

Fundamental indexation for bond markets

Marielle de Jong, Head of Fixed Income Quantitative Research – Amundi
Hongwen Wu, Research Analyst, Fixed Income Quantitative Research – Amundi



Photo credit : Frank Hülsbömer

Fundamental indexation for bond markets

Marielle de Jong

Head of Fixed Income Quantitative Research - Amundi

marielle.dejong@amundi.com

Hongwen Wu

Research Analyst - Fixed Income Quantitative Research - Amundi

About the authors



Marielle de Jong, Head of Fixed Income Quantitative Research, Paris

Marielle de Jong joined Amundi in 2011. Before that she was vice-president of the financial engineering team at Sinopia Asset Management (a Paris-based HSBC subsidiary). She started her working career in London in 1994 as a research analyst with BARRA and an equity fund manager with Quaestor (Yasuda subsidiary).

She holds a graduate degree in econometrics from the Erasmus University in Rotterdam, an MSc in operational research from the University of Cambridge (UK), and a PhD in economics and finance from the University of Aix-Marseille (in 2010). She has published a series of articles on equities, currencies and recently on fixed-income risk modelling issues.

Hongwen WU, Research Analyst – Fixed Income Quantitative Research – Amundi

Hongwen WU is consultant in the fixed-income quantitative research team at Amundi in Paris since 2011. He holds an engineering degree from SUPELEC, and a bachelor's degree in information engineering from Shanghai JiaoTong University in China. His current research focuses on the smart benchmarking and Buy-and-Hold investment strategy.

Abstract

The standard indices available for the bond investment markets, are composed of securities that are weighed by the size of the outstanding debt, and are for that reason weighing heavy on the ones most indebted. Those market indices are risky by construction and indeed appear to be. They are shown to be mean-variance inefficient in recent studies, which is disconcerting since that is in contradiction with the principle underlying the Capital Asset Pricing theory that the market as a whole is in price equilibrium. If market-weighted indices are inefficient, market weighting is inefficient!

We contribute to a growing literature on this question, which mostly focuses on equities, by testing on bonds. In the construction of market indices we weigh by the fundamental value of the debt issuers rather than their debt size. We do this for sovereigns using Gross Domestic Product figures, and for corporates taking sales revenues. The tests, which we run in the Eurozone over the sovereign debt crisis, add to the evidence that market weighting may indeed be inefficient.

Key words: mean-variance efficiency, bums problem, smart benchmarking, fundamental indexing

JEL classification: G10

Rethinking market indices

Ever since Charles Dow and Edward Jones launched their Industrial Average equity index back in 1896, the use of market indices has been on the increase in the investment management industry. It is a practical means to capture the price trend of the market as a whole, whereby the index basket serves as an investable proxy for the Market Portfolio. Cornerstone in the Sharpe-Lintner Capital Asset Pricing Model CAPM (see Sharpe [1964]), the Market Portfolio is said to be mean-variance efficient in theory. The question, raised in the 1970s (see e.g. Roll [1977] and Ross [1977]), however is whether the market index in the way it is constructed is efficient in this sense. If it is not, Roll and Ross [1994] argue, the use of such indices as benchmarks in an investment process is suboptimal.

The debate in the literature had started on equity indices initially and has spilled over to fixed-income as well. Bond indices, first launched by Standard and Poor's in 1926, are criticised on the same basis, by Siegel [2003] among others, who sees an inefficiency in the what-he-calls bums problem: since securities are weighed by the size of debt, the deepest indebted entities tend to be overweight. This problem has surfaced during the sovereign debt crisis in the Eurozone. The near-collapse of indebted Greece and the contagion to other peripheral countries has made the use of debt-weighted benchmarks unpopular and has revived the search for alternative *smart* benchmarks.

