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Small versus Large Caps—Empirical Performance Analyses of Stock Market Indices in Germany, EU & US since Global Financial Crisis

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Abstract

This academic paper applied different models in order to analyse the performance of several small cap and large cap indices for the German-, European- and US-market since the financial crisis in 2008. Thus, the period under consideration amounts to approx. 12 years. The research period starts in July 2008 and ends in August 2020. It was found, that an investment in the US large cap index outperformed the German as well as the European indices with regard to the Sharpe Ratio and Sortino Ratio. Furthermore, it has been proven that small cap indices in Germany and Europe outperformed their counterparts in terms of return, the large cap indices in terms of their risk/return profiles. For the US-market, this relationship turns. Thus, the large cap index represents the better investment compared to the small cap index. It can therefore be said that the small cap anomaly could only be detected on a country-specific basis. With regard to the maximum drawdown, it is evident that the German market implies a very similar risk to the American market. The European market again clearly beats the German and the US-market in terms of maximum drawdown and is therefore less risky.

Keywords

Stock Market Indices, Asset Management, Performance Analysis, MSCI-Index, DAX, SDAX, MSCI Europe, MSCI USA, Small Cap Indices, Large Cap Indices, Sharpe Ratio, Sortino Ratio, Downside Deviation, Maximum Drawdown

1. Introduction

In the asset management field, the question to invest in small or large caps is

highly ranked on the investment agenda and is of major importance in the asset allocation process.

This question is in line with the other questions "Active versus Passive" and "Growth Stocks versus Value Stocks". All these questions are to a large extent determining the performance outcome of the asset allocation, measured in different figures and ratios.

This paper focuses its analysis on the major issue: small versus large caps. What is the better strategy on a long term investment horizon? Some research on this issue has already been undertaken.

To bring further clarity to the development of small cap and large cap returns this paper investigates the performance of several small and large cap indices. The paper analyzes the performance particularly by focusing on specific key performance and risk ratios. Therefore, the SDAX and German Stock Index (DAX) for the German market, the MSCI Europe Small Cap Index and the MSCI Europe Large Cap Index for the European market as well as the MSCI USA Small Cap Index and the MSCI USA Large Cap Index are reviewed since the financial crisis.

In this context the following risk measurement tools have been applied: Sharpe Ratio, Sortino Ratio, Downside Deviation and maximum drawdown. To do so the third chapter provides information on the indices examined and their composition. Chapter four addresses the methodology issue and explains different performance measurement tools which are used to determine the return and risk profile of the country-specific small cap and large cap indices. In the following chapter the collected indices data are examined with regard to the past 12 years, starting in July 2008 and ending in August 2020. The sixth and last chapter draws a conclusion based on the main findings of the investigation.

2. Literature Review

"Small caps do tend to carry more risk, but they should over time reward investors for taking that risk, meaning they normally outperform over long periods of time," so Eric Marshall, President of Hodges Capital (American Entrepreneurship Foundation, 2019).

While in the business world the assumption holds that equity market yields should represent the future cash flows of companies, the so-called anomaly of small companies is already the first challenge for this statement. The main finding of that anomaly states that small cap companies outperform the large cap firms over a long-term horizon. Over the years, this topic has gained increasing interest from academic researchers. Accordingly, different scientists came up with different conclusions. For example, Dhatt, Kim, & Mukherji (1999) found out that small cap companies account for a substantial value premium in comparison to the large cap companies.

Whereas Switzer & Fan (2007) came to the result that the high returns of small caps could be country-specific (Switzer, 2010). Based on the results of Fa-

ma & French (1993), that smaller and therefore riskier firms achieve higher returns than larger companies, Pandey & Sehgal (2016) identified several factors which caused the higher risk. With their investigation Pandey & Sehgal (2016) support the existence of anomaly caused by company size. A recent study by Norland (2020) resumes for the US an outperformance of large versus small caps during economic expansion, whereas small caps outperformed large caps during economic downtrend.

LXV Research (2018) summarizes his research as follows: "In the ten years since the global financial crisis, European stocks have underperformed US stocks by a considerable margin."

A recent study by Svaluto Moreolo (2019) concludes that "lack of research on small-caps leads to higher risk but also higher alpha-generation potential".

3. Indices at a Glance

Table 1 provides an overview of the researched indices, focusing on the market capitalization and the number of companies included in the reviewed indices.

The market capitalisation of the DAX and SDAX is based on September 11th, 2020, the MSCI Europe indices on August 31st, 2020 as well as MSCI United States indices.

This following provides an overview about the indices which will be analysed in more detail in chapter five with regard to their performances. In this context, the respective country-specific small cap and large cap indices are presented. Chapter 3.1 focuses on the DAX and the SDAX which belong to the so-called DAX family. The subsequent Chapter 3.2 explains the MSCI Europe Small Cap Index as well as the MSCI Europe Large Cap Index. Subchapter 3.3 provides some information on the MSCI USA Large Cap Index and the MSCI USA Small Cap Index.

3.1. DAX

The DAX is a brand of the Qontigo GmbH and belongs to the German stock exchange. The DAX family includes approximately 900 different stock indices (Deutsche Börse Gruppe, 2020). The four best-know indices are the DAX, the

Table 1. Market caps of chosen small and large cap indices.

#	Index	Currency	Market Cap	# of Companies Included
1	DAX	EUR	960,910,190,000	30
2	SDAX	EUR	47,531,660,000	70
3	MSCI EU Large Cap	EUR	5,866,141,960,000	193
4	MSCI EU Small Cap	EUR	1,078,551,510,000	944
5	MSCI US Large Cap	USD	27,105,897,770,000	290
6	MSCI US Small Cap	USD	3,408,855,910,000	1,722

Note. Adapted from Thomson Reuters; MSCI 2020, (3, 4, 5, 6).

