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Performance of Quantitative Investment Funds

Summary of doctoral dissertation
in the field of Economics and Finance

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The motivation and the essence of the study

Inevitable and systematic technological progress in the area of Information Technology and Computer Science also has an impact on the way how investment funds manage their assets and make investment decisions. Some asset managers decided to utilize the results of technological progress in order to develop and implement automated, rules-based and objectified portfolio management processes. Investment funds in which investment decisions are based on the indications of a predefined automated investment process with none or a limited human intervention are mostly called *quantitative funds* or *quant funds* (e.g., Chincarini & Kim, 2006; Chincarini, 2014; Abis, 2018; Parvez & Sudhir, 2005; Guida, 2019; Fabozzi & Markowitz, 2011), as well as *systematic funds* (e.g., Harvey et al., 2017; Chuang & Kuan, 2018). Also, there seems to be the lack of complete consensus when it comes to nomenclature pertaining to investment funds, which do not rely on such predefined automated investment processes. In the issue-related literature and financial media they are mostly called qualitative funds (e.g., Chincarini & Kim, 2006; Chincarini, 2014), *discretionary funds* (e.g., Abis, 2018; Chuang & Kuan, 2018) or *fundamental funds* (e.g., Parvez & Sudhir, 2005; Guida, 2019; Fabozzi & Markowitz, 2011). Researchers raising the issue of investment funds that rely on a predefined automated investment process tend to propose their own definitions of such funds and their contrary parts, namely investment funds in which the investment process is not automated and investment decisions are made by human managers. The definitions proposed in the issue-related studies do not seem to be fully consistent, as they indicate various criteria that have to be fulfilled in order to qualify a fund into one of two groups. Nevertheless, proposed definitions appear to share many common elements, which makes them similar in terms of the substance of the problem. The heavy reliance on a predefined automated investment process, the utilization of advanced mathematical models, and the limited interventions of human managers in the portfolio management process can be examples of features commonly assigned to quantitative portfolio management, namely, the approach to portfolio management applied by quantitative funds. On the other hand, a heavy reliance on the judgement, skills, and intuition of a human manager, as well as the lack of the usage of a predefined automated investment process, are mostly proposed features of qualitative portfolio management, namely, the approach to portfolio management applied by qualitative funds. Taking into account no general consensus in terms of nomenclature, in further considerations, terms *quantitative funds* and *qualitative funds* will be used.

Researchers indicate that quantitative and qualitative approaches to portfolio management are often combined. Such approaches are mostly called *quantamental* (e.g., López de Prado, 2018; Arslanian & Fisher, 2019; Gray, Vogel, & Foulke, 2015; Svetlova, 2018) or *hybrid* (e.g., Fabozzi et al. , 2008). The combination of quantitative and qualitative approaches may take various forms (e.g., Guida, 2019; Fabozzi et al., 2008; Narang, 2013).

Despite the existence of investment funds that combine quantitative and qualitative approaches to portfolio management, researchers studying the performance of quantitative

funds, in the majority of cases, conduct a comparative study between the two groups of funds, i.e., quantitative and qualitative funds. A group of funds that combines the features of quantitative and qualitative funds is not distinguished and considered as one of the groups that are compared. The reason for this is that the information included in financial databases does not allow to determine the level of being quantitative or qualitative. Moreover, most financial databases do not provide any information on whether a fund is quantitative or qualitative. Thus, in the majority of issue-related studies, researchers had to come up with their own ideas on how to split a universe of investment funds into quantitative and qualitative groups. Studies raising the issue of the performance of quantitative funds assume that the group of quantitative funds applies more quantitative techniques of portfolio management and aim to learn about the relative importance of their application in terms of generated performance (Chincarini, 2014).

Similarly to the previous issue-related studies, the study conducted for the needs of this thesis considers performance as the outcomes of activities taken in a specific time period. The performance evaluation process taken in the studies dedicated to the evaluation of the performance of quantitative funds provides information regarding historical results and investment-related costs. The foregoing issue-related studies focused on various universes of investment funds obtained from different financial databases and applied various research methodologies. Most studies considering the performance of quantitative funds suggest that quantitative funds mostly outperformed qualitative funds (e.g., Chincarini, 2014; Harvey et al., 2017; Parvez & Sudhir, 2005; Chuang & Kuan, 2018).

The aforementioned issue-related studies usually focused on particular investment fund types, such as hedge funds or equity funds. Their research samples rather did not exceed eleven thousand investment funds. The study conducted for the needs of this thesis utilizes a much larger sample consisting of nearly three hundred thousand live and dead funds coming from the Thomson Reuters Eikon database. According to the knowledge of the author of this thesis, this database was not applied in the issue-related studies. Hence, it would be interesting to see if the results of the study conducted with data retrieved from a different database allow to draw conclusions similar to those drawn on the basis of the results obtained in the previous studies. What is more, this study is dedicated to investment funds coming from four different groups of funds distinguished in terms of the applied strategy according to the Lipper Global Classification, i.e., equity funds, mixed asset funds, absolute return funds, and hedge funds. Such groups of funds like mixed asset funds and absolute return funds were not the objects of the previous issue-related studies. Furthermore, this study evaluates the performance of quantitative funds at the level of four most numerous groups of funds distinguished in terms of the region of a primary investment focus. The analysis of the results at the level of individual groups of funds distinguished in terms of strategy and region may reveal some interesting observations pertaining to differences in the performance of quantitative funds. Moreover, the study conducted for the needs of this thesis also focuses on

the features of the returns of quantitative funds in terms of the weak-form informational efficiency. This part of the study refers to the advantage of quantitative funds over qualitative funds, which is commonly proposed in the issue-related literature, pertaining to the elimination of behavioural errors (Chincarini, 2014; Chincarini & Kim, 2006; Parvez & Sudhir, 2005). Such characteristics were not studied in the foregoing publications dedicated to the evaluation of the performance of quantitative funds. Additionally, this study evaluates the performance of quantitative funds in periods of low weak-form informational efficiency of equity markets. This part of the study refers to the beliefs of some researchers (Chincarini, 2014; Parvez & Sudhir, 2005) that quantitative funds take advantage of informational inefficiencies of financial markets in a better way compared to qualitative funds. All the abovementioned features of the study conducted for the needs of this thesis aim to fill the research gap in the area of the evaluation of the performance of quantitative funds.

Research objectives and hypotheses

The main research objective of this thesis is the evaluation of the performance of quantitative funds in relation to the performance of qualitative funds. The evaluation of the performance of quantitative funds in relation to the performance of qualitative funds will allow to learn about the relative importance of the application of quantitative portfolio management in terms of generated performance. The main research objective is directly related to the H1 hypothesis:

H1: The performance of quantitative funds is higher than the performance of qualitative funds.

