RISK-RETURN PUZZLE IN INTERNATIONALLY DIVERSIFIED EQUITY PORTFOLIOS - THE ROMANIAN PERSPECTIVE

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Abstract

Our paper highlights the benefits derived from holding internationally diversified portfolios, from the perspective of Romanian investors, by assessing the risk and return levels for three portfolio structures, constructed with equities from: (1) Romania and emerging countries; (2) Romania and developed countries; (3) Romania and all countries analysed in this study. Moreover, we undertake a comparative analysis between the results obtained for the period January 2015-February 2018 and the results obtained during the global financial crisis, when increased correlations among global financial markets threatened their diversification potential. Our findings indicate that for both periods considered, portfolios diversified among all equity markets outperform the other two portfolio structures analysed. The performance of portfolios diversified among emerging countries equities is significantly higher than the performance of portfolios diversified with equities from Romania and the developed countries considered, during both the crisis and January -February 2018 period, but the result is reversed when analysing the results for the last six months.

Keywords: portfolio choice, international financial markets, financial crisis, foreign exchange risk

JEL Classification: G11, G15, G01, F31

Introduction

Over the past few decades, investors increased their global exposure, by allocating a significant part of their capital to international assets, characterized by superior returns, compared to the ones in their domestic market. Exposure to global markets is considered a successful diversification strategy at portfolio level, as investors take advantage of the superior returns of global assets, together with a low international correlation, which allow reduction of the volatility, or total risk, of a global portfolio.

The present study shapes the risk-return picture at international portfolios level, in the past three years, with a focus on the last six months, when intraday data is used. We compare the results obtained in recent periods, namely from January 2015 to February 2018, with a focus on the last six months, with the results during the global financial crisis period (January 2007

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- February 2010), as increased correlations between financial markets during the crisis questioned the diversification benefits of internationally diversified portfolios.

In the existing literature, both the international diversification benefits and the financial crisis challenges have been studied, but the risk – return puzzle in global portfolios has not been extensively researched so far from a Romanian investor point of view. Moreover, we investigate the diversification potential of emerging vs. developed markets, by assessing the risk – return levels for three portfolio structures: (1) Romanian and emerging equity markets; (2) Romanian and developed equity markets; (3) Romanian and all markets considered in this study.

In order to better understand the financial markets developments and co-movements recently, we assess the risk-return performance of all foreign markets considered and in addition, for period September 2017-February 2018 we undertake a more detailed analysis on intraday returns for the most relevant indices.

The paper is structured as follows: Chapter 1 presents the review of the scientific literature, Chapter 2 defines the data and methodology, Chapter 3 analyses the main results, both at individual and portfolio level for the markets considered and the last section resumes the main conclusions and sets further research objectives.

1. Review of the scientific literature

In the last years, investors increased their global exposure, by allocating a significant part of their capital to international assets, characterized by superior returns, compared to the ones from their domestic market. Solnik (2004) gives evidence of this fact, as for example U.S. pension funds held around 15% foreign assets from their total portfolio in 2000, compared with the situation in the early 1970, when these pension funds held basically no foreign assets.

Exposure to global markets is considered a successful diversification strategy at portfolio level, as investors take advantage of the superior returns of global assets, together with a low international correlation, which allow reduction of the volatility, or total risk, of a global portfolio. Grubel (1968) is the first researcher that extended portfolio diversification concept, defined and developed by Markowitz (1959), to an international level. Since then, a lot of authors have studied the case for international diversification and the common conclusion is that "foreign investments allow investors to reduce the total risk of the portfolio, while offering additional profit potential" (Solnik, 1974). Therefore, the two major benefits of investors constructing internationally diversified portfolios are an increased expected return, due to global assets outperforming domestic ones and a decreased risk, by adding low correlated assets.

However, there are additional risk in international diversification, the most important one being the currency risk, translated by the depreciation of the foreign currency. Kaplanis and Schaefer (1996) find that unhedged portfolios internationally diversified are riskier than domestic portfolios with the similar returns and that the volatility of exchange rates tends to be higher than that of bond and stock prices, highlighting the fact that exchange rate volatility can affect international diversification benefits. They study currency risk on internationally diversified portfolios from June1987 to February 1998.

Hansson, Liljeblom and Löflund (2010) use data from January 1997 to May 2006 to develop mean–variance intersection and spanning tests with and without short sales constraints, with the purpose of investigating the incremental diversification benefits of emerging market corporate bonds. They assess the currency risk, by analyzing hedged versus unhedged portfolios performance and also country and credit risk, by including both emerging market stocks and corporate bond indices. They find that unhedged portfolios diversified with corporate bonds and stocks from developed markets doesn't offer significant benefits for an investor having as base currency the US Dollar and similar results were found for both British and German investors. Sharpe ratios are improved when the assets from developed markets are currency hedged, for American, as well as for German and British investors.

The diversification potential offered by emerging markets has been intensively studied. Camilleri and Gales (2009), who study the performance of portfolios including both developed and emerging markets for the period January 1998 - December 2007, found that "most portfolios which included developed proved inefficient". They conclude that, for the sub-period January 2003-December 2007, emerging markets "move more in line with developed ones."

