com/download/products/guides/Markit_iBoxx_EURLiquid_Guide.pdf

The eb.rexx Government Germany index family includes only the most liquid standard coupon bonds issued by the German government.[6] Indices are calculated using the quotes from the Eurex Bonds platform, one of the leading European electronic bond platforms.

EuroMTS indices are country specific. Local country system provides opportunities for trading off-the-run and on-the run securities while EuroMTS platform offers trading only in on-the-run securities. EuroMTS indices are priced using real-time quotes from the MTS platform.

In constructing indices, index providers utilize different price sources including all relevant trading platforms currently operating in Europe. Typically, only standard coupon bonds that are redeemed on a fixed maturity date are eligible for inclusion into indices.[7] In order to be included in an index, time to maturity of a bond has to be at least 1 year. Although above index families target the same maturity segment they have very different composition and, thus, very different risk and return characteristics.

[6] For more details about eb.rexx indices see:
http://www.dax- indices.com/EN/MediaLibrary/Document/ebrexx_L_3_8_e.pdf
[7] One exception are Markit iBoxx Benchmark indices which can also include standard discount (stripped) bonds.

2.2. EU government bond ETFs

One of the key differences among ETFs is in the replication technique they employ. It is either physical (in-kind) or synthetic (swap-based) replication. Fund manager of physically-based ETF replicates its index through acquisitions of securities held in it. In that case fund portfolio consists of all, or representative (optimized) sample of securities when index is too large (and therefore incurs high transaction costs) or when markets are less liquid.

Perhaps the most important feature of the in-kind creation and redemption process is that fund managers always distribute securities on the smallest-cost basis. In this way, capital gains tax obligations are transferred from fund investors to authorized participants. Fund's unrealized capital gains are, thus, significantly reduced and, sometimes, completely eliminated resulting in very significant tax savings for investors with respect to regular mutual funds. This makes ETFs very tax-efficient. Importantly, ETFs are required to report Total Expense Ratio (TER), measured as a ratio of total expenses with respect to NAV.

A synthetic ETF, on the other hand, lends its assets (typically a sub-portfolio of a benchmark) to counterparty via collateralized repurchase agreement and then swaps the yield on that loan for the total return of the underlying index. Yield on the loan is based on LIBOR with or without a spread (the spread, if any, is

reflected in the fund performance as an additional cost). While physical replication is more intuitive and transparent, synthetic replication is generally seen to provide better tracking ability, although at the expense of increased counterparty risk.

3. Data and methodology

3.1 Data

The principal source of our data is Bloomberg and the official websites of ETF and index providers.[8] Our sample of ETFs covers daily data for the period between January 2nd, 2007 and May 19th, 2010. For funds which did not exist on January 2nd, 2007, the date of their inception is used as the first date of the corresponding time series.[9] The data source on representative long-term sovereign interest rates is the Web site of the European central bank.

Given that sample ETFs are listed on multiple exchanges, for consistency reasons, we use data from the German listings. All sample indices belong to the class of total return indices (i.e. indices where all coupon payments are reinvested). In

[8] We are grateful to Dr Drago Indjic at Sunningdale Capital for his assistance in data gathering.
[9] All db x-tackers ETFs started trading in May and June, 2007 except for db short iBoxx index, which started trading in May, 2008. Funds iShares Barclays 5-7 i 10-15 started trading in April, 2009, while Lyxor EuroMTS 15+ started trading in June, 2007.

order to analyze quality of tracking performance by various ETFs we use end-of-day Net Asset Values (NAVs). NAVs and the portfolio structure of ETFs are published at the end of each trading day. In addition, the exchanges on which they are traded are required to publish indicative NAV values (iNAVs) throughout the trading day (usually every 15 seconds). iNAVs are calculated based on last realized prices for fund constituents. These values provide investors with a price benchmark throughout the trading day.

We examine 31 ETFs of leading European ETF providers: iShares (track Barclays Term, Markit iBoxx Liquid Capped and eb.rexx Government Germany indices), db x-trackers (track Markit iBoxx benchmark indices) and Lyxor Asset Management (track EuroMTS EuroMTS).[10]Assets under management (AUM) of the above funds are of the order of hundreds of millions of Euros. ETFs tracking longer maturity segments (over 10 year of maturity) and those with shorter history have lower levels of AUM. For instance, in May of 2010, well established short-maturity fund iShares eb.rexx 1.5-2.5 had AUM of around € 1.3 billion, Lyxor EuroMTS 1-3 around € 1.03 billion. On the other hand, longer maturity funds db iBoxx 10-15, 15+, 25+ had roughly € 30 million average AUM while iShares Markit iBoxx € Liquid Sovereigns Capped 10.5+ has AUM of roughly €22 million. In our sample, ETFs from the iShares family are based on full physical

[10] EuroMTS indices tracked by our sample Lyxor ETFs are also known as EMTX indices.

replication while db x-trackers and Lyxor funds are all with the synthetic replication. Table 2 shows the summary of indices by ETF providers and their aggregate country exposure.

