Risk Factors for the Swiss Stock Market

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JEL-Classification: G11, G12, G15
Keywords: Fama French, Carhart, Risk factors, Value, Size, Momentum, Switzerland

1. Introduction

Explaining returns by taking several risk factors into account has become a standard for modern performance evaluation of investment funds and portfolio managers, for estimation of expected returns, for portfolio selection, for event studies, and for other applications as well. Risk factors are a useful tool because they explain an important part of stock return variations.

In this regard, the time-series regression model applied by Carhart (1995) has become a standard in finance. It takes into account four risk factors to explain the time series of excess returns $R_{it} - R_{ft}$:

$$R_{it} - R_{ft} = \alpha_{iT} + \beta_{1iT} RMRF_t + \beta_{2iT} SMB_t + \beta_{3iT} HML_t + \beta_{4iT} UMD_t + e_{it}$$

where $RMRF_t$ is the excess return of the market at time t and SMB_t, HML_t and UMD_t are the returns of zero-investment factor-mimicking portfolios for size, value, and momentum.[1]

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The authors would like to thank Hato Schmeiser, the participants of the "Topics in Finance"-seminar at the University of St. Gallen, and the anonymous referees for their valuable comments. An updated version of the monthly risk factors is available on www.ammannsteiner.ch.

1 This model is an extension of the three-factor model of Fama and French (1993) which takes into account the excess return of the market as well as the size- and value-factor to explain expected returns. SMB stands for "Small Minus Big" (measured by the market capitalization), HML for "High Minus Low" (measured by the book-to-market ratio) and UMD for "Up Minus Down" (measured by the one-year past return). UMD is also known as WML ("Winners Minus Losers") in the literature.

Although these four explanatory variables have been analysed for and applied to various markets, no in-depth study of these factors exists for the Swiss stock market. However, the Swiss market is of special interest for several reasons. First, Switzerland has a highly developed and internationally recognised financial market. By market capitalization, the Swiss stock market is the eighth largest worldwide.[2] For this reason, it is desirable to be able to apply this broadly accepted factor approach to the Swiss market. Second, Switzerland is a small, open economy and one of the few developed, European markets outside the Euro-zone. As a result, some particular aspects of factor development and characteristics have to be taken into account in the Swiss environment. Third, Fama and French (1998) and Griffin (2002) find that size, value, and momentum factors are country-specific. They show that the application of international factors to individual countries leads to disappointing results. Therefore, Swiss factors are important for Swiss research.

To our best knowledge, this is the first study that analyses the three risk factors for size, value, and momentum specifically for the Swiss stock market by developing and investigating monthly factor premiums from January 1990 to December 2005. Local characteristics of the Swiss stock market will be taken into account. To our best knowledge, it is also the first paper to analyse in depth the robustness of the factors by testing their sensitivities to different assumptions. The contribution of this paper is twofold: First, it extends earlier analyses on the Carhart factors[3] to the Swiss market, including detailed sensitivity tests. Second, it sets a clear base for performance evaluation, portfolio selection, and other factor-based analyses in Switzerland.

The remainder of the paper is structured as follows. Chapter Two will give an overview on the international literature including a brief discussion of the factors. Chapter Three will explain the data used as well as the assumptions and methodology for the construction of the Switzerland-specific factors. Chapter Four analyses the factor characteristics, their robustness, and the influence of the January effect. Further, a comparison to US-specific factors is drawn and the explanatory power of the factors tested. Lastly, the results are summarized and conclusions are drawn in the final chapter.

2 Source: Bloomberg, November 2006.

3 As well as analyses related to the model introduced by Fama and French (1993).

2. Carhart Risk Factors

The starting point for all risk factor-based analyses is the Capital Asset Pricing Model (CAPM) first introduced by Sharpe (1964) and Lintner (1965). However, later research documents empirical contradictions and anomalies that strongly question the validity of the CAPM. Banz (1981), for example, first finds that firms with a small market capitalization significantly outperform firms with a large market capitalization. Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) document that average US stock returns are positively correlated with the book-to-market ratio. Later, Fama and French (1992) confirm that US stock returns are significantly related to these two firm characteristics. As a consequence, the extension of the CAPM to a multi-factor model is introduced by Fama and French (1993). The market, size, and value factors are integrated into a risk factor model explaining stock returns. In contrast to Fama and French (1992), they use excess returns or returns on zero-investment factor-mimicking portfolios as explanatory variables. Factor correlation and the related problem of multicolinearity are thereby addressed and the factors SMB and HML introduced.

At the same time, an important step towards the four-factor model is accomplished by Jegadeesh and Titman (1993). They find a highly significant one-year momentum anomaly for the US market by documenting a positive return differential of the portfolios of past winner and loser stocks. Asness (1994) further analyses this anomaly and finds that the momentum effect cannot be explained by the three Fama and French (1993) factors. As a logical conclusion, Carhart (1995) applies an extension of the Fama and French (1993) model by adding the momentum-mimicking portfolio to the three factors for the market, size, and value effect. The UMD factor and the Carhart model are the results of these developments.

Thereafter, this model and its factors for size, value, and momentum are investigated and applied broadly. This vast amount of research gives the model strong justification. Hawawini and Keim (1998) give a structured overview on the international evidence and literature on the factors for size, value, and momentum.

The factors and their related investment styles are analysed as a combined model as well as one by one. After Banz's (1981) first milestone research, international evidence emerges on the tendency of firms with small market capitalizations to outperform firms with large market capitalizations.[4] Nonetheless, the

4 See Hawawini and Keim (1998) for an overview.

relevance and relative importance of the size factor is controversial. As documented by VAN DIJK (2006), this factor is the most questioned in the Carhart model.

The value factor, on the other hand, is the least disputed factor: The first evidence for its existence by STATTMAN (1980) and ROSENBERG, REID, and LANSTEIN (1985) is supported by FAMA and FRENCH (1992) and LAKONISHOK, SHLEIFER, and VISHNY (1994) for the US stock market. CAPAUL, ROWLEY, and SHARPE (1993), FAMA and FRENCH (1998) and BAUMAN, CONOVER, and MILLER (1998) add strong international evidence for the value effect.

In contrast to size and value, the momentum effect has behavioural origins: DEBONDT and THALER (1985) first find a significant relation between past and future long-term returns. The studies about mid-term anomalies by JEGADEESH and TITMAN (1993) and LAKONISHOK, SHLEIFER, and VISHNY (1994) are the starting point for broad research activities: ROUWENHORST (1998) extends these US-analyses and documents the momentum effect for various non-US markets. JEGADEESH and TITMAN (2001) finally review momentum strategies and confirm that strong effects are observable, even after taking size and value into account. The often stated relationship of this factor with behavioural aspects draws special attention to the discussion about the sources of momentum premiums, as the contributions of LEWELLEN (2002) and CHEN and HONG (2002) show.

The literature also offers critical reviews of various aspects of the CARHART (1995) factor approach as well as alternative model specifications. One controversial issue is the interrelation of seasonal effects and the factor premiums. For example, L'HER, MASMOUDI, and SURET (2003) find that part of the premiums may be explained by the January effect for the Canadian market.[5] However, the main critique is about the factor selection. This is not surprising as the variety of potential model specifications is almost unlimited. Alternative models use macroeconomic variables as explanatory factors. CHAN, KARCESKI, and LAKONISHOK (1998) provide one of the broadest analyses on the specification of a factor model to explain the cross-section of stock returns. Factors related to dividend yields, cash flows and earnings as well as other factors such as industrial production, consumption, default spread, term spread are tested against and in combination with the four Carhart factors. They find that most alternative factors have no relation to the cross-section of returns and that the explanatory power may not be increased significantly by an alternative factor combination. BRENNAN, CHORDIA, and SUBRAHMANYAM (1998) show also that alternative factor specifications do

5 HAWAWINI and KEIM (1998) for example give an overview on research about the January effect in relation to the size, value, and momentum premium.

not result in higher explanatory power. These and other studies strongly support the use of the Carhart factors.[6] However, the discussion about potentially better specifications and the economic content of the relationship between the factors and the explained returns is still ongoing. Nevertheless, the Carhart model has become a standard model for a broad range of applications. This is impressively supported by the application of this approach in a lot of recent research, including the work of Aretz, Bartram, and Pope (2006), Lin (2006), Barras, Scaillet, and Wermers (2005) or Bollen and Busse (2005).