Bekaert and. all (2009) show that, in recent years, the benefits derived from international diversification are questioned, due to a significant increase in financial markets integration. Longstaff (2010) brings into discussion the international markets increased co-movements during the global financial crisis, while Camilleri and Galea (2009) conclude that it should be further research whether if "the diversification benefits offered by emerging markets differ across bull and bear periods".

Given these existing debates in the literature, the main purpose of the present paper is to assess the changing diversification potential of both emerging and developed markets, from the perspective of a Romanian investor, by comparing the results during the crises period, considered as being the period January 2007 – February 2010, with the results on recent times developments.

2. Research methodology

As we already stated in previous chapter, the main purpose of the present paper is to study the performance of internationally diversified equity portfolios, from the perspective of an investor from Romania. In this respect, we construct portfolios with equities from the Romanian and the following markets: (1) emerging markets - Hungary, Poland, Greece, India, China, Russia, Brazil; (2) developed markets - Austria, France, Germany, United Kingdom, United States, Canada, Japan.

As a proxy for the equities traded on the markets mentioned above, we use the following corresponding stock market reference indices: BET: IND, BUX: IND, WIG: IND, ASE: IND, SENSEX: IND, SHCOMP: IND, RTS: IND, BVSP: IND, ATX: IND, CAC: IND, DAX: IND, UKX: IND, SPX: IND, SPTX: IND, NKY: IND. Indices daily prices are collected from Bloomberg Database for the period January 2007- February 2018. For the sub-period September 2017 - February 2018, we collect also indices intra-day prices.

The study consists of two parts. In the first part, we assess the risk-return performance of the foreign markets considered, as well as the level of interconnection between them. In this respect, we compute the mean, standard deviation and covariance between the returns of all

indices. These values are calculated using daily data, for three periods: January 2007-February 2010, considered the crisis period, January 2015 - February 2018 and September 2017-February 2018. We also calculate the mean and standard deviation of changes in spot rates for all exchange rates of the foreign currencies in which the indices are denominated against Romanian Leu. The spot rates are collected from the National Bank of Romania website for the period January 2007 - February 2018.

In order to better understand the financial markets integration and co-movement recently, we determine the realized volatility for the four indices with the highest standard deviation within the sub-period September 2017-February 2018 as intraday data is available. The days when any of the market was closed were removed from data series.

Andersen and Bollerslev (1998) estimated realized variance by summing all squared intraday returns. The measurement used in our paper is:

$$r_t = 100(\ln P_t - \ln P_{t-1}) \quad (1)$$

$$r_{t,d} = 100\big(\ln P_{t,d} - \ln P_{t,d-1}\big), \quad d = 1, 2, \dots, 108 \quad (2)$$

$$RV_{t,d} = \sum_{i=1}^{d} r_{t,i}^2 . \quad (3)$$

In the above formula, r_t is the return of the index, P_t is the price of the stock market index and $RV_{t,d}$ is the realized variance

The realized volatility is the square root of realized variance multiplied by 252 – the annual average number of trading days.

In the second part of our paper, we study the performance of internationally diversified equity portfolios from the perspective of an investor from Romania. We derive efficient portfolios, diversified among equities from the following markets: (1) Romanian and emerging equity markets; (2) Romanian and developed equity markets; (3) Romanian and all markets considered in this study.

As a proxy for the equities traded on both emerging and developed markets we used the indices specified above. We won't consider any hedging strategy, so we account for the currency risk by calculating the returns for all the indices considered, with the formula:

$$r_t^{RON} = \ln P_t^{FC} S_t^{RON/FC} - \ln P_{t-1}^{FC} S_{t-1}^{RON/FC} = \ln(P_t^{FC} - P_{t-1}^{FC}) - \ln(S_t^{RON/FC} - S_{t-1}^{RON/FC}) = r_t^{FC} + s_t^{RON/FC} \quad (4)$$

In the above formula, r_t^{RON} is the return obtained by a Romanian based investor in the foreign markets, P_t^{FC} is the price of the stock market index for a particular country at moment t, denominated in its domestic currency and $s_t^{RON/FC}$ represents the daily change in exchange rate values between RON and all foreign currencies used. This equation shows that the return obtained by a Romanian investing in foreign markets is composed by both the return on the index and the exchange rate fluctuations.

The portfolios on the efficient frontier are derived using Portfolio and EstimateFrontier functions in Matlab. Portfolio syntax creates mean-variance optimization models, while EstimateFrontier estimates a specified number of optimal portfolios on the efficient frontier. The efficient frontier comprises the set of the optimal portfolios that offers the highest expected return for a defined level of risk. We obtain, for all three portfolio structures stated above, the return, the standard deviation and the weights corresponding to each asset.

In the Results section, for all periods considered, we undertake a comparative analysis on the risk-return performances of the following efficient portfolios:

- MVPs corresponding to each of the three portfolio structures;
- Optimal portfolios for medium risk adverse investors, which are obtained by choosing the portfolio with the median standard deviation on the efficient frontier corresponding to each of the three portfolio structures;
- Optimal portfolios for high risk adverse investors, which are obtained by choosing the portfolio with the highest standard deviation on the efficient frontier corresponding to each of the three portfolio structures.