The fruits of this research are discussed in next section. The studies that have been carried out are of interest in that they reveal a sense of market inefficiency; they give empirical evidence of a systematic outperformance of smart indices over the value-weighted market index, which is a direct challenge to the fundamentals of finance theory. The evidence leads to believe that there may be an elemental problem in the habitual specification of the Market Portfolio. If the value-weighted index is inefficient, value weighting is inefficient. Much can be learned from the alternative weighting schemes that have been tried. What is more, the work done on equity indices can be seen as complementary to the research based on Fama and French' [1992] seminal paper, where additional risk factors are tried within the CAPM modelling framework. The additional factors that are found may have their origin in the deficiency of the market factor to which they have been tested.

Interestingly the smart indices that have been proposed, all take out the market price from the weighting schemes. The efficiency hypothesis of the Market Portfolio is based on the supposition that all assets traded on the market are in price equilibrium at all times. It gives no

consideration to liquidity issues or other reasons for price distortions. Showing that removing the price from the market specification systematically improves the return-to-risk profile, which reveals an inefficiency, is a novel way to give proof that the pricing anomaly issues are real.

Upon this premise we pursue the research on alternative market indices in this paper. We do this for the bond markets, on which little has been explored to date compared to equities. This paper starts by a short review of the literature and practice of alternative indexing, in section 2. In section 3 we set out the ideas which we put to the test, on empirical data described in section 4 and discussed in section 5. Section 6 concludes.

Review of the literature and investment practice

Three alternative approaches to building market indices have been developed over the last years. One of them, the simplest, is taking an equal weighting scheme. All assets traded on a market are being assigned an equal weight. Benartzi and Thaler [2001] describe the merits of this scheme, which they call the *one-over-N* approach. DeMiguel et al. [2009] show, on equity data, that it beats a large set of indices constructed differently including the classical value-weighted index. However, their results can be ascribed to certain features in their test dataset. Kritzman et al. [2010] show the fallacy of *one-over-N* when applied on markets with small and illiquid securities.

A second category of alternative indices takes a fundamental approach. Assets are weighed by fundamental characteristics that serve as a proxy for size. Such weighting scheme can be applied on an aggregate country level, or alternatively, within a country on a security level. On a country level, international indices are on offer by data providers which are weighed by the Gross Domestic Product (GDP). MSCI launched its GDP-weighted world equity index back in 1988, with the primary motive at the time to counter the large position of Japan. The argument was to avoid over-representing countries with a high ratio of listed companies over unlisted companies. The equity price crash in Japan shortly thereafter revealed that there may have also been an overpricing effect at the origin of Japan's large position.

GDP-weighted bond indices were first marketed in 2009 by Pimco, and by Barclays Capital who wanted at the launch to equilibrate the weight between developed and developing world debt. Bruder et al. [2011] give evidence that the GDP-weighted indices tend to be superior in terms of performance to debt-weighted indices. Researchers, e.g. Serrat et al. [2011], as well

as practitioners, such as Barclays Capital and MTS, propose refinements to the GDP approach for bond indices. Weights are adjusted by making use of certain national accounting statistics to further improve the performance. This approach is called fiscal strength-, or macro weighting. Those adjustments can be seen as attempts to include considerations of solvency into the weighting scheme. It makes sense: rather than size, the capacity to reimburse debts is taken as a criterion for judging the importance of a country.

On a security level, Research Affiliates first built fundamentally-weighted equity and bond indices, known as the RAFI indices, based on their publication “*Fundamental Indexation*”, see Arnott et al. [2005]. With reference to earlier debate on the noise-in-price problem (see Poterba and Summers [1988]), they take valuation-indifferent weights, which are based on the accounting value of firms as opposed to the market value: “[rather than the] Wall Street definition of the size of an enterprise [we take] Main Street measures.” The accounting value is measured by means of revenues, book value, sales, dividends, cash flow and employment figures. In Arnott et al. [2010] the weighting scheme has been refined for bond indices, by adding the bonds’ face value as an auxiliary measure for size.

A third category of alternative indices takes a risk-based approach. Maillard et al. [2010] propose the principle of risk parity, an equal-weighting scheme in terms of risk contribution rather than firm size. The idea is to weigh firms by the extent to which they participate in the market equilibrium pricing process. In practical terms, risk contribution is measured by means of price volatilities and correlation structure between the assets. Another risk-based approach is a weighting scheme that minimises the price volatility, called the minimum-variance approach. Haugen and Baker [1991] show it to structurally outperform the market index.