MDAX, the SDAX as well as the TecDAX (STOXX Ltd., 2020).

Companies which are included in these indices have to fulfil several basic requirements. First, all companies listed in the four named indices are subject to the prime Standard. The Prime Standard pursues the goal of creating more transparency for international investors through extended mandatory disclosure in English language. The Prime Standard was introduced on January 1st, 2003 (STOXX Ltd., 2020). Second, the company is continuously traded on Xetra. Third, a minimum amount of 10% of all shares is free floating on the market. And the last point states that legal and operating headquarters need to be located in Germany (STOXX Ltd., 2020). The DAX represents the 30 largest and with the strongest sales performing companies listed on the Frankfurt Stock Exchange. In terms of market cap the 30 DAX companies account for roughly 80% of listed stock corporations in Germany. Following the DAX, the MDAX comprises the 60 largest and with the highest turnover performing companies in Germany listed on the Frankfurt Stock Exchange.

The market capitalization of the DAX and SDAX is based on September 11, 2020, the MSCI Europe indices on August 31, 2020 as well as MSCI United States indices.

In terms of size, these values are below those of the DAX. These two are followed by the SDAX, which contains the 70 largest companies below the MDAX in terms of sales. With regard to the TecDAX, it can be said that this index represents the 30 largest and with the highest turnover performing tech companies listed on the German stock exchange (STOXX Ltd., 2020).

As the empirical analysis only focuses on the DAX as a large cap index and the SDAX as a small cap index, these two are explained in more detail. The DAX was introduced on July 1st, 1988 and is the most important stock index in Germany. All companies listed in the DAX are also known as Blue Chips. The DAX is based on the trading data of the electronic trading platform Xetra, an exchange-based trading platform of the Frankfurt Stock Exchange (STOXX Ltd., 2020).

The DAX is published both as a performance index and as a price index. Whereby, the performance index includes the dividend payment of the companies in the calculation while the price index does not. Both the DAX and the SDAX are calculated on the basis of the market capitalization of the companies included in the index. Furthermore, they are both based on the Laspeyres index (Equation (1)) formula and only include the free float in the index calculation. The Laspeyres index formula is described in the following:

$$\text{Index}_t = K_T * \frac{\sum p_{it} * ff_{iT} * q_{iT} * c_{it}}{\sum p_{i0} * q_{i0}} * \text{Base} \tag{1}$$

whereas t depicts the time of calculation of the index, K_T is describes as an index specific chaining factor which is valid from chaining date T. In the following the upper half of the fracture is composed of p_{it} which is the stock price i at time t, ff_{iT} the free float of the stock class i at time T, q_{iT} the amount of

stocks of firm i at time T and c_{it} which represents the adjustment factor of firm i at time t. The denominator of the fraction contains p_{i0} which stands for the closing price of stock i on the trading day before its initial inclusion in the index. In contrast to this q_{i0} describes the amount of stocks of firm i on the trading day prior to the first inclusion in the index. Finally, "Base" describes the value of the index on the base day (STOXX Ltd., 2020).

3.2. MSCI Europe

For more than 40 years the MSCI forms the most widely used equity-based indices for institutional investors (MSCI, 2020a). A subset of the various indices is represented by the MSCI Europe. The MSCI Europe is composed of 435 stocks which represent about 85% FreeFloat MCap of the entire European industrialized countries. Further subcategories of the MSCI Europe are represented by the MSCI Europe Large Cap Index and the MSCI Europe Small Cap Index. The last two indices are examined in more detail below (MSCI, 2020b).

With regard to the composition of the MSCI Europe Large Cap Index, it covers several companies out of 15 developed market countries in Europe. These developed market countries include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK. With 193 different companies spread across 15 different countries, the large cap index covers about 70% of FreeFloat MCAP of the European equity market, while the largest company has a market capitalization of EUR 299,060.65 million and the small one of EUR 1772.51 million. The Index was introduced in June 5th, 2007 (MSCI, 2020c).

The construction of the MSCI Europe Large Cap Index is based on the Global Investable Market Indices methodology. The indices of the MSCI family are all based on the Laspeyres index formula (Equation (1)) as already described for the calculation of the DAX indices. The MSCI Europe Large Cap as well as the Small Cap index is calculated both in local currency and in USD. The indices calculation incorporates data from Monday until Friday (MSCI, 2020e).

The selection criteria of the MSCI indices are based on the following five points. The first step is to determine the equity universe. This point is divided into the identification of suitable shares and the allocation of these to only one country. The second step is to determine the market investable equity universe. This includes the identification of companies with local and foreign listing. The purpose is to determine whether certain companies with foreign listing are eligible for inclusion in the index. Furthermore, the individual securities will be checked for investability such as the minimum size requirement, minimum Free Float MCAP, liquidity standards, foreign inclusion factor, minimum length of trading and the foreign room specifications. The third factor is the definition of the size-segments based on the securities market capitalization, while the fourth step ensures index continuity by setting a minimum number of companies for a developed market standard index. Based on the previous evaluation, the fifth

step is to compile the index and calculate it using the Laspeyres index formula (Equation (1)) (MSCI, 2020e).

Both the large cap and small cap index are updated on quarterly and semi-annual basis. While the quarterly review takes place in February, May, August and November, the aim is to indicate changes in the stock market in time and thus restrict undue index turnover. In contrast, the semi-annual adjustment is intended to rebalance the index on the basis of current developments and update the large capitalization cut-off points. The six-monthly adjustments take place in May and November (MSCI, 2020c; MSCI, 2020d).