3. Results and discussion

a. Equity markets risk-return analysis

Figures 1 to 3 illustrate the risk-return relationship between all indices considered, for all three periods analysed in the present paper. The indices performances at individual level are analysed together with the performance of the portfolios diversified according to the three models mentioned in the Methodology section.

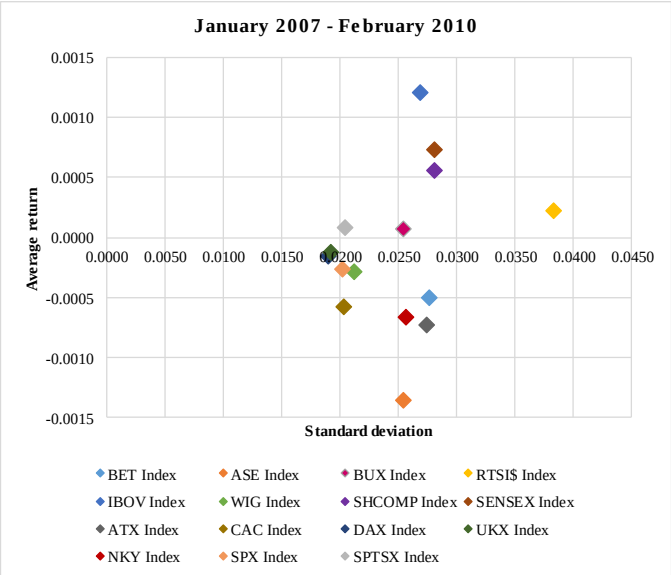

Figure no. 1: Risk and return distribution of all reference indices, Jan. 2007-Feb. 2010

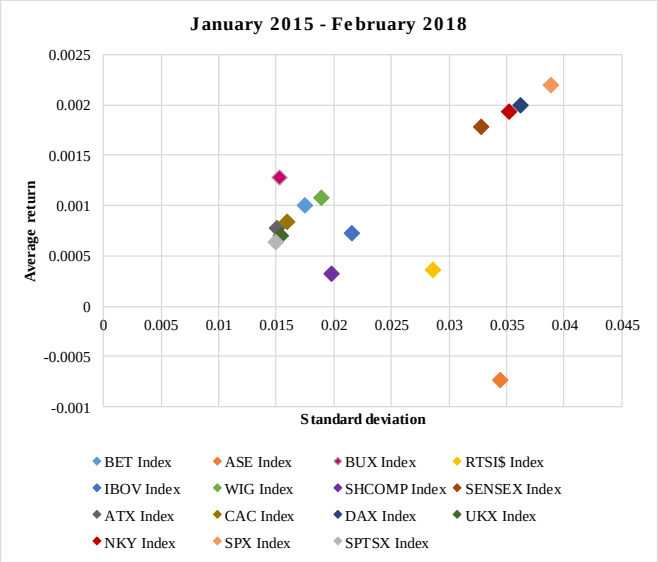

Figure no. 2: Risk and return distribution of all reference indices, Jan. 2015-Feb. 2018

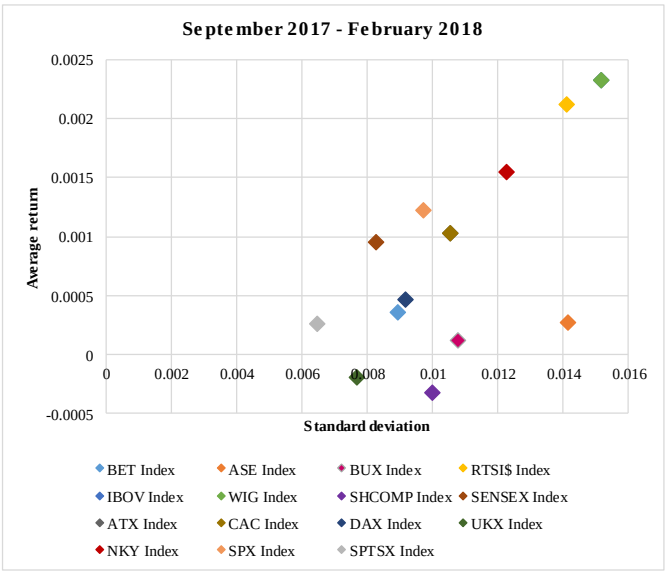

Figure no. 3: Risk and return distribution of all reference indices, Sept. 2017-Feb. 2018

As Figure no. 3 shows, the indexes with the highest standard deviation from the period September 2017-February 2018 are NKY, ASE, RTSI$ and WIG. The realized volatilities for 1-minute aggregation are illustrated in the figures below.

