TOBAM*
CORE INVESTMENTS

DIVERSIFICATION DASHBOARD

September 2016

Diversification Ratios®

TOBAM's Diversification Ratio® (DR) measures to what extent a portfolio is diversified. The DR² (square of the diversification ratio) measures the number of effective degrees of freedom to which a portfolio is exposed.
As the table shows, the "broad market" indices leave diversification on the table. In addition to a snapshot of each market's DR², the table shows the DR² of a well-diversified portfolio, and the fraction of available diversification used by the index.

Universes	DR² Index diversification	DR² Maximum diversification®	% diversification used by index
All Countries World	4.06	13.26	30.3%
World	3.82	11.38	33.5%
Canada	3.81	9.90	38.5%
Emerging Markets	3.69	7.50	49.1%
US Equity	2.78	7.22	38.5%
Pacific Ex-Japan	2.10	5.24	40.1%
UK Equity	2.46	3.66	67.3%
EMU	1.85	3.44	53.7%
Japan	1.77	3.36	52.7%
US Credit	2.99	4.06	73.5%

Source: TOBAM, figures as of August 31, 2016

Portfolio Capacity and Beyond

The concept of capacity often lacks a precise definition. In this dashboard, we propose a particular notion of portfolio as well as investment universe capacity. Using this definition,

- we measure the current capacity of major equity markets,
- we explore how the proximity with the Market Cap Weighted Benchmark may affect the capacity of a portfolio.

As we shall see, this last question leads to answers that are not obvious and may come as a surprise. Indeed, we shall observe that there are portfolios close to the benchmark with very low capacity as there are portfolios very far from the benchmark with equal or higher capacity.

1. Definition of the Capacity of a Portfolio

Let us consider a simple portfolio, composed of 100% of Apple Inc. From the point of view of a single investor, his capacity to invest in this portfolio is clearly very far from $572Bio, i.e. the market capitalization of Apple as of August 31th, 2016.

In this dashboard, we will propose to define portfolio capacity as the maximum portfolio size -measured in dollars- such that one can buy (or sell) the portfolio over a given horizon, without being limited by liquidity.

The SEC has in fact given investors a similar definition, following the Investment Company Act of 1940:

"At least 85% of a fund's portfolio must be invested in "liquid assets"—assets that can be "sold or disposed of in the ordinary course of business within seven days at approximately the value at which the mutual fund has valued the investment".

Therefore, we define in this dashboard the capacity of a portfolio, as the maximum size such that a proportion x of it can be purchased – or sold- in less than d days, at a maximum p participation rate in order to take market liquidity into account. We denote this dollar amount Capacity(x,d,p).

Following the 40-act SEC guidance, we set d=5 trading days (hence 7 calendar days) and x=85%. Concerning the value of the participation, we will use p=20%, which means that trades done with less than a 20% participation rate can be done at (approximately) the same price as initially observed (valued).

We first note that there is one redundant parameter in the definition. Indeed, alternatively setting d=20 (~1 month) and a participation of y=5% would yield the same result. Said otherwise,

$$\text{Capacity}(0.85,5,0.20) = \text{Capacity}(0.85,20,0.05)$$

In fact, we have in general, for any positive number c,

$$\text{Capacity}(x,d,p) = \text{Capacity}(x,d*c,p/c) = \text{Capacity}(x,q,1)$$

where we set q=p*d. We have however chosen to keep these two parameters separately for exposition clarity.