Prior research, however, leaves an important gap for the Swiss stock market. There are studies that include some Switzerland-specific aspects of the Carhart factor model in the context of other research, for example Rouwenhorst (1998) in the context of momentum strategies, Capaul, Rowley, and Sharpe (1993), Fama and French (1998), Arshanapalli, Coggin, and Doukas (1998) and Arshanapalli, Coggin, Doukas and Shea (1998) in the context of value and growth strategies and Grünenfelder (1999), Liew and Vassalou (2000) and Cauchie, Hoesli, and Isakov (2004) in the context of macroeconomic studies. However, to our best knowledge, there exists no exhaustive study for a Switzerland-specific four-factor Carhart model. The remainder of the paper fills this gap by estimating these factors explaining Swiss stock returns.

3. Factor Construction

This section gives an overview on the data and methodology used to construct the four Carhart factors for the Swiss stock market.

3.1 Data

This paper uses end-of-month data from December 1988 to December 2005.[7] Factset is the data provider for CHF Call money rates as well as for all share prices, dividend payments[8], numbers of shares outstanding and book values for all companies listed in Switzerland.

6 As an extension of the unconditional model, conditional ones are proposed and tested as well (e.g. Ferson and Schadt (1996)). These conditional models as well use the factors proposed by Carhart (1995). However, the performance of conditional models is highly controversial (see e.g. Ghysels (1998)).

7 Prior to December 1988, there is no reliable data available from Factset.

8 All returns in this paper are total returns.

In the sample, investment companies are excluded and multiple classes are integrated into the main class of stock.[9] However, there are some additional requirements for companies to be included in the sample at a certain point in time: Data for the determination of size (market capitalization), value (positive book-to-market-ratio) and momentum (one-year past return) has to be available. For that reason, factor construction starts at the end of 1989 from data of companies providing share prices, and therefore a one-year past return, since year-end 1988.

Table 1 shows the average number of companies included in the sample for each year, after all exclusions. This sample is larger than those analysed by Rouwenhorst (1998), Fama and French (1998), Arshanapalli, Coggin, and Doukas (1998), Arshanapalli, Coggin, Doukas, and Shea (1998), Grünenfelder (1999), Liew and Vassalou (2000), and Cauchie, Hoesli, and Isakov (2004). As Vaihekoski (2004) shows, this is a very important prerequisite, as the number of companies in Switzerland is small in comparison to the US and therefore a larger dataset significantly increases the reliability of the results.

Additionally, the high quality of the database is confirmed by Table 2, which shows a comparison of the Swiss Performance Index (SPI) with a hypothetical index constructed from the securities included in the sample. The returns of the sample-index have roughly the same mean and standard deviation as the SPI and are correlated with this broad market index at a coefficient of 0.993. With this in mind, the methodology applied to calculate the factor premiums will be presented in the following section.

3.2 Methodology

In the context of constructing the four factor portfolios, several methodological issues have to be solved. The first and most important challenge is how to address the problem of isolating the four effects from each other with the goal of minimizing the cross-correlations between the factors. As Vaihekoski (2004) describes, this includes the question of minimizing security-specific variance and the goal of working with investable portfolios. Other problems include the choice of the right measure to characterise the factors, the avoidance of the look-ahead bias, and the choice of the right weighting scheme.

A broad consensus exists about the construction of the market factor. In accordance with the CAPM, Fama and French (1993) and Carhart (1995), it is calculated as the excess return of the market portfolio over the risk-free rate,

9 E.g. common versus preference shares.

Table 1: Yearly Number of Companies Included in the Calculation Database

Year	Number of companies in Swiss Stock Guide	+ Adjustments	Adjusted Swiss Stock Guide Base	– Investment companies	– Companies with missing data	Number of companies in database by December	Market capitalization of Top 50 Swiss Stock Guide companies included
1990	259	5	264	30	120	114	81%
1991	258	4	262	31	103	128	91%
1992	249	5	254	28	94	132	94%
1993	241	7	248	27	82	139	93%
1994	239	9	248	29	78	141	79%
1995	238	12	250	35	61	154	95%
1996	245	10	255	34	69	152	94%
1997	260	8	268	39	74	155	96%
1998	260	10	270	41	52	177	94%
1999	289	10	299	51	51	197	98%
2000	298	12	310	58	51	201	98%
2001	294	15	309	58	39	212	99%
2002	274	27	301	43	20	238	99%
2003	266	20	286	41	14	231	100%
2004	267	18	285	38	21	226	100%
2005	265	19	284	36	27	221	99%

Table 1 shows the number of companies included in the calculation database by December of each year in the case of quarterly rebalancing, set in relation to the universe provided by FuW in the Swiss Stock Guide. The number of companies in the Swiss Stock Guide has to be adjusted for asynchronity between the data in the Swiss Stock Guide and in the database as well as for additional companies provided by Factset not included in the Swiss Stock Guide. After this adjustment the difference to the database is fully explained by the exclusion of investment companies and those companies with missing data. Finally, the last row shows the percentage of the market capitalization of the Swiss Stock Guide's Top 50 companies that is included in the final database.

Table 2: Comparison of the SPI and the "Market" Constructed from the Database

	SPI	"Market" from Database
Mean return (annualized)	10.12%	10.08%
Standard deviation (annualized)	16.66%	16.34%
Correlation	0.993	

Table 2 shows a comparison of the Swiss Performance Index (SPI) and a value-weighted index ("market") constructed from all companies included in the database of this study (after all exclusions, based on monthly continuously compounded returns from January 1990 to December 2005, with quarterly adjustment for members).

defined as the Swiss Franc Call Money rate provided by Factset. The market portfolio is compiled value-weighted[10] from all securities included in the final database and has the characteristics described in Table 2.

The approach chosen for the construction of the factors for size, value, and momentum is related to FAMA and FRENCH (1993) and CARHART (1995). However, there are various differences. Specific characteristics of the Swiss stock market and the portfolio construction rules developed by VAIHEKOSKI (2004) are considered.

To isolate the factor premiums from each other, the three factors are designed as zero-investment portfolios, constructed from eight subportfolios as follows: All stocks from the database are ranked by market capitalization and divided into the two groups "Big" (B) and "Small" (S) by the median size. At the same time, the stocks are broken down into two groups by their book-to-market ratio ("High" (H) and "Low" (L)) and by their one-year past return ("Up" (U) and "Down" (D)). Afterwards, each stock is assigned to one of the eight intersectional subportfolios S/H/U, S/H/D, S/L/U, S/L/D, B/H/U, B/H/D, B/L/U, or B/L/D with respect to its characteristics from the three independent sorts.[11] For each of the eight sets, value-weighted monthly returns are calculated. The premiums of the zero-investment factor-mimicking portfolios SMB, HML, and UMD are then constructed from these eight subportfolios as follows:

10 In accordance with FAMA and FRENCH (1993), LIEW and VASSALOU (2000), and the recommendation by VAIHEKOSKI (2004), this paper uses only continuously compounded returns from value-weighted portfolios. Value-weighted portfolios fulfil the prerequisite of investability.

11 The S/H/U portfolio, for example, consists of all stocks from the group "Small" that are at the same time in the groups "High" and "Up".

$$SMB = 1/4*((S/H/U - B/H/U) + (S/H/D - B/H/D) + (S/L/U - B/L/U) + (S/L/D - B/L/D))$$

$$HML = 1/4*((S/H/U - S/L/U) + (S/H/D - S/L/D) + (B/H/U - B/L/U) + (B/H/D - B/L/D))$$

$$UMD = 1/4*((S/H/U - S/H/D) + (S/L/U - S/L/D) + (B/H/U - B/H/D) + (B/L/U - B/L/D))$$

SMB may be interpreted as the return to a portfolio that is long on small companies and short on big companies, controlling for the market, value, and momentum effects. Similar explanations can be given for HML and UMD.

Two of the assumptions for the construction of the factor-mimicking portfolios need special attention. The first one is related to the chosen characteristics, as factor premiums could be sensitive to the choice of market capitalization, book-to-market ratio and one-year past return as proxies for size, value and momentum.

Market capitalization, defined as market price times shares outstanding, is standard as characterization of size and therefore an obvious selection.

The correct measure for value is less clear-cut. However, three strong reasons support the book-to-market ratio as the measure for value. First, Lakonishok, Shleifer, and Vishny (1994), Fama and French (1998), Chan, Karceski, and Lakonishok (1998), and Bauman, Conover, and Miller (1998) compare the results from the use of the book-to-market ratio as proxies for value to the use of the price-earnings ratio, the cash-flow-to-price ratio, and the dividend yield. These studies either document that the book-to-market ratio delivers the highest premium in the long-short portfolios or show that book-to-market portfolios have higher explanatory power than those based on the alternative ratios. Second, the application of the book-to-market ratio is in line with the vast majority of all research, including Fama and French (1993), Asness (1994), Carhart (1995), Liew and Vassalou (2000), and Barras, Scaillet, and Wermers (2005). Third, the book-to-market-ratio is available for more companies than the other ratios, as dividends may be zero and earnings as well as cash flows may be negative or strongly influenced by one-time effects. For these reasons, the book-to-market ratio is applied as measure for value. To avoid a look-ahead bias, six-month-prior book values are used.[12] In other words, this analysis uses end-of-year book values from year $t - 1$ not earlier than at the end of June of year t. This is

12 To ensure that the book-values are available to the public when the portfolios are formed.

conservative and in accordance with Fama and French (1993), Carhart (1995), Liew and Vassalou (2000), and others.

