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Risk and Return of Open-End Real-Estate Funds: The German Case

No. 114
September 2003

WORKING PAPER SERIES: FINANCE & ACCOUNTING

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This Version: Friday, 12 September 2003

No. 114

ISSN 1434-3401

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This article has been developed at *The Research Program for Real Estate Finance*, at the University of Frankfurt/Main. We thank the *German Investment Funds and Asset Management Association* (BVI) for their support in data collection, in addition to that the participants of the 10th ERES Annual Conference in Helsinki for their helpful comments. Opinions remain solely those of the authors.

Abstract

Due to the recent downturn in international equity markets, the interest in real-estate investments has soared. However, the well-known problems of direct real-estate investments complicate becoming well-diversified with this investment class. Indirect real-estate investments can provide a solution to this problem. Shares of real-estate investment companies are very popular in this context. The German market for securitised real-estate investments additionally provides open-ended real-estate funds (so called "Offene Immobilienfonds"). An open-end real-estate fund is a pool of money from many investors, with which a special investment company, acting as a trustee, invests it in real estate. Thus, the individual investors are directly involved in the real-estate market.

This study is based on monthly and yearly return data from January 1975 to December 2002. It seeks to identify the short and long-term financial characteristics of investments into open-ended real-estate funds, and to compare them with those of other major asset classes like bonds, equities, and money market investments. In this sense, the considerations comprise extensive univariate and multivariate analyses of real-estate fund returns. Furthermore, the long-term risk/return profile of real-estate fund investments relative to other investment opportunities is investigated. Additionally, this paper provides a brief overview of the institutional design and role of German open-end real-estate mutual funds.

Empirical evidence suggests that the financial characteristics of open-ended real-estate funds clearly distinguish them from other (financial) asset classes. These characteristics are in many respects similar to those known from direct real-estate investments. Accordingly, the German open-end real-estate funds qualify themselves more for medium and long-term investment horizons, than for short holding periods. All in all, this indirect real-estate investment vehicle is characterised by moderate and relatively stable returns over time.

Key words:

open-end real-estate fund, asset allocation, long-term investments, shortfall risk

1 Introduction

The empirical real-estate literature shows that the return characteristics of property portfolios are significantly different from those of financial assets, like bonds and stocks.[1] Typically, property portfolios have a lower mean return than that of stocks and bonds, but also show a lower volatility and low co-movements with financial asset classes. Furthermore, real-estate returns exhibit significant positive serial correlation, indicating a mean-reverting behaviour over time. Due to these specific risk and return characteristics, property was shown to be beneficial in diversifying multi-asset portfolios. Typically, in portfolio allocation strategies, property primarily plays the role of a "risk stabiliser", while stocks contribute as a "return driver". In addition to its diversification benefits, there is a general belief that investment in real estate is an effective vehicle to insulate the risk of inflationary erosion, which is particularly important for long-term pension investments. However, some adverse features associated with direct ownership may offset the benefits by adding direct property investments into asset allocation strategies. *Ball*, *Lizieri*, and *MacGregor* (1998), *Hoesli* and *MacGregor* (2000), *Seiler*, *Webb*, and *Myer* (2001), among others, pointed out that these problematic features include the following: the large lot size of property investments, the lack of a central market where continuous information on property transaction is provided, high transaction costs, low liquidity, the need for local market knowledge and management requirements of direct property investments.

A potential alternative to avoid the drawbacks of direct property ownership is to purchase units of property companies. The basic idea of such equity-type indirect property vehicles is to pool money by selling shares to many investors and invest it into a portfolio of income-producing properties, such as housing, commercial properties, or both. Investors gain a number of advantages by buying shares of a property company. First, a property investment company may provide investors with economics of scale on transaction and management costs by pooling the assets of many individuals. As unit costs are low compared to direct property ownership, investors are highly flexible to invest part of their wealth into and/or withdraw from real-estate companies, e.g. to accumulate money for future pensions, or to finance consumption during the post-retirement phase. Second, investors are able to enjoy a degree of within-property portfolio diversification, which they could not achieve on their own, due to their low investment budget. Third, property investment companies provide access to and benefit from the expertise of skilled and specialised asset managers, which select and manage the fund's properties. Forth, units of property companies are more liquid than direct holdings, insofar as unit holders can ask for redemption of their holdings to net asset value prices at any point in time (in the case of an open-ended fund), or they can sell them in an active secondary market (in the case of a closed-end fund). Furthermore, investment funds are (if tax credits are provided) regulated by a comprehensive legal framework that is designed to protect investors' rights. Finally, since unit prices are publicly available, indirect real-estate investments heightened the transparency of disclosed information on risk and return. This enables investors to make financial decisions based on comparable information, as with stocks and bonds.

