

Portfolio Diversification through Structured Catastrophe Bonds amidst the Financial Crisis

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Abstract

The paper explores the impact of investing in structured catastrophe bonds on the performance of both European and international well diversified portfolios formed by stocks from developed and emerging countries and other several assets, by focusing on examining its evolution during periods of tranquility, turmoil and slow recovery that characterized the international financial markets recently. The analysis is developed by deriving efficient frontiers shaped by portfolios formed with and without catastrophe bonds and by examining their shifting profile. The main findings reflect that, overall, investing in catastrophe bonds proved to be a prudent strategic decision both in normal, turbulent and recovery times, while the recent crisis had some influences on the performance of the portfolios, even when diversifying by investing in cat bonds. The importance of the analysis resides from studying if adding catastrophe bonds within portfolios improves the risk-return profile of investments made at European and international level.

Key words: *structured catastrophe bonds, alternative risk transfer solutions, international financial crisis, portfolio diversification, efficient frontiers*

JEL Classification: *G15, G01, G11*

Introduction

There is worldwide consensus that the most recent economic crisis proved to be one that had a severe impact on the international financial markets, affecting the developed and emerging economies and altering one of the fundamental pillars of the global financial system, mainly the confidence of the investors. One asset class that exposed resilience during the economic crisis was represented by the catastrophe bonds markets.

Nevertheless, even this sector of the alternative risk transfer solutions (ART) proved not to be totally neutral to the financial turmoil, mostly due to the bankruptcy of Lehman Brothers as guarantor of certain catastrophe bonds and as a result of the worsening condition of several hedge funds that were significant investors within this market [2].

Taking into account that natural catastrophes are not correlated with market risk, the catastrophe – linked assets are considered to be an important source of diversification for investors by improving the risk-return profile within portfolios [5]. In view with this statement, there are several studies that investigate the relation between catastrophe risk and other asset classes.

Within a paper that explores the securitizing catastrophic risks in the form of instruments accessible to the broad capital markets, the authors find that the correlations between the adjusted historical loss ratios (AHLRs) and the S&P 500 index and a government bond index were 0.058 and 0.105, respectively, over the sample period, March 1955-December 1994. Furthermore, the study concludes that the addition of small amounts of securitized reinsurance to diversified portfolios would enhance the risk/reward opportunities [4].

Within another research paper, that focuses on explaining the terminology of insurance and reinsurance, the structure of insurance-linked securities, by also providing an overview of major transactions, the authors find that the risk-adjusted returns on CAT bonds dominate high-yield bonds and show that a relatively small allocation of insurance-linked securities within a fixed income portfolio enhances the expected return while simultaneously decreases risk [1].

In a more recent study, the authors examine the correlation of returns on the Swiss Re BB-rated ILS index with other investment indices before and during the financial crisis. The authors conclude that catastrophe bond total returns have almost no correlation with returns on alternative investments during normal times, while the situation is different during the most recent financial crisis. However, the correlations with stocks are still relatively low and these assets are not significantly correlated with the Barclays government bond index. Therefore, they could still be used effectively to diversify portfolios containing most types of stocks and bonds [3].

Research Methodology and Data

The research is developed by considering two types of investors: *the first one focuses on developed and emerging European stock markets while the second one invests in international developed (except USA) and emerging markets*. They both diversify their portfolios by investing on the US market by considering three different types of investments: *traditional* (the bond market), *alternative* (the commodities and the real estate market) and *thematic* (stocks of US companies that fulfil high environmental, social and governance criteria).

In order to reflect the exposure of the first investor to the *catastrophe bond market* the selected index was represented by *Swiss Re Cat Bond Total Return Index (SRCBTR)* which tracks the total rate of return for all outstanding USD denominated cat bonds. The exposure to catastrophe bonds market of the second investor was reflected within the analysis by the *Swiss Re Global Unhedged Cat Bond Performance Index Total Return (SRCBGL)* that tracks the aggregate performance of all USD and EUR denominated cat bonds, capturing all ratings, perils and triggers. The index captures the full impact of the foreign currency risk by converting the EUR-denominated bonds to USD each week. The two indices are based on Swiss Re pricing indications only and are published on Bloomberg.

For the first index the weekly data was collected for the *26th of November 2004 – 29th of July 2011* period, while for the second one for the *18th of August 2006 – 29th of July 2011*. In order to take into account the different lengths of the two series, the other indices were introduced within the analysis accordingly.