Finally, the definition of momentum as the one-year past return from month $t-12$ to $t-1$ reflects not only the definition by Carhart (1995), but also the results of the detailed analyses by Jegadeesh and Titman (1993), Asness (1994), and Rouwenhorst (1998). Jegadeesh and Titman (1993) as well as Rouwenhorst (1998) show that a one-year formation period shows the highest momentum effect, whereas the exclusion of the most recent month is based on Asness (1994), who finds that one-month stock returns are negatively autocorrelated due to microstructure issues such as the bid-ask bounce.

The second assumption to be explained is the use of eight subportfolios on the basis of three independent sorts.[13] Fama and French (1993) break the sample down in two size groups, but three book-to-market groups while Liew and Vassalou (2000) break the database down into three groups for each characteristic, resulting in 27 subportfolios.[14] The approach of Fama and French (1993) is rejected, as it would result in an arbitrary differentiation between the three factors. Dividing by all characteristics into either two or three groups is the more consistent way due to the fact that factor premiums may be sensitive to the choice of dividing it into three instead of two groups. However, there are two reasons the portfolio was divided into 8 ($2 \times 2 \times 2$) instead of 27 ($3 \times 3 \times 3$) subportfolios[15]: First, the number of securities in Switzerland is too small to construct 27 portfolios with a sufficient number of securities per portfolio. Vaihekoski (2004) recommends in this regard having at least 5 assets in a portfolio. Tests not reported here show that over the whole 16 year period, the quarterly number of stocks in the eight portfolios is smaller than 7 in only 0.39% of all observations, smaller than 5 only once and as large as 21 on average. On the other hand, the use of 27 subportfolios would result in many temporarily empty subportfolios and on average 6.2 assets per subportfolio. Obviously, the results from a ($3 \times 3 \times 3$) grouping would be negatively affected by security-specific noise from very small groups.[16] Second, there is a methodological concern about

13 This is a slightly different approach than in Fama and French (1993) and Liew and Vassalou (2000).

14 Carhart (1995) adds the momentum factor to the approach applied by the Fama and French (1993) by breaking down the database into three groups based on the one-year past return.

15 As in Liew and Vassalou (2000) and other studies.

16 Liew and Vassalou (2000) use sequential sorts to make sure that no empty portfolios emerge. The disadvantage of this approach is that the results may be sensitive to the sorting order used. However, this paper uses independent, simultaneous sorts in accordance with Fama and French (1993).

the (3 × 3 × 3)-approach. This sorting has the disadvantages that not all securities are included in the factors and that each factor is calculated on the basis of a different set of securities.[17]

In summary, the construction of the factors is strongly inspired by Fama and French (1993) and Carhart (1995). However, to consider Switzerland-specific parameters and to use a consistent methodology, some distinct differentiations are applied. The most important is the use of eight subportfolios from (2 × 2 × 2) independent sorts instead of 27 from (3 × 3 × 3) sequential sorts.

4. Resulting Factor Premiums

This chapter studies the premiums of the Swiss Carhart factors RMRF, SMB, HML, and UMD resulting from the Switzerland-specific construction approach previously presented. First, descriptive statistics are presented and compared to earlier research. Second, the robustness of the results to different assumptions is analysed and discussed. Third, a comparison to well known US-premiums is drawn and, finally, the explanatory power of the four factors on the eight subportfolios is tested and interpreted.

4.1 Characteristics

Table 3 shows the main statistics of the premiums from January 1990 to December 2005, based on quarterly rebalancing of the subportfolios. The market factor RMRF has the expected structure, with an average premium of 7.16% p.a. and a standard deviation of 16.41% p.a. The distribution of the monthly market premiums is slightly skewed and fat-tailed. From the three factors SMB, HML, and UMD, the momentum premium is the most pronounced with an average of 10.33% p.a., but with a strikingly high excess kurtosis of 4.86. Whether these fat tails and the skewness are responsible for the resulting market and momentum premiums will be tested later by an outlier analysis. The value premium has an annualised average of 2.35% and the size premium of –0.67%. The negative size premium confirms the critical discussion of the size factor in the literature and questions its existence in Switzerland.

The positive momentum premium is significantly different from zero, the size and value premiums are not. However, a look at different subperiods in Table 4

17 This results from the fact that only the highest and lowest of the three portfolios are used to calculate SMB, HML and UMD.

Table 3: Premiums of the Swiss Factors Based on Quarterly Rebalancing

	RMRF	SMB	HML	UMD
Average premium (annualized)	7.16%	–0.67%	2.35%	10.33%
Standard deviation (annualized)	16.41%	9.92%	7.48%	11.58%
t-statistic	1.75	–0.27	1.26	3.57
Skewness	–0.89	0.04	–0.08	0.40
Kurtosis	1.79	0.97	0.18	4.86
Jarque-Bera	50.86	7.65	0.49	194.11
Autocorrelation (1 month)	0.17	0.05	0.07	0.29
Autocorrelation (2 months)	0.03	–0.09	–0.11	0.12
Average monthly premium	0.60%	–0.06%	0.20%	0.86%
Median monthly premium	1.27%	0.19%	0.19%	0.59%
Maximum monthly premium	11.20%	10.37%	6.05%	15.54%
Minimum monthly premium	–18.42%	–8.86%	–6.10%	–13.62%

Table 3 shows the descriptive statistics for the Swiss premiums of the four Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). Additionally, the standard deviation, t-statistic, skewness, kurtosis, Jarque-Bera test, autocorrelations, as well as median, maximum and minimum premium are shown. All calculations have been based on monthly premiums from January 1990 to December 2005. The portfolios have been rebalanced quarterly.

shows that size and value premiums in Switzerland are time-varying and significant in several subperiods. Market and momentum premiums are by contrast consistently positive for all subperiods analysed.

Earlier research confirms these results. While the market factor is indisputable by taking into account the numbers of Table 2, size, value, and momentum need further assessment. The negative size effect is not in line with the size effect of most other countries that show a significantly positive premium. However, for Switzerland, LIEW and VASSALOU (2000) find a premium of –4.13% p.a. from 1986 to 1996, based on a quarterly rebalancing and a small sample divided into 27 subportfolios from (3x3x3) sequential sorts. This result is not significantly different from zero, either. This confirms our results, and even more so if we compare them with the early subperiods of this study in Table 4. Further support

Table 4: Premiums of the Swiss Factors for Different Subperiods Based on Quarterly Rebalancing

Subperiod	RMRF	SMB	HML	UMD
Subperiods of 4 years				
1990–1993	4.62%	–7.47%*	7.03%**	13.80%***
1994–1997	15.16%**	–4.37%	–1.76%	3.78%
1998–2001	2.28%	4.80%	–3.99%	10.64%**
2002–2005	6.58%	4.36%	8.10%***	13.09%*
Subperiods of 8 years				
1990–1997	9.89%**	–5.92%**	2.64%	8.79%***
1998–2005	4.43%	4.58%*	2.05%	11.87%**

Table 4 shows for different subperiods the annualized Swiss premiums of the four Carhart factors RMRF (Market factor, excess return of the market over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). All calculations have been based on monthly premiums from January 1990 to December 2005. The portfolios have been rebalanced quarterly. *, ** and *** stand for significance at the 10%-, 5%-, and 1%-Level.

comes from Arshanapalli, Coggin, Doukas, and Shea (1998), who find a Swiss size premium of –2.37% p.a. from 1975–1996 and of as much as –7.41% p.a. for the subperiod of 1990–1996.[18] However, these results have been calculated without controlling the value and momentum effects. In sum, the magnitude of the size premium is in line with the results of other studies.