Yet other risk-based approaches have been proposed for equities such as the maximum diversification scheme by Choueifaty and Coignard [2008] or the risk-budgeting approach by Bruder and Roncalli [2012]. Demey et al. [2012] give an overview. In all, risk-based indexing deploys systematic asset allocation strategies giving a fixed reference point for investment managers. They have little relation though with the market index in its purpose to reflect the general market price trend. Risk-based investment is, to give an interpretation, a remedy to passive benchmark strategies based on a flawed index. The investment trend is becoming increasingly popular among equity fund managers, as reports Russo [2013].

Research approach

Of the three approaches to index building discussed in previous section, the fundamental approach seems to us the most adept, in the sense that it directly tackles the problems that have been identified in the standard indices. Taking valuation-indifferent asset values eliminates the non-informative price noise, as mentioned in previous section, and in the same time it resolves the bums problem in bond indices, as weights no longer depend on debt size. Arnott et al. [2005, 2010] were the first to bring these arguments forward and try fundamental indexing on bonds. Our study builds on their work.

Rather than taking a set of accounting measures, as they do, to determine the firm weights, we take a single measure, namely the sales revenues. We do this for two reasons. The first reason is data related. Sales revenues are relevant and easy to interpret in all types of economic activity, and are for that reason directly comparable between firms. Moreover data on revenues are easy to acquire compared to other accounting data. For the pertinence of the tests we reckon that data loss is to be avoided. To give a ballpark figure, Arnott et al. [2010] report to lose 16% of their test bed because of missing data, whereas our loss is less than 3%.

The second reason why we measure firm size by a single accounting measure is a more conceptual one. By no means do we intend to appraise the financial condition of a firm. That would be a different exercise. We want to measure firm size using a relatively objective criterion. Our test purpose is to see if the flaw in the value-weighted indices can be resolved through fundamental indexing and this without introducing any new elements. Following this logic through to sovereign debt, we carry out tests weighing countries by their Gross Domestic Product. More sophisticated weighing schemes, e.g. macro weighting, are interesting in itself but are, again, a different exercise beyond the scope of this paper.

We build fundamentally-weighted bond indices and compare them in empirical tests to their value-weighted counterparts, in order to establish the relative performance behaviour. We do this in the Eurozone, on a country level for sovereign debt and on a firm level for corporate debt. We test on existing indices built by data providers. We adopt their constituent definition and the bond selection criteria inherent to that. We are aware that by doing this Roll's [1977] critique is not addressed, who argued that the inefficiency of the Market Portfolio found in tests greatly stems from the incompleteness of the proxies that are being used. Indeed indices are sub-selections meant to be representative for the complete market. Our tests therefore give

relative results, determining whether fundamental weighting is more efficient than value weighting within the existing bond screening processes.

Only the index weighting schemes are modified in the tests. For the corporate index the debt structure is kept intact and this on the most consolidated firm holding level. The relative (value) weights of the bonds issued by the same holding are thus conserved. The sole modification is when, once a year, the weights between the firms are reset to the sales revenues. The rest of the time the weights evolve in accordance with the price movements, in the same way as for value-weighted indices. The turnover is kept low in this way. The extra turnover provoked by the annual rebalancing to revenues is around 15% on an annual basis.

Data and index construction

Tests on corporate debt are carried out on the Merrill Lynch Investment Grade Euro Corporate Index over a five-year period from March 2008 to December 2012. This index contains more than 1700 bonds issued by around 350 firms by the end of the period. Market data of the index members have been retrieved on a monthly frequency, including returns, yields-to-maturity and credit spreads. The bond durations, ratings and the economic sector classifications as defined by Merrill have been retrieved as well.

The firms' annual sales revenues have been retrieved from Bloomberg. A second data provider, Factset, has been called in for the purpose of data checking and to fill a few missing gaps. We have made use of Reuters to establish the link between the bonds and the issuing firms. Certain manual adjustments were necessary to deal with corporate actions in a way that data is timely yet foresight-free. A few isolated cases of negative revenues have been discarded. We eventually obtained a data coverage exceeding 97% of the index members.