In contrast to the large cap index, the MSCI Europe Small Cap Index focuses on companies with low market cap. It contains 944 companies from 15 different European developed market countries. These are the same as the MSCI Europe Large Cap Index incorporates. However, the small cap index only covers 14% of the FreeFloat MCAP for the European equity market. The largest company in the index has a market capitalization of EUR 9880.50 million and the smallest one of EUR 76.62 million. The MSCI Europe Small Cap Index was launched on January 1st, 2001 (MSCI, 2020d).

3.3. MSCI USA

Another country specific index of the MSCI is the in 1986 launched MSCI USA Index. It displays the performance with regard to the large cap and small cap segments within the United States share market. Therefore, the index includes 616 different companies which represent roughly 85% of the US FreeFloat Market Cap. While the largest company accounts for a market capitalization of USD 1,859,754.02 million and the smallest for USD 3029.18 million (MSCI, 2020f).

As this paper aims to compare the large and small cap segments, the MSCI USA Large Cap Index and the MSCI USA Small Cap Index are presented below. In comparison to the MSCI USA its large cap index contains only 290 companies which still cover 70% of the Free Float Market Cap. Within the 290 companies, the largest market capitalisation is USD 1,859,754.02 million and the smallest is USD 3398.02 million. The Index was established on January 5th, 2007 (MSCI, 2020g). Like the MSCI Europe, the MSCI USA is also part of the MSCI family and is accordingly also compiled on the Global Investable Market Indices methodology. As a result, the US-index is also based on the Laspeyres index formula (Equation (1)). The selection procedure follows the same steps as described in chapter 3.2.

On the other hand, the MSCI USA Small Cap Index contains 1772 companies which account for approximately 14% of the Free Float Market Cap in the US. The market capitalization ranges from the largest company with USD 14,038.84 million to the smallest with USD 84.61 million. The introduction of the MSCI USA Small Cap Index dates back to January 1st, 2001 (MSCI, 2020h).

4. Methodology

The current chapter provides an overview about the performance analysis in-

struments which will be applied in chapter five in order to examine the performance behaviour of large and small cap indices. Chapter 4.1 explains the Sharpe Ratio, a tool for measuring the risk/return ratio of an investment. The explanation of the Sortino Ratio is provided, a measure which, as a modification of the Sharpe Ratio, concentrates solely on the volatility caused by downward price movements. Thus, the explanation of the downside deviation is also addressed in Chapter 4.2. Chapter 4.3 covers the explanation of the maximum drawdown, which provides information about the largest maximum loss of value that has ever occurred within a given time frame based on a specific investment.

4.1. Sharpe Ratio

In 1966 William F. Sharpe developed a measurement tool to evaluate the performance of mutual funds in terms of expected return and risk, originally named Reward-to-Variability Ratio (later known as Sharpe Ratio). The idea behind the Sharpe Ratio is to achieve easier comparability between investments by simultaneously considering return and risk. The return, also called yield (from the Italian "rendita") is based on a time series of prices $p_1, p_2, \cdots, p_k$ and calculates the return between two periods. Therefore, the simple return is defined as followed (Equation (2)):

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{2}$$

where R_t depicts the return at time t and P_t the price at time t (Franke, Härdle, & Hafner, 2004). The risk, also called volatility, is defined as the standard deviation. The standard deviation is the square root of the variance (Equation (3)) and is composed as follows:

$$\sigma = \sqrt{VAR(X)} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}} \tag{3}$$

where σ expresses the volatility or standard deviation. In more detail x_i represents the return at time i, μ denotes the average return and n is the number of data points (Franke et al., 2004).

Nowadays it is without any doubt the most used model to determine the risk-adjusted return. The Sharpe Ratio measures the return on an investment above the risk-free interest rate, also described as excess return, associated with each risk taken. This means that only the reward for the additional risk is taken into account as return, since investors could have earned the risk-free interest rate even without any risk by investing into a risk-free security. In the following the excess return is adjusted for the risk associated with it and can be more transparent compared with other risk/return combinations (Sharpe, 1966). The ex post/historic Sharpe Ratio (S_h) is explained by the following formula (Equation (4)):

$$S_h = \frac{\bar{D}}{\sigma_D} \tag{4}$$

where $\bar{D}$ depicts the average value of D_t which is defined as the difference in excess return achieved by a fund in period t and the excess return generated by a benchmark portfolio or security in period t. σ_D is the standard deviation of $\bar{D}$ and D_t. Approximately 30 years later Sharpe introduced the ex-ante Sharpe Ratio, which uses expected returns and an expected standard deviation instead of the actual parameters. This is the main difference to the ex post Sharpe Ratio (Sharpe, 1994).

The Sharpe Ratio concept is based on the portfolio theory of Markowitz (1952), which as the first theory made the formation of optimal portfolios dependent on return and standard deviation possible. Both the Sharpe Ratio and the portfolio theory are based on the assumption that a risk-free security exists on the market. In this case risk-free means that the variance or standard deviation of the return of the risk-free investment is equal to zero (Markowitz, 1952).

Regardless of the application, it is important to take into consideration that the Sharpe Ratios do not take correlations into account. Nevertheless, the Sharpe Ratio provides a convenient summary of two important aspects of any strategy (return and risk) that affect the difference between the return of a fund and the return of a related benchmark (Sharpe, 1994).