A look at the value premium in other studies shows a broad range of findings, resulting from research on different time periods. It ranges from of 8.66% p.a. (1986 to 1996) in Liew and Vassalou (2000) to 3.7% p.a. (1981 to 1992) in Capaul, Rowley, and Sharpe (1993), 3.49% p.a. (1975 to 1995) in Fama and French (1998), and 2.67% p.a. (1975 to 1995) in Arshanapalli, Coggin, and Doukas (1998). The premiums in the latter three papers are not isolated from size and momentum effects and result from a comparably small sample of companies. It must additionally be considered that the time frames are different. Although the premium in Liew and Vassalou (2000) is considerably larger

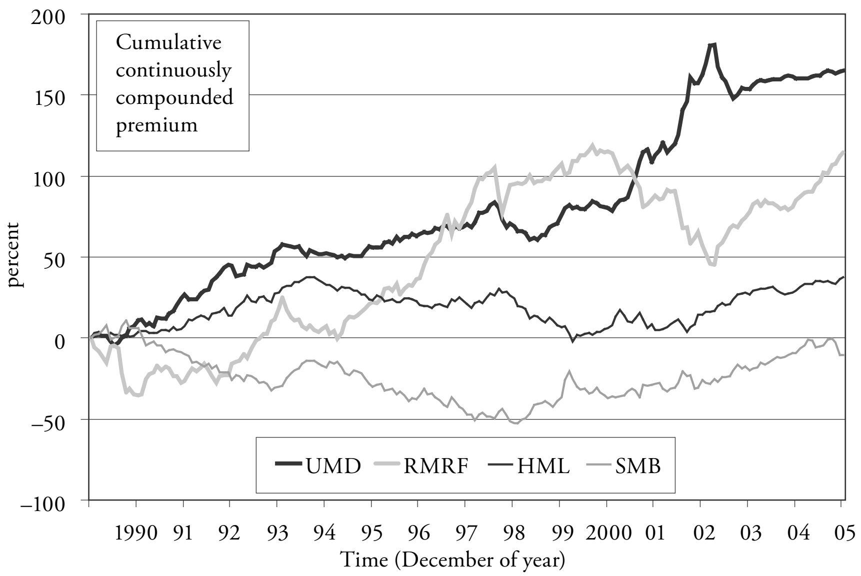
18 From 1990–1996, the premium in this study is –5.09%.

than the average value premium of 2.35% p.a. in this paper, this does not contradict our results as calculation methods and time periods are different. For the 4-year subperiod from 1990–1993, which was included in most of the mentioned studies and described in Table 4, the premium in this paper is as high as 7.03% p.a. and positive in every year. Consequently, our value premium shows a reasonable magnitude.

Through the literature, the validity of the momentum premium of 10.33% is confirmed as well: ROUWENHORST (1998) shows an effect of 7.7% p.a. from 1980 to 1995, without, however, controlling for size or book-to-market. LIEW and VASSALOU (2000) find 9.01% p.a. from 1986 to 1996.

Finally, Graph 1 visualizes the cumulative premiums of the four factors RMRF, SMB, HML, and UMD from 1990 to 2005. Graph 2 (pp. 16 f.) shows the four premiums with 95% confidence bounds, calculated by means of a Monte Carlo simulation. From this point of view, the main results become apparent again: The momentum effect has the highest premium and is significantly different from zero, the market premium has the highest volatility, and the sign of the premiums can vary considerably over time.

Graph 1: Cumulative Premiums of the Four Swiss Factors



The correlations between the factors become important for a potential use in a multifactor regression model. Low correlations improve the quality of the model by preventing the model from multicolinearity.[19] Table 5 shows the correlations between the four factors. These results confirm the construction methodology of the mimicking portfolios of SMB, HML, and UMD as most cross-correlations are close to zero. The results indicate that size, value, and momentum effects can be isolated properly from each other by the construction from 8 subportfolios. However, the only one of the six cross-correlations that raises additional questions due to its magnitude is the one between the market and the size factor of –0.57. This issue will be addressed later in this paper. Nevertheless, this high negative correlation is not surprising, as SMB is by definition short the large capitalization stocks that dominate the value-weighted market factor RMRF.

Table 5: Correlations of Monthly Premiums of the Swiss Factors

	RMRF	SMB	HML	UMD
RMRF	1.00	–0.57	–0.14	–0.28
SMB	–0.57	1.00	–0.04	0.08
HML	–0.14	–0.04	1.00	–0.01
UMD	–0.28	0.08	–0.01	1.00

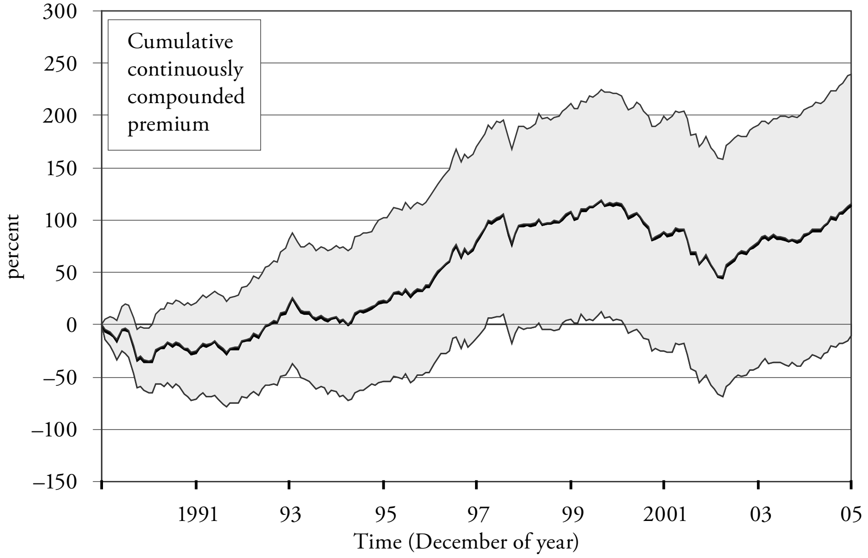
Table 5 shows the correlations of the Swiss premiums of the four Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). All calculations have been based on monthly premiums from January 1990 to December 2005. The portfolios have been rebalanced quarterly.

The comparison of these factor correlations with the six cross-correlations obtained by Carhart (1997) for the four US factors from 1963 to 1993 further confirms the validity. Four out of the six cross-correlations in the Swiss factor model are smaller than the respective ones obtained by Carhart (1997) for the US factor model. The same is true for the average correlation calculated from the absolute values of the six correlations. Only the correlations of the market factor

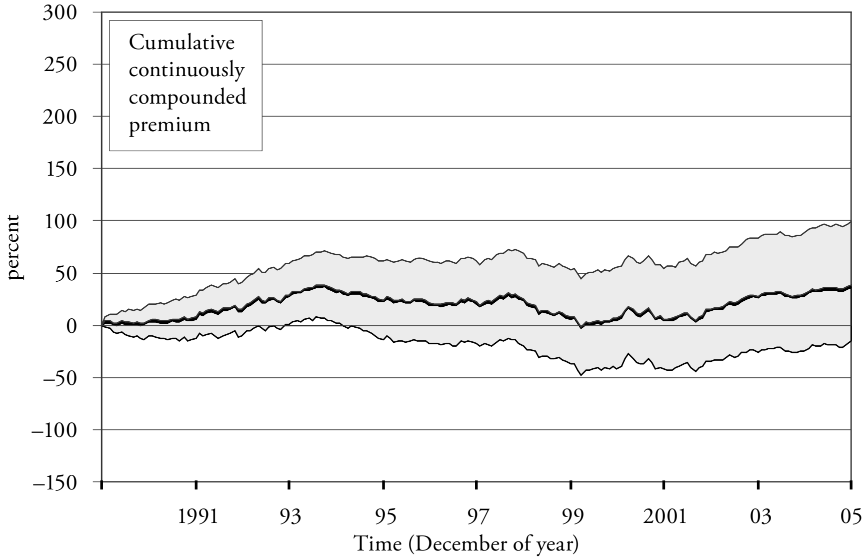
19 See also Carhart (1997).