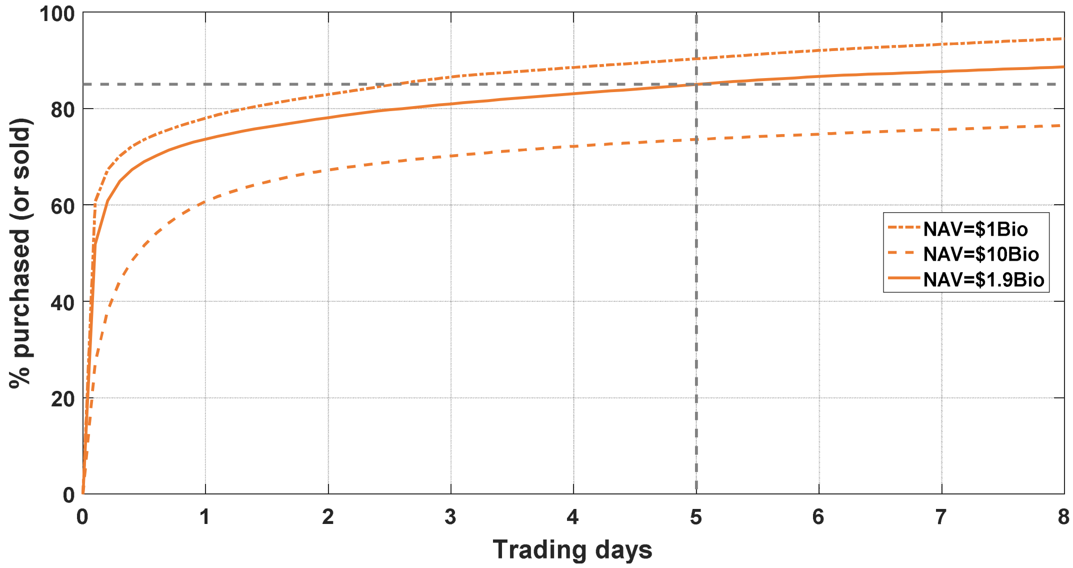
Secondly, since capacities are dollar-valued, they are comparable across portfolios, universes and times. Going further, if a portfolio P1 has twice the capacity of a portfolio P2, then it also means that P1 can be purchased or liquidated twice as fast as P2. This is formalized by the identity

$$\text{Capacity}(x,d*c,p) = \text{Capacity}(x,d,p*c) = c*\text{Capacity}(x,d,p) ,$$

for any positive c such that the participation p*c remains less than 1.

In order to illustrate the previous definition, Chart 1 depicts the investment in (or liquidation of) a portfolio with fixed weights and a NAV of either $1Bio or $10Bio.

Chart 1: Portfolio Capacity(0.85,5,0.20) Illustration



Source: TOBAM.

On the one hand, 85% of the $1Bio investment is liquidated in a little more than two days (dashed line at the top) while, on the other hand, it takes more than 10 days to liquidate the $10Bio (dashed line at the bottom). According to the definition, the capacity of this portfolio strategy is therefore in-between $1Bio and $10Bio. Its capacity is actually $1.9Bio, as shown by the orange plain line (crossing Trading days=5 and %purchased (or sold) =85%).

2. Definition of the Capacity of an Investment Universe

Let us introduce the notion of capacity of an investment universe, defined as the highest capacity an unlevered portfolio may reach within a given universe.

For instance, the Maximum Capacity(0.85,5,0.20) of the MSCI UK Universe is $8.6Bio, whereas the capacity of the MSCI UK index is of $7Bio (as of Aug. 2016, see table 1 below).

Interestingly, one can show that this maximum capacity is given by

Maximum Capacity(0.85,5,0.20) = (Sum of Trading Volumes across stocks)/0.85.

Furthermore, and as we shall also see in Section 3 below, the Maximum Capacity is reached by an infinite number of long-only unlevered portfolios.

We may actually expect the capacity of the cap-weighted portfolio to be almost identical to the capacity of the universe but this is surprisingly not the case for major universes as is detailed in the following table:

Table 1: MSCI Indices vs. Universe Capacity

MSCI Universe	UK	USA	WORLD	EM	ACWI
Index Capacity(0.85,5,0.20) ($Bio)	7.0	111.1	174.1	10.6	181.4
UniverseMax Capacity(0.85,5,0.20) ($Bio)	8.6	150.3	236.0	19.7	255.7
Ratio (%)	81.3	73.9	73.8	53.9	70.9

Note that all capacities are reported in dollars, and are hence comparable with one another. In particular, this table indicates that it takes about 17 times longer to invest the same $-position in the UK than in the US if invested in their respective MSCI Indices.

In the same way, the capacity of the MSCI EM universe is similar to that of the MSCI UK, whereas their capacity is *about ten times* lower than that of other large multi-currency universes.

Finally, we also wish to point out that within the EM universe, an investor could have invested twice as much in the portfolio with the highest capacity, instead of investing in the MSCI EM Index, *caeteris paribus.*

This last observation may come as a surprise, and motivates the analysis carried out in the next section.