Insert Table 2 about here

Barclays' indices predominantly focus on Germany, Italy, and France. Those 3 countries constitutes typically three quarters of the overall index. The reminder is allocated to Netherlands and to smaller extent to Spain. Spain is the only risky country (by CDS spread) with weighting ranging from 7% to 13.3%. In terms of weighting, iBoxx Euro Sovereign index and EuroMTS indices do not differ substantially. They both include riskier countries such as: Ireland, Greece, Austria, Portugal, and Belgium in similar proportions. The iBoxx Euro Liquid Sovereign index caps any one country's weight to 20%. Consequently, the weightings outside Germany, France, and Italy are larger. For example, the allocation to Spain is around 20%, Belgium from 4.4% to 14.5%, Greece from 5.9% to 13.9%. Ireland is included in 1.5-2.5 index (allocation of 3.8%). Finally, eb.rexx consists entirely of German government bonds. They are, therefore, less diversified out of all sample indices.

3.2 Methodology

Performance analysis of Euro zone sovereign debt ETFs starts with selection criteria for targeted benchmark indices. These criteria include rules that specify the number of benchmark constituents, eligible bond issues, weights and aggregate country exposure. The returns on sovereign bond index are thus determined by the index composition and changes in constituent interest rates.

In order to determine how closely an ETF tracks the targeted index, we calculate tracking error (TE). Tracking error is the single most important factor in the analysis of an index fund performance. It measures the difference between the return of a fund and its underlying (benchmark) index.[11] The tracking errors have 3 main sources: transaction costs related to constructing the indexed portfolio, differences in composition of indexed fund and the index itself, and discrepancies between prices used by the organization constructing the index fund and actual transaction prices. (Fabozzi, 2000). Smaller tracking error means better tracking performance of the fund with respect to its underlying index. The main task of a fund manager is, therefore, to find an optimal tradeoff between closeness of index replication and the cost of replication.

[11] The difference is often referred to as active risk.

One simple way to define tracking error is to calculate the difference in returns between the fund and the index (also referred to as active return) at the end of a certain period of time. However, passive investing is about gaining exposure, as accurately as possible, to all index characteristics and not just to match the value at the end of the investment horizon. One way to do this is to compare volatilities (or some other relevant statistic) of the fund with that of the benchmark. However, that would ignore co-movement between the two for the time period in question. Furthermore, variability of total returns may not be symmetric in rising and falling markets (Fabozzi, 2000). Having this in mind, tracking error (TE) is commonly defined as standard deviation of the difference between the return on the portfolio and that of the benchmark, that is, the standard deviation of the active return (see (1)): [12]

$$TE = \sqrt{Var\left(r_P - r_B\right)} \qquad \text{equation (1)}$$

Where rp is return on the portfolio and rb is return on the benchmark.

Equation (1) is the most frequently used performance measure of index funds. Note that it describes variability in active returns but provides no information on a

[12] See Alexander (2008), Bacon (2008) and Martellini et al., (2003) for more details on TE measurement.

fund's under- or over-performance vis-à-vis the benchmark index. It ranks equally both positive and negative active returns of the same magnitude. Thus, as a performance measure TE is more appropriate for tracking (index) funds and less appropriate for active funds.

The equation (1) also measures co-movement of portfolio returns with that of a benchmark:

$$TE = \sqrt{\sigma_P^2 + \sigma_B^2 - 2\sigma_P\sigma_B\rho_{P,B}} \qquad \text{equation (2)}$$

Where σ_P is standard deviation of fund returns, σ_B standard deviation of benchmark returns, and $\rho_{P,B}$ is correlation between the fund and benchmark returns. Clearly, the higher the correlation the lower the TE.

It is worth mentioning that TE tends to be very good in picking up the trading noise while it largely ignores bias introduced by fund management fees.[13] While trading noise often causes an ETF to close at a slight premium management fees tend to produce a consistent daily underperformance compared to the benchmark

[13] Trading noise is associated with timing differences when underlying index is published continuously while ETF trades less frequently. Another example is so called bid/offer spread caused by difference in prices used to report the value of indices and the prices used to construct or rebalance ETFs (Flood, C., ETF tracking errors can 'mislead', Financial Times, 5th October 2010).

index. The accumulated net effect of these daily deviations is much more important for long term investors than for short term investors.

4. Results

5.1 Volatility and correlation of sample ETFs and respective bond indices

Table 3 presents results for volatility of sample ETFs and respective indices together with their correlations during the sample period. All ETFs exhibit similar volatility to the volatility of underlying indices. The correlation between ETFs and indices is very high except for EuroMTS which are clearly outliers with the correlation almost half of the one recorded for other ETFs. Overall, the correlation between sample ETFs and respective bond indices has not changed significantly with the escalation of the sovereign debt crisis in 2009.