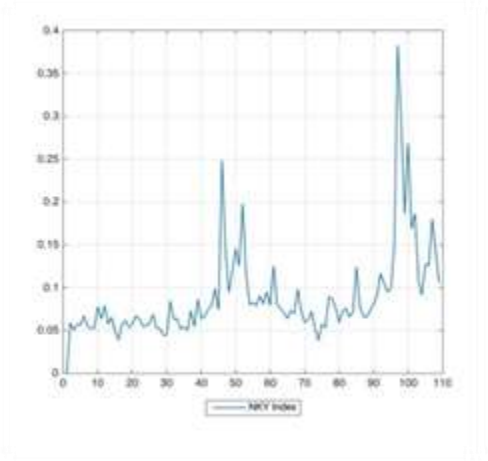

Figure no. 4: Realized volatility for NKY, 1-min aggregation, Sept. 2017-Feb. 2018

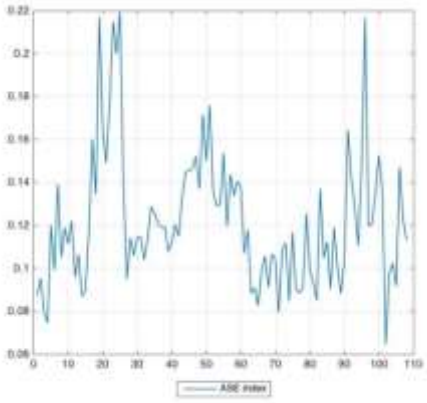

Figure no. 5: Realized volatility for ASE, 1-min aggregation, Sept. 2017-Feb. 2018

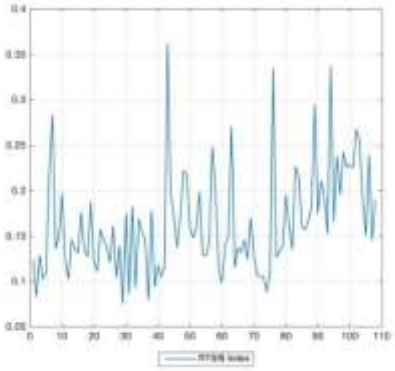

Figure no. 6: Realized volatility for RTSI$, 1-min aggregation, Sept. 2017-Feb. 2018

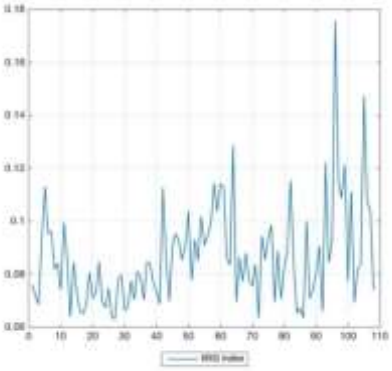

Figure no. 7: Realized volatility for WIG, 1-min aggregation, Sept. 2017-Feb. 2018

The figures presented above show that the emerging countries experience a rather high daily realized volatility throughout the entire period. In spite of high realized volatility, we note that ASE's index average return from Figure no. 3 is rather low even when compared to indexes with lower standard deviation. As for the NKY index, for a developed market the daily realized volatility is rather low, for almost entire period, having only two major

volatility spikes. The WIG index, compared to both ASE and RTSI$ index, has a significant lower realized volatility, which demonstrates the maturity of the Polish capital market.

b. Risk-return analysis of internationally diversified portfolios

Figures 8 to 10 present the efficient frontiers of internationally diversified portfolios between Romanian and emerging markets stocks, Romanian and developed markets stocks and Romanian and both emerging and developed stocks, for all three periods considered.

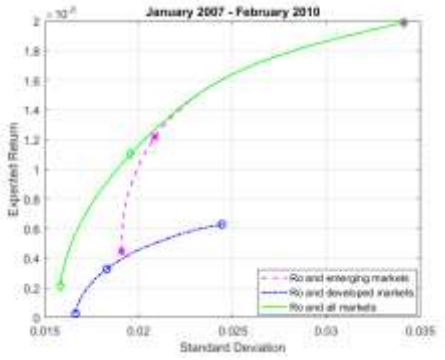

Figure no. 8: Efficient frontiers of international portfolios, Jan. 2007-Feb. 2010

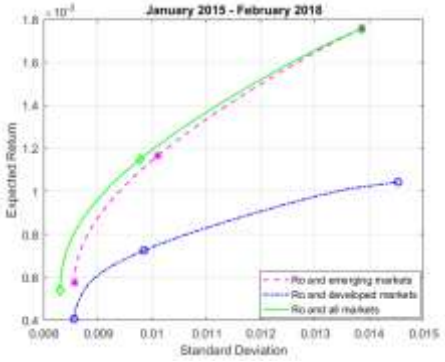

Figure no. 9: Efficient frontiers of international portfolios, Jan. 2015-Feb. 2018

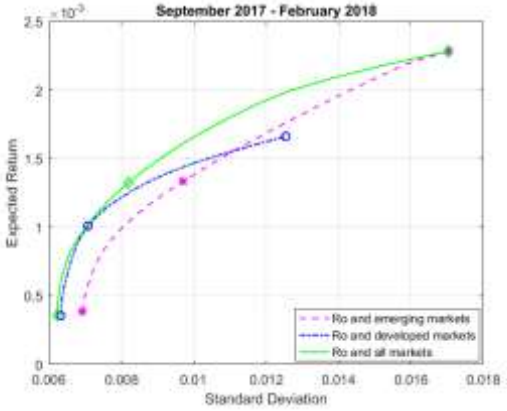

Figure no. 10: Efficient frontiers of international portfolios, Sept. 2017-Feb. 2018

For all periods considered, portfolios diversified among all equity markets outperform the other two portfolio structures considered. Figure 8 shows that, in the case of portfolios constructed with Romanian and developed markets assets, the minimum variance portfolio offers a lower return at a higher standard deviation, compared with the return and standard deviation offered by the minimum variance portfolio diversified among all markets

considered. This means that, during the crisis period, the optimal policy for Romanian investors seeking a minimum variance internationally diversified portfolio would have been to diversify their international portfolios among both emerging and developed markets.