The *stock market* is represented by Standard & Poor's Global Broad Market Indices (for large and medium capitalization companies). In order to reflect the choice of the first investor, there was selected an index that measures the performance of European developed and emerging stock markets, while for the second investor there was considered an index that reflects the performance of developed (excepting USA) and emerging stock markets.

The *bond market* is represented by the BofA Merrill Lynch US Corp Master Total Return Index Value which tracks the performance of US dollar denominated investment grade rated corporate debt publically issued in the US domestic market.

For the *commodities market* there was selected the Dow Jones-UBS Commodity Index Total Return, composed of commodities traded on U.S. exchanges, with the exception of aluminium, nickel and zinc, which trade on the London Metal Exchange (LME).

To reflect the exposure to the *real estate market* there was selected the Dow Jones U.S. Select REIT Total Return that includes only REITs and REIT-like securities.

The MSCI USA ESG index, collected from the Morgan Stanley Capital International Database, mirrors the exposure to US stocks of companies that that have high environmental, social and governance – *ESG performance*.

Therefore, we explore the benefits derived from investing in catastrophe bonds for the two investors by deriving efficient frontiers shaped by portfolios formed both without and with catastrophe bonds, by allowing short selling. The analysis is employed both by considering the overall period and by decomposing it in three sub-periods that reflect the state of the international financial markets: (1) a period of tranquillity/normal period, up to September 2007; (2) a period of crisis, October 2007-March 2009 and (3) a period of slow recovery, April 2009-July 2011.

In *Table 1: Descriptive statistics of returns – first investor perspective* there are presented the values of mean weekly returns, standard deviations, skewness and kurtosis of the seven assets that the first investor considers within his portfolios, both for the overall period, and for the three sub-periods.

Table 1. Descriptive statistics of returns – first investor perspective

<i>Overall period</i>							
	<i>Dev Eur</i>	<i>Em Eur</i>	<i>Bond US</i>	<i>Comm</i>	<i>REIT US</i>	<i>ESG US</i>	<i>SRCBTR</i>
Mean	0,0011	0,0022	0,0011	0,0006	0,0013	0,0007	0,0016
St. Dev.	0,0352	0,0536	0,0078	0,0289	0,0480	0,0279	0,0035
Kurtosis	11,4760	8,8777	9,5395	2,8426	5,3097	9,1518	17,2235
Skewness	-1,6503	-0,2711	-1,3589	-1,0812	-0,2856	-1,0337	-2,8530
Minimum	-0,2673	-0,2646	-0,0535	-0,1459	-0,2150	-0,1975	-0,0218
Maximum	0,1391	0,3608	0,0317	0,0628	0,2168	0,1150	0,0151
<i>The normal period</i>							
Mean	0,0039	0,0063	0,0006	0,0018	0,0032	0,0020	0,0017
St. Dev.	0,0195	0,0384	0,0049	0,0238	0,0249	0,0147	0,0029
Kurtosis	1,3624	2,5209	-0,7535	0,2203	1,0097	0,6773	16,7649
Skewness	-0,5479	-0,9613	-0,0840	-0,3458	-0,6089	-0,5051	-2,6921
Minimum	-0,0631	-0,1448	-0,0106	-0,0725	-0,0920	-0,0459	-0,0177
Maximum	0,0521	0,1255	0,0119	0,0571	0,0616	0,0345	0,0103
<i>The crisis period</i>							
Mean	-0,0097	-0,0129	-0,0009	-0,0058	-0,0137	-0,0075	0,0008
St. Dev.	0,0570	0,0851	0,0121	0,0405	0,0766	0,0466	0,0042
Kurtosis	5,0330	5,1043	5,4346	1,5660	1,8231	3,4004	18,9922
Skewness	-1,1146	0,3873	-1,3562	-1,0875	0,0359	-0,5053	-3,7310
Minimum	-0,2673	-0,2646	-0,0535	-0,1459	-0,2150	-0,1975	-0,0218
Maximum	0,1391	0,3608	0,0317	0,0628	0,2168	0,1150	0,0108

Table 1 (cont.)