The main research hypothesis has its grounds in the studies by Harvey et al. (2017), Chincarini (2014), Parvez and Sudhir (2005), and Chuang and Kuan (2018), which constituted a major part of the studies on the performance of quantitative funds. They suggest that in most cases, quantitative funds performed better compared to qualitative funds. A sample of the study conducted for the needs of this thesis also consists of other fund types, such as absolute return and mixed asset funds, which were not examined in the issue-related studies. However, it seems that the application of quantitative portfolio management techniques in such fund types may be beneficial. Absolute return funds aim to generate positive returns with low volatility, which are independent of the conditions on financial markets and conventional benchmarks. Mixed asset funds combine different asset types to create a portfolio. The commonly proposed advantages of quantitative funds over qualitative funds in areas such as the breadth of selection and risk management should enhance the performance of quantitative funds in such types of funds (Chincarini, 2014).

This thesis also aims to answer some supplementary research questions that may detail knowledge about the performance of quantitative funds. The first supplementary research question pertains to the similarity of quantitative funds to qualitative funds in terms of the

homogeneity of performance generated. The second supplementary research question pertains to the similarity of quantitative funds to qualitative funds in terms of the correlation between their raw returns. These two questions refer to the study by Harvey et al. (2017) in which the results suggested that systematic and discretionary funds (as they called them) were quite similar in terms of performance dispersion and performance correlation. Such conclusions were not in line with common beliefs that systematic funds were highly homogenous and highly correlated due to the similarities of their strategies (Harvey et al., 2017). By providing the answers to the first and second supplementary questions, this study aims to verify whether it is possible to obtain results similar to those obtained by Harvey et al. (2017).

The third supplementary research question relates to differences in performance between quantitative and qualitative funds that may possibly differ between the groups of funds distinguished in terms of strategy and the region of a primary investment focus. By making an attempt to answer this question, this study may indicate the groups of investment funds in which the application of quantitative portfolio management may be especially beneficial.

The fourth supplementary research question refers to a possible connection between the fund size and its performance. According to Chincarini and Kim (2006), the development of a quantitative investment process may require to devote high capital expenditures; however, once a quantitative investment process is in place, the cost of portfolio management may become lower compared to qualitative portfolio management. The quality and performance of a quantitative investment process may be related to initial capital expenditures incurred for its development. Larger investment funds may be able to invest more in the development of quantitative investment processes that are more advanced and allow to generate higher performance. Thus, it is worth verifying whether larger quantitative funds perform better than smaller quantitative funds.

The fifth supplementary research question refers to the risk related to the distribution of returns generated by quantitative funds. The sixth supplementary research question pertains to the systematic risk of quantitative funds. According to Chincarini and Kim (2006), quantitative portfolio management is better than qualitative portfolio management in measuring and controlling the risk. The results of the study by Harvey et al. (2017) indicated that systematic funds (as they called them) were less exposed to risk factors compared to discretionary funds. Abis (2018) proposed that quantitative funds have better risk management and portfolio diversification throughout the business cycle. It will be interesting to verify whether, also in the case of the study conducted for the needs of this thesis, quantitative funds appear to be less risky.

The seventh supplementary research question relates to the possible higher performance of quantitative funds compared to their relevant equity market benchmark selected in this study. This study aims to evaluate the performance of quantitative funds in relation to the performance of qualitative funds. However, the evaluation of the performance of quantitative funds in relation to their relevant equity market benchmarks may constitute an additional

insight on the issue of the performance of quantitative funds. All supplementary research questions related to the main research objective are as follows:

1. Are quantitative funds similar to qualitative funds in terms of the homogeneity of performance generated?
2. Are quantitative funds similar to qualitative funds in terms of the correlation between their raw returns?
3. Do the differences in performance between quantitative and qualitative funds differ between the groups of funds distinguished in terms of strategy and the region of a primary investment focus?
4. Do larger quantitative funds perform better than smaller quantitative funds?
5. Are quantitative funds less risky than qualitative funds in terms of risk related to the distribution of returns they generate?
6. Are quantitative funds less exposed to systematic risk than qualitative funds?
7. Do quantitative funds outperform their relevant equity market benchmark selected in this study?

Furthermore, two supplementary research objectives have been formulated in order to extend and detail the study. The first supplementary research objective is the evaluation of the weak-form informational efficiency of quantitative funds in relation to qualitative funds. The first supplementary research objective is directly related to the H2 hypothesis:

H2: The weak-form informational efficiency of quantitative funds is higher compared to qualitative funds.

The issue-related literature suggests that investment decisions of a qualitative portfolio manager can be affected by some behavioural biases. In the case of quantitative portfolio management, the model determines investment decisions, thus, the impact of a human factor is minimised (Chincarini & Kim, 2006; Chincarini, 2014). Behavioural errors, which occur in the case of qualitative portfolio management, may negatively affect the weak-form efficiency of qualitative funds. Thus, due to the possibly lower vulnerability of quantitative portfolio management to behavioural errors, quantitative funds may be marked by a higher weak-form efficiency. In the context of investing in quantitative funds, their higher weak-form efficiency may suggest a lower possibility of generating abnormal returns by investors and a lower predictability based on historical returns (Zamojska, 2012).

In addition, some further supplementary research questions have been posed with regard to the H2 hypothesis. By answering the next supplementary research question, this study will provide information on the lowest levels of the weak-form informational efficiency of equity markets. Furthermore, the study will provide information on the difference between

quantitative and qualitative funds in terms of their weak-form efficiency in periods of low weak-form efficiency of equity markets. The minimisation of behavioural errors by quantitative funds proposed by Chincarini and Kim (2006) and Chincarini (2014) should be especially beneficial in periods of the exceptional instability of financial markets. The supplementary research questions pertaining to the first supplementary research objective are as follows:

8. Which periods were marked by the lowest levels of the weak-form informational efficiency of equity markets?
9. Are quantitative funds more weak-form efficient than qualitative funds in periods of low weak-form efficiency of equity markets?

Furthermore, with regard to the first supplementary research objective, this study aims to find out whether the differences in the weak-form informational efficiency between quantitative and qualitative funds differ between the groups of funds distinguished in terms of strategy and the region of a primary investment focus. Moreover, referring to the aforementioned possibility of developing and implementing more advanced quantitative investment processes by larger quantitative funds, this study aims to verify whether larger quantitative funds are more weak-form efficient compared to smaller quantitative funds. Such a difference may result from a possible advantage of larger quantitative funds in terms of possessing more advanced quantitative investment processes, which are also less vulnerable to behavioural errors. Additionally, the answer to the question of whether quantitative funds are more weak-form informationally efficient than their relevant equity market benchmark selected in this study will constitute additional insight on the weak-form efficiency of quantitative funds.