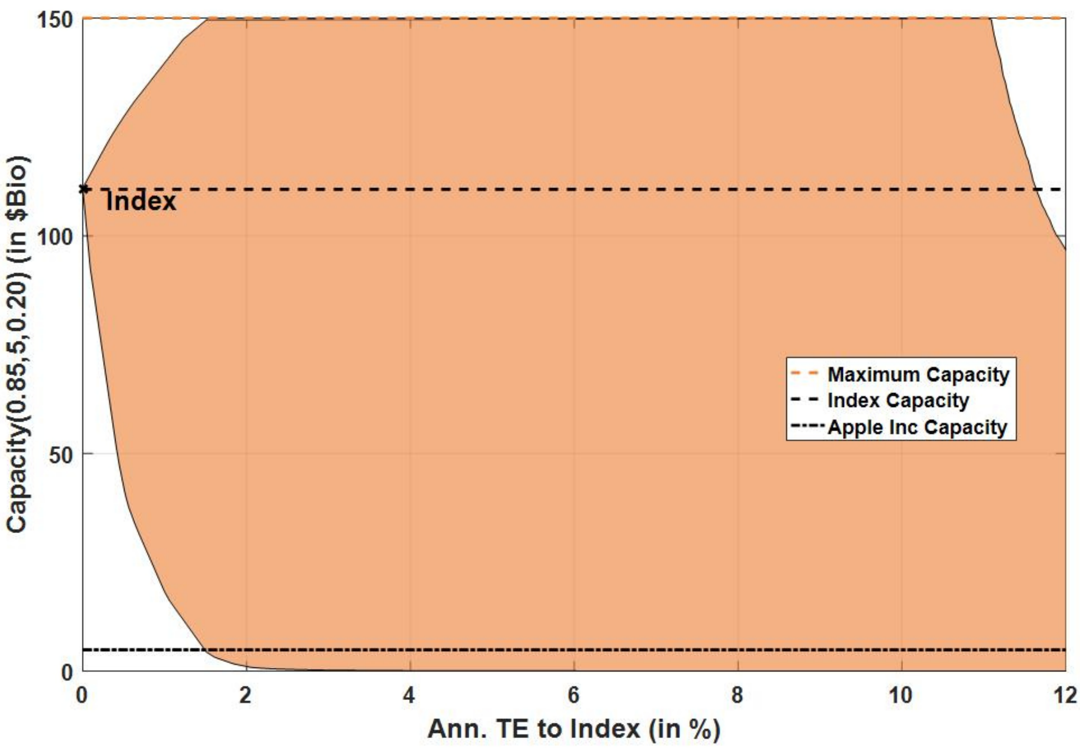
3. Is there a simple relationship between the Capacity of a Portfolio and its Tracking Error to the Market Capitalization Weighted Benchmark?

In this section, we are going to study the Capacity(0.85,5,0.20) of a Long-Only unlevered portfolio as a function of its annualized Tracking Error to the Index portfolio (henceforth denoted TE).

This study leads to many interesting observations and it becomes clear that the capacity of a portfolio is not related in a simple way to its TE to the index.

To observe this, let us first introduce Chart 2. In this chart, the shaded area depicts the Capacity(0.85,5,0.20) and Annualized Tracking Error of long-only and unlevered portfolios built within the MSCI USA Universe.

Chart 2: Capacity and Tracking Error to the Index of Long-Only Portfolios



Data Source: Bloomberg, MSCI, TOBAM. Results as of September 2016.

In Chart 2, we first note that the benchmark portfolio has a capacity that is about 74% of the Maximum Capacity(0.85,5,0.20), as already noted in Table 1. In fact, the universe Maximum Capacity(0.85,5,0.20) is actually reached by an infinite number of portfolios. Indeed, as we request only 85% of the portfolio positions to be bought – or sold- within d=5 days, the remaining positions can be chosen randomly without affecting the resulting capacity.

Now, given a portfolio with increasing TE, the maximum capital that can be invested increases from the Index Capacity(0.85,5,0.20) =$111Bio to reach the universe Max Capacity(0.85,5,0.20)=$150Bio and then decreases slowly.

Also, being close to the benchmark does not guarantee a high capacity. There is for instance a portfolio with a tracking error of only 2%, having a Capacity(0.85,5,0.20) of only $1Bio, representing less than a hundred times the Capacity of the MSCI USA index. It is also remarkable that portfolios with TE to the Index portfolio as low as 1% may actually have a Capacity(0.85,5,0.20) of about $20Bio, that is more than seven times lower than the MSCI USA Universe Capacity.

Conversely, there are portfolios very far from the benchmark that delivers the maximum capacity of the MSCI USA Universe. Said otherwise, there is an infinite number of portfolios with a tracking error greater than 10%, having a Capacity(0.85,5,0.20), 35% higher than that of the MSCI USA index.

4. Conclusion

In this dashboard, we formalized the notion of portfolio and universe capacity.

Using this definition, we observed that the benchmark portfolio, though having a high capacity, does not reach the maximum capacity of the investment universe.

