**3. Data, variables, and methodology**

**3.1 Data**

The data we used in this study is extracted from Worldscope database and provided to us by our supervisors Steffen Windmüller (steffen.windmueller@tum.de) and Matthias Hanauer (matthias.hanauer@tum.de). It contains data of public listed companies in BRIC region. The sample data provided information on three aspects of a company - profile, annual financial statement, and monthly stock returns. To make monthly and yearly data comparable and to have both figures in the same scale, we multiplied market capitalization in the monthly returns data frame with 10^6 and income statement figures with 10^3.

Due to either poor and/or rare company information before the mid-90s, we decided to limit our raw data to the period from July 1996 to October 2018 for the monthly data and from 1995 to 2018 for the annual data. Subsequently we calculated the 1-month lagged market value (LMV and LMV.USD), the 36-month rolling window volatility (Volatility) and the 12-month rolling window Momentum. Finally, we added a column, with the lagged market value in June of year y for a stock in the respective time July of year y to June of year y + 1 (“MV.USD.June”). In further data cleansing, we included a security in our sample only if all earlier mentioned parameters were available along with market value in local currency, market value in US-Dollar, and returns in US-Dollar.

Additionally, we excluded securities where no book equity, operating profit or asset growth was available for year y.

As risk-free rate we used the US-Treasury 1-month T-bill rate. We therefore downloaded from Kenneth R. French’s website the Fama/French 5 Factors (2x3) CSV-sheet, which includes the 1-month T-bill rate.

Big stocks are defined as the stocks belonging to a portfolio of the first stocks summing up to 90% of the overall market capitalization in the BRIC region. The next 7% are considered small stocks, while the last 3% are labelled micro stocks and not included. Hereby, we rebalance yearly based on “MV.USD.June”. The benchmark is defined as the portfolio containing all big stocks in the referring year. Micro stocks were around 44% of all stocks, who at least fulfilled the criteria for one month.

Table X?1X – Statistics on securities included: all stocks.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **BRIC** | **Brazil** | **Russia** | **India** | **China** |
| Total no. firms | 6471 | 232 | 395 | 3022 | 2822 |
| Min no. firms | 201 | 33 | 1 | 167 | 34 |
| Mean no. firms | 2492.96 | 100.39 | 99.57 | 1131.1 | 1184.27 |
| Max no. firms | 5255 | 169 | 241 | 2284 | 2696 |
| Mean size in USD | 3.390743E+12 | 3.085326E+11 | 3.756992E+11 | 7.388358E+11 | 2.045772E+12 |
| Median size in USD | 2.322141E+12 | 3.331569E+11 | 4.258591E+11 | 6.159941E+11 | 1.074046E+12 |
| Total size in USD | 9.087190E+14 | 7.528195E+13 | 8.716221E+13 | 1.980080E+14 | 5.482669E+14 |
| % of total size | 100 | 8.28 | 9.59 | 21.79 | 60.33 |
| Start ym | July 1996 | July 1998 | July 1999 | July 1996 | July 1996 |
| End ym | October 2018 | October 2018 | October 2018 | October 2018 | October 2018 |

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*& BRIC & Brazil & Russia & India & China \\*

*\hline*

*Total no. firms & 6471 & 232 & 395 & 3022 & 2822 \\*

*Min no. firms & 201 & 33 & 1 & 167 & 34 \\*

*Mean no. firms & 2492.96 & 100.39 & 99.57 & 1131.1 & 1184.27 \\*

*Max no. firms & 5255 & 169 & 241 & 2284 & 2696 \\*

*Mean size in USD & 3.390743e+12 & 3.085326e+11 & 3.756992e+11 & 7.388358e+11 & 2.045772e+12 \\*

*Median size in USD & 2.322141e+12 & 3.331569e+11 & 4.258591e+11 & 6.159941e+11 & 1.074046e+12 \\*

*Total size in USD & 9.08719e+14 & 7.528195e+13 & 8.716221e+13 & 1.98008e+14 & 5.482669e+14 \\*

*\% of total size & 100 & 8.28 & 9.59 & 21.79 & 60.33 \\*

*Start ym & Jul 1996 & Jul 1998 & Jul 1999 & Jul 1996 & Jul 1996 \\*

*End ym & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 \\*

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Table X?2X – Statistics on securities included: big and small stocks.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | BRIC | Brazil | Russia | India | China |
| Total no. firms | 3787 | 184 | 163 | 704 | 2736 |
| Min no. firms | 108 | 15 | 1 | 62 | 33 |
| Mean no. firms | 1315.49 | 58.74 | 41.32 | 231.49 | 994.75 |
| Max no. firms | 2765 | 116 | 99 | 411 | 2229 |
| Mean size in USD | 3.275574E+12 | 3.033386E+11 | 3.699309E+11 | 6.903260E+11 | 1.988835E+12 |
| Median size in USD | 2.232000E+12 | 3.208394E+11 | 4.116409E+11 | 6.002086E+11 | 1.024141E+12 |
| Total size in USD | 8.778538E+14 | 7.401462E+13 | 8.582397E+13 | 1.850074E+14 | 5.330079E+14 |
| % of total size | 100 | 8.43 | 9.78 | 21.07 | 60.72 |
| Start ym | July 1996 | July 1998 | July 1999 | July 1996 | July 1996 |
| End ym | October 2018 | October 2018 | October 2018 | October 2018 | October 2018 |