The second supplementary research objective is the evaluation of the performance of quantitative funds in relation to the performance of qualitative funds in periods of low weak-form informational efficiency of equity markets. The second supplementary research objective is directly related to the H3 hypothesis:

H3: Quantitative funds perform better than qualitative funds in periods of low weak-form informational efficiency of equity markets.

The second supplementary research hypothesis H3 has its grounds in the beliefs of some researchers (Chincarini, 2014; Parvez & Sudhir, 2005) that quantitative funds take advantage of informational inefficiencies of financial markets in a better way compared to qualitative funds. This study verifies these beliefs by evaluating the performance of quantitative funds in relation to the performance of qualitative funds in periods of the lowest efficiency of equity markets. Information on periods of the lowest efficiency of equity markets will be obtained by answering the eighth supplementary research question, which was mentioned above.

This study also aims to contribute to the body of knowledge related to the evaluation of the performance of quantitative funds by introducing some theoretical considerations pertaining to the issue-related definitions and nomenclature proposed in the foregoing studies. The aim of these theoretical considerations is to verify whether there is a consensus among researchers when it comes to defining quantitative, qualitative, and hybrid funds and when it comes to the issue-related nomenclature they apply. In the case of the lack of uniformity in the preceding publications, this thesis will make an attempt to propose some universal nomenclature and definitions. Conclusions drawn on the basis of the literature review should enable to answer the question of which features make an investment fund a real quantitative fund.

Research sample and methodology

For the purpose of this study, data pertaining to investment funds have been retrieved from the Thomson Reuters Eikon database. The research period began on 1st January 2000 and ended on 31st December 2020. The research sample includes all live and dead funds as of 15th January 2021, which were classified as absolute return funds, equity funds, hedge funds, and mixed asset funds according to the Lipper Global Classification scheme. A total number of retrieved investment funds was 392 089. Nevertheless, 97 001 of them were dropped due to missing data and additional assumptions made. Hence, a basic research sample consisted of 295 088 investment funds. They were grouped by the applied strategy according to the Lipper Global Classification scheme into four groups, namely absolute return funds, equity funds, hedge funds, and mixed asset funds. Moreover, they were also grouped by the region of a primary investment focus, taking into account The United Nations geo-scheme. However, in a detailed study, only four most numerous groups were examined, namely, funds primarily investing in Eastern Asia, Northern America, Northern Europe, and Western Europe.

This study had a comparative character. Thus, it was necessary to distinguish the groups of quantitative and qualitative funds. Most financial databases did not provide such a classification. They did not even provide any similar one. Hence, similarly to most of the foregoing studies on the performance of quantitative funds, this study had to deal with the problem of the research sample split into quantitative and qualitative groups. Some issue-related studies utilized a word-search method, which consisted in searching for specific words related to quantitative portfolio management in the description of fund operations (Chincarini, 2014; Harvey et al., 2017). If a given word was found in the description of fund operations, a fund was classified as a quantitative one. Otherwise, it was classified as a qualitative one. Some researchers declared that in order to gain more objectivity, they applied some more sophisticated split methods based on machine learning classification algorithms (Abis, 2018; Chuang & Kuan, 2018). In order to retrieve a training sample, Abis (2018) classified a part of the whole research sample personally. In the case of Chuang and Kuan (2018), some fund categories were already divided in the database and the researchers used them as training

samples. The study conducted for the needs of this thesis follows the fund classification methodology proposed by Harvey et al. (2017).

A basic sample of 295 088 investment funds did not constitute the final research sample. Final research samples were selected in each of the three parts of the study separately due to the application of the rolling window method with additional requirements pertaining to a number of required observations in the windows. In order to ensure that this study had a clear structure, it was divided into three parts:

1. Weak-form informational efficiency study
2. Performance study with the use of the relative measures of portfolio performance, as well as raw and excess returns
3. Performance study with the use of econometric models

Supplementing a study on the performance of investment funds with a study on the features of their returns in the context of the weak-form informational efficiency is not that common. Nevertheless, this is not a completely new case. A similar approach was applied, for instance, by Zamojska (2012). The first part of the study verifies the H2 hypothesis and aims to answer the question of whether quantitative funds are more weak-form informationally efficient than qualitative funds. In order to do this, the first part of the study applies the tests for the martingale difference hypothesis (MDH) and normality tests. As far as the MDH tests are concerned, two tests were applied, namely the automatic Portmanteau test for serial correlation proposed by Escanciano and Lobato (2009), as well as the wild bootstrapped automatic variance ratio test under conditional heteroskedasticity proposed by Kim (2009) and constituting the modification of the automatic variance ratio test proposed by (Choi, 1999). When it comes to normality tests, the Lilliefors and D'Agostino-Pearson tests were applied. As opposed to the abovementioned MDH tests, tests for normality are considered strict random walk tests. The normality tests are conducted not only to verify the weak-form informational efficiency, but also to check if the application of some performance measures is justified, as some performance measures require the normality of the distribution of returns.

All calculations in the first part of the study were performed for the monthly returns of investment funds using a rolling window methodology. The tests were conducted for the 60-month windows of the monthly logarithmic returns of net asset values (hereinafter NAV) at the end of each month, rolled by 12 months (the next window began 12 months from the beginning of the previous window). A test was run only if, in a given window, a fund had at least 90% of a maximum number of observations, i.e., a required minimum number of observations to run a test was 54 (a maximum number of observations was 60).

Both the second and third part of the study verify the main research hypothesis H1 and aim to answer the question of whether the performance of quantitative funds is higher than the performance of qualitative funds. They also verify a supplementary research hypothesis H3 and aim to answer the question of whether quantitative funds perform better than qualitative

funds in periods of low weak-form informational efficiency of equity markets. However, they do this with the use of different methods. The second part of the study applies the relative measures of portfolio performance, as well as raw and excess returns. Eleven measures applied come from the five groups of portfolio performance measures, such as unadjusted returns, classic measures based on the CAPM model, performance measures based on value at risk, lower partial moments, and maximum drawdown. This division of measures was based on divisions proposed by Aldridge (2010) and Bacon (2008). The second part of the study also applies a rolling window method with the same parameters as in the first part of the study.