4.2. Sortino Ratio

This chapter focuses on the explanation of the Sortino Ratio, a variation of the Sharpe Ratio. Compared to the Sharpe ratio, the Sortino ratio uses only the downward deviation instead of the total standard deviation of portfolio returns. Accordingly, it distinguishes between harmful volatility and non-harmful volatility (Hoechner, Reichling, & Schulze, 2019). This means that the Sortino Ratio takes into account the standard deviation of negative portfolio returns. The following outlines the Downside deviation then follows the description of the Sortino Ratio.

Downside deviation, also named downside risk, takes the risk preference of investors into account by introducing the Minimum Acceptable Return (MAR). The MAR focuses more on the interests of the investors and thus solves the problem of the downside deviation, as it considers only these. Therefore, good volatility is said to exist as soon as the deviations are above the minimum acceptable return. Conversely, one speaks of bad volatility when the deviations are below the MAR. Sortino described the minimum acceptable return (MAR) based on the following formula (Equation (5)):

$$\delta_{MAR} = \sqrt{\sum_{t=1}^{T} i + p_t \left(r_t - r_{MAR}\right)^2} \tag{5}$$

where i represents the index to be examined, r_t stands for the return of the index investigated in month t, the probability of an investigation is depicted by $p_t = 1/T$, while r_{MAR} is the minimum acceptable return (Van der Meer, Sortino, & Plantinga, 2001).

Having already explained, the Sharpe ratio does not give us any information

whether the deviation from the mean is positive (above) or negative (below), the Sortino Ratio takes into account the asymmetry of risk. Instead of applying the standard deviation the Sortino ratio uses the semi-variance downwards. This means that only those yields are penalized that fall below an investor specified rate, namely the MAR. As a result, this ratio is a performance measurement of return deviation under a minimum acceptable rate (Le Sourd, 2007). Whereas the Sharpe Ratio takes the risk-free-rate into consideration the Sortino Ratio replaced this term by the minimum acceptable rate. The Sortino Ratio (SR) is described with the following formula (Equation (6)):

$$SR = \frac{E\left(R_p\right) - r_{MAR}}{\sqrt{\frac{1}{T}\sum_{R_{pt} < r_{MAR}}^{T\ t=0} \left(R_{pt} - r_{MAR}\right)^2}} \tag{6}$$

where $E\left(R_p\right)$ denotes the expected return of portfolio p, r_{MAR} the minimal acceptable rate, T is interpreted as the number periods and R_{pt} denotes the return generated by portfolio p within the sub-period t (Sortino & Van der Meer, 1991).

As can be seen, the Sortino Ratio focuses on negative deviation and thus ignores the upside volatility which is favourable for investors. Similar to a higher Sharpe ratio, a higher Sortino ratio expresses a better result. This means that an investment with a higher Sortino Ratio per additional unit of negative risk taken will generate more return than an investment with a lower Sortino Ratio. It can therefore be concluded that the Sharpe ratio penalises the investor for positive volatility, above the MAR, whereas the Sortino ratio does not (Pekar, Čičková, & Brezina, 2015).

4.3. Maximum Drawdown

The maximum drawdown is an asymmetric risk measurement tool frequently used in reality. For example, it finds application in the area of commodity trading. A drawdown denotes the loss of an investment with regard to a specific period. In contrast, the draw-up stands for a profit that ranges from the lowest point of an investment to the maximum. In contrast, the maximum drawdown outlines the largest loss that has ever occurred within a period for a particular investment (Reza & Baghdadabad, 2015). Grossman & Zhou (1993) defined the maximum drawdown as the loss generated when buying an asset at its maximum and sold it at its minimum. In comparison to the downside risk the maximum drawdown accounts for serial correlation within the returns in a non-parametric way. Another point is that the maximum drawdown is independent of the time during which the fall has occurred (Hamelink & Hoesli, 2004). The maximum drawdown considers the lower partial moments (LPM) as risk below the target risk in addition to the maximum loss suffered by an investor during the holding period. Therefore, the maximum drawdown (MDD) is defined as follows (Equation (7)):

$$MDD\left(n,t\right) = \frac{1}{k}\sum_{i=1}^{k}\left\{\mathrm{Min}\left[\left(D_{t-1} + \left(R_{it} - E\right)\right), 0\right]\right\}^n \tag{7}$$

where $D_{t-1} = \ln \text{Max}\left(P_0^{\text{high}}, \cdots, P_{t-1}^{\text{high}}\right) - \ln \text{Min}\left(P_0^{\text{low}}, \cdots, P_{t-1}^{\text{low}}\right) + \left(\ln P_0^{\text{close}} - \ln P_{t-1}^{\text{close}} - \mu\right)$, additionally k depicts the number of data whereas E is the target return. The component R_{it} stands for the return of fund i with respect to time t. The maximum loss that an investor can be hit by from 0 to $t-1$, is shown by D_{t-1}. Furthermore, $D_0 = 0$ and n depicts the degree of the maximum drawdown risk (Reza & Baghdadabad, 2015). Equation seven represents an important risk measurement tool for institutional investors in terms of choosing a portfolio since it shows the loss from the former maximum point (prior outermost loss) to the nearest minimum point (next maximum loss) (Reza & Baghdadabad, 2015).

In the following chapter, the models described above are used for empirical performance analysis of small cap and large cap portfolios with regard to the German, European and American market.

