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The New Portfolio Management Process in the Context of the Use of Artificial Neural Networks

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The main objective of this article is to draw attention to the subject of portfolio management process, which is often not discussed in the professional literature. It has been shown that globalization affects the portfolio management process, which is presented in the literature in a similar manner. Thus, in this publication, the presentation of the process was made in terms of the classical one, and then the attempt was made to establish its form after the evolution that results from the above mentioned globalization. In addition, this new form is presented from the perspective of the use of artificial neural networks as organizations which invest cash primarily in financial instruments should take into account the mentioned expert tool for the purpose of further development. The publication also shows the key areas which the professional literature focuses on with regards to the subject of portfolio management. The study used the literature from the area of portfolio management, which is the basis for theoretical consideration, but these results have got the cognitive and practical value. They are a basis for separate quantitative research, and the proposed portfolio management process model can be considered cognitively interesting for researchers and investors.

Keywords: financial asset management, stock exchanges, investment, globalization, evolution, artificial intelligence

Introduction

The broad portfolio management is a rapidly growing field of knowledge, used by both institutional investors and individual investors, the main feature of which is its practical nature. Since the 1980s and the 1990s of the 20th century, the process of globalization has been significantly strengthened, not without the impact on the portfolio management process. This is in part due to the fact that modern organizations managing customers' cash holdings and offering other wealth management services in the context of globalization must be flexible and respond quickly to changes in the current situation on the capital markets. The result derived from such conditions is that the portfolio management process will be evolved, forced by the organization with the purpose of their further development. It should also be mentioned that it is the process of portfolio management of financial instruments which is discussed herein, though such concept is not used in foreign literature. Therefore, it must be explicitly stated that the article refers to the portfolios of financial instruments. It can be added that in German literature, portfolio management often refers to investment management (Albrecht & Maurer, 2008).

The evolution of the portfolio management process forces the development of the organization to focuse

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on cash investing, both due to the unfavorable internal conditions (which may include the fact that financial institutions reduce overly excessive costs of portfolio management mitigating the achieved rate of return) (The Scorpio Partnership Private Banking Benchmark, 2013) and the negative external factors (mainly manifested by a decrease in financial transactions in the world, because it is approx. 30% lower than in 2006-2007) (Allen & Overy LLP, 2013). Undoubtedly, one of the effects of this type of conditioning is to force the development of the organization, which due to the volatility of the capital markets, must focus on the management and the raising of funds by adapting the customer' portfolio management process.

This is manifested by the evolution of this process, to which attention is not given in the literature. An insightful study would be desirable in order to identify the points of contact between the development of characterized organizations and the evolution of the portfolio management process. It is worth mentioning the fact that such a study cannot be found in the literature. Given the above, the purpose of this article is to fill the resulting cognitive gap on the portfolio management process after its evolution, because in the literature, only the nature of classical portfolio management process can be found. Its classical approach is presented in the next part of the article due to the fact that only after sketching the broader framework, a better understanding of its nature is possible. Only then can the attempt be made to develop a new form after the evolution, associated with the development of organizations involved in investing money in the era of globalization. All this leads to the development of a new model of portfolio management process, including stages which may require an expert assistance.

This article is based on both literature research and purely theoretical considerations, which can be regarded as significant for the reason that they can become a distinct contribution to the empirical research. The starting point for these considerations is the work of Steiner, Bruns, and Stöckl (2012).

Chapter 1 presents portfolio management as a classical process and literature review. The methodology is presented in chapter 2. The next chapter describes research findings. In the last two chapters, analysis and conclusions are demonstrated.

Literature Review

In the English-language literature devoted to the investments, a dominant view is that "classical" portfolio management process consists of the following steps (Maginn & Tuttle, 1990):

(1) The investment objectives setting.

(2) Developing and implementing of a portfolio strategy.

(3) The portfolio monitoring.

(4) The portflolio adjusting.

At this stage of the analysis, an important conceptual aspect is also worth emphasizing, namely, that the literature does not use the term "classic portfolio management process". However, due to the evolution of this process, it became expedient to use it to highlight the importance of their work, opening a new stage in the management sciences, which already operates from the presentation of classical portfolio management process to the presentation of the portfolio management process after its evolution.