The third part of the study applies two modified econometric models, namely, a modified Capital Asset Pricing Model (CAPM) and a modified Treynor-Mazuy Model (TM). The aforementioned modifications aim to capture differences between quantitative and qualitative funds in terms of selectivity and market-timing skills, as well as systematic risk. Studies dedicated to portfolio performance evaluation focus especially on two basic skills of a portfolio manager, namely selectivity and market timing. A portfolio manager using selectivity skills indicates which financial instruments are overvalued and undervalued. Selectivity is related to portfolio diversification that aims to reduce specific risk. Market timing refers to the ability to forecast market movements, which aims to choose a right moment for the conclusion of a transaction (Zamojska, 2012). The models were also estimated with the use of the rolling window method. However, its parameters changed. The changes pertained to the length of a window and a minimum percentage of observations in the window. The length of the window was changed to 84 months, and a minimum percentage of observations in a window was changed to 80%.

When it comes to applied research tools, calculations were performed mostly in RStudio, with the use of the R programming language. Moreover, Microsoft Excel was also used; however, in the minority of cases. The most important R packages used for the calculations were: nortest, vrtest, PerformanceAnalytics, and plm. Visualizations were mostly prepared with the use of the ggplot2 package.

Conclusions and the verification of research hypotheses

The research hypotheses stated in the introduction were tested in the empirical part of this thesis. The main research hypothesis (H1) states that the performance of quantitative funds is higher than the performance of qualitative funds. This hypothesis was verified in the second and third part of the study. The performance was examined for monthly returns over many rolling windows in the entire research period from 2000 to 2020 for several different samples of investment funds, namely, a whole research sample, four sub-samples distinguished in terms of strategy applied, and four most numerous sub-samples distinguished in terms of the region of a primary investment focus.

When considering the estimates of the coefficient informing about differences in alpha obtained in the third part of the study and the results obtained for the relative measures of portfolio performance in the second part of the study, in the case of a whole research sample, they allowed to draw some inconsistent conclusions. According to the estimates of the coefficient informing about differences in the alpha parameter, quantitative funds were outperformed by qualitative funds most of the time. However, a substantial part of the estimates was statistically insignificant, reducing the validity of this conclusion. On the other hand, according to the results for the relative measures of portfolio performance, quantitative funds outperformed qualitative funds just slightly more often. The results obtained in the second and third part of the study appeared to be more consistent at the level of particular strategies. Quantitative funds turned out to outperform qualitative funds in the majority of cases in the groups of absolute return, equity, and hedge funds. It should be mentioned that quantitative funds had a clear advantage over qualitative funds only in the group of absolute return funds. On the other hand, quantitative funds managed clearly worse in the group of mixed asset funds. The results at the level of individual regions appeared to be more ambiguous compared to the results at the level of individual strategies. Nevertheless, they rather suggest that quantitative funds were outperformed by qualitative funds slightly more often in all groups except for the group of funds primarily investing in Northern Europe. The advantage of qualitative funds was not high. The results of the Northern European group suggest that quantitative funds outperformed qualitative funds slightly more often. However, a certain level of ambiguousness between different measures could also be observed. The least level of ambiguousness could be observed in the group of funds primarily investing in Western Europe, in which qualitative funds slightly more frequently outperformed quantitative funds.

When considering market-timing skills, the results obtained in the third part of the study turned out to be mostly not in line with the estimates of the coefficient informing about differences in the alpha parameter, which referred to selectivity skills. In the case of a whole sample, quantitative funds outperformed qualitative funds in the vast majority of cases in terms of market timing. In the case of selectivity skills, the opposite was true. However, it should be noted that slightly less than half of the estimated coefficients pertaining to market timing were statistically significant. What is more, the advantage of quantitative funds over qualitative funds in terms of market timing tended to decrease over the windows.

At the level of individual strategies, in the great majority of cases, quantitative funds had worse market timing in the groups of absolute return and hedge funds. This may be quite surprising, as in these groups, quantitative funds had a more systematic advantage in terms of selectivity skills. On the other hand, quantitative funds had a more systematic advantage in terms of market timing in the group of mixed asset funds. According to the estimates of the coefficient informing about differences in the alpha parameter and the results obtained in the second part of the study, in the group of mixed asset funds, quantitative funds were

outperformed in the vast majority of cases. Quantitative funds also had better market timing in the group of equity funds. In none of the groups distinguished in terms of applied strategy, quantitative funds had a clear advantage over qualitative funds in terms of both selectivity and market-timing skills. The same was true to for groups distinguished in terms of the region of a primary investment focus. When it comes to the examined regions, a more systematic outperformance of qualitative funds by quantitative funds in terms of market timing could be observed in the groups of funds primarily investing in Eastern Asia, Northern America, and Northern Europe. This observation also may be surprising, as quantitative funds in the Eastern Asian and Northern American groups tended to be outperformed in the majority of cases in terms of selectivity skills. More consistent results were obtained for the groups of funds primarily investing in Northern Europe and Western Europe. In the group of funds primarily investing in Western Europe, quantitative funds were outperformed slightly more often in terms of both selectivity and market timing. The opposite was true in the case of the group of funds primarily investing in Northern Europe.

The results obtained in the second and third parts of the study do not unambiguously suggest rejecting the H1 hypothesis, as according to some performance measures, in some examined samples, quantitative funds provided systematically better performance compared to qualitative funds. According to the estimates of the coefficient informing about differences in the alpha parameter and the relative measures of portfolio performance, quantitative funds managed to systematically outperform qualitative funds in the group of hedge funds and in the group of absolute return funds. The advantage of quantitative funds was clear in the case of the latter one in particular. However, the dominance of quantitative funds in the groups of hedge funds and absolute return funds did not hold in the case of market-timing skills. According to estimates of the coefficient informing about differences in the alpha parameter and the parameter related to differences in market-timing skills, quantitative funds managed to gain more systematic advantage over qualitative funds in the group of funds primarily investing in Northern Europe. In terms of market-timing skills, quantitative funds tended to gain more systematic advantage also in the overall sample, in the groups of equity and mixed asset funds, and in the groups of funds primarily investing in Eastern Asia and Northern America. However, it should be noted that the estimates of the parameter pertaining to differences in market timing were statistically significant in the minority of cases.

The second and third part of the study also provided many interesting conclusions, which constituted the answers to supplementary research questions posed in the introduction. Regarding the similarity of quantitative and qualitative funds in terms of the homogeneity of performance they generated, the interquartile range of most relative measures of portfolio performance appeared to be slightly higher in the case of quantitative funds compared to qualitative funds. Almost no differences in spread between quantitative and qualitative funds could be observed in the case of raw and excess returns. The main differences in the spreads between quantitative and qualitative funds turned out to result from the differences in the 75th

percentiles. The 75th percentiles appeared to be higher in the case of quantitative funds, suggesting that the upper 25% of observations of the relative measures of portfolio performance in the group of quantitative funds had higher values.