There are also disadvantages that come along with ownership of real-estate investment funds. First, as with any other financial intermediary, there are costs associated with investing

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[1] A recent extensive and systematic review of literature concerning direct and indirect real-estate return properties is provided by *Benjamin*, *Sirmans*, and *Zietz* (2001), which updates previous reviews by *Norman*, *Sirmans*, and *Benjamin* (1995), and *Sirmans* and *Sirmans* (1995).

through investment funds. The fund management charges an investment management fee, and investors must pay to cover the administration cost, e.g. for providing investors with financial statements, and for employing custodial and accounting services. To cover the distribution and sales costs, the investor pays either a front-end load when purchasing, or a back-end load when selling a fund unit. Further transaction costs arise in connection with the purchase and the sale of properties to implement (start-up costs) and to update (turnover costs) the fund's portfolio strategy. Other disadvantages with indirect property investment can be caused by taxation, especially for tax-exempt investors like pension funds, if real-estate investment funds are not fully tax-transparent. In addition, there could be a lack of management control, since it might be difficult for investors to get full information on the property assets and the development schemes of the investment fund. Finally, the critical question, whether the returns of these financial claims "backed" by real estate-related assets behave like direct property investments or whether they are another type of stock, has been the centrepiece of numerous empirical studies.

Most of the empirical work addressing this question has focused on the risk and return characteristics of closed-end real-estate funds, whose units are traded on an active secondary market. Such an indirect investment vehicle issues a fixed number of shares, usually leverage the position of the common shareholders by issuing debt, and must not follow the principle of diversification due to financial regulation. If the funds enjoyed favourable tax treatments, tax authorities would require special conditions, i.e. number of shareholders, composition of the real-estate portfolios, or income-distribution to shareholders among others. Investors who are simultaneously shareholders of the investment company do not have the right to redeem their units to the fund company. Instead, shareholders must sell them on a secondary market. The price of a closed-end share is thus determined by supply and demand and can fall below, or rise above, the net asset value per share. Particularly for listed Real-Estate Investment Trusts (REITs) in the USA, the empirical literature shows that the returns on such shares are highly volatile and exhibit high degrees of correlation with the stock market. In addition, listed property companies are often priced with substantial net asset value discounts. Similar results are reported for traded property companies in the UK, France, and Canada.[2]

Open-end funds, also referred to as mutual funds, do not have a fixed number of outstanding units. Instead, the number of shares changes as the funds continually stand ready to both sell new shares to all kinds of investors, and to redeem old shares on demand from them. While an open-end structure for real-estate funds is an interesting institutional design, the empirical literature is considerably rare. For example, *Hoesli* and *Anderson* (1991) and *Hoesli* (1993) report that Swiss real-estate mutual funds exhibit a lower risk and return than shares, and a higher risk and return than bonds. However, these results are not generally transferable, as the real-estate funds in Switzerland are not obliged to redeem shares at any time. An investor has to announce the redemption of his units twelve months before the end of the fiscal year. To compensate for the disadvantage of the long notification period, the shares are usually quoted at the stock market. Due to the limited redemption possibilities, *Hoesli* (1993) characterised the Swiss real-estate funds as "semi-closed-end".