Insert Table 3 about here

All ETFs exhibit similar volatility to the volatility of underlying indices. In Figure 1, we also present evolution of volatilities for sample ETFs targeting 10+ year maturities. The volatility increased significantly from the later part of 2008, which is corresponding with the beginning of the financial crisis. Since reaching its peak in the spring of 2009, the volatility has exhibited decreasing trend.

Insert Figure 1 about here

4.2 ETFs' performance

The ETFs annual returns and benchmark adjusted ETFs performance is presented in Table 4. Overall, sample ETFs' returns increased significantly in 2008. The high returns reflected increase in popularity of ETFs as investors sought alternatives to equity markets and as interest rates continue with declining trend. The situation, however, changed with the signs of financial crisis in late 2008. Consequently, the returns, for all ETFs, dropped sharply reflecting increase in CDS spreads and speculations that one or more countries could be forced to leave the single currency. More recently, we witnessed reversal to higher returns similar to those during the pre-crisis period.

Insert Table 4 about here

In terms of the specific funds' performance, Barclays and db.x trackers funds performed better than their counterparts. iBoxx Liquidity ETFs were the worst

performers. Notably, they have the highest weighting for Spain, Greece, and Belgium compared to all other sample ETFs.[14]

Overall, ETFs outperformed their respective indices. The average over-performance during the sample period varies from 10 basis points (Lyxor) to 27 basis points (iShares - Barclays).[15] Notable the over-performance is more pronounced for funds which employ physical replication. The levels of the ETFs over-performance dropped in 2009 only to increase again during the first part of 2010.

4.3 Tracking errors (TE)

The results of the sample ETFs' tracking errors are presented in Table 5. All sample ETFs have statistically significant average (mean) tracking errors at 1% level of significance.[16] This result is robust to use of monthly instead of daily NAV series. Overall, iShares funds which replicate Barclays Term indices exhibit smallest while Lyxor ETFs exhibit largest TEs. This finding is consistent with earlier reported differences in correlations between ETFs and respective indices.

[14] It is worth mentioning that CDS spreads do not automatically affect bond yields. First, CDS spreads are typically quoted for 5y maturity while bonds may have shorter/longer maturities. Second, there is normally basis risk equal to differences between CDS spreads and bond yield spreads (Financial Times, Sovereign Default Risk and European Bond ETFs, 10th March 2009).
[15] Lyxor ETFs actually underperformed respective benchmarks in 2007.
[16] Unreported results for one sample Wilcoxon test for median are economically and statistically consistent with the reported results for T tests.

The highest TEs, thus, are associated with the lowest correlation with the underlying index.

Insert Table 5 about here

The results also suggest that that (more volatile) higher maturity segments have typically higher levels of tracking error.[17] This is the case in all sample ETF families. There are also some differences in the way TEs changed during the sample period. iBoxx Liquidity and eb.rexx, for example, exhibited highest TE in 2009 which is consistent with high weightings for Greece (in iBoxx liquidity) and Germany (in eb.rexx), two countries with extremely volatile interest rates during 2009. Barclays, db, and Lyxor indices, however, exhibited highest TEs during 2008.

Table 6 presents results for tests for differences in mean and median TEs for different families of ETFs. The results confirm superior tracking performance of iShares Barclay's family followed by db x-trackers. The difference in mean and median TE between Barclay's family and the rest of the sample is statistically significant at 5% level of significance, or better. The difference between mean TE

[17] The only outlier seems to be db iBoxx € Sov 5-7.

for db x-trackers and eb.rexx families is not statistically significant, confirming similar performance of eb.rexx and db x-tracker funds.

Insert Table 6 about here

4.4 Beyond TE numbers

As can be concluded from the tables 3-6, iShares funds which replicate Barclays have the lowest average volatilities, lowest average TE values and highest correlation coefficients with benchmark indices have. This should be attributed to compact index structuring approach and to the full physical replication. By comparing different index providers one finds that iShares benchmarks have the smallest numbers of constituents and, also, the lowest average TE (relative to the funds of the other two providers that track index of the same or similar maturity segment). In addition iShares employ full physical replication strategy. The physical replication involves taking possession in most or all of the positions of the benchmark portfolio. In this case, fund and benchmark returns are highly correlated (they would be identical if expenses and income from other activities are excluded). This leads to low variability in active returns and, therefore, to low TE.

It is important to say that TE alone is not enough for full evaluation of the performance across iShares family of the sample funds. The overall performance is affected by other costs such as sampling costs, cash drag, costs of index constituents' change, as well as by the level of additional income-producing activities such as securities lending. It is only after careful assessment of all these factors that one should be able to find sources of differences in the performance across the family of funds.