The following supplementary research question pertained to the similarity of quantitative and qualitative funds in terms of the correlation between their raw returns. When considering the results obtained for the entire research sample and all windows, the average Pearson correlation coefficients in the groups of quantitative and qualitative funds appeared to be positive, moderate, and quite similar. In the case of quantitative funds, the average Pearson correlation coefficient was slightly higher, suggesting that quantitative funds were slightly more similar to each other than qualitative funds in terms of the correlation between their raw returns. The average correlation coefficient between quantitative and qualitative funds was very similar to the coefficients mentioned above. The levels of the Pearson correlation coefficient in the examined groups changed substantially over the windows, from being on the verge of positively low and moderate to positively high. The behaviour of the correlation coefficients was similar in the groups of quantitative and qualitative funds.

When taking into account the results obtained between and within the strategies, the results turned out to be strategy-dependent. The lowest results that indicate low and positive correlations could be observed in the groups paired with hedge funds. Only in these groups, the average correlation coefficients of quant funds were lower compared to qualitative funds. Slightly higher correlations could be observed in the groups paired with absolute return funds. The highest correlations could be observed in the groups related to equity and mixed asset funds. Correlations in these groups could be considered moderate. In these groups, the investment funds applied the most similar strategies in terms of the raw returns generated. A common feature of the examined groups was that the differences between the correlations of quant and qual funds were mostly slight. Low correlations in the groups related to hedge and absolute return funds seem to be justified, as funds from these groups are expected to apply varied and sophisticated strategies engaging derivatives and short positions.

In the case of grouping by the region of a primary investment focus, the correlations turned out to be region-dependent. The lowest average correlation coefficients could be observed in the groups paired with the groups of funds primarily investing in the region of Eastern Asia. The highest correlations on the verge of moderate and high could be observed in the case of the group of funds primarily investing in Northern Europe. Slightly lower correlations could be observed in the groups of Northern America and Western Europe. The differences between the correlations among the quant and qual funds were slight.

In the process of the verification of the H1 hypothesis, it turned out that the differences in performance between quantitative and qualitative funds behaved differently among the examined samples. It referred to groups distinguished in terms of strategy, as well as groups distinguished in terms of the region of a primary investment focus. However, the differences between the groups distinguished in terms of strategy were much more visible.

The second part of the study delivered some interesting conclusions related to the connection between the size of quantitative funds and their performance. The results obtained suggest that larger quantitative funds in terms of total net assets (TNA) delivered higher performance than smaller quantitative funds in the majority of cases across almost all examined groups. The larger funds in terms of TNA delivered higher performance also in the group of qualitative funds. However, it did not pertain to such many examined samples as in the case of quantitative funds, and the outperformance of smaller funds by the larger ones was not so clear. In the case of some groups distinguished in terms of the region of a primary investment focus, larger qualitative funds managed even worse. These groups were qualitative funds primarily investing in Northern Europe and Western Europe. A higher positive relationship between TNA and performance in the case of quantitative funds may suggest that the TNA managed has a greater impact on performance in the case of quantitative funds. Larger managed funds may be related to larger expenditures on the development of profitable quantitative portfolio management processes.

Moving to the following important conclusions, the differences between the indications of the relative measures of portfolio performance and raw returns, as well as excess returns, suggest that in most examined groups, quantitative funds were less risky than qualitative funds in terms of risk related to the distribution of returns they generated. It did not pertain to groups of funds primarily investing in Eastern Asia and Northern Europe.

The differences in systematic risk between quantitative and qualitative funds were examined in detail in the third part of the study. The results obtained allow for stating that differences in systematic risk between quantitative and qualitative funds differed between the samples examined. When it comes to groups in which some clear differences could be observed, quantitative funds were exposed to a higher systematic risk compared to qualitative funds in the great majority of cases in a whole research sample, in the samples of equity and mixed asset funds, as well as in the sample of funds primarily investing in Eastern Asia. The opposite was true in the case of hedge funds, as well as in the case of funds primarily investing in Northern America and Western Europe.

Regarding the differences in performance between quantitative funds and their relevant equity market benchmarks, when looking at the results obtained for the relative measures of portfolio performance, in the second part of the study, quantitative funds turned out to clearly systematically outperform the market only in the case of hedge funds. Moreover, the outperformance of the market by quantitative funds, but not that systematic, could be observed in the case of a whole sample, samples of absolute return and equity funds, as well as sample of funds primarily investing in Eastern Asia. On the other hand, the market systematically outperformed quantitative funds in the case of funds primarily investing in the remaining three regions. A not so clear and systematic outperformance of quantitative funds by the market could be observed in the group of mixed asset funds. The abovementioned considerations pertained to the indications of the relative measures of portfolio performance.

According to raw and excess returns, quantitative funds were dominated by the market in almost all examined groups. It suggests that the risk related to investment in quantitative funds is much lower compared to investment in a passive equity market portfolio.

The first supplementary research hypothesis, which was verified in this thesis, namely the H2 hypothesis, stated that the weak-form informational efficiency of quantitative funds was higher than the weak-form informational efficiency of qualitative funds. The H2 hypothesis was verified in the first part of the study with the use of the MDH and normality tests. The two groups of applied tests provided quite different results. Nevertheless, drawing some general conclusions was still manageable. When looking at the results obtained for a whole sample over the windows, quantitative funds turned out to be more frequently more efficient compared to qualitative funds. However, the advantage of quantitative funds was not substantially often. At the level of individual groups distinguished in terms of the applied strategy, a similar situation could be observed in the groups of absolute return and equity funds. When it comes to the other two strategies, namely hedge and mixed asset funds, the situation was not so clear, as the results provided by the two types of tests were highly inconsistent. However, according to the more preferable MDH tests, the advantage of quantitative funds in terms of efficiency was clearly more often. Regarding groups distinguished in terms of the region of a primary investment focus, both groups of tests provided results that allowed to draw consistent conclusions only in the case of two groups, i.e., funds primarily investing in Northern America and Northern Europe. In the case of funds primarily investing in Northern America, qualitative funds were more efficient clearly more often. On the other hand, in the case of funds primarily investing in Northern Europe, quantitative funds were more efficient slightly more often. In the other two groups, the results provided by the two groups of tests were highly inconsistent. However, according to the MDH tests, in the group of Eastern Asia, quantitative funds had lower efficiency most of the time. In the case of the group of Western Europe, the opposite was true.