In the standard American literature on investment management, represented for instance by Reilly and Brown (2011), a similar, commonly known definitional framework to the one discussed earlier can be found, which divides the portfolio management process (in terms of the classical approach) into the following four steps (Reilly & Brown, 2011):

(1) Investment policy design.

(2) Analysis of conditions (e.g. financial, economic).

(3) Implementation of the investment plan by building a portfolio.

(4) Feedback, in which the profitability of the portfolio is evaluated and the needs of the investor and the environment are re-examined.

Another equally well-known view on the portfolio management process is promulgated by an American association called the Chartered Financial Analyst (CFA) Institute, which does not differ from those presented in the article. This is reflected in the characteristics of this process, which includes (Investopedia.com, 2015):

(1) Creating the (investment) policies.

(2) Developing an investment strategy.

(3) Implementing the created (investment) plan.

(4) Monitoring and updating the (investment) plan.

At this stage of the analysis, it is worth mentioning one more fact, namely, in the German literature, a view can be found that despite the existence of many elements associated with the portfolio management process, this process can be divided into less than four stages (Albrecht & Maurer, 2008; Bruns & Meyer-Bullerdiek, 2013), which includes:

(1) Planning.

(2) Implementation.

(3) Control.

These views are based on the belief that the process of portfolio management should be considered as the abstract and a general one. One of the expressions of abstraction and generality of this formula is the penultimate stage of this process, which does not take into account the fact that the funds will be invested in financial instruments. This is due to the fact that the portfolio management process (the classic one) has been designed to invest primarily in such instruments. There is nothing more to explain here other than that these instruments are characterized by a specific nature, which distinguishes them from the other investment assets. The specificity of this should therefore be included in the portfolio management process, especially considering the nature of the financial markets (which include capital markets), the variable ones, and often being a subject to the phenomenon of alienation[1]. Portfolio management process with the increasing wealth of research presented in the thematic literature (mainly in magazines), was generally regarded as a subsidiary theme, without analyzing the correlation with the development of organizations involved in investing cash and without taking into account the processes of globalization. This is mainly due to the thematic areas of that kind of literature to which the most attention is devoted.

The extent of the matter discussed, while making the real assessment of its usefulness in the context of this research, requires focusing on the key thematic areas addressed in the article literature, mainly because it presents the most important (often the most recent) studies on portfolio management. These include:

(1) Modeling approach and treating the risk of the entire portfolio of assets and its diversification and optimization—sample publication: “Portfolio Selection” (Markowitz, 1952).

(2) Modeling approach for the rate of return on assets—sample publication, “Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk” (Sharpe, 1964), along with the works of Lintner

[1] This phenomenon is a detachment of the financial markets from the real economy at the micro, meso and macro.

(1965a; 1965b), Mossin (1966), and Treynor (1961; 1962).

(3) Empirical tests of these model solutions—sample publication: "Yes, the CAPM Is Testable" (Guermat, 2014).

(4) Diversification of the portfolio in terms of international—sample publication: "Internationally Diversified Portfolios: Welfare Gains and Capital Flows" (Grubel, 1968).

(5) The financial crises in the context of portfolio management—sample publication: "International Diversification During the Financial Crisis: A Blessing for Equity Investors?" (Vermeulen, 2013).

(6) The efficiency of the capital market theory—the sample publication: "Efficient Capital Markets: A Review of Theory and Empirical Work" (Fama, 1970).

(7) Research related to the implementation of investment strategies—an example of the publication: "Age-Dependent Investing: Optimal Funding and Investment Strategies in Defined Contribution Pension Plans Are Rational When Members Life Cycle Financial Planners" (Blake, Wright, & Zhang, 2014).

(8) Econometric approach in analysis of financial instruments that are the basis for the selection of portfolios. It should be noted that the first models were sometimes prepared with a view to another application, rather than in the context of capital investment, and then were adapted to the analysis of financial instruments—sample publication: "Autoregressive Conditional Heteroscedasticity With Estimates of the Variance of United Kingdom Inflation" (Engle, 1982).

(9) Explanatory research by investors to make decisions under risk—sample publication: "Prospect Theory: An Analysis of Decision Under Risk" (Kahneman & Tversky, 1979).

(10) The use of derivatives from the perspective of reducing investment risk or improve the efficiency of investment funds—sample publication: "Derivatives Holdings and Systemic Risk in the US Banking Sector" (Mayordomo, Moreno, & Peña, 2014).