The annual revenue figures correspond to fiscal years, which are in Europe for the largest part, 89%, calendar years, and are made public after the year's close in January or February. Given this situation we set the fundamental weights once a year in March on the basis of the last-reported revenues. The small time-lag for the few firms that publish their accounts in other periods has been ignored.

The tests on sovereign debt have been carried out on the Barclays Euro Government All Maturities Index from 2005 to 2012, composed of nominal bond issues from Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. Five small new members, Slovakia, Slovenia, Luxemburg, Malta and Cyprus, have

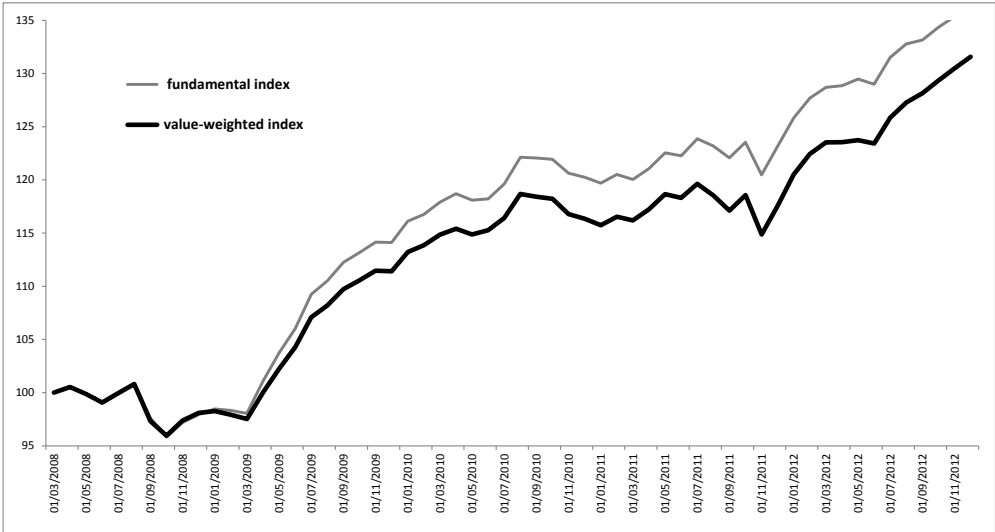
been discarded. Monthly market data has been provided by Barclays, and the GDP figures are those published annually by the International Monetary Fund in January.

Empirical tests

Corporate debt

Let us start by comparing the performance of the fundamentally-weighted index with that of the value-weighted index over the five-year test period. The fundamental index outperforms steadily, as can be seen in Exhibit 1. It outperforms by 0.8% per annum and that with a same volatility level at 4.2%. These results are comparable to those of Arnott et al. [2010] on the US corporate debt market from 1997 to 2009, and add to the evidence that the value-weighted market proxy may not be mean-variance efficient.

Exhibit 1 Performance of the fundamental- and value-weighted index



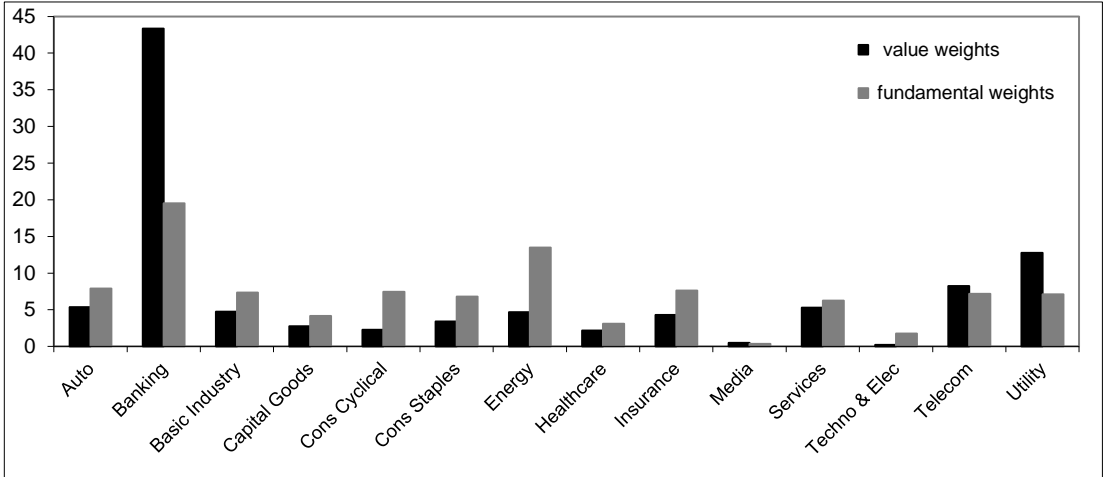
Data source: Merrill Lynch. Calculations made by the authors. Total returns are given in index levels starting at 100.