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*& BRIC & Brazil & Russia & India & China \\*

*\hline*

*Total no. firms & 3787 & 184 & 163 & 704 & 2736 \\*

*Min no. firms & 108 & 15 & 1 & 62 & 33 \\*

*Mean no. firms & 1315.49 & 58.74 & 41.32 & 231.49 & 994.75 \\*

*Max no. firms & 2765 & 116 & 99 & 411 & 2229 \\*

*Mean size in USD & 3.275574e+12 & 3.033386e+11 & 3.699309e+11 & 6.90326e+11 & 1.988835e+12 \\*

*Median size in USD & 2.232e+12 & 3.208394e+11 & 4.116409e+11 & 6.002086e+11 & 1.024141e+12 \\*

*Total size in USD & 8.778538e+14 & 7.401462e+13 & 8.582397e+13 & 1.850074e+14 & 5.330079e+14 \\*

*\% of total size & 100 & 8.43 & 9.78 & 21.07 & 60.72 \\*

*Start ym & Jul 1996 & Jul 1998 & Jul 1999 & Jul 1996 & Jul 1996 \\*

*End ym & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 \\*

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Table X?3X – Statistics on securities included: big stocks/benchmark.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | BRIC | Brazil | Russia | India | China |
| Total no. firms | 2987 | 144 | 121 | 468 | 2254 |
| Min no. firms | 67 | 11 | 1 | 49 | 18 |
| Mean no. firms | 829.93 | 44.19 | 32.85 | 149.09 | 612.16 |
| Max no. firms | 1865 | 91 | 72 | 270 | 1571 |
| Mean size in USD | 3.021811E+12 | 2.965056E+11 | 3.659025E+11 | 6.536660E+11 | 1.781440E+12 |
| Median size in USD | 2.045943E+12 | 3.078790E+11 | 4.067016E+11 | 5.652418E+11 | 8.723458E+11 |
| Total size in USD | 8.098453E+14 | 7.234736E+13 | 8.488939E+13 | 1.751825E+14 | 4.774260E+14 |
| % of total size | 100 | 8.93 | 10.48 | 21.63 | 58.95 |
| Start ym | July 1996 | July 1998 | July 1999 | July 1996 | July 1996 |
| End ym | October 2018 | October 2018 | October 2018 | October 2018 | October 2018 |

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*& BRIC & Brazil & Russia & India & China \\*

*\hline*

*Total no. firms & 2987 & 144 & 121 & 468 & 2254 \\*

*Min no. firms & 67 & 11 & 1 & 49 & 18 \\*

*Mean no. firms & 829.93 & 44.19 & 32.85 & 149.09 & 612.16 \\*

*Max no. firms & 1865 & 91 & 72 & 270 & 1571 \\*

*Mean size in USD & 3.021811e+12 & 2.965056e+11 & 3.659025e+11 & 6.53666e+11 & 1.78144e+12 \\*

*Median size in USD & 2.045943e+12 & 3.07879e+11 & 4.067016e+11 & 5.652418e+11 & 8.723458e+11 \\*

*Total size in USD & 8.098453e+14 & 7.234736e+13 & 8.488939e+13 & 1.751825e+14 & 4.77426e+14 \\*

*\% of total size & 100 & 8.93 & 10.48 & 21.63 & 58.95 \\*

*Start ym & Jul 1996 & Jul 1998 & Jul 1999 & Jul 1996 & Jul 1996 \\*

*End ym & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 & Okt 2018 \\*

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All size variables refer to monthly market capitalization in USD including all stocks from the mentioned region.

**3.2 Variables**

For calculating the five factors from Fama and French (2015) we calculated multiple variables. These variables include the book equity for the HML and RMW factor, the operating profits for the RMW factor and asset growth for the CMA factor. Additionally, for designing our strategy and assess the Momentum factor, we needed to define and calculate which stocks are considered winner and which loser stocks. To implement our low volatility strategy, we further calculated the volatility for each stock. The construction of these factors is elaborated in the [table X?1?].

All variable calculations refer to a security in year y. For accounting data, we refer to the accounting data from the fiscal year ending in the mentioned year.