(11) Assessment of investment efficiency of financial institutions—the sample publication: "Evaluating Business Performance of Wealth Management Banks" (Wu, Lin, & Tsai, 2010).

(12) Analysis of the relationship between the broader portfolio management and tax issues—sample publication: "Modellierung von Aktienanlagen bei laufenden Umschichtungen und einer Besteuerung von Veräußerungsgewinnen" (eng. "How to model share investments regarding frequent portfolio turnovers and capital gains taxation?") (Fochmann & Rumpf, 2010).

(13) Research related to the use of the latest technologies in managing a portfolio of financial instruments—sample publication: "Portfolio Optimization: New Capabilities and Future Methods" (Steuer, Hirschberger, & Qi, 2006).

To sum up this part of the work, it can be said that generally in the literature, there are issues related to the profitability and risk portfolios and a psychological aspect of the tool and the subject of financial crises are discussed. Context financial institutions and market efficiency are also the subject of ongoing research. The theme of the portfolio management process is usually ignored, but with the development of the organization and the globalization of financial markets, the classic approach seems to be outdated. It is also worth mentioning that in this section, not all areas in the field of portfolio management, to which the article literature is devoted, were presented. However, the author characterized the most important and most common ones.

Methodology

The methodological approach of the research consists of purely theoretical considerations, supported by

literature review. The starting point of the consideration is the work of Steiner et al. (2012). The scientific problem is the deficiency in research, presented in study papers or any quantitative methods which could help to build stages of portfolio management in the light of its evolution resulting from globalization. The use of artificial neural networks in such perspective is not presented in the literature, either.

In conclusion, this methodology was used to present a selected part of theory. This theory can become a new base, which can be helpful in conducting another research comprising quantitative methods.

Research Findings

The Process of the Portfolio Management After Evolution

Portfolio management process is mainly related to investment funds in accordance with the adopted strategy and subsequently with its reconstruction. However, this process due to its nature should take into account the fact that the capital is invested in financial instruments, as managing a portfolio of financial instruments is discussed, which in turn are most commonly listed on stock exchanges, especially, those with the highest liquidity. For that reason, the characterized process should be subject to modification, because many stock exchanges operate worldwide, allocated to three main regions (the division has been proposed on the basis of WFE) (WFE, 2015), i.e. America, Asia-Pacific, and Europe-Africa-Middle East. It should also be noted that the number of major stock exchanges in the world is 65 (the number of major stock exchanges was calculated on the basis of the data received from WFE and FESE) (WFE, 2015; FESE, 2015). These conditions make it difficult to clearly define the investment objectives and decision-making, as in the era of globalization, the amount of information to be analyzed by the portfolio managers continues to grow, and with the increasing competitive pressure among financial institutions, a properly selected stock exchange will increase the probability of the selection of attractive financial instruments, offering satisfactory feet return. Nevertheless, it should be noted that the previously selected stock exchange may in the course of the investment turn out to be a place too risky to invest, as the financial instruments listed on it may become instruments offering negative returns.

Consequently, in the era of globalization, the selection of investment assets also requires a new approach, because every reconstruction of portfolios as well as changing the investment currency for the placement of funds in foreign markets leads to high transaction costs, reducing the profitability of the investment. At the same time, the number of financial instruments potentially attractive in terms of their profitability is large and so their in-depth analysis can often be impossible. All of this can make the process of portfolio management less efficient. To sum up, the process described in classical terms to improve efficiency should be subject to evolution, after which it could consist of the following steps:

(1) Definition of the investment objectives.

(2) Setting investment policy.

(3) Choice of stock exchange (65 major stock exchanges in the world).

(4) Choice of management strategies.

(5) The timing of investments in the stock exchange(s).

(6) Selection of investment assets (search for new methods in the selection or the timing of investing in the value).

(7) Measurement and evaluation of investment performance of selected strategies.

The essence of the process of managing the evolution is similar to that before the evolution, which was enforced by the globalization of economies and technological progress. Nevertheless, the new form of the

selection process takes into account the stock exchanges and also market conditions prevailing on them. Despite the proposed changes, the evolution of this process can still be characterized by similar values in terms of the classical one. This is manifested in its initial stage, because it still begins by defining investment objectives which are always dominated by the age and socio-economic status of investors (Francis, 1976). However, because of globalization, the proposed process should support tools that can raise the level of return on investment. In this light, it seems reasonable to conclude that these tools may include artificial neural networks.