In comparison with iShares funds, db x-tracker and Lyxor funds track indices with more constituents and more complex country exposures (and, also, employ swap-based replication). Our analysis shows that Lyxor funds performances have considerably higher average TE compared to those of the other two providers. Such high tracking error could be explained by lower correlation between the fund and benchmark returns (see Table 3) rather than funds' characteristics that are similar to db x-trackers.[18] The different performance of Lyxor funds is also evident from the results presented in Figure 2, which depicts patterns of three month daily TEs for the sample ETFs. The figure highlights positive association

[18] Obviously, with swap replication strategy it is the swap contract that defines characteristics of fund replication. So, to compare the performance quality of such funds it would crucial to know the details of the swap contract, especially provisions that determine what part of the portfolio is physically replicated and what part is covered by the swap contract. In cases when fund manager takes part in swap collateral lending one should also analyze the structure of collateral basket. However, no data on this is readily available on the market.

of TEs with levels of volatility, presented in Figure 1, for all ETFs except for Lyxor.[19]

Insert Figure 2 about here

Finally, we should bear in mind that iShares funds distribute income while db x.tracker and Lyxor reinvest all income. The choice between distribution of income and reinvestment of income is, however, not a clear cut. On one hand, the distribution provides periodic income for investors and leads to higher realized return in falling markets. On the other hand, when an index is rising the reinvestments tend to provide more reliable way to lock in positive returns.

[19] In case of synthetic ETF, performance over the whole range of ETFs of the same provider and difference in correlation coefficients among providers can only be explained by details of the swap contract.

5. Summary and conclusions

In times of market distress and high uncertainty investors typically rebalance their portfolio towards less risky and more liquid assets. It appears that these trends spurred the development of Euro zone sovereign debt ETF market in recent years. Number of new indices and ETFs is still growing to meet the demand for different risk/reward profiles. Despite of the sovereign debt crisis, government bonds ETFs represent one of the fastest growing segments of the overall European ETF market. For example, in 2009 these products gathered $6.2bn in new cash which was 7.5% of total inflows in all European ETFs. In the first half of 2010 they have already attracted $5.3bn in new cash. [20]

To the best of our knowledge this is the first paper that analyzes the tracking errors and performance of Euro zone sovereign debt ETFs. A shear number of such funds in existence, their relative transparency, liquidity and total assets under management make them an interesting investment class. On the other hand the investors are facing problems when selecting among many similar bond ETFs tracking the same indices. Investors who wish to make an informed investment

[20] Flood, C., iShares considers expanding fixed income ETF range in Europe, Financial Times, 9th August 2010.

decision need to examine ETFs' tracking errors and understand their determinants, magnitude, and persistence.[21]

Overall, the Euro zone sovereign debt ETFs are efficient tracking vehicles. There are however some important differences across families of ETFs. iShares funds which replicate Barclays Term indices exhibit smallest while Lyxor ETFs exhibit largest TEs. The results also suggest that that (more volatile) higher maturity segments have typically higher levels of tracking error. This is the case in all sample ETF families. There are also some differences in the way TEs changed during the sample period in response to changes in the volatility.

We also show that selection rules can result in significantly different performance of two, at a first glance, similarly structured indices. In particular, funds with exposure to the riskiest sovereign issuers (e.g. iBoxx Euro Liquid) exhibit different performance in comparison with funds that exclude the risky issuers (Barclays Term and eb.rexx). In the environment of widening sovereign CDS spreads and divergent yield trends, understanding selection rules of a benchmark index is, therefore, crucial for understanding fund performance.

[21] Flood, C., ETF tracking errors can 'mislead', Financial Times, 5th October 2010.

There are several issues that are left for future research. For investors in Euro zone sovereign debt counterparty risk has recently become a real concern. In case of a swap-based ETF, required collateral provides some protection but it does not eliminate the risk completely. In addition, there is often little transparency when it comes to collateral assets. Since different providers have different policies for swap contracts it is very important that investors properly assess counterparty risk when ranking swap-based ETFs. Finally, given that some EU countries are facing serious financial difficulties, and important question is: should the weighting system for a broad Eurozone benchmark be based on the size of members' GDP or on the amount of members' debt?

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The EDHEC European ETF Survey 2009 - May 2009

Table 1 Summary of government bond indices together with index selection rules

This table presents a summary of index families together with index selection rules. F=France; G=Germany, I=Italy, N=Netherlands; S=Spain; Gr=Greece; Ir=Ireland; Port=Portugal; Fin=Finland.

Index family	**Prices**			**Min amount**	**Rating**	**Exposure**	**Country**	**Coupons' reinvestment**
	Source	**Adjustment**	**Type**					
Barclays team	Barclays capital	Daily	Mid price	€2billion	Lower of S&P and Moody's	Max 30% per issue	F, G, I, N, S	Monthly at rebalancing
iBoxx Liq. EUR Sovereign	Consortium	Per minute	Bid price	€2billion	Lower of S&P, Moody's, Fitch	Max 20% per country; one issue per issuer; 3 bonds per country	Euro zone	Monthly at rebalancing
eb.rexx German Gov.	Eurex Bonds	Per minute	Best bid price	€4billion	Lowest grade	Max 30% per issue	G	Monthly at rebalancing
iBoxx EUR Sovereign	Consortium	Per minute	Bid price	€2billion	Lower of S&P, Moody's, Fitch	-	Euro zone	Monthly at rebalancing
EuroMTS	MTS markets	Per 30 seconds	Best bid price	€4billion	-	Max 2 per issuer	A, B, Fin., F, G, Gr., Ir., I, N, Port., S.	Overnight

Table 2 Aggregate country exposure of government bond indices by sample ETF providers

Calculated by authors; based on data provided in ETFs' prospectuses.