The advantage of quantitative funds over qualitative funds could be observed at the level of a whole sample and individual groups distinguished in terms of the applied strategy. Nevertheless, just in the case of few groups, this advantage was clearly systematic. At the level of individual groups distinguished in terms of the region of a primary investment focus, the situation looked quite different, as in the case of some samples, qualitative funds had more systematic advantage over quantitative funds. Therefore, the results obtained in the first part of the study do not unambiguously suggest the rejection of the H2 hypothesis.

The first part of the study also delivered many interesting conclusions that constituted the answers to supplementary research questions posed in the introduction. The results of the first part of the study suggest that the differences in the weak-form informational efficiency between quantitative and qualitative funds differed between the groups of funds distinguished in terms of strategy and the region of a primary investment focus.

Moreover, according to the results of the first part of the study, larger quantitative funds in terms of TNA turned out to be more frequently more efficient than smaller quantitative funds in almost all the examined groups. The most systematic advantage of larger quantitative funds over the smaller ones could be observed in a whole sample, a sample of equity funds and a sample of funds primarily investing in Northern America. Larger funds in terms of TNA turned out to be more frequently more efficient also in the group of qualitative funds. Nevertheless, a discussed phenomenon was stronger in the case of quantitative funds.

Regarding the differences in informational efficiency between quantitative funds and their relevant equity market benchmarks, quantitative funds did not manage to gain any clear advantage over the market. It pertained to any group examined. Moreover, according to the results of the MDH tests, the efficiency of quantitative funds was lower compared to the efficiency of the markets in the great majority of cases in the groups of absolute return and hedge funds. According to the indications of normality tests, quantitative funds had lower efficiency compared to equity markets in the vast majority of time windows in all examined groups. However, it is worth mentioning that qualitative funds were found to be even slightly worse than quantitative funds in terms of differences in informational efficiency between them and their relevant equity market benchmarks. Differences in informational efficiency between quantitative funds and their relevant equity market benchmarks for the groups distinguished in terms of the region of a primary investment focus were not examined due to the small number of markets in each region.

The window ending in 2009 was indicated as the window of the lowest levels of equity market efficiency by the results of the MDH tests. The windows ending in 2008 and 2020 were indicated as the windows of the lowest levels of equity market efficiency by the results of normality tests. Regarding the differences in efficiency between quantitative and qualitative funds in periods of low efficiency of equity markets, when comparing the results obtained for the non-weighted fund categories, none of the applied tests suggested any significant differences between quantitative and qualitative funds. However, when taking into account the TNA-weighted categories, larger funds turned out to be less efficient, especially in the quant fund group. However, this observation was not confirmed by the indication of the automatic Portmanteau test. Therefore, the results suggest that in periods of the lowest levels of equity market efficiency, some substantial differences in efficiency between quantitative and qualitative funds were observable after accounting for TNA. The larger funds in terms of TNA were less efficient in the groups of quantitative and qualitative funds. However, especially larger quantitative funds were worse in this matter.

A supplementary research hypothesis H3 states that quantitative funds perform better than qualitative funds in periods of low weak-form informational efficiency of equity markets. The same as in the case of the H1 hypothesis, the H3 hypothesis was verified in the second and third part of the study. When considering the estimates of the coefficient informing about differences in the alpha parameter obtained in the third part of the study and

the results obtained for the relative measures of portfolio performance in the second part of the study, they allowed to draw quite similar conclusions, especially in the period related to the global financial crisis. When looking at a whole research sample, quantitative funds appeared to take advantage of market inefficiencies in a worse way compared to qualitative funds. At the level of individual strategies, quantitative funds seemed to do mostly better in the group of absolute return funds. The opposite was true in the case of equity and mixed asset funds. In the case of the hedge fund group, the results were inconsistent. Regarding the groups distinguished in terms of the region of a primary investment focus, a clear outperformance of quantitative funds by qualitative funds could be observed in the groups of funds primarily investing in Eastern Asia and Northern America. On the other hand, quantitative funds performed better in the group of Northern Europe. As far as a group of Western Europe is concerned, it is difficult to make any general conclusions, as the results obtained in both parts of the study were too inconsistent.

Moving to differences in market timing between quantitative and qualitative funds in periods of low weak-form informational efficiency of equity markets, in the overall sample, quantitative funds turned out to outperform qualitative funds in the period related to the global financial crisis. In the window ending in 2020, the opposite was true. At the level of individual groups distinguished in terms of the applied strategy and the region of a primary investment focus, quantitative funds usually outperformed qualitative funds. Nevertheless, a group of hedge funds was a clear exception. In the group of hedge funds, quantitative funds had worse market-timing skills compared to qualitative funds.

The results obtained in the second and third part of the study do not unambiguously suggest rejecting the H3 hypothesis, as according to some performance measures, in some examined samples, quantitative funds provided a better performance in periods of low weak-form informational efficiency of equity markets compared to qualitative funds. Quantitative funds were marked by higher performance in terms of market timing in most of the groups and especially in the period related to the global financial crisis. Nevertheless, when looking at the alpha parameter and the relative measures of portfolio performance, the advantage of quantitative funds was not that obvious. Taking into account the results obtained for all discussed performance measures, quantitative funds appeared to take advantage of market inefficiencies in a better way only in the groups of absolute return funds and funds primarily investing in Northern Europe.

Discussion

In most cases, the foregoing issue-related studies addressing the problem of the performance of quantitative funds were dedicated to one group of investment funds, such as equity or hedge funds. Not all groups of funds examined in this study were covered in the previous issue-related studies. Thus, it is difficult to fully discuss the results of the study conducted for the needs of this thesis with other issue-related studies. Such studies like those

by Chincarini (2014), Harvey et al. (2017), and Chuang and Kuan (2018) focused on hedge funds retrieved from the Hedge Fund Research (HFR) database. The results obtained in these studies allowed to draw partially similar conclusions to those drawn from the results obtained for hedge funds in the study conducted for the needs of this thesis. Similarly as in the case of the aforementioned studies, the results obtained in this study suggest that quantitative hedge funds mostly outperformed qualitative hedge funds in terms of generated alpha. However, it should be remembered that the studies discussed applied different models. The advantage of quantitative funds resulting from the estimates of econometric models obtained in this study also appeared to be confirmed by the indications of the relative measures of portfolio performance. However, the estimates of the coefficients that inform about differences in generated alphas obtained in this study for hedge funds turned out to be statistically insignificant in the majority of cases. Taking into account generated alphas and the relative measures of portfolio performance, in the case of the study conducted for the needs of this thesis, the clearest differences between quantitative and qualitative funds in favour of quantitative funds could be observed in the case of absolute return funds. On the other hand, the clearest differences between quantitative and qualitative funds in favour of qualitative funds could be observed in the case of mixed asset funds. It is also worth adding that the indications of the numerous relative measures of portfolio performance were similar. It was in line with the studies by Eling and Schuhmacher (2007), Eling (2008), Ornelas, Silva, and Fernandes (2012), as well as Zakamouline (2010), who proposed that different relative measures of portfolio performance allowed to develop similar rankings of investment funds.