Artificial Neural Networks in the Area of the Portfolio Management Process After Evolution

Investment management process can be supported by many tools (Steiner et al., 2012), which include: fundamental analysis, technical analysis, and portfolio management. According to Steiner et al. (2012), there are new methods which can be helpful for investors. Artificial neural networks are one of them. They are the model of the brain presented in a very simplified form and have been used in various fields of science for many years. This is due to the fact that the dedicated knowledge has been developing since 1943, that is since the release of McCulloch and Pitts's (McCulloch & Pitts, 1943) work which dealt with the subject of a mathematical model of artificial neuron, which can map any logical function. However, artificial neural networks have become the subject of worldwide research, first and foremost due to the development of computer systems, which allowed for the advancement of new technological solutions for the artificial perception and also created an appropriate basis for this purpose. Secondly, they do not require programming because they learn by themselves with quite high efficiency, depending, among other things, on the designed structure. Thirdly, they are resistant to damage and in the case of some of the damage, they are still working having the ability to generalize, which is desirable in the social sciences, including economics. Despite the advantages listed above, artificial neural networks also have disadvantages. These include: small precision, since they operate fuzzy concepts, and the lack of a multi-step reasoning required for the reaching of some conclusions, based on the results of the earlier reasoning. However, they are still used many different aspects of social life, as in the case of research, that requires in-depth analysis of various issues, composed of a large amount of information. During that analysis, they learn and can become a tool expert, for example, supporting decision-making. This tool has been successfully used in many financial decision-making problems, which include (Doumpos, Zopounidis, & Pardalos, 2012):

(1) Portfolio optimization.

(2) Financial time-series forecasting.

(3) Trading systems.

(4) Credit scoring.

With this in mind, artificial neural networks can be considered as a tool that can assist in the process of portfolio management in the context of the evolution of these stages, which especially affects its efficiency. The proposed process of the evolution of the portfolio management (Figure 1) covers all the stages of its classical form, while taking into account the additional steps that specifically require an expert assistance in the form of the use of artificial neural networks. It was mentioned that the development of organizations involved in investing money in a globalizing world needs to adapt to the economic realities of the process to which the analysis becomes more time-consuming. That is why it is necessary to support the proposed three additional processes using artificial neural networks. Needless to explain any further, the various stages require an individual approach to network configuration, probably different from the one used in this study. For this

reason, the demand to conduct separate studies seems clearly rational, presenting the usefulness of the network for specific stages of the process, after the evolution of portfolio management. It seems reasonable that the proposed form of the evolutionary process should be more useful for organizations to manage portfolios, rather than its classic form, especially in the context of achieving a satisfactory rate of return on invested capital.