	Germany	Italy	France	Spain	Belgium	Netherlands	Greece	Portugal	Austria	Ireland	Finland
iShares											
Barclays Term 1-3	32.6	42.1	11.1			14.2					
Barclays Term 3-5	32.2	23.7	30.8	13.3							
Barclays Term 5-7	48.0	25.0	12.7			14.2					
Barclays Term 7-10	56.6	7.9	29.9			5.6					
Barclays Term 10-15	9.3	41.4	30.3	7.0		12.0					
Barclays Term 15-30	29.4	34.8	21.7	9.7		4.4					
iBoxx€ Liq Sov Cap 1.5-2.5	20.3	20.0	20.2	8.0	4.4	9.5	13.9			3.8	
iBoxx€ Liq Sov Cap 2.5-5.5	20.3	20.0	20.5	20.0	13.0		6.1				
iBoxx€ Liq Sov Cap 5.5-10.5	20.5	20.3	20.3	19.9		13.1	5.9				
iBoxx€ Liq Sov Cap 10.5+	20.6	19.8	20.1	19.3	14.5	5.7					
iBoxx€ Liq Sov Cap 1.5-10.5	20.4	20.2	20.3	19.8		11.9	7.4				
eb.rexx 1.5-2.5	100.0										
eb.rexx 2.5-5.5	100.0										
eb.rexx 5.5-10.5	100.0										
eb.rexx 10.5+	100.0										
eb.rexx DE	100.0										
db-trackers											
Short iBoxx € Sov	21.6	23.7	20.9	9.4	5.9	5.4	3.9	2.2	3.7	2.0	1.1
iBoxx € Sov	21.6	23.7	20.9	9.4	5.9	5.4	3.9	2.2	3.7	2.0	1.1
iBoxx € Sov 1–3	25.1	24.4	19.8	11.1	5.7	5.5	3.8	1.8	1.2	1.0	0.7
iBoxx € Sov 3–5	24.4	17.2	19.8	11.0	7.2	5.4	4.2	2.3	4.3	2.0	
iBoxx € Sov 5–7	21.1	20.1	22.4	6.8	8.6	6.0	3.9	2.5	5.7	1.7	1.2
iBoxx € Sov 7–10	19.3	25.3	21.2	8.3	4.3	5.8	4.5	2.5	4.1	3.1	1.7
iBoxx € Sov 10–15	4.3	26.0	23.4	7.2	5.8	6.6	5.8	4.8	7.2	7.6	1.3
iBoxx € Sov 15+	23.9	30.1	21.3	9.4	4.6	3.7	2.4	0.9	3.4		0.5
iBoxx € Sov 25+	22.0	20.7	31.0	11.6		4.9	4.4	2.3	3.0		
Lyxor											
EuroMTS 1-3Y	23.7	23.4	21.8	11.5	6.2	4.3	4.6	0.9	1.3	1.84	0.7
EuroMTS 3-5Y	24.1	18.0	21.2	9.0	7.6	6.0	3.7	2.6	4.7	1.34	1.8
EuroMTS 5-7Y	20.8	16.9	23.6	6.1	8.9	6.2	5.5	2.8	6.2	1.91	1.2
EuroMTS 7-10Y	18.6	24.2	19.6	9.1	4.1	5.6	5.3	3.3	3.9	4.36	2.1
EuroMTS 10-15Y	2.1	31.0	23.2	5.2	6.8	8.5	5.3	4.6	8.4	5.0	
EuroMTS 15Y+	22.3	29.0	21.3	11.0	5.3	3.7	2.3	0.9	3.6		0.8

Table 3 Volatility and correlation of sample ETFs and respective Indices, 2007-2010
This table presents volatility of sample ETFs and respective indices together with their correlations during the sample period. The volatility of ETF and respective indices is annualized standard deviation of daily returns. Volatility calculations assume 252 trading days per annum. The correlation is calculated using daily time series of ETFs' NAVs. N is number of assets in the portfolio.