5. Empirical Analysis

The following analysis investigates the performance differences between small cap and large cap indices. In this context small and large cap indices from Germany, Europe and the US are analysed with regard to their return and risk ratio. To do so, the following three performance measurement tools will be applied. Chapter 5.1 characterizes and presents the collected data. Chapter 5.2 analyses the small and large cap indices regarding their annualized returns, volatilities and Sharpe Ratios. Subsequently Chapter 5.3 covers the Sortino ratio, a modified form of the Sharpe ratio. In this context, the downside deviation as well as the Sortino Ratio will be presented and interpreted. Finally, Chapter 5.4 focuses on the maximum drawdown with reference to the country-specific indicators.

5.1. Data

Several country-specific indices have been downloaded in order to analyze the performance behaviors of small and large cap indices. In detail, the DAX as large cap index and the SDAX as small cap index were taken for the German market. For the European market, the MSCI Europe Large Cap Index and the MSCI Europe Small Cap Index were retrieved. The US-market comprises the MSCI USA Large Cap Index and the MSCI USA Small Cap Index. All indices were downloaded on a monthly basis and cover a period of 145 months (roughly 12 years) starting from July 2008 and ending in August 2020. Both the German and the European indices were taken in euros, the US-indices in US-dollars. All indices were retrieved via the business information services provider Thomson Reuters. In addition, the risk-free rate has been taken for a similar period of time. With regard to the risk-free rate for the German the average risk-free rate has been taken from Statista. The Euro area yield curve based on AAA-rated euro central government bonds and all euro area central government bonds (including AAA-rated) has been downloaded from the European Central Bank. Whereas for the US-market the risk-free rate based on the 10-year Treasury bill has been obtained from Bloomberg.

In order to gain a first glimpse of the development of the indices, **Figure 1** shows the index point development over the entire period under investigation.

It can be seen that the global financial crisis, which began as a real estate crisis on the subprime market in the USA in 2007, has pulled down all indices (Bundeszentrale für politische Bildung, 2017). On closer inspection, however, one can see that small caps have fallen a little further in both the German and the US-market. Only in Europe the large caps have fallen lower within that period. With regard to February 2009 it can be seen that the SADX has been fallen to 54.86 index points while the DAX only fell to 59.89 index points, based on the indexed values of **Figure 1**. The same applies to the US market its small cap index fell 55.94 index points whereas the American large cap index decreased to 59.22 with regard to the same point in time. In the following years, prices rose again until the beginning of March 2011 when the nuclear reactor of the Japanese nuclear power plant in Fukushima exploded due to a tidal wave caused by an earthquake (Krumrey, 2011).

In rising market phases such as this one, however, it becomes clear that the small cap indices perform better than the large cap indices. The scissor-like development between small cap and large cap indices shows that the small cap index outperforms the respective large cap index in its region. In our case, scissors-shaped implies the ever-growing index points difference between the small and large cap indices.

The MSCI US S outperformed the MSCI US L starting roughly in the last quarter of 2009 until January 2020, the beginning of the corona crisis. This effect is also known in economic research as the small company anomaly and means that shares with low market cap perform better than shares with high market cap during longer holding periods (Hawawini & Keim, 1998).

The following figure shows the development of the Euro/Dollar exchange rate and its potential influence on the return.

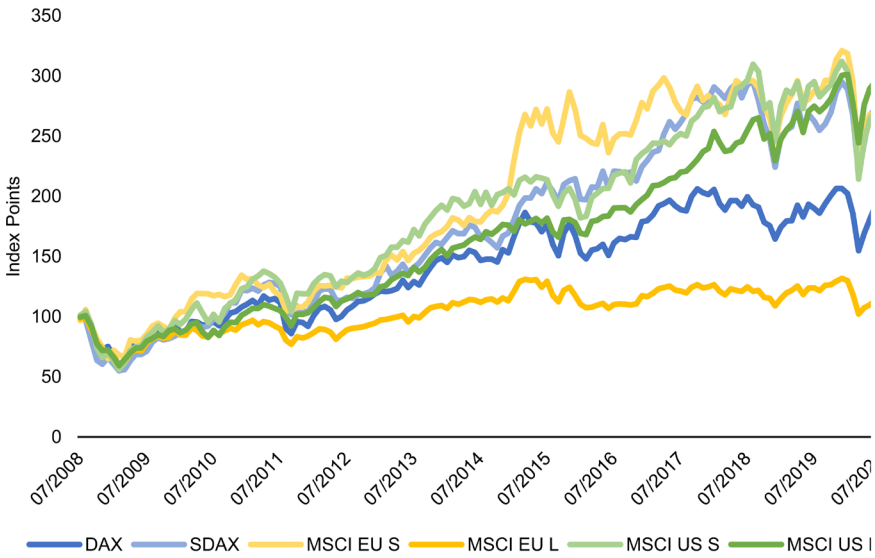

Figure 1. Index development of the past 12 years. Data from Thomson Reuters.

Figure 2 shows that the euro/dollar exchange rate fell from 1.56 at the end of June 2008 to 1.19 at the end of August 2020. This represents a percentage decrease of −23.72% within 12 years. It is a significant revaluation of the US-Dollar versus the Euro, leading for US-companies to a competitive disadvantage. And the EU-corporates have taken the windfall-profits of the continuous devaluation of the Euro against the US-dollar. In the end the economic result has been reflected in the profit and loss accounts and finally in the stock market performance of EU- and US-companies. Therefore, it is regarded as appropriate to apply the EU-data on Euro-basis, whereas US-data are kept in US-Dollars.

5.2. Sharpe Ratio Analysis

This chapter analyses the performance, volatility and Sharpe Ratio in order to find out whether country specific small cap and large cap indices performed differently within the last 12 years, on average. Table 2 depicts the results of the Sharpe Ratio analysis.