We compare the makeup of the two indices to see to what the outperformance is due. In Exhibit 2 the economic sector weights are given of the two indices. Its shows a substantial shift in weight: the overlap between the two indices in terms of weight is 40%. By construction the weight shifts away from the deepest indebted firms, which are the banks as can be seen in the Exhibit. The banking sector having underperformed considerably over the period, it is this weight shift which explains the largest part of the outperformance.¹ Fundamental weighting clearly reduces the bums problem in this empirical test.

Within each sector the makeup changes as well when modifying the weights, again shifting away from relatively indebted firms. In an additional test where the shift between sectors is separated from the shift within sectors, we find that the impact of the latter is small. Thus, it is less important to apply a fundamental weighting scheme on the individual firms of a sector than it is on the sectors as a whole. This makes sense. As the performance of bonds issued by firms that are in the same economic activity tends to be similar, reweighing them has less effect on their aggregate performance.

It is surprising that the fundamental index has not been spared in the heat of the banking crisis in 2008. The drawdown of 5% after Lehman’s collapse was as severe as for the market index. This observation seems to suggest that fundamental indexing doesn’t protect against extreme market events.

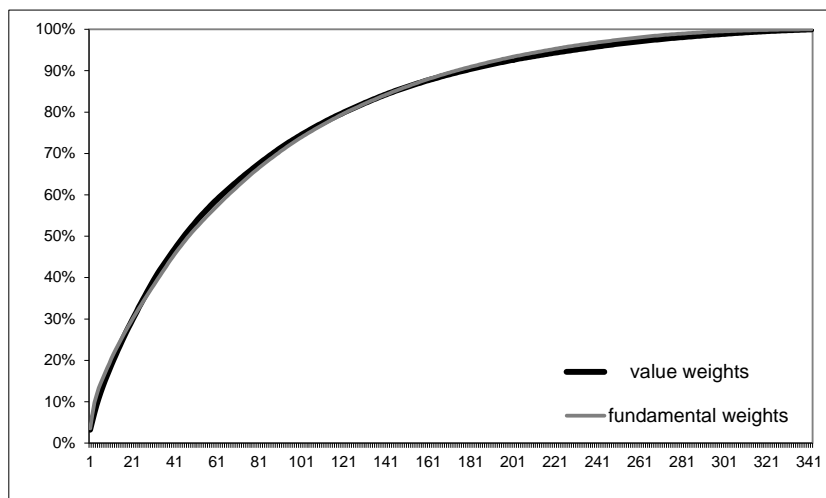
Exhibit 2 Economic sector weights



Data source: Merrill Lynch for market values, Bloomberg for sales revenues. Calculations made by the authors. Weights, as of December 2012, are verified to be stable over the test period.

We check whether fundamental indexing introduces a size bias compared to market weighting. In Exhibit 3 the firm sizes in terms of revenues and in terms of outstanding debt are ranked in decreasing order and then cumulated. The degree of convexity of the curves that result indicates the level of concentration. No size bias appears; the two indices have the same level of concentration. The 46 biggest firms in terms of revenues and the 48 biggest in terms of debt out of 342 firms in total, cover half of the respective index weights. They are not the same firms though, 18 of them overlap in December 2012.