The differences in market timing between quantitative and qualitative funds examined by Chincarini (2014) in the study on the sample of hedge funds suggested that quantitative funds performed better in this matter. The results of the study by Chincarini (2014) were not in line with the results of the study conducted for the needs of this thesis, as in the group of hedge funds, quantitative funds appeared to be mostly outperformed by qualitative funds in terms of market-timing skills. A clear advantage of quantitative funds over qualitative funds in terms of market-timing skills could be observed in the case of the groups of equity and mixed asset funds.

The advantage of quantitative funds over qualitative funds was also found in a relatively small sample of enhanced index equity funds examined by Parvez and Sudhir (2005) in one of the first issue-related studies addressing the issue of differences in performance between quantitative and qualitative funds. It seems difficult to compare the results of the study by Parvez and Sudhir (2005) with the results of the study conducted for the needs of this thesis, as the methodology of the study conducted for the needs of this thesis did not distinguish a sample of enhanced index equity funds. Moreover, the documentation of the Lipper Global Classification applied in this study does not distinguish the universe of enhanced index equity funds and does not provide any information on whether this group of funds is included in the database. If the results of the study by Parvez and Sudhir (2005) were

compared with the results obtained for the group of equity funds in the study conducted for the needs of this thesis, there would be another issue, namely, a small size of the sample applied by Parvez and Sudhir (2005) that might result in a limited power of tests. This limitation was also indicated by Parvez and Sudhir (2005). However, as opposed to the results of the study by Parvez and Sudhir (2005), the results obtained in the study conducted for the needs of this thesis for equity funds did not suggest a clear advantage of quantitative funds.

Following Harvey et al. (2017), this study aimed to answer supplementary research questions pertaining to the similarity of quantitative and qualitative funds in terms of the homogeneity of performance they generated and in terms of the correlation between their raw returns. Regarding the homogeneity of performance, the findings of the study conducted for the needs of this thesis slightly deviated from the findings of Harvey et al. (2017), who proposed that in general, systematic and discretionary funds (as they called them) were similar in terms of the homogeneity of performance generated. According to the results of the study conducted for the needs of this thesis, the spread of the majority of the relative measures of portfolio performance appeared to be slightly higher in the case of quantitative funds. The main differences in the interquartile range between quantitative and qualitative funds turned out to result from the differences in the 75th percentiles.

In order to verify common beliefs that systematic funds were highly homogenous and highly correlated due to the similarities of their strategies, Harvey et al. (2017) examined the correlations between the performance of systematic and discretionary funds. According to the results of Harvey et al. (2017), the correlations between the performance of systematic and discretionary funds appeared to be high and positive, suggesting that systematic and discretionary funds were quite similar in terms of performance generated and the common beliefs were unjustified. The results of the study conduced for the needs of this thesis are quite different. The correlation between the raw returns of quantitative and qualitative funds in the group of hedge funds turned out to be positive and low, suggesting that quantitative and qualitative funds are not that similar in terms of performance generated. It was one of the lowest results among all the examined groups. Results similar to those obtained by Harvey et al. (2017) could be observed in the groups of equity and mixed asset funds.

Moderate correlations between quantitative and qualitative funds obtained in this study in the group of equity funds were not in line with the results presented in the reports by AQR (2017), Lakonishok and Swaminathan (2010), and Lin (2019), who examined active equity funds retrieved from the eVestment database. According to the results obtained by these researchers, the correlations within the groups of quantitative and qualitative funds were positive, low, and similar. When it comes to the results obtained in the study conducted for the needs of this thesis, similar results could be observed in the group of hedge funds.

According to Harvey et al. (2017), who examined the universe of hedge funds, the exposure to risk factors was higher in the case of discretionary managers. Such results are in line with the results obtained in this study, as in the group of hedge funds, quantitative funds

were less exposed to systematic risk in the majority of cases. On the other hand, the results obtained in this study for equity funds are not in line with the results of the study by Abis (2018), who focused on US equity mutual funds. According to Abis (2018), quantitative funds had better risk management and portfolio diversification throughout the business cycle. The results obtained in the study conducted for the needs of this thesis suggest that in the group of equity funds, quantitative funds were exposed to a higher systematic risk in most cases.

The results of the MDH and normality tests in the study on the weak-form informational efficiency unambiguously suggested that the period related to the GFC was marked by the lowest levels of the weak-form efficiency. Especially in the groups of equity and mixed asset funds in the period related to the GFC, quantitative funds turned out to be outperformed by qualitative funds. Such results are in line with the conclusions proposed by Abis (2018). According to Chincarini (2014), who examined a sample of hedge funds retrieved from the HFR database, quantitative funds had higher alphas during the GFC. Such results also appear to be in line with the results obtained in the study conducted for the needs of this thesis, as in the group of hedge funds, quantitative funds appeared to mostly outperform qualitative funds. However, it should be noted that the estimates obtained were statistically insignificant.

A common decrease in the informational efficiency of equity markets up to the window ending in 2009, which was indicated by the results of the first part of the study, was most likely related to the global financial crisis 2007-2008. This conclusion would be in line with the studies by Horta et al. (2014), Sensoy and Tabak (2015), Anagnostidis et al. (2016), as well as Mensi et al. (2017). They suggested that the global financial crisis negatively affected the weak-form informational efficiency of equity markets. On the other hand, Katris and Daskalaki (2013), as well as Singh, Deepak, and Kumar (2015) proposed that the global financial crisis had no significant impact on the weak-form informational efficiency of equity markets. The results of the first part of the study also suggested that the efficiency of quantitative and qualitative funds followed the efficiency of the markets, indicating that their efficiency behaved similarly. According to normality tests, after the post-crisis recovery, the efficiency started to decrease across the markets and funds again in the following windows, reaching the lowest levels in the window ending in 2020. There is a possibility that this plunge could be related to the coronavirus outbreak. It would be in line with the studies by Dias, Heliodoro, Alexandre, and Silva (2020), Dias et al. (2020), as well as Lalwani and Meshram (2020). However, this decrease began in the windows preceding the coronavirus outbreak and was not indicated by more reliable MDH tests.