Looking at the six investigated country specific indices it is striking, that the MSCI US S has outperformed its counterpart, the MSCI US L index, by only 0.21 percentage points over the entire period with an annual return of 11.01% to 10.80% respectively. The second strongest small cap and large cap indices are the German ones. Here too, the SDAX clearly outperformed the DAX with an annual return of 10.83% compared to 7.56%.

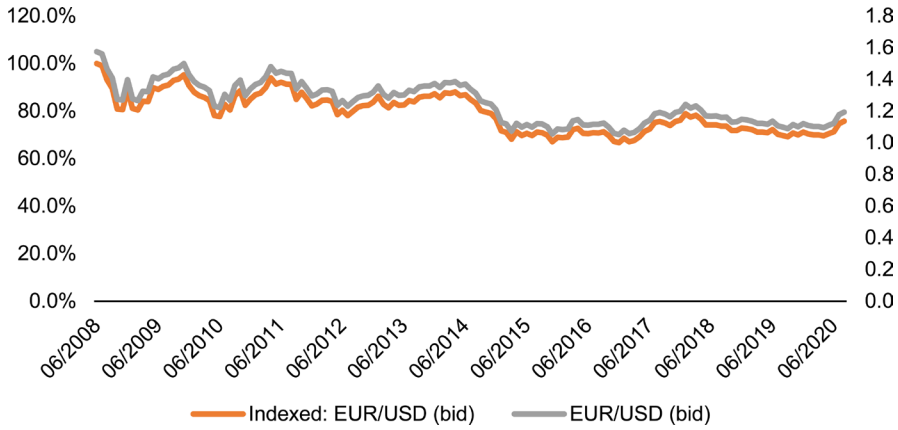

Figure 2. Euro/US-Dollar spot rate history last 12 years. Data from Thomson Reuters.

Table 2. Sharpe Ratio analysis—July 8th, 2008 until August 20th, 2020.

	SDAX	DAX	MSCI EU S	MSCI EU L	MSCI US S	MSCI US L
	Rounded figures on annual basis					
Return (%)	10.83	7.56	9.95	2.08	11.01	10.80
Risk-free (%)	0.80	0.80	−0.47	−0.47	0.76	0.76
Volatility (%)	18.99	18.78	18.98	14.52	20.46	15.31
Sharpe Ratio	0.53	0.36	0.55	0.18	0.50	0.66

In terms of returns, the European indices performed worst. However, even here it can be seen that the MSCI EU S beats the MSCI EU L with a return of 9.95% to 2.08% respectively. In terms of all returns, the MSCI EU L is roughly four times smaller than the return of the next largest index, the DAX. However, when the risk is considered, the tide turns. Here, the large cap indices prove to be less risky than the small cap indices. In this case the European large cap index, MSCI EU L, turns out to bear the lowest risk with an annual standard deviation of 14.52%.

A look at the American and German indices also shows that the large cap indices are less risky than the small caps. The American MSCI US S carries the greatest risk at 20.46%, the SDAX of 18.99%. With regard to the Sharpe Ratio, it can be said that the MSCI US L achieved the best combination of return and risk, depicted by an annual Sharpe Ratio of 0.66. Second place was claimed by the European small cap index MSCI EU S with a Sharpe ratio of 0.55, closely followed by the German SDAX with a Sharpe ratio of 0.53. By far the lowest Sharpe Ratio Value was achieved by the MSCI EU L at 0.18 and the DAX with 0.36.

Based on the results, the following assumptions can be made. First, one could assume that small cap indices are normally young companies and therefore more growth potential is seen with small caps. At the same time these companies also represent a higher risk of default. However, this assumption only applies to the US-market, as the Sharpe ratio demonstrates. With regard to Europe, the small cap indices clearly have beaten the large cap indices. The SDAX also clearly outperformed the DAX with regard to the German indices. By contrast, the American large cap index outperformed the small cap index in terms of volatility. In contrast, in terms of return the two indices are quite close to each other, which Figure 3 illustrates once again with the comparison of return and risk.

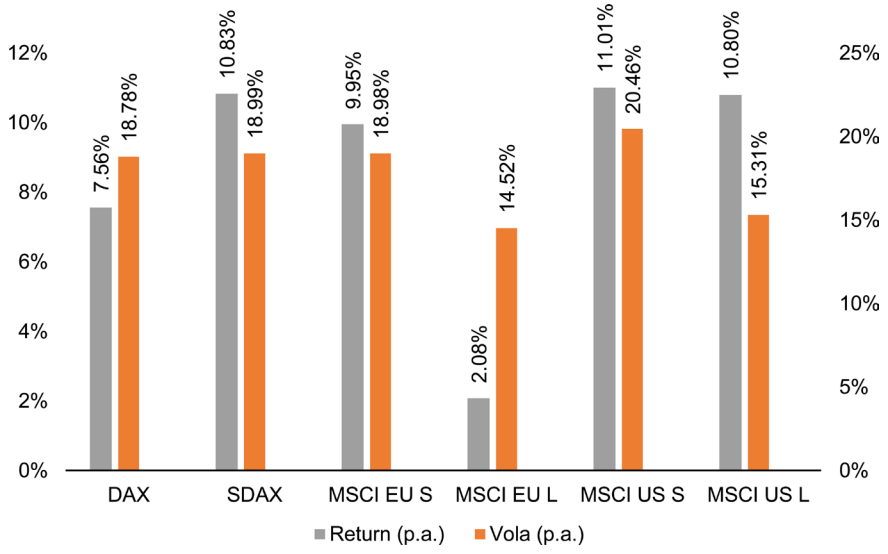

Figure 3. Return/Volatility comparison—July 8th, 2008 until August 20th, 2020.