Exhibit 3 Cumulated firm weights



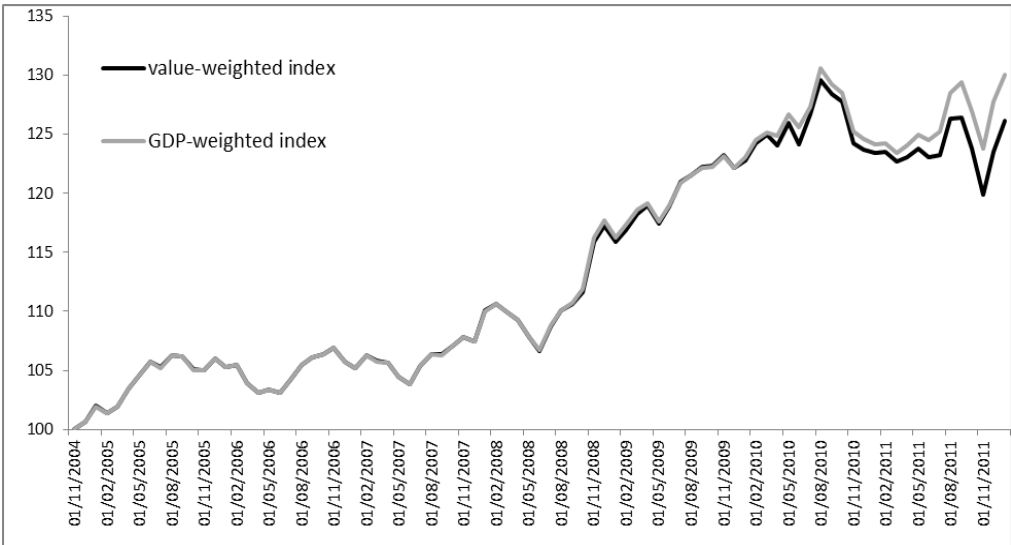
Data source: Merrill Lynch for market values, Bloomberg for sales revenues. Calculations made by the authors. Weights, as of December 2012, are verified to be stable over the test period.

Lastly, we look whether the outperformance can be attributed in part to the extra turnover that is generated by the annual rebalancing towards the revenue levels. Perold [2007], Blitz and Swinkels [2008] see this rebalancing turnover as the essential source of outperformance for fundamental indexing applied on equities. Indeed there is an implicit contrarian investment strategy in the rebalancing process when assets that have appreciated over the year are being sold and ones that have depreciated are bought. It cumulates to an outperformance if prices are mean reverting. We find that in our test this is not the case. When we increase the rebalancing frequency from annually to quarterly and monthly the outperformance of the fundamental index diminishes. This is an important point. It tells that the price noise is not the main issue for bond indices; it is before all the bums problem.

Sovereign debt

Turning to sovereigns, in Exhibit 4 the performance of the GDP-weighted Eurozone government bond index is compared to that of the market-weighted equivalent. Its outperformance, which starts to cumulate in the sovereign debt crisis as can be seen in the Exhibit, adds once more to the evidence that market weighting is inefficient. It is to us the most obvious example. Fundamental weighting reduces the weight of the peripheral countries (Portugal, Ireland, Italy, Greece and Spain), their aggregate GDP being inferior to their debt, as can be seen in Exhibit 5, where the debt-to-GDP ratios are given of the member states as of December 2011.

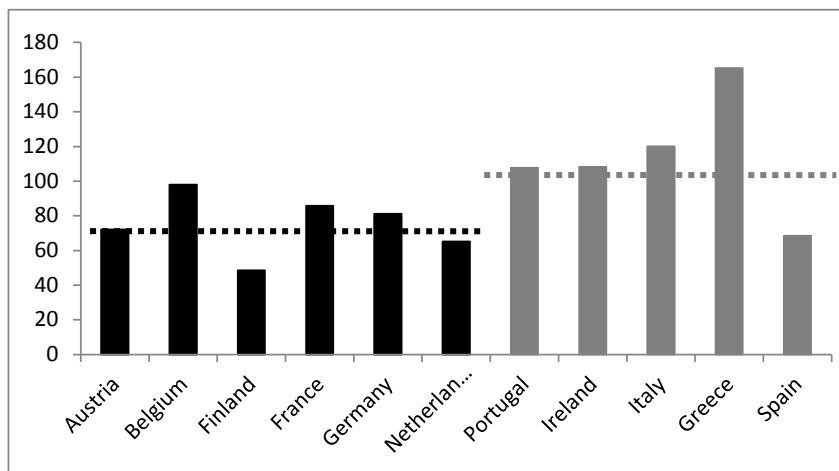
Exhibit 4 Performance of the GDP-weighted and value-weighted index