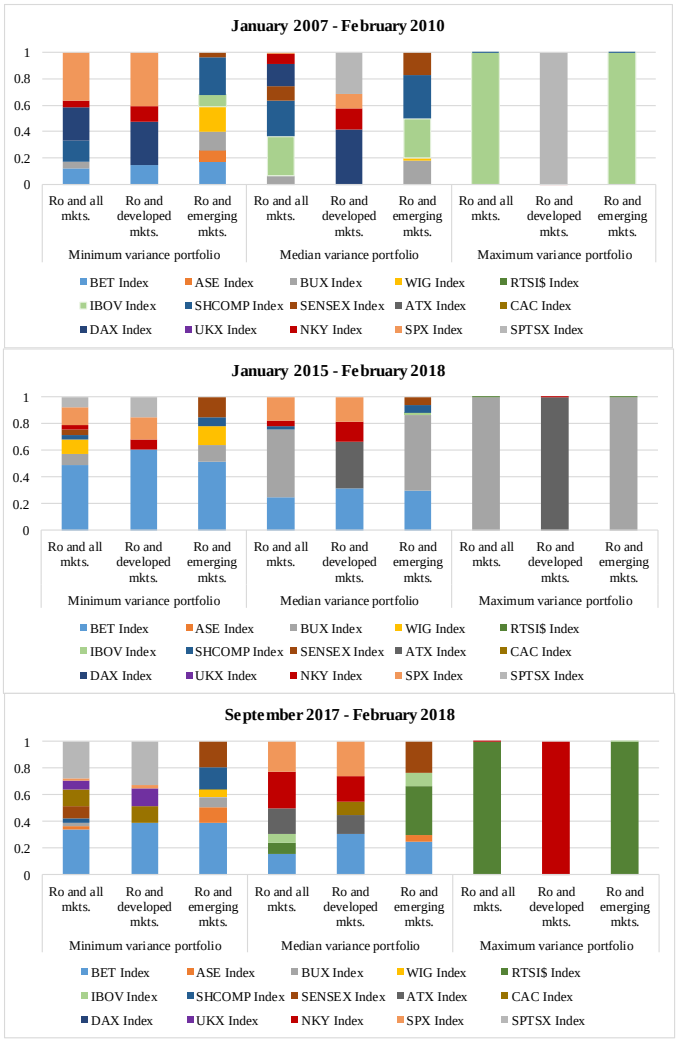

Figure no. 11. Asset allocation within efficient portfolios during all periods considered

According to the asset allocation results presented in Figure 11 above, the highest weight in the MVP diversified among all equity markets considered is attained by the SPX Index, which is the main reference index for American equities. From Figure 1, SPX Index is characterized by one of the lowest values for standard deviation from all indices considered. Even if its average return during the period January 2007 - February 2010 amounts only -0,

0001, its low level of correlation with other assets in this portfolio (BET Index, BUX Index, SHCOMP Index), combined with a low standard deviation of the RON/USD exchange rate, as it results from Tables 1 and 2 from Annex 1, are significant reasons for Romanian investors to allocate the highest weight of their MVP to assets from the American capital market.

The results are similar for the other two periods considered. Figures 9 and 10 show that the minimum variance portfolios diversified among Romanian and both developed and emerging assets have the lowest standard deviation from the MVP on the other two efficient frontiers, which don't offer neither lower risk portfolios, nor higher returns. It's important to highlight the fact that BET Index accounts for approximately 50% from all assets in all three MVP formed during January 2015 - February 2018. This results are in accordance with the risk-return image presented in Figure 2, where we find BET Index as part of the cluster composed of all indices with high returns at moderate values of standard deviation. Moreover, the preference for a high weight allocated to BET Index in the portfolio of a Romanian investor can be explained by the exchange rate risk, given that the exchange rates between RON and all foreign currencies are characterized by relatively high values of standard deviation, ranging from 0.0018 to 0.0218, according to Table 2 in Annex 1 Weights allocated to BET Index in the minimum variance portfolios display decreasing values from the second (January 2015-February 2018) to the last analysed period (September 2017-February 2018).

With respect to the portfolios having the median standard deviation on the three efficient frontiers presented in Figure 8, the portfolio diversified among Romanian and emerging markets stocks records a superior expected return compared to the portfolio diversified among Romanian and all markets considered, with a slightly higher standard deviation though. We can therefore affirm that, from January 2007 to February 2010, the optimal strategy for Romanian investors that tolerate medium levels of risk would have been to diversify their international portfolios among equities from both emerging and developed countries. We notice from Figure 11 that the highest weight in this portfolio is attained by IBOV Index, followed by SHCOMP Index. It's important to highlight the fact that both of them, reference indices in two emerging markets, are characterized by high levels of average returns at medium risk levels (see Figure 1) and low correlations with the other indices (see Table 1 from Annex 1). Actually, IBOX Index outperforms most of the other indices considered, given the risk-return image presented in Figure 1. Moreover, the exchange rates fluctuations between Romanian Leu and both Brazilian Rubble are Chinese YEN are low, given the values of standard deviation for exchange rates changes presented in Table 2 from Annex 1, so we can conclude that the emerging markets represented interesting opportunities in terms of risk diversification for Romanian investors during crisis times.