<i>The slow recovery period</i>							
Mean	0,0046	0,0070	0,0028	0,0032	0,0086	0,0043	0,0019
St. Dev.	0,0305	0,0406	0,0068	0,0250	0,0441	0,0232	0,0035
Kurtosis	2,5457	1,8924	0,0966	1,1143	1,8337	0,6102	11,7140
Skewness	-0,6575	-0,5292	0,0104	-0,7215	0,3957	-0,2678	-1,8606
Minimum	-0,1351	-0,1548	-0,0128	-0,0951	-0,1335	-0,0659	-0,0165
Maximum	0,0787	0,1065	0,0236	0,0571	0,1643	0,0677	0,0151

In Table 2: Descriptive statistics of returns – second investor perspective there are presented the values of mean weekly returns, standard deviations, skewness and kurtosis of the seven assets that the first investor considers within his portfolios, both for the overall period, and for the three sub-periods.

Table 2. Descriptive statistics of returns – second investor perspective

<i>Overall period</i>							
	<i>Dev_Glob- exUS</i>	<i>Em_Glob</i>	<i>Bond_US</i>	<i>Comm</i>	<i>REIT_US</i>	<i>ESG_US</i>	<i>SRCBGL</i>
Mean	0,0005	0,0021	0,0013	0,0001	0,0003	0,0006	0,0018
St. Dev.	0,0348	0,0386	0,0086	0,0297	0,0541	0,0314	0,0039
Kurtosis	10,2513	5,8686	8,5920	3,3926	3,9467	7,2747	14,8659
Skewness	-1,6696	-0,9116	-1,4225	-1,2704	-0,2174	-0,9684	-2,1885
Minimum	-0,2448	-0,2161	-0,0535	-0,1459	-0,2150	-0,1975	-0,0276
Maximum	0,1172	0,1595	0,0317	0,0628	0,2168	0,1150	0,0159
<i>The normal period</i>							
Mean	0,0045	0,0079	0,0011	0,0014	0,0019	0,0035	0,0031
St. Dev.	0,0182	0,0261	0,0050	0,0193	0,0278	0,0157	0,0022
Kurtosis	2,2407	2,6413	-0,9011	1,1326	1,7276	1,5997	4,0813
Skewness	-0,8753	-0,8158	0,0189	-0,7282	-0,7778	-0,8977	1,3114
Minimum	-0,0559	-0,0758	-0,0089	-0,0577	-0,0920	-0,0459	-0,0029
Maximum	0,0474	0,0764	0,0119	0,0394	0,0616	0,0314	0,0103
<i>The crisis period</i>							
Mean	-0,0088	-0,0080	-0,0009	-0,0058	-0,0137	-0,0075	0,0008
St. Dev.	0,0512	0,0553	0,0121	0,0405	0,0766	0,0466	0,0049
Kurtosis	5,2284	3,0792	5,4346	1,5660	1,8231	3,4004	15,8710
Skewness	-1,2171	-0,4993	-1,3562	-1,0875	0,0359	-0,5053	-3,0563
Minimum	-0,2448	-0,2161	-0,0535	-0,1459	-0,2150	-0,1975	-0,0276
Maximum	0,1172	0,1595	0,0317	0,0628	0,2168	0,1150	0,0111
<i>The slow recovery period</i>							
Mean	0,0045	0,0057	0,0028	0,0032	0,0086	0,0043	0,0019
St. Dev.	0,0260	0,0283	0,0068	0,0250	0,0441	0,0232	0,0037
Kurtosis	1,5087	1,0612	0,0966	1,1143	1,8337	0,6102	4,1469
Skewness	-0,4710	-0,2954	0,0104	-0,7215	0,3957	-0,2678	-0,5724
Minimum	-0,1021	-0,0914	-0,0128	-0,0951	-0,1335	-0,0659	-0,0128
Maximum	0,0719	0,0936	0,0236	0,0571	0,1643	0,0677	0,0159

The analysis was performed by using the MATLAB computational package, using the Financial Toolbox. Hence, for each of the four periods considered within the analysis (the overall, the normal, the crisis and the slow recovery period), we derived the efficient frontiers which stand for the set of all *efficient portfolios*, portfolios for which the expected returns achieve the maximum value given a certain level of risk. Therefore, combinations along the curve stand for portfolios for which, for a certain level of return, there is the lowest level of risk (represented by the standard deviation).

Consequently, for each series, within each of the four periods, there were computed the weekly logarithmic returns. Starting from the weekly returns series, for each asset there were calculated the *expected returns* – the mean of each series, the *standard deviations* and the *correlation coefficients* between the assets. Afterwards, by using the standard deviations and the correlation coefficients there was determined the *covariance matrix of the returns series* (with the cat bonds included and without the cat bonds). Each of the sixteen mean-variance efficient frontiers (eight derived by investing in catastrophe bonds and eight derived without including the catastrophe bonds indices) was generated with twenty *efficient portfolios* determined by using the *portop function* and specifying as its arguments the previously determined *expected returns and covariance*.