Taking into account alpha and the relative measures of portfolio performance, quantitative funds outperformed qualitative funds in periods of low informational efficiency of the market in just few examined groups. As opposed to the assumptions of Parvez and Sudhir (2005), quantitative funds mostly did not take advantage of market inefficiencies in a better way than qualitative funds. The situation looked different in the case of market

timing. When considering market timing, quantitative funds were better than qualitative funds in the majority of examined samples.

Limitations and future directions for studies

Data pertaining to investment funds retrieved from the Thomson Reuters Eikon database allowed to collect a relatively large research sample compared to other studies raising the issue of the performance of quantitaive funds. The method of the classification of investment funds applied in this study was similar to the method applied by Harvey et al. (2017). However, the share of quantitative funds in their research samples was much higher. They applied a different database, namely the Hedge Fund Research (HFR) database. High differences in the share of quantitative funds between the aforementioned study and the study conducted for the needs of this thesis may suggest that the fund objective description in Thomson Reuters Eikon database could have been insufficient and inaccurate to distinguish quantitative funds properly. However, the results of the studies by Chincarini (2014) and Harvey et al. (2017), which used the HFR database, share some similarities with the results of the study conducted for the needs of this thesis. Furthermore, the results of the study by Chuang and Kuan (2018) also share some similarities with the results of the study conducted for the needs of this thesis. They also utilized the HFR database, but applied a much different method of classification of investment funds. Future studies addressing the issue of the performance of quantitative funds may apply some different databases in order to find out whether their selection allows to draw conclusions similar to those obtained in the foregoing studies.

Future studies addressing the problem of the performance of quantitative funds may also focus on developing more and more robust methods of classification of investment funds. This study applied a method similar to the one proposed by Harvey et al. (2017). A possible bias resulting from the application of different split methods was first emphasized by Chincarini (2014). In further studies, the researchers tried to come up with less and less subjective split methods. For instance, Abis (2018), as well as Chuang and Kuan (2018) applied more sophisticated methods based on machine learning. Thus, the following issue-related studies can focus on finding more robust and more objective methods for distinguishing quantitative funds in financial databases.

The study conducted for the needs of this thesis focused on testing just one form of informational efficiency, namely the weak one. Future studies can examine quantitative funds also in terms of the other forms of informational efficiency, such as the semi-strong and strong form. Another limitation of this study pertains to considering just one risk factor in applied econometric models, namely the equity market benchmark, which constitutes a systematic risk factor. It was some kind of compromise between the size and diversity of the research sample and the number of considered risk factors. Collecting and processing such a large sample of investment funds constituted a huge challenge, especially in terms of

technical aspects. Collecting other risk factors would constitute another great challenge. In addition, in many cases, it would be impossible due to the lack of access to relevant databases.

Contribution and applications

This study aimed to contribute to the body of knowledge related to the evaluation of the performance of quantitative funds not only by presenting a different approach to the evaluation of the performance of quantitative funds, but also by introducing some theoretical considerations pertaining to the issue-related definitions and nomenclature proposed in the foregoing studies. In the light of the lack of complete consensus among researchers on the nomenclature and formulation of definitions, this study proposed the universal definitions of quantitative, qualitative, and hybrid funds that aimed to reflect their substance in the best way possible. The results of theoretical considerations highlighted significant differences between quantitative and qualitative funds and led to the proposal of the most important criterion that separates quantitative funds from qualitative funds. This criterion is the answer to the question: "Does the investment fund apply a predefined and automated investment process?". Further considerations taking into account market data presented in widely accessible industry reports indicated that indisputably, quantitative funds, as well as related phenomena, such as quantitative and algorithmic trading, are very important to financial markets and their importance still increases.

Regarding empirical considerations, this thesis aimed to contribute to the body of knowledge pertaining to the evaluation of the performance of quantitative funds by introducing a comprehensive study employing a relatively large sample and covering a relatively long research period compared to the foregoing issue-related studies. The study conducted for the needs of this thesis examined the performance of quantitative funds included in four numerous groups distinguished in terms of the strategy applied. The empirical study was also conducted at the level of individual groups of funds distinguished in terms of the region of a primary investment focus. What is more, this thesis aimed to fill the research gap by connecting the study on the performance of quantitative funds with the study on the features of the returns of quantitative funds in the context of the weak-form informational efficiency. The application of the rolling window method aimed to capture changes in the performance and efficiency of quantitative funds. The further contribution of this thesis may be related to the study on the performance of quantitative funds in periods of low weak-form efficiency of equity markets, which aimed to verify the validity of a belief shared in the issue-related literature that quantitative funds make use of market inefficiencies in a better way than qualitative funds.

The study conducted for the needs of this thesis may be useful especially to portfolio managers who consider the implementation of quantitative portfolio management techniques. It may also be useful to investors wondering whether quantitative funds have an advantage

over classic approaches to portfolio management in terms of generated performance. Market regulators interested in the operations of quantitative funds, which apply predefined and automated investment processes, may learn about their profitability and risk to investors, weak-form efficiency, and the behaviour of their performance and weak-form efficiency in periods of the instability of equity markets. Furthermore, this study may constitute a motivation to providers of financial databases to implement the next classification of investment fund that indicates whether a given fund is quantitative.

Thesis structure

This thesis is divided into eight chapters. Chapter 1 focuses on the review of the definitions of quantitative funds and qualitative funds. This chapter is also dedicated to the review of the relevant nomenclature proposed in the issue-related literature. Moreover, this chapter aims to distinguish characteristic features of quantitative and qualitative funds and standardise their definitions by proposing the new ones. Additionally, Chapter 1 discusses other important concepts related to quantitative funds. Chapter 2 shows the meaning of quantitative funds and other related concepts to financial markets. Chapter 3 constitutes a theoretical background for testing the efficiency of quant funds in the context of the weak-form informational market efficiency. Chapter 4 considers a theoretical background for the evaluation of the performance of quant funds. Chapter 5 presents a developed methodology for the research sample collection, a methodology for a study on the weak-form efficiency, and a methodology for a study on the performance of quant funds. Moreover, Chapter 5 discusses the structure of the research sample. This chapter also discusses the methodological approaches applied in the issue-related studies. Chapter 6 refers to a discussion of the results of the first part of the study, namely, the study on the weak-form informational efficiency of quantitative funds. Chapter 7 refers to a discussion of the results of the second part of the study, namely, the performance study with the use of the relative measures of portfolio performance as well as raw and excess returns. Chapter 8 refers to a discussion of the results of the third part of the study, namely, the performance study with the use of econometric models. This dissertation is concluded in the Ending remarks section.

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