Regarding the portfolios with the highest standard deviation for all three frontiers illustrated in Figure 8, interesting things emerge: (1) the portfolio diversified among Romanian and developed equity markets offers an extremely low return, approximately half of the return corresponding to the median-variance portfolios from the other two frontiers, at a much higher risk; (2) only portfolios consisting of emerging markets have the potential of offering high returns, so the portfolios with the highest standard deviation on the two superior frontiers from Figure 8 are identical. The highest weight in this portfolio is attained, like in the case of medium-variance portfolios, by reference indices for assets from the Brazilian and Chinese equity markets.

We obtain similar results for the last two analysed periods, January 2015-February 2018, and September 2017-February 2018, as portfolios with the highest standard deviation on the

efficient frontier of portfolio diversified among all markets outperform the ones from the other 2 frontiers. The weights distribution, pictured in Figure 11, shows that during the period January 2015 - February 2018 the highest weight in the efficient portfolio with the maximum standard deviation from both the Romanian and all and Romanian and emerging markets frontiers is attained by BUX Index. During this period, developed markets also offer high risk portfolios, but with significant lower returns than the other two models considered. For the sub-period September 2017- February 2018, the highest weight in the efficient portfolio with the maximum standard deviation from both the Romanian and all and Romanian and emerging markets frontiers is attained by RTSI$ Index.

Conclusions

The main conclusion derived from the present study is that for all periods considered, portfolios diversified among all equity markets outperform the other two portfolio structures considered: Romanian and emerging equity markets, respectively Romanian and developed equity markets.

Regarding the financial crisis period, for high risk averse Romanian investors seeking a minimum variance for their global portfolio, the optimal strategy would be to diversify their international portfolios among both emerging and developed markets. For the portfolios having the median standard deviation on the three efficient frontiers presented for the crisis period, the portfolio diversified among Romanian and emerging markets stocks records a superior expected return compared to the portfolio diversified among Romanian and all markets considered, with a slightly higher standard deviation though. Regarding the portfolios with the highest standard deviation, we can stress out that, during the crisis period, the portfolio diversified among Romanian and developed equity markets offers approximately half of the return corresponding to the median-variance portfolios from the other two frontiers, at a much higher risk, while the highest returns can be obtained only from portfolios consisting of emerging markets.

For the period January 2015 - February 2018, portfolios that have the highest standard deviation on the efficient frontier diversified among all markets are the most performant, overpassing the portfolios from the other two frontiers. During this period, the highest weight in the efficient portfolio with the maximum standard deviation from both Romanian and all equity markets and Romanian and emerging markets frontiers is attained by the BUX Index. Even though during this interval developed markets also offered high risk portfolios, the returns were significant lower. Another important conclusion is that BET Index accounts for approximately 50% from all assets in all three MVP formed during January 2015 - February 2018.

The present paper offers multiple directions for future research. For example, it would be interesting to study how results change when we consider transaction costs for entering foreign markets. Also, it should be further researched whether the best performers among the portfolios constructed change their risk – return values if we implement hedging policies against exchange rate risk.

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Annex 1

Table no. 1. Correlation matrix between reference indices during all periods analysed