Data source: Barclays Capital. Calculations made by the authors. Total returns are given in index level starting at 100.

The financial situation of the peripheral countries has declined progressively over the observation period, which is one explanation as to why the performance of the market-weighted index has been lagging in a progressive manner as well. But it is before all the perception of the financial situation and of the consequences in terms of investment risk which has led to the gradual diversion in bond prices between the core- and the peripheral countries. We reckon that the extensive use of the market-weighted index as benchmark by market participants has played a role in this. The fact that this index is generally considered to provide a neutral exposure to the bond market as a whole, leads to a semi-automatic purchase of bonds as soon as they are included in the index. In this situation, if an indebted country issues yet another bond, the demand for this bond may be such that the risks related to the added leverage may not be priced in.

Exhibit 5 Debt-to-GDP ratios of the principal Eurozone member states



Data source: Barclays Capital. Calculations made by the authors. Data as of December 2011.

Conclusion

Fundamental indexation is proving an effective alternative for representing the bond markets. The philosophy is different from that of the longstanding market-weighted indices. Importance is being given to the role bond issuers play in the real economy rather than to their presence on the capital markets. By this more attention is paid to the capacity to take on debt and to eventually reimburse, which is an alternative appreciation of what the market stands for. The core of the question is to what degree entities participate in the market equilibrium pricing process. Is debt size the determinant factor or is it the economic activity that is financed by the debt?

The recent experience over the debt crisis in Europe indicates that debt size may not always be an effective reference point. On the sovereign bond market the high leverage of Greece was not expressed in the prices until late. Had the reference point been its domestic product there would perhaps not have been such appetite for Greek bonds, as its weight in the index would have been tiny and disconnected to its mounting debt. In the same way this could be argued for the banking sector within the corporates indices. How would banks have fared in the 2000s if they would have not been able to count on a semi-automatic demand for new issues due to massive market-index trading?

There are signs that in recent years investment practice is starting to adapt. An increasing number of alternative *smart* indices are being developed as well as investment products that are based on them. Those innovations are destined for equity investing mainly in today's

markets. This paper adds arguments why it should involve fixed-income investing equally well.

Endnote

¹This is a global phenomenon. We have verified this on the Merrill Lynch Global Corporate Investment Grade index over the same test period.

References

Arnott, R., J. Hsu, and P. Moore. "Fundamental Indexation." *Financial Analysts Journal*, Vol. 61, No. 2 (2005), pp. 83-99.

Arnott, R., J. Hsu, F. Li, and S. Shepherd. "Valuation-Indifferent Weighting for Bonds." *Journal of Portfolio Management*, Vol. 36, No. 3 (2010), pp. 117-130.

Benartzi, S., and R. Thaler. "Naive Diversification Strategies in Defined Contribution Saving Plans." *American Economic Review*, Vol. 91, No.1 (2001), pp. 79-98.

Blitz, D., and L. Swinkels. "Fundamental Indexation: an Active Value Strategy in Disguise." *Journal of Asset Management*, Vol. 9, No. 4 (2008), pp. 264-269.

Bruder, B., P. Hereil, and T. Roncalli. "Managing Sovereign Credit Risk." *Journal of Indexes Europe*, Vol. 1, No. 4 (2011), pp. 20-27.

Bruder, B., and T. Roncalli. "Managing Risk Exposure using the Risk Budgeting Approach." MPRA paper series No. 37749, 2012.