Results and Discussion of Findings

The research results are displayed in Fig. 1-Fig. 4 as far as the investments of the European based investor are regarded, and in Fig. 5-Fig. 8 for the international based investor.

European stock markets portfolio

As one can notice from Fig. 1.: *SRCBTR – Efficient frontiers – Overall period*, the portfolios that include catastrophe bonds represented by the SRCBTR index (continuous red curve) outperform the portfolios that do not consider catastrophe bonds for the overall period (dotted blue curve). Furthermore, one can observe that by choosing to invest in catastrophe bonds, the investor expanded the risk-return profile and had the opportunity to obtain returns that otherwise could not have been achieved.

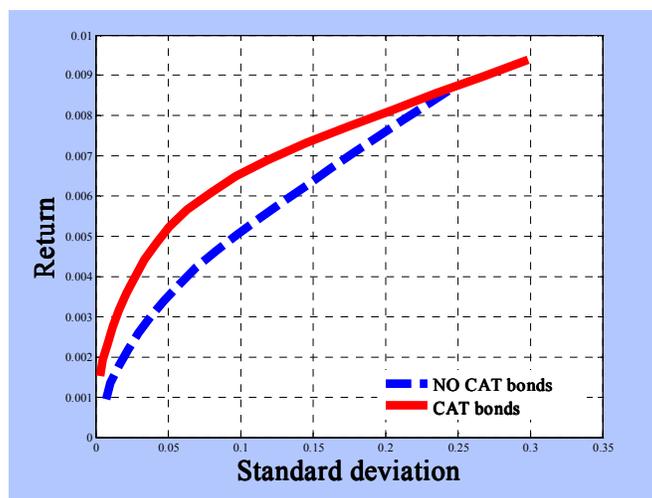


Fig. 1. SRCBTR – Efficient frontiers – Overall period

As far as the tranquillity period on the international financial markets is concerned, Fig. 2.: *SRCBTR – Efficient frontiers – Normal period* suggests that the portfolios including catastrophe bonds have an enhanced risk-return performance in comparison with those including only stocks

from European developed and emerging markets and the assets from the US market (bonds, commodities, real estate securities and ESG stocks).

One can also notice that the efficient frontier formed by portfolios that include catastrophe bonds (the red continuous curve) expands beyond the efficient frontier shaped by portfolios that do not include catastrophe bonds, reflecting that the investors tolerating higher levels of risk could have obtained considerable higher returns, unattainable when considering the opposite situation. However, for the middle levels of risk, the two frontiers are superimposed, fact that suggests a situation of indifference towards the two types of analyzed portfolios during normal times.

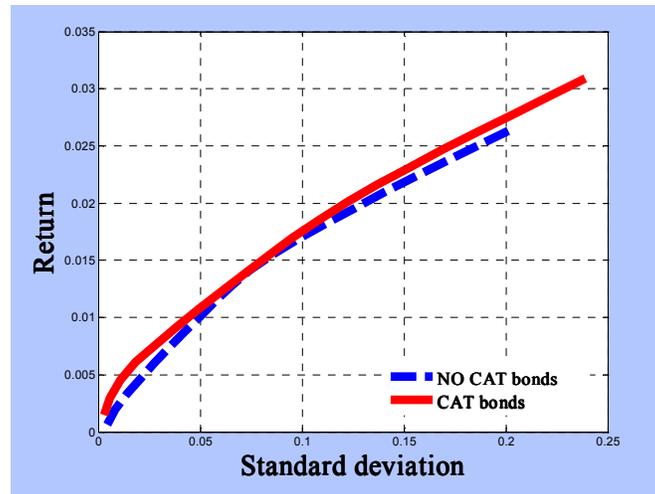


Fig. 2. SRCBTR – Efficient frontiers – Normal period

When analyzing the crisis period that characterized the international environment in recent times (see Fig. 3.: SRCBTR – Efficient frontiers – Crisis period), the research reveals that the efficient frontier formed by portfolios including catastrophe bonds significantly shifts on the north-west direction and, the higher the tolerated risk, the more it distances from the efficient frontier of the portfolios formed without investing in catastrophe bonds.