Graph 2: Cumulative Premiums and 95% Confidence Bounds (Confidence Bounds are Based on a Monte-Carlo-Simulation with 1000 Paths per Factor)

Panel 1: Market Premium RMRF

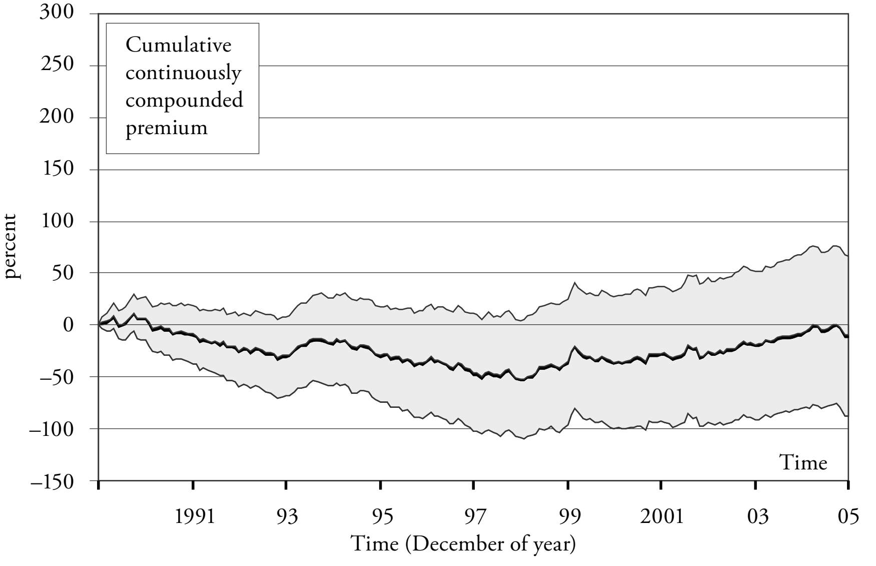


Panel 2: Value Premium HML

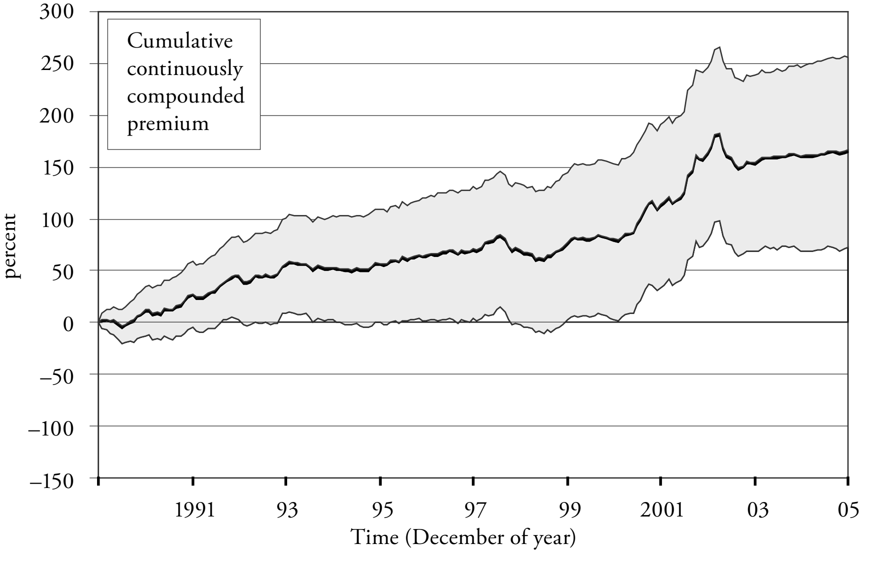


Graph 2 (continued)

Panel 3: Size Premium SMB



Panel 4: Momentum Premium UMD



with the size factor SMB and the momentum factor UMD are higher. Qualitatively, the same is true if we compare our results to CHAN, KARCESKI, and LAKONISHOK (1998), presenting as well the cross-correlations of various US factors. All reported correlations[20] are higher than the ones in this paper, with a correlation of as much as –0.67 between the market and the size factor.

4.2 Robustness

One important question for the use and the deeper understanding of these premiums is whether the results presented above are sensitive to the key assumptions about the construction of the factors. This is even more essential because there are questions about, for example, the negative average size premium, the high kurtosis of the momentum factor, and the high negative correlation between the market and the size factor.

The robustness of the results will be tested with respect to various assumptions. First, the chosen rebalancing horizon of three months could potentially have an influence on the results. Second, the inclusion of micro caps could bias the findings through inefficiencies in the market microstructure such as the bid-ask spread. Third, the construction of the factors from 8 subportfolios is different from the approach of FAMA and FRENCH (1993) and LIEW and VASSALOU (2000). Therefore, the results of alternative approaches will be investigated. Fourth, the comparison of the chosen value-weighted with the equally-weighted building method is interesting in the light of a potential reduction of the correlations. Fifth, an outlier analysis will examine the sensitivity of the descriptive statistics to the tails of the distributions. Last, this subchapter will conclude with a study of the influence of the January effect on the market, size, value, and momentum premiums.

The first analysis is about different rebalancing periods. Instead of a quarterly rebalancing, the factors could also be constructed with a shorter or a longer rebalancing period. In addition to the standard case of a quarterly adjustment, Table 6 (p. 20) shows the descriptive statistics for a monthly, semi-annual and annual rebalancing.

The results from a monthly rebalancing are almost the same. Surprisingly, the average factor premiums become even slightly less pronounced. This shows that there is no reason to apply a shorter rebalancing horizon. Although a more frequent rebalancing would make the factors theoretically more accurate, this

20 The correlation between RMRF and UMD is not reported in CHAN, KARCESKI, and LAKONISHOK (1998).

approach is not realistic in practice due to transaction costs, which would increase dramatically.[21] A semi-annual or annual rebalancing is methodologically less appealing in comparison to the quarterly period, as they use less current information. Table 6 confirms that the results are qualitatively the same. However, the size factor shows a slightly different result for the annual rebalancing. Although still not significantly different from zero, the average size premium gets positive. However, both the value and momentum premium decrease considerably, which shows that the quarterly rebalancing is a good assumption as it pronounces stronger the factor characteristics. The justification of the use of a quarterly rebalancing is also shown by the high correlations of the factors constructed for different rebalancing horizons in Table 7 (p. 21). In sum, Tables 6 and 7 show that the results are robust to a variation in the rebalancing frequency. Therefore, the application of the theoretically most appealing solution of a quarterly rebalancing is reasonable.

One other important issue is to test whether the results are sensitive to the inclusion of all companies, as the data used for the smallest of the companies could potentially be biased. From a theoretical point of view, there are several reasons to use all listed companies: The most important one is that the number of companies in Switzerland is comparably small. Consequently, there should be a strong effort to include as many companies as possible in the analysis. A higher number of companies per subportfolio increases the reliability of the results and decreases the security-specific variation in premiums.

Tables 8 and 9 (pp. 23 f.) show that the results have not changed substantially after the exclusion of the smallest companies. In the first scenario of Tables 8 and 9, all companies with a market capitalization smaller than CHF 50 million (approximately 13%) and in the second, all companies with a market capitalization smaller than CHF 200 million (approximately 37%) have been excluded.[22] The signs and the magnitude of the premiums remain the same for all three scenarios, however, SMB and HML tend to be a little more pronounced and UMD a little less so. The stability of the results is also confirmed by Table 9, which shows the high correlations between the calculated premiums of a factor from different scenarios. There is no reason to set aside some companies. In other words, the presented Swiss factor premiums are also robust to the inclusion or exclusion of the smallest companies.

21 See for example Yu (2002).

22 The levels of CHF 50 and 200 million were an arbitrary choice, but they fulfil well the goal of showing different scenarios of exclusionary criteria by market capitalization.

Table 6: Premiums of the Swiss Factors for Different Rebalancing Horizons

		RMRF	SMB	HML	UMD
Monthly rebalancing	Average premium	7.22%	–0.63%	2.18%	9.39%
	Standard deviation	16.30%	9.70%	7.41%	12.17%
	t-statistic	1.77	–0.26	1.18	3.09
	Skewness	–0.90	–0.04	0.17	0.50
	Kurtosis	1.91	1.06	0.38	4.67
	Autocorrelation (1 month)	0.17	0.03	0.04	0.26
	Correlation to RMRF	1.00	–0.55	–0.14	–0.32
Quarterly rebalancing	Average premium	7.16%	–0.67%	2.35%	10.33%
	Standard deviation	16.41%	9.92%	7.48%	11.58%
	t-statistic	1.75	–0.27	1.26	3.57
	Skewness	–0.89	0.04	–0.08	0.40
	Kurtosis	1.79	0.97	0.18	4.86
	Autocorrelation (1 month)	0.17	0.05	0.07	0.29
	Correlation to RMRF	1.00	–0.57	–0.14	–0.28
Semi-annual rebalancing	Average premium	7.50%	–0.27%	2.66%	10.01%
	Standard deviation	16.62%	9.74%	7.63%	12.15%
	t-statistic	1.80	–0.11	1.39	3.29
	Skewness	–0.84	0.21	–0.25	–0.12
	Kurtosis	1.73	0.78	0.19	6.60
	Autocorrelation (1 month)	0.16	0.01	0.19	0.20
	Correlation to RMRF	1.00	–0.60	–0.21	–0.29
Annual rebalancing	Average premium	7.06%	0.73%	0.80%	6.44%
	Standard deviation	16.72%	10.03%	8.03%	11.21%
	t-statistic	1.69	0.29	0.40	2.30
	Skewness	–0.83	0.39	–0.02	–0.27
	Kurtosis	1.56	1.18	0.25	6.84
	Autocorrelation (1 month)	0.17	0.04	0.20	0.20
	Correlation to RMRF	1.00	–0.60	–0.17	–0.34

Table 6 shows the robustness of the premiums to the rebalancing horizon. In this regard, for a monthly, quarterly, semi-annual and annual rebalancing the annualized Swiss premiums of the four Carhart factors RMRF (Market factor, excess return of the “market” from the database over the CHF call money rate), SMB (Size factor “Small Minus Big”, zero-investment factor mimicking portfolio for market capitalization), HML (Value factor “High Minus Low”, zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor “Up Minus Down”, zero-investment factor mimicking portfolio for one-year past return) are presented. Additionally, standard deviation, t-statistic, skewness, kurtosis, autocorrelation and correlation to the factor RMRF are shown. All calculations have been based on monthly premiums from January 1990 to December 2005.