ETFs and Indices	**Correlation**					**Volatility**	
						ETF	**Index**
	2007	2008	2009	2010	2007-10	2007-10	2007-10
IShares							
Barclays Term 1-3	0.99	0.99	1.00	1.00	0.99	1.43	1.42
Barclays Term 3-5	0.99	0.99	1.00	1.00	0.99	2.99	2.97
Barclays Term 5-7				0.99	0.97	3.27	3.29
Barclays Term 7-10	0.99	0.99	1.00	0.99	0.99	5.19	5.20
Barclays Term 10-15				1.00	0.98	4.71	4.70
Barclays Term 15-30	0.99	0.99	1.00	1.00	0.99	8.93	8.95
Average for Barclays	**0.99**	**0.99**	**1.00**	**0.99**	**0.99**	**4.42**	**4.42**
iBoxx€ Liq Sov Cap 1.5-2.5	0.95	0.98	0.98	1.00	0.99	2.34	2.42
iBoxx€ Liq Sov Cap 2.5-5.5	0.99	0.99	0.98	0.98	0.99	2.94	2.97
iBoxx€ Liq Sov Cap 5.5-10.5	0.92	0.99	0.96	1.00	0.97	4.79	4.98
iBoxx€ Liq Sov Cap 10.5+	0.84	0.99	0.93	1.00	0.94	8.73	9.32
iBoxx€ Liq Sov Cap 1.5-10.5	0.93	0.99	0.96	1.00	0.98	4.33	4.50
Average for iBoxx	**0.92**	**0.99**	**0.96**	**0.99**	**0.97**	**4.63**	**4.84**
eb.rexx 1.5-2.5	0.97	0.98	0.98	0.98	0.98	1.51	1.54
eb.rexx 2.5-5.5	0.99	0.99	0.98	1.00	0.99	2.92	3.01
eb.rexx 5.5-10.5	1.00	0.99	0.96	1.00	0.98	4.94	5.08
eb.rexx 10.5+	1.00	0.96	0.92	1.00	0.96	10.02	10.31
eb.rexx DE	0.99	0.99	0.98	1.00	0.99	3.36	3.40
Average for eb.rexx	**0.99**	**0.98**	**0.96**	**0.99**	**0.98**	**4.55**	**4.67**
db x-trackers							
short iBoxx		0.97	0.98	0.99	0.98	4.40	4.40
iBoxx € Sov	0.99	0.98	0.98	0.99	**0.98**	4.25	4.23
iBoxx € Sov 1–3	0.96	0.98	0.98	0.99	0.98	1.68	1.67
iBoxx € Sov 3–5	0.98	0.97	0.98	0.99	0.98	3.28	3.25
iBoxx € Sov 5–7	0.97	0.95	0.98	1.00	0.96	4.38	4.34
iBoxx € Sov 7–10	0.99	0.98	0.99	1.00	0.98	5.29	5.27
iBoxx € Sov 10–15	0.99	0.98	0.99	1.00	0.99	6.46	6.44
iBoxx € Sov 15+	0.99	0.99	0.98	0.98	0.99	9.21	9.20
iBoxx € Sov 25+	1.00	0.98	0.98	0.98	0.98	11.08	11.02
Average for db x	**0.98**	**0.98**	**0.98**	**0.99**	**0.98**	**5.56**	**5.54**
Lyxor							
EuroMTS 1-3	0.46	0.46	0.47	0.27	0.43	1.66	1.58
EuroMTS 3-5	0.43	0.47	0.38	0.34	0.42	3.14	2.97
EuroMTS 5-7	0.43	0.48	0.40	0.28	0.42	4.28	4.12
EuroMTS 7-10	0.40	0.44	0.43	0.39	0.43	5.08	4.90
EuroMTS 10-15	0.39	0.39	0.44	0.45	0.41	6.24	6.07
EuroMTS 15+	0.74	0.98	0.99	0.96	0.96	10.31	10.28
Average for Lyxor	**0.48**	**0.54**	**0.52**	**0.45**	**0.51**	**5.12**	**4.99**

Figure 1 Changes in volatility for sample ETFs

This figure represents changes in volatility for the sample ETFs targeting 10+ year maturities