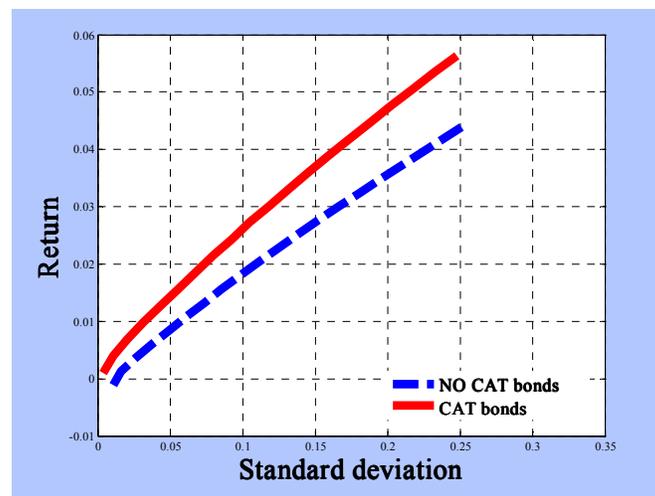


Fig. 3. SRCBTR – Efficient frontiers – Crisis period

Nevertheless, unlike the case of the overall and the normal period, the efficient frontier formed by including cat linked bonds does not expand beyond the efficient frontier derived from

portfolios that do not include cat bonds, fact that could be the consequence of the turmoil on the catastrophe bond market.

As for the slow recovery of the international financial markets period (see Fig. 4.: *SRCBTR – Efficient frontiers – Slow recovery period*), one can notice that by including catastrophe bonds, the efficient frontier is shifted in a positive manner for the investor, while the higher the risk, the larger the distance between the two efficient frontiers. An additional remark refers to the fact during the recovery period another pattern is resumed: cat bonds efficient frontier unfolds beyond the efficient frontier of portfolios made up without cat bonds.

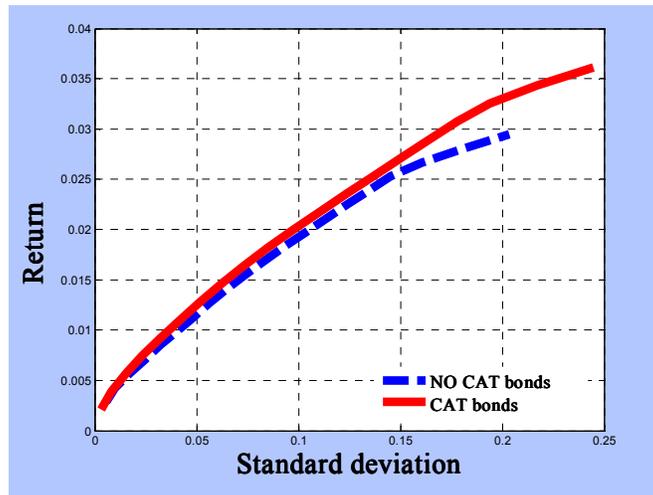


Fig. 4. SRCBTR – Efficient frontiers – Slow recovery period

International Stock Markets Portfolio

As far as the overall period is concerned, the investor having a portfolio diversified at international level who also chose to invest in catastrophe bonds (see Fig. 5.: *SRCBGL – Efficient frontiers – Overall period*) achieved a better performance in comparison with the situation eluding the cat bond markets. In addition, one can remark that over a certain level of risk, by investing in catastrophe bonds, the investors could have achieved returns that could not have been obtained by investing only in classic assets.