Table 7: Correlations of the Swiss Factor Premiums from Different Rebalancing Horizons

	$RMRF_{1M}$	$RMRF_{3M}$	$RMRF_{6M}$	$RMRF_{12M}$
$RMRF_{1M}$	1.00	1.00	1.00	0.99
$RMRF_{3M}$	1.00	1.00	1.00	1.00
$RMRF_{6M}$	1.00	1.00	1.00	1.00
$RMRF_{12M}$	0.99	1.00	1.00	1.00
	SMB_{1M}	SMB_{3M}	SMB_{6M}	SMB_{12M}
SMB_{1M}	1.00	0.95	0.92	0.88
SMB_{3M}	0.95	1.00	0.95	0.90
SMB_{6M}	0.92	0.95	1.00	0.93
SMB_{12M}	0.88	0.90	0.93	1.00
	HML_{1M}	HML_{3M}	HML_{6M}	HML_{12M}
HML_{1M}	1.00	0.91	0.80	0.73
HML_{3M}	0.91	1.00	0.86	0.75
HML_{6M}	0.80	0.86	1.00	0.85
HML_{12M}	0.73	0.75	0.85	1.00
	UMD_{1M}	UMD_{3M}	UMD_{6M}	UMD_{12M}
UMD_{1M}	1.00	0.88	0.85	0.72
UMD_{3M}	0.88	1.00	0.87	0.76
UMD_{6M}	0.85	0.87	1.00	0.86
UMD_{12M}	0.72	0.76	0.86	1.00

Table 7 analyses the robustness of the results by means of the correlations between the calculated premiums of a factor for different (monthly, quarterly, semi-annual and annual) rebalancing horizons. The premiums analysed are from the four Swiss Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). The index of the factor describes the rebalancing horizon in months. All calculations have been based on monthly premiums from January 1990 to December 2005.

The earlier discussion of the use of 8 subportfolios from 3 independent sorts made clear that the use of 12 or 27 subportfolios is not applicable for the Swiss stock market. Nonetheless, we tested these two alternative construction methodologies as well. The details of this analysis are not reported here, but are available from the authors on request. The construction from 12 shows almost the same results as from 8 subportfolios. The construction from 27 subportfolios, on the other hand, changes three aspects in comparison with the standard approach. First, the size premium changes to a positive sign. Second, the average momentum premium increases from 10.33% p.a. to 14.77% p.a. Third, all volatilities of the premiums increase. These results are not surprising, as the size premium is still not significantly different from zero. The increase of the standard deviation was expected as a result of the small number of stocks in the single subportfolios and the related security-specific volatility. The increase of the UMD premium also fulfils expectations because the use of three independent sorts normally results in a higher pronunciation of the premiums in comparison with 2 sorts.

One observation from all the alternative construction methodologies analysed so far is that none of them could substantially reduce the highly negative correlation between market and size premiums of –0.57. An alternative that has the potential to do so is the equally weighted construction of the factors. Although value-weighted portfolios are more desirable from a practical point of view, as they are investable and therefore closer to reality, there is also an argument favouring an equally-weighted approach: This approach pronounces more the factor characteristics themselves. The equally-weighted approach is less prone to the domination by a few large capitalized stocks. However, our analysis shows that the premiums are comparable for the value- and the equally-weighted method. The correlations do not decrease substantially. For the realistic case of a value-weighted market factor and equally-weighted size, value, and momentum factors, the correlations are almost the same or even somewhat higher than for the construction from value-weighted factors.[23] This shows that the results are robust to the weighting scheme and that there is no benefit from employing an equally-weighted methodology with respect to a lower correlation between RMRF and SMB. The details of the analysis dealing with equally- and value-weighted factors are not reported here, but are available from the authors on request.

Another observation that needs further investigation is that the distributions of the premiums are skewed and fat-tailed for various factors, most importantly for

23 The use of an equally-weighted market factor decreases the correlation between RMRF and SMB to –0.40, but marginally increases all the others. This is not a substantial improvement. Furthermore, an equally-weighted market factor is not practical.

Table 8: Premiums of the Swiss Factors **Calculated from Databases Excluding Different Size Groups**

		RMRF	SMB	HML	UMD
Full sample	Average premium	7.16%	–0.67%	2.35%	10.33%
	Standard deviation	16.41%	9.92%	7.48%	11.58%
	t-statistic	1.75	–0.27	1.26	3.57
	Skewness	–0.89	0.04	–0.08	0.40
	Kurtosis	1.79	0.97	0.18	4.86
	Autocorrelation (1 month)	0.17	0.05	0.07	0.29
	Correlation to RMRF	1.00	–0.57	–0.14	–0.28
Exclusion of Micro Caps	Average premium	7.17%	–0.85%	3.08%	10.51%
	Standard deviation	16.42%	9.73%	7.36%	11.82%
	t-statistic	1.75	–0.35	1.67	3.56
	Skewness	–0.89	–0.15	–0.04	0.41
	Kurtosis	1.79	0.84	–0.17	4.38
	Autocorrelation (1 month)	0.17	0.13	0.09	0.31
	Correlation to RMRF	1.00	–0.54	–0.14	–0.29
Exclusion of Small Caps	Average premium	7.22%	–1.40%	2.99%	8.99%
	Standard deviation	16.48%	9.65%	8.18%	11.42%
	t-statistic	1.75	–0.58	1.46	3.15
	Skewness	–0.88	0.15	–0.23	0.32
	Kurtosis	1.78	1.12	0.46	3.17
	Autocorrelation (1 month)	0.17	0.08	0.01	0.27
	Correlation to RMRF	1.00	–0.48	–0.12	–0.28

Table 8 shows the robustness of the premiums to the in- and exclusion of micro and small caps. In this paper, micro caps are defined as companies with a market capitalization of <CHF 50 mio. (which holds for approximately 13% of full sample), small caps of <CHF 200 mio. (which holds for approximately 37% of full sample). Annualized premiums of the four Swiss Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return) are presented. Additionally, the standard deviation, t-statistic, skewness, kurtosis, autocorrelation and the correlation to the factor RMRF are shown. All calculations have been based on monthly premiums from January 1990 to December 2005 and on quarterly rebalancing.

Table 9: Correlations of the Swiss Factor Premiums Calculated from Databases Excluding Different Size Groups

	$RMRF_{Full}$	$RMRF_{exMicro}$	$RMRF_{exSmall}$
$RMRF_{Full}$	1.00	1.00	1.00
$RMRF_{exMicro}$	1.00	1.00	1.00
$RMRF_{exSmall}$	1.00	1.00	1.00
	SMB_{Full}	$SMB_{exMicro}$	$SMB_{exSmall}$
SMB_{Full}	1.00	0.94	0.78
$SMB_{exMicro}$	0.94	1.00	0.85
$SMB_{exSmall}$	0.78	0.85	1.00
	HML_{Full}	$HML_{exMicro}$	$HML_{exSmall}$
HML_{Full}	1.00	0.93	0.78
$HML_{exMicro}$	0.93	1.00	0.85
$HML_{exSmall}$	0.78	0.85	1.00
	UMD_{Full}	$UMD_{exMicro}$	$UMD_{exSmall}$
UMD_{Full}	1.00	0.97	0.90
$UMD_{exMicro}$	0.97	1.00	0.94
$UMD_{exSmall}$	0.90	0.94	1.00

Table 9 analyses the robustness of the results by means of the correlations between the calculated premiums of a factor for different sample definitions (full sample, sample with exclusion of micro caps, sample with exclusion of small caps). In this paper, micro caps are defined as companies with a market capitalization of <CHF 50 mio. (which holds for approximately 13% of full sample), small caps of <CHF 200 mio. (which holds for approximately 37% of full sample).The premiums analysed are from the four Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). The index of the factor describes which database has been used. All calculations have been based on monthly premiums from January 1990 to December 2005 and on quarterly rebalancing.

the market and the momentum factor. Whether these characteristics are responsible for the significance of the results will be tested by analysing the influence of the outliers on the results. This is evaluated by comparing the main findings to distributions resulting from an elimination of the outliers at the 1%-, 5%- and 10%-levels. Table 10 (p. 26) shows the resulting descriptive statistics for the distributions that lack the respective tails. Most importantly, the statistics confirm earlier findings that in Switzerland, the market and momentum premiums are significantly positive and the size premium is negative. The positive value premium becomes significant even for the scenario of outlier elimination at the 10% level. This shows that the premiums do not result from outliers.