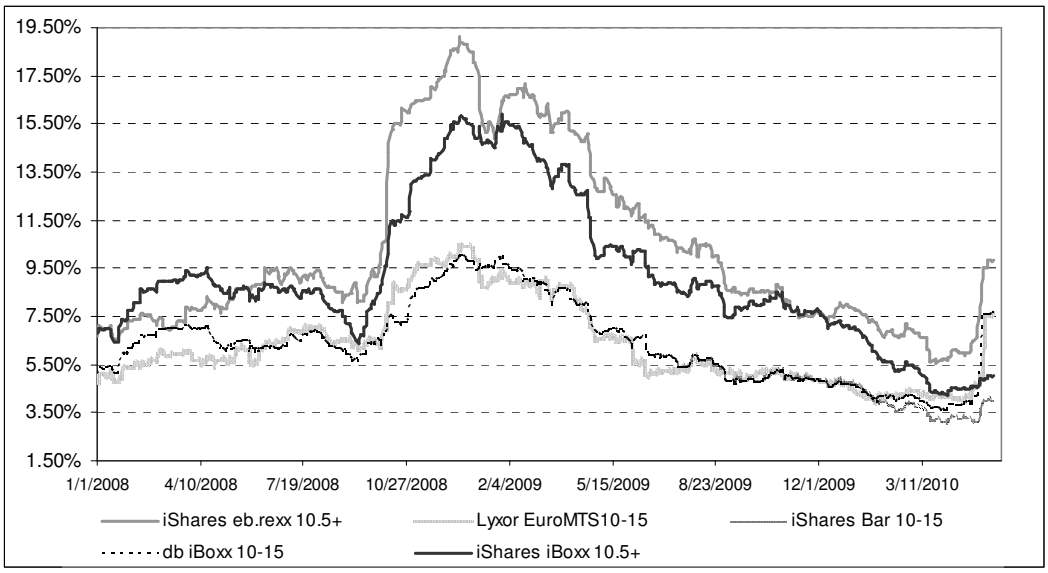

Table 4 Performance of sample ETFs by ETF providers, 2007-2010
This table represents ETFs annual returns (%) and benchmark adjusted performance presented in basis points [in brackets]. Positive basis points indicate overperformance of the funds over relevant indices.

		iShares			db x-track	Lyxor
		Barclays T.	iBoxx L.S.C.	eb.rexx		
Mean	2007	1.10 [23]	1.35 [8]	1.51 [5]	5.00 [16]	2.29 [-7]
	2008	9.99 [28]	8.99 [24]	12.35 [32]	8.17 [17]	9.13 [17]
	2009	4.39 [28]	3.64 [9]	1.91 [7]	2.79 [15]	4.46 [3]
	2010	12.45 [20]	7.88 [16]	14.58 [68]	7.80 [15]	8.37 [33]
	2007-10	6.58 [27]	4.95 [13]	6.10 [19]	5.37 [16]	5.86 [10]
Median	2007	2.15 [23]	1.89 [7]	2.66 [9]	5.03 [16]	2.97 [10]
	2008	10.37 [29]	9.77 [24]	11.52 [36]	8.97 [17]	9.43 [17]
	2009	4.21[27]	3.73 [8]	2.78 [10]	4.19 [15]	4.81 [0]
	2010	14.08 [21]	6.53 [14]	12.03 [63]	9.37 [16]	8.12 [31]
Min	2007	-3.42 [19]	-3.29 [3]	-3.59 [-11]	3.42 [15]	-0.2 [99]
	2008	6.42 [24]	6.48 [18]	7.13 [15]	-3.54 [12]	6.48 [15]
	2009	2.23 [21]	1.19 [6]	-1.59 [-12]	-3.21 [13]	2.13 [-7]
	2010	4.14 [13]	1.87 [10]	5.42 [29]	-7.77[12]	3.36 [4]
Max	2007	3.52 [26]	3.42 [12]	3.51 [13]	6.44 [16]	3.55 [20]
	2008	12.8 [31]	11.53 [27]	18.44 [47]	13.81 [19]	10.76 [18]
	2009	7.39 [39]	5.34 [11]	3.47 [15]	5.29 [16]	5.40 [17]
	2010	16.38 [25]	17.21 [30]	28.02 [127]	14.37 [18]	13.51 [63]

Tabela 5 Sample ETFs tracking error

This table presents results for average (mean) 3 month TE for respective ETFs, based on monthly and daily NAV series. N is number of assets in the portfolio – calculated by authors based on the data from ETFs' prospectuses. P-values for one sample T-test for mean=0 vs. mean#0 in brackets. Unreported results for one sample Wilcoxon test for median=0 vs. median#0 are economically and statistically consistent with the reported results for the T-test.