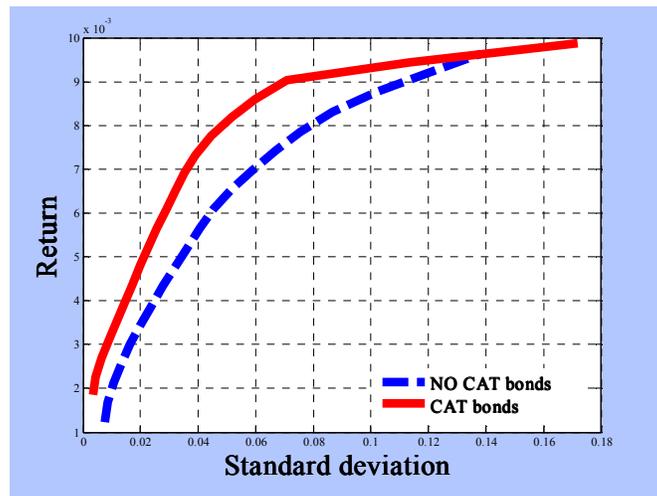


Fig. 5 SRCBGL – Efficient frontiers – Overall period

For the normal period (see Fig. 6.: SRCBGL – Efficient frontiers – Normal period), one can observe that the cat bond efficient frontier is superior to the efficient frontier derived from portfolios made up only of traditional, alternative and thematic assets. Furthermore, the pattern regarding the expansion of the cat bond efficient frontier further than the efficient frontier made up of portfolios that do not include cat bonds still holds. However, unlike the precedent situation, the two efficient frontiers do not superimpose. This could be due to the fact that in this case the diversification of the international portfolio through catastrophe bonds is considered through an index that tracks the global performance of the cat bond market, considering all the perils and trigger types; therefore the potential of diversification is higher.

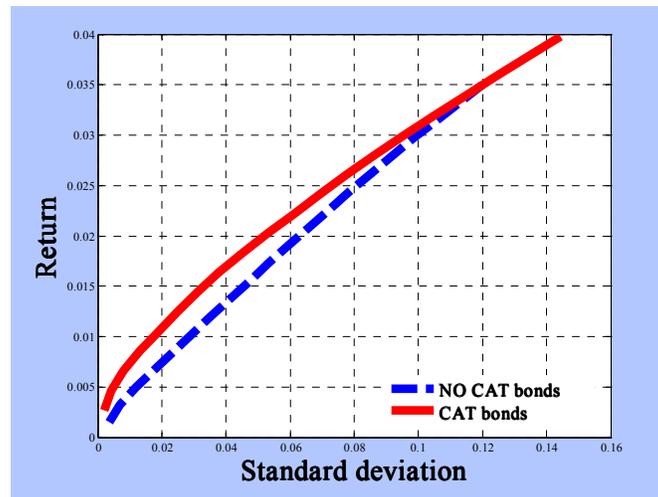


Fig. 6. SRCBGL – Efficient frontiers – Normal period

Not surprisingly, the turmoil period (see Fig. 7.: SRCBGL – Efficient frontiers – Crisis period) reveals the fact that investing in catastrophe bonds would have been a good strategy. First, the efficient frontier formed by portfolios made up by cat bonds is considerably upwards shifted from the efficient frontier shaped with no cat bonds portfolios. In addition, the higher the tolerated risk, the higher the distance between the two frontiers.

Nonetheless, as in the case of the portfolio diversified at European level, it seems that by investing in catastrophe bonds does not expand the efficient frontier beyond the efficient frontier formed without considering the catastrophe bonds in the investment decision.

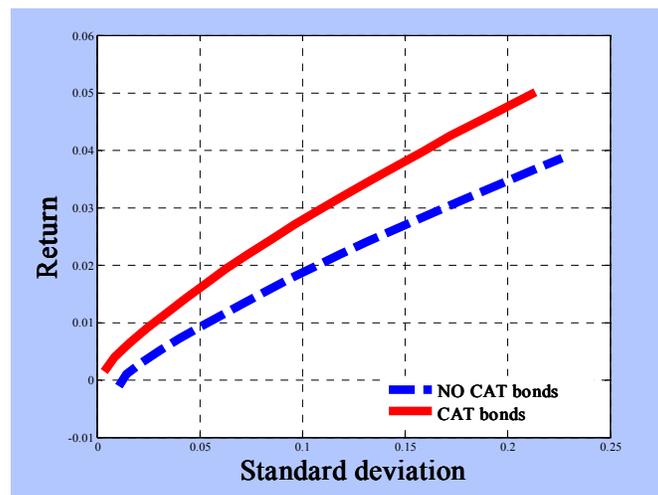


Fig. 7. SRCBGL – Efficient frontiers – Crisis period

When considering the slow recovery period, one can notice from Fig. 8.: SRCBGL – Efficient frontiers – Slow recovery period that, overall, choosing to invest in catastrophe bonds would have been advisable for the investor having an internationally diversified portfolio.

First, the analysis reveals that only for very low levels of risk the two frontiers overlap each other, suggesting indifference with respect to the two types of portfolios. Second, the two efficient frontiers seem to follow each other for the middle levels of risk (the cat bond efficient frontier always being above the efficient frontier formed by portfolios not including cat bonds), while there is an obvious upwards shift of the cat bond efficient frontier when dealing with high levels of risk. Third, as for the overall and normal periods, the performance of the cat bond portfolios transcends the performance of the portfolios formed without investing in cat bonds, allowing the investors who bear high levels of risk to achieve higher returns, unreachable when considering the opposite.