Last but not least, the influence of the January effect on the factors must be clarified. L'Her, Masmoudi, and Suret (2003) as well as Hawawini and Keim (1998) discuss this issue extensively. Chan, Karceski, and Lakonishok (1998), Drew and Veeraraghavan (2002), and many others find that the factors are stronger in January than in the other months. Whether this is also true for Switzerland may be seen in Table 11 (p. 27). It becomes clear that the January effect is strong for the SMB and HML and not observable for the RMRF and UMD premiums. This means that in the Swiss stock market, the size and the value premiums are influenced by the January effect. In January, the premiums are significantly positive, but in the other months they are not significantly different from zero. This finding, however, has to be interpreted with care as there are only 16 observations. Although the January effect detected does not question earlier findings it may be an important insight for the application of the Swiss Carhart model to time-series regressions. The explanatory power of the model could potentially be increased by the use of a January dummy.

In summary, this section shows that the factors are robust to the key assumptions of the construction methodology. A change in the rebalancing horizon, the exclusion of small capitalization stocks, the use of more subportfolios, the application of an equally-weighted factor construction, or the elimination of outliers all do not affect the characteristics of the premiums substantially. The results are confirmed by the robustness tests. Finally, the January effect detected in the SMB and HML premiums could help to increase the explanatory power of the Swiss Carhart model in a time-series regression. Whether this is true will be tested later in this paper. Before doing so, we will compare our results to US premiums.

Table 10: Premiums of the Swiss Factors for Different Levels of Outlier-Elimination

		RMRF	SMB	HML	UMD
Full sample	Average premium	7.16%	–0.67%	2.35%	10.33%
	Standard deviation	16.41%	9.92%	7.48%	11.58%
	t-statistic	1.75	–0.27	1.26	3.57
	Skewness	–0.89	0.04	–0.08	0.40
	Kurtosis	1.79	0.97	0.18	4.86
	Jarque-Bera	50.86	7.65	0.49	194.11
Elimination of outliers at 1%-level	Average premium	7.69%	–0.77%	2.37%	10.32%
	Standard deviation	15.56%	9.36%	7.20%	10.42%
	t-statistic	1.98	–0.33	1.32	3.96
	Skewness	–0.75	–0.06	–0.07	0.54
	Kurtosis	1.12	0.25	–0.05	3.12
	Jarque-Bera	27.49	0.62	0.17	86.26
Elimination of outliers at 5%-level	Average premium	8.81%	–0.74%	2.44%	9.77%
	Standard deviation	13.38%	8.18%	6.42%	8.25%
	t-statistic	2.63	–0.36	1.52	4.73
	Skewness	–0.60	–0.03	–0.05	0.01
	Kurtosis	0.34	–0.63	–0.40	0.29
	Jarque-Bera	11.97	3.01	1.31	0.64
Elimination of outliers at 10%-level	Average premium	10.51%	–1.23%	2.82%	9.61%
	Standard deviation	11.58%	7.48%	5.77%	7.16%
	t-statistic	3.63	–0.66	1.96	5.37
	Skewness	–0.37	–0.15	0.05	0.14
	Kurtosis	–0.37	–0.77	–0.63	–0.35
	Jarque-Bera	5.02	4.88	2.96	1.48

Table 10 shows the robustness of the average premiums to outliers. In this regard, for a 1%-, 5%- and 10%-level half of this number has been eliminated on both tails of the distribution (e.g. for 192 observations and an elimination of outliers at the 5%-level, the 5 highest and the 5 lowest observations have been eliminated). Annualized premiums of the four Swiss Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return) are presented. Additionally, standard deviation, t-statistic, skewness, kurtosis and Jarque-Bera test are shown. All calculations have been based on monthly premiums from January 1990 to December 2005 and on quarterly rebalancing.

Table 11: January Seasonality of the Premiums in the Swiss Factors

		RMRF	SMB	HML	UMD
Full sample	Monthly average premium	0.60%	–0.06%	0.20%	0.86%
	Monthly standard deviation	4.74%	2.86%	2.16%	3.34%
	t-statistic	1.75	–0.27	1.26	3.57
	Skewness	–0.89	0.04	–0.08	0.40
	Kurtosis	1.79	0.97	0.18	4.86
January	Monthly average premium	0.50%	1.37%	1.27%	0.33%
	Monthly standard deviation	4.48%	3.22%	2.44%	3.17%
	t-statistic	0.45	1.70	2.09	0.41
	Skewness	–0.01	1.23	–0.80	–0.23
	Kurtosis	–1.01	3.60	0.53	0.56
February–December	Monthly average premium	0.61%	–0.19%	0.10%	0.91%
	Monthly standard deviation	4.77%	2.80%	2.11%	3.36%
	t-statistic	1.68	–0.88	0.61	3.59
	Skewness	–0.95	–0.14	–0.05	0.44
	Kurtosis	1.98	0.47	0.34	5.15

Table 11 shows the robustness of the premiums to the January effect by presenting average premiums for January alone and for all other months. Monthly premiums of the four Swiss Carhart factors RMRF (Market factor, excess return of the "market" from the database over the CHF call money rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return) are presented. Additionally, standard deviation, t-statistic, skewness and kurtosis are shown. All calculations have been based on monthly premiums from January 1990 to December 2005 and on quarterly rebalancing. The numbers for the month January have to be interpreted with care as they resulted from only 16 observations.

4.3 Comparison to US Premiums

We aim to gain some more insights on the validity of the Swiss premiums with the following comparison to an international dataset. For this purpose, the highly recognized and often applied US premiums provided by Kenneth French on his homepage are used as reference. To make the descriptive statistics comparable, the premiums in Table 12 are also calculated on a monthly basis from January 1990 to December 2005.

Table 12: Premiums of the US Factors

	$RMRF_{US}$	SMB_{US}	HML_{US}	UMD_{US}
Average premium (annualized)	7.17%	2.32%	4.35%	10.92%
Standard deviation (annualized)	14.66%	12.91%	11.89%	16.79%
t-statistic	1.96	0.72	1.46	2.60
Skewness	–0.65	0.80	0.13	–0.70
Kurtosis	0.93	7.50	2.63	5.63
Jarque-Bera	20.61	470.86	55.73	269.19
Autocorrelation (1 month)	0.02	–0.04	0.10	–0.05
Autocorrelation (2 months)	–0.02	0.02	0.06	–0.06
Average monthly premium	0.60%	0.19%	0.36%	0.91%
Median monthly premium	1.04%	0.12%	0.33%	1.23%
Maximum monthly premium	10.30%	21.87%	13.71%	18.40%
Minimum monthly premium	–16.20%	–16.58%	–12.66%	–25.05%

Table 12 shows the descriptive statistics for the US premiums of the four Carhart factors RMRF (Market factor, excess return of the US market), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). Additionally, the standard deviation, t-statistic, skewness, kurtosis, Jarque-Bera test, autocorrelations, as well as median, maximum and minimum premiums are shown. The premiums have been taken from the homepage of Prof. Kenneth French. All calculations have been based on monthly premiums from January 1990 to December 2005.

Many analogies with the Swiss premiums in Table 3 may be found by looking at Table 12. The market premiums are similar, with a slightly higher standard deviation of the Swiss premium. The momentum premiums also have the same magnitude and are the largest ones in both markets. In accordance with the Swiss premiums, SMB_{US} and HML_{US} are both not significantly different from zero, although the value premium is somewhat larger in the US than in Switzerland and the US size premium – also the least pronounced – is positive. The standard deviations of the size, value, and momentum premiums in the US are up to 5%-points larger than in Switzerland, showing that the monthly Swiss premiums are more stable than their US counterparts. This evidence supports the Swiss factors observed in this study, as the US-factors show average descriptive statistics that are quite similar to the Swiss factors presented in this paper.