Choueifaty, Y., and Y. Coignard. "Towards Maximum Diversification." *Journal of Portfolio Management*, Vol. 34, No. 4 (2008), pp. 40-51.

DeMiguel, V., L. Garlappi, and R. Uppal. "Optimal Versus Naive Diversification: How Inefficient is the 1/N Portfolio Strategy?" *Review of Financial Studies*, Vol. 22, No. 5 (2009), pp. 1915-1953.

Fama, E. and French, K. "The Cross-Section of Expected Stock Returns." *Journal of Finance*, Vol. 47, No. 2 (1992), pp. 427-465.

Haugen, R., and N. Baker. "The Efficient Market Inefficiency of Capitalization-Weighted Stock Portfolio." *Journal of Portfolio Management*, Vol.17, No. 3 (1991), pp. 35-40.

Kritzman, M., S. Page, and D. Turkington. "In Defense of Optimization: The Fallacy of 1/N." *Financial Analysts Journal*, Vol. 66, No. 2 (2010), pp. 31-39.

Maillard, S., T. Roncalli, and J. Teiletche. "The Properties of Equally Weighted Risk Contribution Portfolios." *Journal of Portfolio Management*, Vol. 36, No. 4 (2010), pp. 60-70.

Perold, A. "Fundamentally Flawed Indexing." *Financial Analysts Journal*, Vol. 63, No. 6 (2007), pp. 31-37.

Poterba, J., and L. Summers, L. “Mean Reversion in Stock Prices: Evidence and Implications.” *Journal of Financial Economics*, Vol. 22, No. 1 (1998), pp. 27-59.

Roll, R. “A Critique of the Asset Pricing Theory’s Tests.” *Journal of Financial Economics*, Vol. 4, No. 2 (1977), pp. 129–176.

Ross, S. “The Capital Asset Pricing Model (CAPM), Short-Sale Restrictions and Related Issues.” *Journal of Finance*, Vol. 32, No. 1 (1977), pp. 177–183.

Roll, R., and S. Ross. “On the Cross-Sectional Relation between Expected Returns and Betas.” *Journal of Finance*, Vol. 49, No. 1 (1994), pp. 101-121.

Russo, A. “Low Risk Equity Investments: Empirical Evidence, Theories, and the Amundi Experience of Alternative Beta Strategies.” Amundi working paper series, 2013.

Serrat, A., and S. Sundaresan. “Market Capitalisation Weighted Indexes versus Macro Weighted Indexes.” Capula working paper, 2011.

Siegel, L. “Benchmarks and Investment Management.” Working Paper in the Research Foundation of the AIMR series, 2003.

Sharpe, W. “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk.” *Journal of Finance*, Vol. 19, No. 3 (1964), pp. 425-442

Chief Editors:

Pascal Blanqué

Deputy Chief Executive Officer

Head of Institutional Investors and Third Party Distributors

Group Chief Investment Officer

Philippe Ithurbide

Global Head of Research

Assistant Editor: Florence Dumont

Amundi Working Paper

WP-036-2013

April 2013



Written by Amundi.

Amundi is a French joint stock company (société anonyme) with a registered capital of EUR 584,710,755.

An investment management company approved by the French Securities Authority (Autorité des Marchés Financiers - "AMF") under No. GP04000036. Registered office: 90, boulevard Pasteur 75015 Paris-France. 437 574 452 RCS Paris.

In each country where they carry on investment business, Amundi and its affiliates are regulated by the local regulatory authority. This information contained herein is not intended for distribution to, or use by, any person or entity in any country or jurisdiction where to do so would be contrary to law or regulation or which would subject Amundi or its affiliates to any registration requirements in these jurisdictions. The information contained herein is produced for information purposes only and shall not be considered as an investment advice nor the sole basis for the evaluation of any Amundi's product. Any data provided herein is based on assumptions and parameters that reflect our good faith judgment or selection and therefore no guarantee is given as to the accuracy, completeness or reasonableness of any such data. No examination has been executed by us with respect to the financial, legal, tax, regulatory – and any related aspects thereof – situation of any addressee of the information here in.

amundi.com