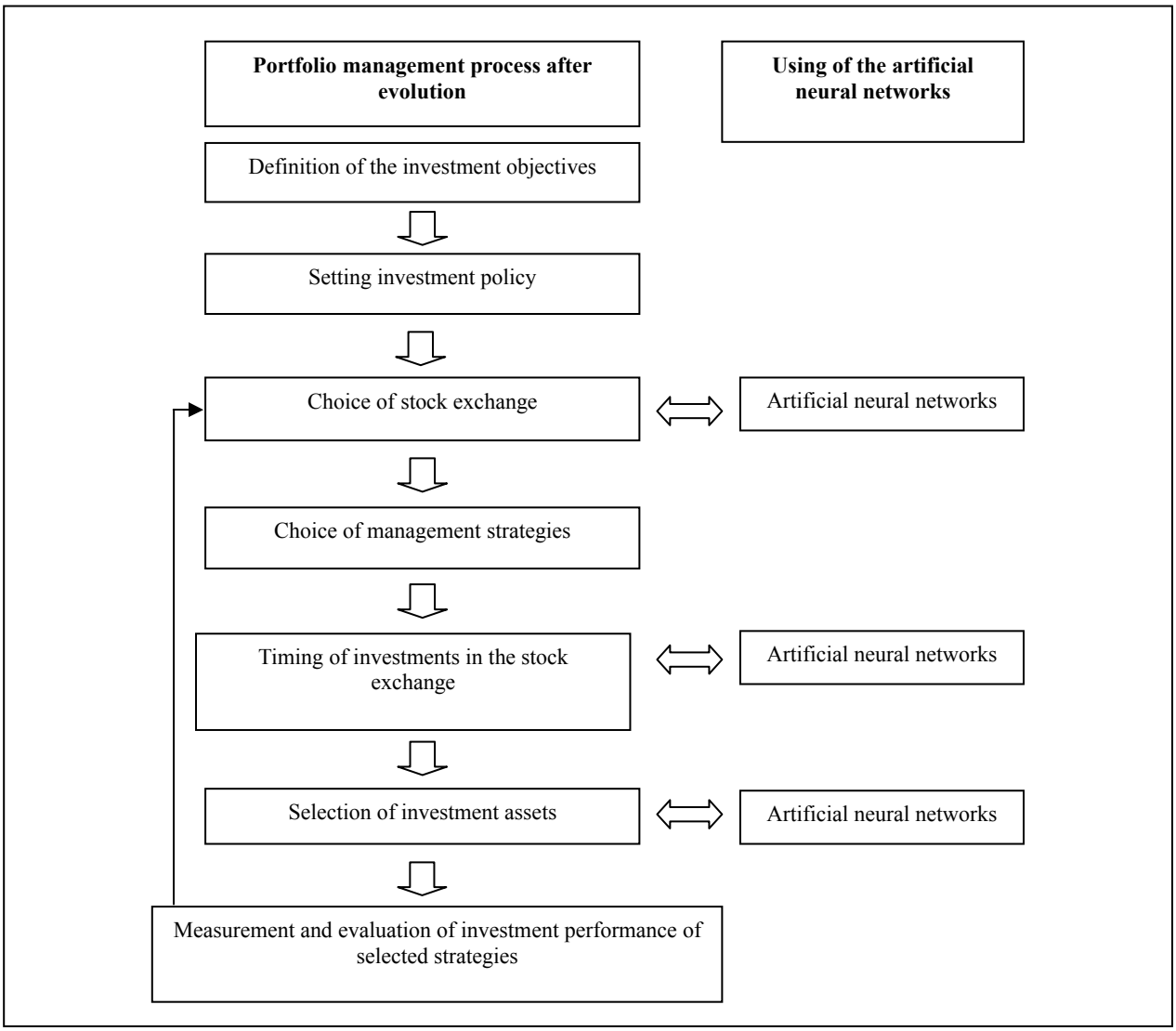

Figure 1. The model of portfolio management process after the evolution in the context of the use of artificial neural networks.

Analysis

This article aims to draw attention to the underestimation of the impact of globalization on the portfolio management process. Accordingly, the attempt was made to design the process which takes this effect into account. Considering the solutions proposed in this publication, future research is needed and will include:

(1) Using artificial neural networks in the context of choice of stock exchange and of timing of investments in the stock exchange.

(2) Selection of investment assets based on artificial neural networks.

(3) Presentation of a profitability of constructed portfolios.

Conclusions

Summarizing the presentation of the portfolio management process (of financial instruments) from the perspective of the evolution of the use of artificial neural networks, it seems reasonable to conclude that the organizations investing cash, primarily in financial instruments, should consider the mentioned expert tool for further development. Globalization, in which they carry out investment activity, presents them with new requirements, even related to the choice of stock exchanges, whose number is 65 (including the largest and the most well-known stock exchanges), as well as requirements relating to the selection of assets or the determination of the length of the investment in the previously selected stock market.

This causes that the process of managing a portfolio of financial instruments in a globalized world, meaning after the evolution, which is analyzed from the perspective of efficiency, should be assisted by an expert tool, such as an artificial neural network. For this reason, the contents of this publication can make a contribution to separate studies. Referring to the article, having presented the most important areas, addressed in the literature on the management of a portfolio of financial instruments, it seems to be a legitimate thesis that the subject of the evolution of portfolio management in the era of globalization is a kind of a gap, due to the fact that the presentation of the model process, drawn up on the basis of its own proposals, can be considered as an attempt to fill in this gap.

References

Albrecht, P., & Maurer, R. (2008). *Investment—und Risikomanagement*. Stuttgart: Schäffer Poeschel Verlag.