Table 13 presents the national and international cross-correlations of the Swiss and US factors. It shows that the correlation of –0.57 between the Swiss market and size factors is of similar magnitude as the correlation between $RMRF_{US}$ and HML_{US} of –0.50 or between SMB_{US} and HML_{US} of –0.45. In addition, the broadly applied US factors have higher average cross-correlations than the Swiss factors. For these reasons, the Swiss factors are confirmed from this perspective as well.

Table 13: Correlations of Monthly Premiums of the Swiss and the US Factors

	$RMRF_{CH}$	SMB_{CH}	HML_{CH}	UMD_{CH}	$RMRF_{US}$	SMB_{US}	HML_{US}	UMD_{US}
$RMRF_{CH}$	1.00							
SMB_{CH}	–0.57	1.00						
HML_{CH}	–0.14	–0.04	1.00					
UMD_{CH}	–0.28	0.08	–0.01	1.00				
$RMRF_{US}$	0.68	–0.34	–0.20	–0.33	1.00			
SMB_{US}	0.04	0.20	0.00	–0.05	0.21	1.00		
HML_{US}	–0.12	–0.06	0.32	0.00	–0.50	–0.45	1.00	
UMD_{US}	–0.19	0.13	–0.08	0.38	–0.18	0.12	–0.05	1.00

Table 13 shows the correlations of the Swiss and the US premiums of the four Carhart factors RMRF (Market factor, excess return of the market over the risk-free rate), SMB (Size factor "Small Minus Big", zero-investment factor mimicking portfolio for market capitalization), HML (Value factor "High Minus Low", zero-investment factor mimicking portfolio for book-to-market) and UMD (Momentum factor "Up Minus Down", zero-investment factor mimicking portfolio for one-year past return). The indices CH and US mark Swiss- and US-factors respectively. All US factor premiums are from the homepage of Kenneth French. All Swiss factor premiums are calculated as described in this paper. The correlations have been calculated from monthly premiums from January 1990 to December 2005.

A look at the correlation between US and Swiss factors in Table 13 confirms earlier international findings. The two market factors are strongly correlated, but the size, value, and momentum factors have low correlations. This shows that the Swiss factors contain information on the Swiss market not included in the US-factors. This structure is in accordance with FAMA and FRENCH (1998) and GRIFFIN (2002). They also find that size, value, and momentum factors are country-specific. Not global, but local forces determine the time-series of the factors. It may be therefore concluded that the presented Swiss factors have a high relevance for further research in the Swiss stock market and may not be replaced by US-factors. Supported by these results, we will test the explanatory power of the Swiss Carhart factors in the following section.

4.4 Explanatory Power

The four Swiss Carhart factors developed in this paper show reasonable characteristics, are robust to the key assumptions and are validated by various tests. The only missing validation is to investigate their explanatory power for Swiss portfolio returns. This will be tested by regressing the excess returns of the eight size-, value-, and momentum-sorted subportfolios on the premiums of the four factors RMRF, SMB, HML, and UMD. The subportfolios are optimal testing portfolios because they are sufficiently diversified and differentiated with respect to the characteristics in focus. This approach is in accordance with that of FAMA and FRENCH (1993), DANIEL and TITMAN (1997), DREW and VEERARAGHAVAN (2002), GRIFFIN (2002), VAIHEKOSKI (2004), PETKOVA (2006), and others.

The constant, the factor loadings, and the adjusted R^2 of these regressions are presented in Table 14. These results show that the Swiss Carhart factors have high explanatory power, as the adjusted R^2 are all between 0.69 and 0.93, with half of them equal to or higher than 0.86. Every single element of the model is important as well, as proven by the highly significant factor loadings. The SMB-factor loadings are positive and highly significant for portfolios with small capitalization stocks, but small or even negative for the others. The same differentiation is true for high and low book-to-market and high and low momentum portfolios. Finally, the constant c is not significantly different from zero in seven out of eight regressions, which is another sign for a good model specification. In sum, the Swiss Carhart factors as defined in this paper perform well in jointly explaining Swiss stock returns.

Different versions of this model are also tested after including a dummy variable for the January effect. This takes into account that a January effect has been detected in the Swiss size and value premiums. However, the quality of the model does not increase. The results not reported here show lower adjusted R^2 persistently.

Table 14: Explanatory Power of the Factors with Respect to the Returns of the Eight Subportfolios

Subportfolio	c	b	s	v	m	adj. R^2
S/H/U	0.001 (0.42)	0.984 (29.32)	1.010 (19.10)	0.834 (14.39)	0.291 (7.58)	0.83
S/H/D	–0.001 (–1.17)	1.005 (32.19)	0.995 (20.21)	0.946 (17.55)	–0.618 (–17.31)	0.91
S/L/U	0.002 (1.06)	1.034 (20.32)	1.046 (13.05)	0.139 (1.58)	0.275 (4.72)	0.69
S/L/D	–0.003 (–1.30)	1.049 (19.48)	1.166 (13.74)	–0.146 (–1.57)	–0.685 (–11.12)	0.79
B/H/U	–0.002 (–0.75)	0.990 (17.46)	0.094 (1.06)	0.851 (8.69)	0.370 (5.71)	0.71
B/H/D	0.001 (0.54)	1.092 (22.43)	0.118 (1.53)	1.142 (13.58)	–0.780 (–14.01)	0.87
B/L/U	–0.002 (–2.40)	1.064 (39.94)	0.066 (1.57)	–0.051 (–1.10)	0.327 (10.73)	0.93
B/L/D	0.002 (0.93)	0.925 (20.88)	–0.061 (–0.87)	–0.169 (–2.21)	–0.654 (–12.91)	0.86

Table 14 shows the estimates of constants, factor loadings and adjusted R-squares from regressions of the excess returns of the eight subportfolios on the Swiss Carhart factor premiums. The estimates are based on the linear regression model

$$R_{Subportfolio,t} - RF_t = c_T + b_T RMRF_t + s_T SMB_t + v_T HML_t + m_T UMD_t + e_t$$

where $R_{Subportfolio,t}$ is the return of the subportfolio at time t, RF_t is the CHF call money rate at time t, c_T is a constant over the whole time period T, $RMRF_t$ is the excess return of the market portfolio from the database over the CHF call money rate at time t, SMB_t, HML_t and UMD_t are the Swiss zero-investment factor mimicking portfolios for size, value and momentum at time t and b_T, s_T, v_T and m_T are the factor loadings over the whole time period T for the respective factors and e_t is the error term at time t. The Swiss factors are constructed as described in this paper. All estimates have been based on monthly data from January 1990 to December 2005 (192 months).

5. Conclusion

CARHART (1995) applies an extension of the CAPM to performance evaluation, taking into account not only the market factor, but also mimicking portfolios for the size, value, and momentum effect. Although this model has become highly recognized and is broadly applied in financial research, no such risk factors existed for the Swiss stock market so far. This paper fills this gap by developing these Switzerland-specific risk factors from a comprehensive sample, taking into account several local characteristics, such as the relatively small number of stocks in the market.

We find that the market factor has an average premium of 7.16% p.a. Of the three factor-mimicking portfolios for the size, value, and momentum effect, the last one is the most pronounced with an average premium of 10.33% p.a. The value premium has an annualised average of 2.35% and the size premium of –0.67%. While the positive difference from zero is significant for the momentum factor, the average size and value premiums are not significantly different from zero, possibly due to strong time-varying behaviour.

The validation of the factor premiums and the investigation of their robustness is an important prerequisite for future research activities based on these Swiss factors. In this regard, we find low correlations between most factors, both in absolute terms and in comparison to earlier international studies. Additionally, a change in rebalancing horizon, the exclusion of small capitalization stocks, the use of more subportfolios, the application of an equally-weighted factor construction, and the elimination of outliers do not substantially affect the characteristics of the premiums. Furthermore, the results are confirmed by comparisons to the US market and to earlier research. In sum, we show that the Switzerland-specific factor premiums are robust to the key assumptions of the construction methodology.

Finally, we find high explanatory power in a regression of excess portfolio returns on these factors, confirming their relevance to the Swiss stock market.

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SUMMARY

The four risk factors controlling for the market, size, value, and momentum effect have become a state-of-the-art framework for various applications in financial markets research. However, previous work shows that these broadly recognized risk factors are country-specific. For these reasons, this paper develops and analyses these factors for the Swiss stock market from January 1990 to December 2005, building on a high quality dataset and taking into account specific characteristics of the Swiss stock market. We find a negative size premium of –0.67% p.a. and a positive value premium of 2.35% p.a. Both, however, show a time-varying character. The momentum effect is the most pronounced with a premium of 10.33% p.a. The results are robust and validated by a comparison to data from the US. Furthermore, we find that the explanatory power of the factors is high, confirming their relevance to the Swiss stock market.