5.3. Sortino Ratio

The Sortino Ratio is a modified form of the Sharpe Ratio, since it only considers bad volatility. Therefore, the downside deviation as well as the Sortino Ratio has been analyzed from July 2008 until August 2020 for the country-specific small and large cap indices. The results of the analysis are presented in Table 3.

With a view to the results it can be seen that the MSCI EU L depicts the lowest downside deviation of 3.16% below the average annual return. This is followed by the MSCI US L with a bad volatility of 3.66% and the DAX with 3.97%. As in the previous chapter, the large cap indices are subject to lower risk also with regard to downside risk.

In terms of downside deviation—or downside risk which focuses only on the risk dimension of investments—the European large cap index turns out to be less risky whereas the DAX appears to be the riskiest of the three large cap indices. Also, with regard to the small cap indices the European MSCI EU S claims for the smallest downside deviation of 3.86% followed by the SADX with 4.54% downside risk and by the MSCI US S with 4.69% bad volatility. By analyzing the Sortino Ratios it is striking, that the MSCI US L again outperformed its counterpart, the MSCI US S, and the other European and German small cap and large cap indices.

It is also interesting to note that when applying the Sortino Ratio, the American large cap index again beats the small cap index. One could therefore assume that the outperformance of large cap indices by small cap indices is country dependent. Since in Germany and Europe the small cap indices have dominated the large caps, the MSCI EU S outperformed the MSCI EU L with a Sortino Ratio of 2.70 to 0.81, respectively. Also, in the German market the SDAX has beaten the DAX with a Sortino Ratio of 2.21 to 1.70.

In summary, small cap indices in Germany and Europe achieve a higher return per unit of downside risk than large caps. This is exactly the opposite in the American market.

5.4. Maximum Drawdown

This chapter identifies the country-specific indices in terms of maximum drawdown, which depicts the maximum cumulative loss over the observed 12-year period. Since the maximum drawdown is a ratio which concentrates on the

Table 3. Sortino Ratio analysis—July 8th, 2008 until August 20th, 2020.

	SDAX	DAX	MSCI EU S	MSCI EU L	MSCI US S	MSCI US L
	Rounded figures on annual basis					
Return (%)	10.83	7.56	9.95	2.08	11.01	10.80
Risk-free (%)	0.80	0.80	−0.47	−0.47	0.76	0.76
Downside Deviation (%)	4.54	3.97	3.86	3.16	4.96	3.66
Sortino Ratio	2.21	1.70	2.70	0.81	2.07	2.74

conservation of capital it provides information about the maximum loss between the lowest and highest point, before the turning point is reached. Table 4 summarizes the results of the maximum drawdown calculations in six percentage values.

The following conclusions can be drawn: The MSCI EU S exhibits the smallest drawdown with −38.69% of the indices examined. In comparison to that, the MSCI US S shows largest loss of −46.25% within the twelve years. Additionally, the European indices have outperformed the German and American indices.

However, the American indices have exceeded the other indices, as shown in Figure 1. With regard to the European market, this relationship inverted again. Here the small cap index showed a smaller price drop than the large cap index with −38.69% to −39.81%, respectively.

With regard to the maximum drawdown, an investment in German or American indices behaves relatively identically. Similar to the Sharpe Ratio and Sortino Ratio comparison the MSCI EU S has dominated the MSCI EU L, which has not changed with regard to the maximum drawdown. But exactly this has changed with the measurement of the biggest single drop in the German indices. In terms of the maximum drawdown, the SDAX was thus beaten by the DAX with −40.11% to −45.14%, respectively. This is made particularly clear by Figure 4.

5.5. Summary Performance Measurement Tools

The most important results of this chapter are summarized in Figure 5 focusing

Table 4. Maximum Drawdown analysis—July 8th, 2008 until August 20th, 2020.

	SDAX	DAX	MSCI EU S	MSCI EU L	MSCI US S	MSCI US L
	Rounded figures in %					
Maximum Drawdown	−45.14	−40.11	−38.69	−39.81	−46.25	−40.78

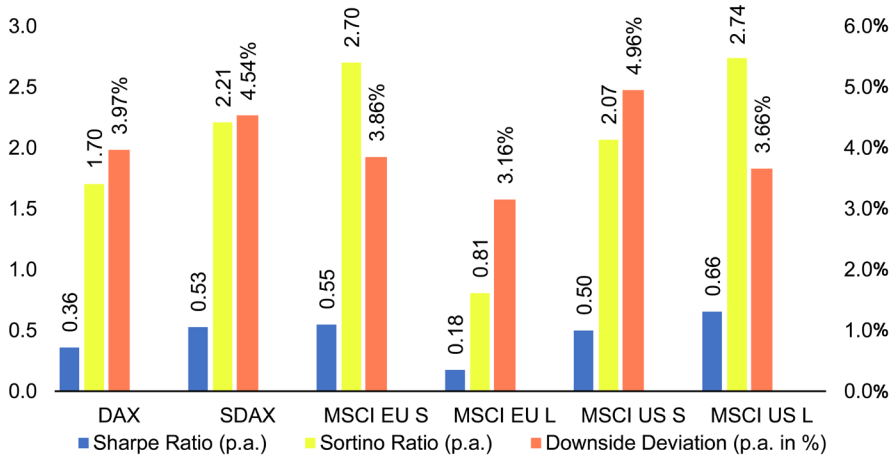

Figure 4. Summary Performance Measurement Ratios—July 8th, 2008 until August 20th, 2020.

on the major ratios like Sharpe ratio, Sortino ratio and Downside Deviation.