Table X?1? - Variables

|  |  |
| --- | --- |
| Book equity | Book equity was calculated as shown in Hanauer and Lauterbach (2019). We added Common Equity (Worldscope code: WC03501) in year y - 1 and Deferred Taxes (WC03263) in year y – 1 to each other. Deferred taxes were set to 0, if the data was missing. |
| Operating profits | Operating profits were calculated as in Fama and French (2015) as Net Sales or Revenue (WC01001) minus Cost of Goods Sold (WC01051) minus Selling, General and Administrative Expenses (WC01101) minus Interest Expense on Debt (WC01251). All from year y – 1. If a value was missing for one of these items, we set the respective item to 0. This was not the case, when all four items were missing. |
| Asset growth | Asset growth was calculated as in Cooper et al. (2008). Therefore, we divided Total Assets (WC02999) from year y – 1 minus Total Assets from year y – 2 by Total Assets from year y – 2. |
| B/M\_recent- ratio | As we use Momentum as one of the portfolio selection criteria, we followed Hanauer and Lauterbach (2019), Asness and Frazzini (2013) and Barillas and Shanken (2018) and calculated additionally a B/M-ratio - for both strategy and Fama French factors - by dividing book equity by the latest local currency market value. We label this book-to-market ratio with “recent” in parentheses. |
| B/M-ratio | We calculated the book-to-market ratio by dividing book equity by the market value of the company in year y-1. |
| OP/BE-ratio | The Operating Profits-to-Book Equity Ratio (OP/BE-Ratio) is computed dividing Operating Profits by Book Equity. |
| Momentum | Our Momentum variable was calculated following Grinblatt and Moskowitz (2004) using positive returns as criterium and looking at a 12-month rolling window. A security is defined a winner, if 8 out of 11 months had positive returns. The 11 months comprise the last 12 months without the most recent previous month measured. As we are not considering contrarian strategies, we treat missing returns (NA’s) like negative returns, to avoid filtering out winner stocks, where only one to three returns are missing, due to bad data quality. |
| Momentum\_C | We calculated a custom momentum, which is based on Grinblatt and Moskowitz (2004) and calculated exactly like the momentum above with the exception that it also includes the most recent previous month. |
| Volatility | We calculated our volatility variable based on Hanauer and Lauterbach (2019) with a 36-month rolling window. The volatility is thereby the standard deviation of the last 36 monthly stock returns, with a minimum of 12 returns being required. Deviating from Hanauer and Lauterbach (2019) we use USD-returns instead of local currency in order to eliminate the local currency impact while we consider the whole BRIC region. |

**3.3 Factor calculation**

Following Fama and French (2015) we calculated our factors based on 2x3 sorts using the 30th and 70th NYSE percentiles for respectively B/M, OP/BE, and Asset growth. For Size we followed Hanauer and Lauterbach (2019) and Fama and French (2012) and used 90% of market capitalization as breakpoint instead of the NYSE median. Like in their paper, we decided to exclude micro stocks. Small stocks therefore comprise the next 7% after the 90% market capitalization, summing up to 97%. The rest 3% are the mentioned and excluded micro stocks. We calculated two variants of the HML factor. The first “HML” is using the B/M-ratio and the second one “HML\_DEVIL” is using the B/M\_recent-ratio. RMW is calculated based on the OP/BE-ratio and CMA based on asset growth. The SMB factor was calculated as in Fama and French (2015) as the mean of the SMB\_HML, SMB\_RMW and SMB\_CMA portfolios.

X.2 Factors and variables

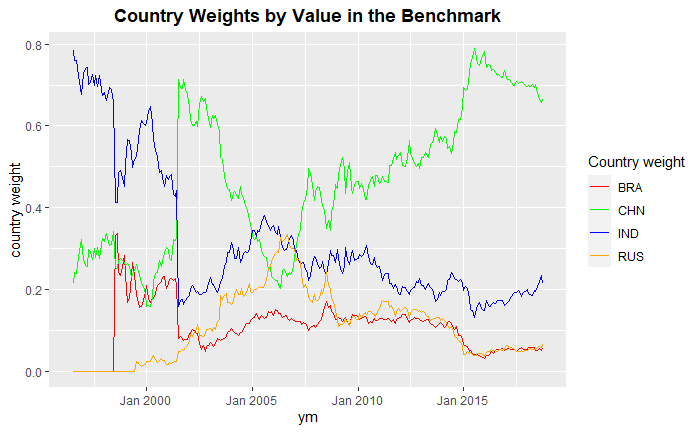
|  |  |
| --- | --- |
| Factor | Used Variable |
| SMB “Size” | MV.USD |
| HML “Value” | B/M |
| HML\_DEVIL “Value” | B/M (recent) |
| RMW “Profitability” | OP/BE |
| CMA “Investment” | Asset Growth |
| MOM “Momentum” | Momentum |

The factors are all calculated with the return in USD with respect to the weight of a stock, which is based on the 1-month lagged market capitalization of it. The momentum factor was calculated analogically with subtracting a portfolio of Losers from a portfolio of Winners.

4.3 Country weights

The weight of a country is measured by relating the market capitalization of the invested stocks from this country to the market capitalization of all invested stocks. The weights were measured monthly.

For the benchmark, in the beginning India takes up most of the weight. From 2002, China's weight got significantly higher accounting to the highest weight in most periods. Russia and Brazil – with exceptions – add only around 5 – 15 % of weight in most periods.



For the analyzed strategies on the other hand the picture differs strongly. For our growth strategies Indian stocks share after 2005 most of the weight, while for our value strategies this stronger fluctuating with a clear weight focus on China. Overall, we can see, that weights in general fluctuate strongly. Through the focus on the whole BRIC region and the subsequent diversification effect our strategies work more effective.

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