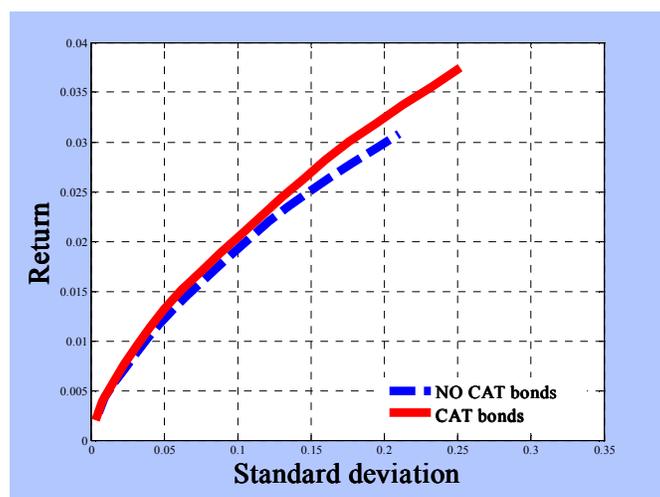


Fig. 8. SRCBGL – Efficient frontiers – Slow recovery period

Conclusions

The research developed within the paper investigated whether the performance of well diversified portfolios could be enhanced by including catastrophe bonds which lately confirmed to be a new asset class. The analysis was conducted by considering two types of well diversified portfolios. The first one was made up of stocks from the European developed and emerging markets, while the second of stocks from international developed (except USA) and emerging markets. Both portfolios were diversified by investing in several types of assets from the USA market: investment grade corporate bonds, commodities, real estate securities and ESG stocks. By deriving efficient frontiers constructed from portfolios made up with and without catastrophe bonds, for the overall period considered within the analysis and for the three sub-periods that described it (normal, crisis and slow recovery), we found some patterns.

Therefore, we conclude that both for the overall period and for normal and slow recovery times, diversifying the portfolios through catastrophe bonds shifts favourably the efficient frontiers in two ways. First, it allows obtaining a better risk-return tradeoff. Second, the efficient frontiers shaped by portfolios including catastrophe bonds expand beyond the efficient frontiers derived from portfolios not including catastrophe bonds and, therefore, allow those investors that tolerate higher levels of risk to obtain returns unattainable when eluding catastrophe bonds.

As far as the crisis period is concerned, investing in catastrophe bonds proved to be a good choice for both investors, as the cat bonds efficient frontiers were superior to the efficient

frontiers formed by portfolios not including cat bonds. However, it seems that the recent crisis affected to a certain extent the catastrophe bond market, as the cat bond efficient frontier do not seem to unfold beyond the efficient frontiers derived from portfolios shaped without catastrophe bonds. Therefore, as further research, the relation between the catastrophe bonds market and the international financial markets should be additionally analysed, especially with a focus on turmoil times.

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Diversificarea portofoliului prin obligațiuni structurate de catastrofă în contextul crizei financiare

Rezumat

În cadrul articolului este analizat impactul investiției realizate în obligațiuni structurate de catastrofă atât asupra performanței unor portofolii formate din acțiuni de pe piețele dezvoltate și emergente europene și alte active, cât și asupra performanței unor portofolii formate din acțiuni de pe piețele dezvoltate și emergente internaționale și alte active, concentrând demersul de cercetare asupra examinării evoluției impactului în perioadele de normalitate, criză și ușoară revenire ce au caracterizat piețele financiare internaționale recent. Analiza este dezvoltată prin trasarea frontierelor eficiente formate din portofolii ce includ sau nu obligațiuni de catastrofă și prin examinarea modificărilor acestora. Principalele rezultate reflectă faptul că, în ansamblu, investițiile realizate în obligațiuni CAT s-au dovedit a fi o decizie prudentă în timpul celor trei perioade analizate, în timp ce criza recentă a avut un anumit impact asupra performanței portofoliilor chiar și atunci când s-a investit în obligațiuni de catastrofă. Importanța analizei rezidă în examinarea efectelor introducerii obligațiunilor de catastrofă în cadrul portofoliilor asupra profilului risc-randament al investițiilor realizate la nivel european și internațional.