Furthermore, analysing the capacity of major investment universes, it appears that they may have significantly different capacities: the MSCI UK and MSCI EM both have a capacity that is about ten times lower than that of the MSCI USA.

It is also remarkable that the proximity, in terms of tracking error, of a portfolio with the benchmark portfolio, does not tell us much about its capacity.

Indeed, there are portfolios close to the benchmark with very low capacity, as there are portfolios very far from the benchmark that actually delivers the maximum capacity achievable in their universe.

For more information

TOBAM is an asset management company offering innovative investment capabilities whose aim is to maximize diversification. TOBAM's Maximum Diversification® approach, supported by original, patented research and a mathematical definition of diversification, provides clients with diversified core exposure, in both the equity and fixed income markets. The company manages $9 billion (September 2016) via its Anti-Benchmark® strategies in Equities and Fixed Income. Its team includes 46 investment professionals.

Contacts

Paris
49-53, Avenue des Champs-Elysées
75008 Paris
France

Cape Town
Dublin
Hong Kong
New York
Toronto
Zürich

Client Service
clientservice@tobam.fr

Disclaimer

This material is solely for the attention of institutional, professional, qualified or sophisticated investors and distributors. It is not to be distributed to the general public, private customers or retail investors in any jurisdiction whatsoever. This document is intended only for the person to whom it has been delivered.

Funds and/or SICAV specific information may have been provided for information solely to illustrate TOBAM's expertise in the strategy. Funds or the SICAV that might be mentioned in this document may not be eligible for sale in some states or countries and they may not be suitable for all types of investors. In particular, TOBAM funds are not registered for sale in the US, and this document is not an offer for sale of funds to US persons (as such term is used in Regulation S promulgated under the 1933 Act). This material is provided for information purposes only and does not constitute a recommendation, solicitation, offer, advice or invitation to purchase or sell any fund, SICAV or sub-fund or to enter in any transaction and should in no case be interpreted as such, nor shall it or the fact of its distribution form the basis of, or be relied on in connection with, any contract for the same.

The information provided in this presentation relates to strategies managed by TOBAM, a French investment adviser registered with the U.S. Securities and Exchange Commission (SEC) under the U.S. Investment Advisers Act of 1940 and the Autorité des Marchés Financiers (AMF) and having its head office located at 49-53 avenue des Champs Elysées, 75008 Paris, France. TOBAM's Form ADV is available free of charge upon request. In Canada, TOBAM is acting under the assumed name "Tobam SAS Inc." in Alberta and "TOBAM Société par Actions Simplifiée" in Québec.

Investment involves risk. All investors should seek the advice of their legal and/or tax counsel or their financial advisor prior to any investment decision in order to determine its suitability. The value and income produced by a strategy may be adversely affected by exchange rates, interest rates, or other factors so that an investor may get back less than he or she invested.

Past performance and simulations based on thereon are not indicative of future results nor are they reliable indicators of future performance. Any performance objective is solely intended to express an objective or target for a return on your investment and represents a forward-looking statement. It does not represent and should not be construed as a guarantee, promise or assurance of a specific return on your investment. Actual returns may differ materially from the performance objective, and there are no guarantees that you will achieve such returns. Back tests do not represent the results of an actual portfolio, and TOBAM does not guarantee the accuracy of supporting data. The constraints and fees applicable to an actual portfolio would affect results achieved.

This material, including back tests, is based on sources that TOBAM considers to be reliable as of the date shown, but TOBAM does not warrant the completeness or accuracy of any data, information, opinions or results. TOBAM has continued and will continue its research efforts amending the investment process from time to time accordingly. TOBAM reserves the right of revision or change without notice, of the universe, data, models, strategy and opinions. TOBAM accepts no liability whatsoever, whether direct or indirect, that may arise from the use of information contained in this material. TOBAM can in no way be held responsible for any decision or investment made on the basis of information contained in this material. The allocations and weightings, as well as the views, strategies, universes, data, models and opinions of the investment team, are as of the date shown and are subject to change.

This document and the information herein is disclosed to you on a confidential basis and shall not be reproduced, modified, translated or distributed without the express written permission of TOBAM or TOBAM NORTH AMERICA and to the extent that it is passed on, care must be taken to ensure that any reproduction is in a form which accurately reflects the information presented here. This information could be presented by TOBAM NORTH AMERICA, a wholly-owned subsidiary of the TOBAM group of companies that is authorized to present the investment strategies of TOBAM, subject to TOBAM's supervision, but is not authorized to provide investment advice.