January 2007 - February 2010

	BET Index	ASE Index	BUX Index	WIG Index	RTSI$ Index	IBOV Index	SHCOMP Index	SENSEX Index	ATX Index	CAC Index	DAX Index	UKX Index	NKY Index	SPX Index	SPTSX Index
BET Index	1.0000	0.5890	0.5121	0.6088	0.5593	0.4021	0.2014	0.5329	0.6201	0.5410	0.4816	0.5327	0.5143	0.3120	0.4272
ASE Index	0.5890	1.0000	0.5849	0.6754	0.6712	0.5618	0.1991	0.5367	0.7452	0.7105	0.6201	0.6777	0.4450	0.4175	0.5319
BUX Index	0.5121	0.5849	1.0000	0.6464	0.5847	0.4584	0.1393	0.4503	0.6372	0.6456	0.5905	0.6360	0.4709	0.3815	0.4722
WIG Index	0.6088	0.6754	0.6464	1.0000	0.6728	0.5681	0.1797	0.5518	0.7218	0.7100	0.6663	0.6790	0.4907	0.4830	0.5349
RTSI$ Index	0.5593	0.6712	0.5847	0.6728	1.0000	0.5815	0.2029	0.4744	0.7065	0.6584	0.5580	0.6500	0.5786	0.3968	0.6000
IBOV Index	0.4021	0.5618	0.4584	0.5681	0.5815	1.0000	0.2250	0.4367	0.6123	0.6801	0.5900	0.6521	0.3293	0.6827	0.7395
SHCOMP Index	0.2014	0.1991	0.1393	0.1797	0.2029	0.2250	1.0000	0.2567	0.1762	0.1603	0.1104	0.1482	0.2498	0.0228	0.0986
SENSEX Index	0.5329	0.5367	0.4503	0.5518	0.4744	0.4367	0.2567	1.0000	0.5545	0.5581	0.4926	0.5064	0.4243	0.3732	0.3747
ATX Index	0.6201	0.7452	0.6372	0.7218	0.7065	0.6123	0.1762	0.5545	1.0000	0.8122	0.7360	0.7980	0.5444	0.5010	0.6284
CAC Index	0.5410	0.7105	0.6456	0.7100	0.6584	0.6801	0.1603	0.5581	0.8122	1.0000	0.8962	0.9449	0.4966	0.6333	0.6853
DAX Index	0.4816	0.6201	0.5905	0.6663	0.5580	0.5900	0.1104	0.4926	0.7360	0.8962	1.0000	0.8571	0.3615	0.6603	0.6469
UKX Index	0.5327	0.6777	0.6360	0.6790	0.6500	0.6521	0.1482	0.5064	0.7980	0.9449	0.8571	1.0000	0.4991	0.6144	0.7043
NKY Index	0.5143	0.4450	0.4709	0.4907	0.5786	0.3293	0.2498	0.4243	0.5444	0.4966	0.3615	0.4991	1.0000	0.1829	0.4226
SPX Index	0.3120	0.4175	0.3815	0.4830	0.3968	0.6827	0.0228	0.3732	0.5010	0.6333	0.6603	0.6144	0.1829	1.0000	0.7507
SPTSX Index	0.4272	0.5319	0.4722	0.5349	0.6000	0.7395	0.0986	0.3747	0.6284	0.6853	0.6469	0.7043	0.4226	0.7507	1.0000

January 2015 - February 2018

	BET Index	ASE Index	BUX Index	WIG Index	RTSI$ Index	IBOV Index	SHCOMP Index	SENSEX Index	ATX Index	CAC Index	DAX Index	UKX Index	NKY Index	SPX Index	SPTSX Index
BET Index	1.0000	-0.4602	-0.2672	0.7869	-0.4103	-0.3343	0.1816	0.8425	-0.0090	0.5807	0.8396	0.7034	0.7978	0.8371	0.7313
ASE Index	-0.4602	1.0000	0.5892	-0.4005	0.6046	0.5235	0.0288	-0.5936	0.5349	-0.0043	-0.5019	-0.2452	-0.5094	-0.6137	-0.3743
BUX Index	-0.2672	0.5892	1.0000	-0.2129	0.5821	0.4754	-0.0367	-0.4332	0.5640	0.1429	-0.3291	-0.0712	-0.3660	-0.4661	-0.2324
WIG Index	0.7869	-0.4005	-0.2129	1.0000	-0.2793	-0.2436	0.2309	0.8490	0.0987	0.6711	0.8738	0.8036	0.8152	0.8494	0.8133
RTSI$ Index	-0.4103	0.6046	0.5821	-0.2793	1.0000	0.6749	0.1248	-0.5206	0.5719	0.0325	-0.4596	-0.1245	-0.4861	-0.5345	-0.2151
IBOV Index	-0.3343	0.5235	0.4754	-0.2436	0.6749	1.0000	0.1132	-0.4233	0.4553	0.0546	-0.3774	-0.0693	-0.3936	-0.4117	-0.1422
SHCOMP Index	0.1816	0.0288	-0.0367	0.2309	0.1248	0.1132	1.0000	0.1726	0.1388	0.1626	0.1685	0.2422	0.2172	0.1703	0.2433
SENSEX Index	0.8425	-0.5936	-0.4332	0.8490	-0.5206	-0.4233	0.1726	1.0000	-0.1321	0.5795	0.9311	0.7660	0.9033	0.9500	0.8222
ATX Index	-0.0090	0.5349	0.5640	0.0987	0.5719	0.4553	0.1388	-0.1321	1.0000	0.5695	0.0337	0.3278	-0.0714	-0.1414	0.1397
CAC Index	0.5807	-0.0043	0.1429	0.6711	0.0325	0.0546	0.1626	0.5795	0.5695	1.0000	0.7518	0.8591	0.6128	0.5844	0.6985
DAX Index	0.8396	-0.5019	-0.3291	0.8738	-0.4596	-0.3774	0.1685	0.9311	0.0337	0.7518	1.0000	0.8545	0.9033	0.9465	0.8518
UKX Index	0.7034	-0.2452	-0.0712	0.8036	-0.1245	-0.0693	0.2422	0.7660	0.3278	0.8591	0.8545	1.0000	0.7494	0.7734	0.8393
NKY Index	0.7978	-0.5094	-0.3660	0.8152	-0.4861	-0.3936	0.2172	0.9033	-0.0714	0.6128	0.9033	0.7494	1.0000	0.9052	0.8011
SPX Index	0.8371	-0.6137	-0.4661	0.8494	-0.5345	-0.4117	0.1703	0.9500	-0.1414	0.5844	0.9465	0.7734	0.9052	1.0000	0.8743
SPTSX Index	0.7313	-0.3743	-0.2324	0.8133	-0.2151	-0.1422	0.2433	0.8222	0.1397	0.6985	0.8518	0.8393	0.8011	0.8743	1.0000