Starting with the small cap anomaly, it can be stated that in theory "companies with low market capitalization outperform large companies" can only be proven here on a country-specific basis. This was the case for the European and German small cap index. In the USA, the large cap index outperformed the small cap index. It can therefore be concluded that investing in German and European small cap indices is a much better investment proposition than investing in large caps. The exception to this is the USA, where an investment in large caps would have been more profitable compared to small caps.

6. Curreny Impact

Table 5 demonstrates the major performance and risk-ratios on US-Dollar calculation only. The numbers are different, but they do not change the overall conclusions.

DAX, SDAX and MSCI EU investments are denominated in Euros. A conversion into US-Dollars incorporates also the volatility of the exchange rates between Euros und US-Dollars. Euro based investors are receiving returns in Euro; DAX, SDAX and MSCI EU indices are reflecting the EUR-returns; vice versa for

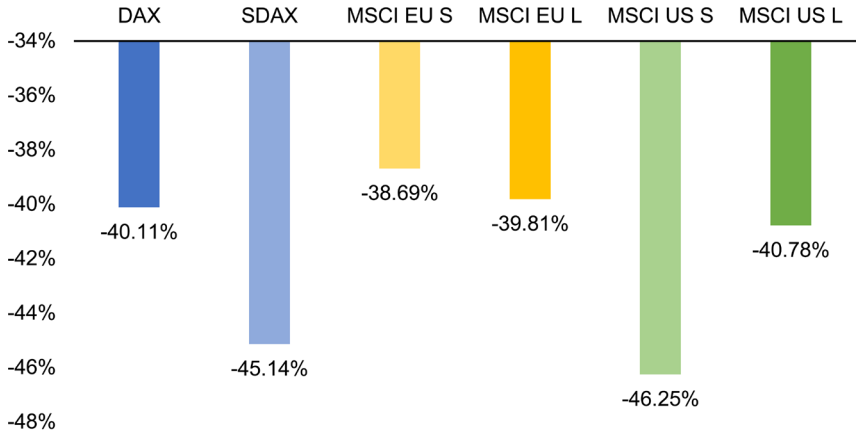

Figure 5. Maximum Drawdown comparison—July 8th, 2008 until August 20th, 2020.

Table 5. Major performance and risk ratios, US-Dollar basis only; July 8th, 2008 until August 20th, 2020.

	SDAX	DAX	MSCI EU S	MSCI EU L	MSCI US S	MSCI US L
	Rounded figures on annual basis					
Return (%)	9.42	6.06	7.07	0.54	11.01	10.80
Risk-free (%)	0.80	0.80	−0.47	−0.47	0.76	0.76
Volatility (%)	24.57	23.52	19.40	19.33	20.46	15.31
Sharpe Ratio	0.35	0.22	0.39	0.05	0.50	0.66
Downside Deviation (%)	5.49	4.81	4.65	4.09	4.96	3.66
Sortino Ratio	1.57	1.09	1.62	0.25	2.07	2.74

Table 6. Deviations between Euro-Dollar based numbers and only US-Dollar based numbers (%).

Return (%)	1.41	1.10	2.88	1.54
Volatility (%)	−5.58	−4.74	−0.42	−4.81
Sharpe Ratio	0.18	0.14	0.16	0.13
Sortino Ratio	0.64	0.61	1.08	0.56

US-Dollar investors. If Dollar investors are investing in the Euro-market they are also bearing the foreign exchange fluctuations.

During the review period the US-Dollar appreciated versus the Euro by 23.7% in 12 years, around 2% p.a. (see **Figure 2**). By converting the Euro return/performance numbers into US-Dollars, the US-Dollar numbers are declining.

But the general conclusions on Return, SharpeRatio and Sortino Ratio are still remaining valid. The paper summarizes the results how they have been realized by the investors in the market.

7. Conclusion

This paper has shown that US large caps represented by the MSCI US Large Cap Index outperformed since the financial crisis the MSCI US Small Cap Index with regard to the Sharpe Ratio (0.66 vs. 0.50) the Sortino Ratio (2.74 vs. 2.07) as well as the maximum drawdown (−40.78 vs. −46.25).

Furthermore, it was found that EU country-specific small caps account for better risk/return ratios in comparison to large caps (0.53 vs. 0.36 and 0.55 vs. 0.18).

Looking specifically at return and volatility figures small caps in each market are exhibiting higher rates than the corresponding large cap markets. This is a remarkably conclusion that small caps are offering on a longer time horizon excellent investment opportunities in particular in times of low interest return for fixed income investments, and at higher risk-return ratios in Germany and the EU. In the US the risk-return ratios for large caps exceeds those for small caps.

Banz (1981) expected already some decades ago this conclusion. He showed in his study that small caps outperformed the larger large caps, since they earned a higher return. This statement can be confirmed, regardless of the country specification.

After all, it can be stated that an investment in the US-large cap index would have outperformed both the European and the German market. In terms of ratios the US-small cap index is slightly behind the equivalent ratios in Europe (Sharpe ratio of 0.50 versus 0.53 Germany and 0.55 Europe; Sortino ratio of 2.07 versus 2.21 Germany and 2.70 Europe)

And Equation (1) shows that the MSCI US L is developing better out of the corona crisis than the MSCI US S. This could indicate that the corona crisis has hit smaller US-companies harder than the large US-companies

The low respective negative interest rate regime in all markets has not any

significant impact on the risk-return ratios.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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