		AVERAGE 3-MONTH TE (IN BPS)					
	N	MONTHLY	DAILY				
		2007-10	2007-10	2007	2008	2009	2010
iShares							
Barclays Term 1-3	10	1.23(0.000)	0.77(0.000)	0.69	1.37	0.44	0.2
Barclays Term 3-5	15	1.96(0.000)	1.53(0.000)	1.28	3.02	0.59	0.54
Barclays Term 5-7	9	2.38(0.000)	2.29(0.000)	-	-	3.48	0.83
Barclays Term 7-10	13	2.80(0.000)	2.33(0.000)	2.08	5.08	0.36	0.76
Barclays Term 10-15	14	3.32(0.000)	2.95(0.000)	-	-	4.43	1.12
Barclays Term 15-30	30	4.69(0.000)	4.08(0.000)	4.14	8.77	0.62	0.68
Average for Barclays	**15**	**2.73(0.000)**	**2.32(0.000)**	**2.05(0.000)**	**4.56(0.000)**	**1.65(0.000)**	**0.69(0.000)**
iBoxx€ Liq Sov Cap 1.5-	15	1.97(0.000)	1.87(0.000)	1.84	2.28	1.55	1.72
iBoxx€ Liq Sov Cap 2.5-	15	2.63(0.000)	2.52(0.000)	1.81	2.81	2.93	2.11
iBoxx€ Liq Sov Cap 5.5-	15	7.05(0.000)	5.30(0.000)	7.53	4.26	6.02	1.75
iBoxx€ Liq Sov Cap	15	17.46(0.000)	12.80(0.000)	19.65	7.9	16.61	2.1
iBoxx€ Liq Sov Cap 1.5-	25	6.03(0.000)	4.65(0.000)	6.20	3.96	5.29	1.72
Average for iBoxx	**17**	**7.03(0.000)**	**5.43(0.000)**	**7.40(0.000)**	**4.24(0.000)**	**6.48(0.000)**	**1.88(0.000)**
eb.rexx 1.5-2.5	6	1.77(0.000)	1.89(0.000)	1.55	2.33	1.92	1.33
eb.rexx 2.5-5.5	12	3.15(0.000)	2.57(0.000)	1.74	2.63	3.56	1.47
eb.rexx 5.5-10.5	10	6.54(0.000)	4.84(0.000)	1.68	4.11	9.18	1.62
eb.rexx 10.5+	10	15.66(0.000)	11.78(0.000)	2.23	14.23	20.09	2.38
eb.rexx DE	25	2.77(0.000)	2.90(0.000)	1.54	3.09	4.28	1.44
Average for eb.rexx	**13**	**5.98(0.000)**	**4.79(0.000)**	**1.75(0.000)**	**5.28(0.000)**	**7.8(0.000)**	**1.65(0.000)**
db x-trackers							
short iBoxx	252	4.54(0.000)	4.38(0.000)	-	6.81	4.81	0.56
iBoxx € Sov	252	3.49(0.000)	3.32(0.000)	3.69	4.85	2.72	0.48
iBoxx € Sov 1–3	60	1.57(0.000)	1.53(0.000)	2.52	2.05	1.01	0.6
iBoxx € Sov 3–5	48	3.03(0.000)	3.07(0.000)	4.06	4.67	2.03	0.65
iBoxx € Sov 5–7	33	5.34(0.000)	5.03(0.000)	5.26	9.03	2.71	0.39
iBoxx € Sov 7–10	47	4.10(0.000)	3.81(0.000)	3.89	6.2	2.63	0.55
iBoxx € Sov 10–15	24	4.55(0.000)	4.34(0.000)	3.88	6.74	3.55	0.51
iBoxx € Sov 15+	44	6.33(0.000)	6.40(0.000)	5.45	7.69	7.56	0.79
iBoxx € Sov 25+	18	11.74(0.000)	9.42(0.000)	5.90	13.86	9.2	1.3
Average for db iBoxx	**86**	**4.97(0.000)**	**4.59(0.000)**	**4.33(0.000)**	**6.88(0.000)**	**4.02(0.000)**	**0.65(0.000)**
Lyxor							
EuroMTS 1-3	20	10.08(0.000)	9.54(0.000)	6.97	12.76	9.07	7.37
EuroMTS 3-5	22	20.33(0.000)	19.34(0.000)	13.68	25.15	20.07	13.27
EuroMTS 5-7	20	28.61(0.000)	26.94(0.000)	20.60	32.61	28.39	19.82
EuroMTS 7-10	22	34.78(0.000)	32.65(0.000)	26.20	38.86	34.22	24.02
EuroMTS 10-15	18	44.40(0.000)	40.72(0.000)	31.52	49.46	43.12	29.6
EuroMTS 15+	36	15.77(0.000)	12.87(0.000)	34.85	15.88	5.68	8.09
Average for Lyxor	**23**	**25.66(0.000)**	**23.68(0.000)**	**22.30(0.000)**	**29.12(0.000)**	**23.42(0.000)**	**17.03(0.000)**

Table 6 Differences in average TE across index families

This table presents results for the two sample T test for difference in mean and Mann Whitney (MW) test for difference in median TEs for different families of ETFs. All tests are for TEs estimated based on daily NAV series.

		T-test	**MW test**
Barclays T. vs.	iBoxx Liq.Sov.	-13.50(0.000)	16.31(0.000)
	eb.rexx	-14.26(0.000)	15.92(0.000)
	db.iBoxx	-11.29(0.000)	**2.33(0.020)**
	EuroMTS	-110.00(0.000)	33.55(0.000)
eb.rexx vs.	iBoxx Liq.Sov.	**-2.57(0.010)**	-3.93(0.000)
	db.iBoxx	**-0.74(0.458)**	-5.29(0.000)
	EuroMTS	-80.40(0.000)	33.60(0.000)
iBoxx Liq.Sov vs.	Db.iBoxx	3.01(0.003)	-7.19(0.000)
	EuroMTS	-69.29(0.000)	32.29(0.000)
Db.iBoxx vs.	EuroMTS	-74.06(0.000)	32.28(0.000)

Figure 2 Patterns of ETFs' tracking errors

This figure presents the patterns of three month daily TEs (in bps) for the sample ETFs targeting 10+ year maturities