Allen & Overy LLP. (2013). *Life after Lehman, five years on.* Retrieved from http://www.allenovery.com/SiteCollectionDocuments/lifeafterlehman2013

Blake, D., Wright, D., & Zhang, Y. (2014). Age-dependent investing: Optimal funding and investment strategies in defined contribution pension plans when members are rational life cycle financial planners. *Journal of Economic Dynamics & Control, 8,* 105-124.

Bruns, C., & Meyer-Bullerdiek, F. (2013). *Professionelles portfolio management*. Stuttgart: Schäffer-Poeschel Verlag, 5. Auflage.

Doumpos, M., Zopounidis, C., & Pardalos, P. M. (Eds.). (2012). *Financial decision making using computational intelligence* (Vol. 70). Springer Optimization and Its Applications.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica, 50*(4), 987-1007.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance, 25*(2), 383-417.

Fochmann, M., & Rumpf, D. (2010). Modellierung von aktienanlagen bei laufenden umschichtungen und einer besteuerung von veräußerungsgewinnen. *Zeitschrift für Betriebswirtschaft, 80,* 945-968.

Francis, J. C. (1976). *Investments analysis and management*. New York, NY: McGaw-Hill.

Grubel, H. G. (1968). Internationally diversified portfolios: Welfare gains and capital flows. *The American Economic Review, 58*(5), 1299-1314.

Guermat, C. (2014). Yes, the CAPM is testable. *Journal of Banking & Finance, 46,* 31-42.

Investopedia.com. (2015). *CFA Level 1.* Retrieved from http://www.investopedia.com/exam-guide/cfa-level-1/portfolio-management/portfolio-management-process.asp

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-291.

Lintner, J. (1965a). Securities prices, risk, and maximal gains from diversification. *The Journal of Finance, 20*(4), 587-615.

Lintner, J. (1965b). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economics and Statistics, 47*(1), 13-37.

Maginn, J. L., & Tuttle, D. L. (1990). The portfolio management process and its dynamics. In J. L. Maginn and D. L.Tuttle (Eds.), *Managing investment portfolios: A dynamic process. Warren, Gorham & Lamont* (pp. 1-5). Sponsored by the Institute of Chartered Financial Analysts). Second Edition, New York.

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77-91.

Mayordomo, S., Moreno M. R., & Peña, J. I. (2014). Derivatives holdings and systemic risk in the US banking sector. *Journal of Banking & Finance, 45,* 84-104.

McCulloch, W. S., & Pitts, W. H. (1943). A logical calculus of the ideas immanent in nervous activity. *The Bulletin of Mathematical Biophysics, 5,* 115-133.

Mossin, J. (1966). Equilibrium in a capital asset market. *Econometrica, 34*(4), 768-783.

Reilly, F. K., & Brown, K. C. (2011). *Investment analysis and portfolio management*. Australia, Brazil, Japan, Korea, Mexico, Singapore, Spain, UK, USA: South Western-Cengage Learning.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance, 19*(3), 425-442.

Steiner, M., Bruns, C., & Stöckl, S. (2012). *Wertpapier management*. Stuttgart: Schäffer-Poeschel Verlag.

Steuer, R., Hirschberger, Y., & Qi, M. (2006). Portfolio optimization: New capabilities and future methods. *Zeitschrift für Betriebswirtschaft, 76,* 199-219.

The Federation of European Securities Exchanges (FESE). (2015). Retrieved from http://www.fese.eu/en/?inc=art&id=4

The Scorpio Partnership Private Banking Benchmark. (2013). Retrieved from http://www.scorpiopartnership.com/uploads/pdfs/2013%20Scorpio%20Partnership_Global%20Private%20Banking%20KPI%20Benchmark_Final.pdf

The World Federation of Exchanges (WFE). (2015). Retrieved from http://www.world-exchanges.org/statistics/monthly-reports

Treynor, J. L. (1961). Market value, time, and risk. Unpublished manuscript.

Treynor, J. L. (1962). Toward a theory of market value of risky assets. Unpublished manuscript.

Vermeulen, R. (2013). International diversification during the financial crisis: A blessing for equity investors? *Journal of International Money and Finance, 35,* 104-123.

Wu, C. R., Lin, C. T., & Tsai, P. H. (2010). Evaluating business performance of wealth management banks. *European Journal of Operational Research, 207,* 971-979.