September 2017 - February 2018

	BET Index	ASE Index	BUX Index	WIG Index	RTSI$ Index	IBOV Index	SHCOMP Index	SENSEX Index	ATX Index	CAC Index	DAX Index	UKX Index	NKY Index	SPX Index	SPTSX Index
BET Index	1.0000	0.2358	0.2625	0.3743	0.4087	0.3471	0.4724	0.3116	0.4270	0.3590	0.2833	0.3084	0.2923	0.2456	0.2452
ASE Index	0.2358	1.0000	0.2634	0.1728	0.1574	0.0616	0.1482	0.1717	0.3042	0.2915	0.2437	0.2607	0.3512	0.1845	0.1887
BUX Index	0.2625	0.2634	1.0000	0.6026	0.3948	0.1885	0.2878	0.4684	0.3701	0.5264	0.5700	0.5774	0.4108	0.2028	0.4176
WIG Index	0.3743	0.1728	0.6026	1.0000	0.5097	0.2660	0.3820	0.4989	0.4573	0.5601	0.6072	0.6386	0.3951	0.2543	0.4207
RTSI$ Index	0.4087	0.1574	0.3948	0.5097	1.0000	0.4199	0.6214	0.1982	0.4806	0.5380	0.4124	0.4681	0.3402	0.3838	0.4893
IBOV Index	0.3471	0.0616	0.1885	0.2660	0.4199	1.0000	0.2365	0.2326	0.1584	0.4287	0.2504	0.3185	0.0073	0.5140	0.3334
SHCOMP Index	0.4724	0.1482	0.2878	0.3820	0.6214	0.2365	1.0000	0.2818	0.4495	0.4300	0.4184	0.4114	0.4253	0.1834	0.3818
SENSEX Index	0.3116	0.1717	0.4684	0.4989	0.1982	0.2326	0.2818	1.0000	0.1391	0.3675	0.4466	0.3722	0.4177	0.2460	0.3053
ATX Index	0.4270	0.3042	0.3701	0.4573	0.4806	0.1584	0.4495	0.1391	1.0000	0.6257	0.6012	0.5594	0.4400	0.3050	0.4059
CAC Index	0.3590	0.2915	0.5264	0.5601	0.5380	0.4287	0.4300	0.3675	0.6257	1.0000	0.8533	0.7561	0.4791	0.4376	0.5607
DAX Index	0.2833	0.2437	0.5700	0.6072	0.4124	0.2504	0.4184	0.4466	0.6012	0.8533	1.0000	0.7529	0.4277	0.4226	0.5614
UKX Index	0.3084	0.2607	0.5774	0.6386	0.4681	0.3185	0.4114	0.3722	0.5594	0.7561	0.7529	1.0000	0.4337	0.4091	0.5050
NKY Index	0.2923	0.3512	0.4108	0.3951	0.3402	0.0073	0.4253	0.4177	0.4400	0.4791	0.4277	0.4337	1.0000	0.1680	0.4947
SPX Index	0.2456	0.1845	0.2028	0.2543	0.3838	0.5140	0.1834	0.2460	0.3050	0.4376	0.4226	0.4091	0.1680	1.0000	0.7412
SPTSX Index	0.2452	0.1887	0.4176	0.4207	0.4893	0.3334	0.3818	0.3053	0.4059	0.5607	0.5614	0.5050	0.4947	0.7412	1.0000

Table no. 2 Mean and standard deviation of all analysed exchange rate returns

January 2007 - February 2010											
	RON/EUR	RON/HUF	RON/PLN	RON/RUB	RON/R$1	RON/CNY	RON/INR	RON/GBP	RON/JPY	RON/USD	RON/CAD
Average return	0.0004	0.0003	0.0004	0.0001	0.0007	0.0006	0.0003	-0.0001	0.0010	0.0004	0.0005
Standard deviation	0.0080	0.0105	0.0108	0.0100	0.0174	0.0138	0.0118	0.0124	0.0183	0.0139	0.0125
January 2015 - February 2018											
	RON/EUR	RON/HUF	RON/PLN	RON/RUB	RON/R$1	RON/CNY	RON/INR	RON/GBP	RON/JPY	RON/USD	RON/CAD
Average return	0.0002	0.0000	0.0001	-0.0005	-0.0005	0.0007	-0.0002	0.0003	0.0001	0.0005	0.0001
Standard deviation	0.0046	0.0051	0.0040	0.0218	0.0155	0.0176	0.0082	0.0134	0.0086	0.0131	0.0095
September 2017 - February 2018											
	RON/EUR	RON/HUF	RON/PLN	RON/RUB	RON/R$1	RON/CNY	RON/INR	RON/GBP	RON/JPY	RON/USD	RON/CAD
Average return	0.0002	-0.0001	0.0004	0.0003	-0.0005	0.0003	-0.0004	0.0008	0.0002	-0.0001	-0.0003
Standard deviation	0.0018	0.0028	0.0026	0.0063	0.0081	0.0047	0.0050	0.0057	0.0059	0.0057	0.0060