In this study, we focus on German open-end real-estate funds, which are important indirect property investment vehicles in the German capital market. From the investor's perspective, they are similar to REITs paper assets that are backed by direct properties, tax exempt on the corporate level, and have the possibility to accumulate and/or disperse assets in small lot sizes. However, German real-estate mutual funds exhibit a pure open-end architecture, as the

[2] For example, see *Hoesli* and *MacGregor* (2000, chapter 11).

funds do not have a fixed number of units. While fund units are not traded on a secondary market (e.g. the stock exchange), they are liquid like traded stocks because investors can ask for redemption of their fund units on a daily basis. The unit price is based on the fund's net asset value, which is determined by regular valuations of the properties held by the fund. As a result of this "pricing" based on valuation rather than on a secondary market place, the performance of real-estate mutual funds might be closer to the underlying direct market than listed property company shares, which are exposed to the day-to-day pricing volatility of the stock markets. However, the advantages of an open-end structure for real-estate funds are not without burden. Besides estimating the market value of the fund's properties, which are not directly substantiated by sales, a central point is the appropriate management of long-term illiquid property investments with short-term daily callable liabilities. The solution to these problems might influence the risk and return profiles that investors receive by investing in an open-end real-estate fund.

The remainder of this paper is organised as follows: section 2 describes the institutional design, the regulatory environment, as well as size and role of open-end real-estate funds in the German market. In addition, we examine the ways that German real-estate mutual funds address the structural liquidity mismatch of assets and liabilities. In section 3, we address the short-term risk and return characteristics of real-estate funds employing time series analysis, and compare them with other major asset classes, like money market instruments, bonds, and stocks. In section 4, we analyse the risk and return characteristics of real-estate funds for long-term horizons, which are typical for pension investments. In addition, we examine the question of whether the risk-return characteristics of real-estate mutual funds over different investment horizons can be replicated by using a simple portfolio strategy consisting of cash and bonds. Section 5 offers a summary and the main conclusions.

2 Real-Estate Mutual Funds in Germany

2.1 Size and Role in the Mutual Fund Market

German real-estate mutual funds („Offene Immobilienfonds") are fiscally transparent open-end investment funds and may invest in properties, certain types of participations in real-estate companies, and in fixed income instruments (e.g. bonds and money markets vehicles). They have operated for over four decades in the German mutual fund market.[3] Table 1 provides an overview of the number and the total amount of assets under management of the real-estate mutual funds, compared with security-based funds. Compared with security-based funds, the number of real-estate mutual funds is low. By the end of 2002, investors could choose between 22 different real-estate mutual funds, which were managed by 14 investment management companies registered in Germany. Most of them are owned by commercial banks using their network of branches throughout Germany as the most important distribution channel for mutual funds products.

In contrast to the number of funds offered, the real-estate mutual funds are important players in the German mutual fund market with respect to assets under management. In 2002, more than 70 bill. € were invested in real-estate mutual funds, representing a market share of nearly 19% of total assets under management in the German mutual fund industry. The average volume of assets under management is 3 bill. €, while security-based funds averaged only 0.15 bill. €. In addition, high cash inflows in this investment vehicle could be observed over

[3] The first German real-estate mutual fund (iii Fonds Nr. 1) was launched in 1959.

the last decade, except in 2000. After the stock market collapse in 2002, real-estate funds faced tremendous cash inflows of about 15 bill. €.

Table 1: German Real-Estate Mutual Funds: Assets under Management and Net Cash Flow

Year	Number (all mutual funds)		Assets in mill. € (in % of total assets)		Net Cash Flow (in mill. €)
1993	14	(667)	21,840	(13.64 %)	7,466
1994	14	(793)	25,764	(13.73%)	3,914
1995	14	(919)	29,694	(14.82%)	3,489
1996	14	(1,058)	37,023	(16.89%)	7,113
1997	15	(1,188)	40,493	(16.09%)	3,274
1998	16	(1,343)	43,137	(14.96%)	2,392
1999	17	(1,477)	50,403	(12.86%)	7,483
2000	19	(1,717)	47,919	(11.31%)	-2,821
2001	19	(1,939	55,868	(13.38%)	7,312
2002	22	(2,068)	71,165	(18.63%)	14,903

Source: 2002 Yearbook of German Investment- and Asset Management Association (BVI)

Looking at the percentage change of the funds' volume and the prior year, the stock market return (measured by the major German stock index, the DAX) shows a coefficient of correlation of –0.52. It seems that German fund investors consider real-estate mutual funds at to be, in part, a 'flight to quality' investment. This means that after low prior stock market returns, investors become more risk-averse. They shift to less risky assets and demand higher expected real returns on risky assets. However, it should be noted that with respect to this safe-haven feature, real-estate funds are competing especially with money market instruments, which offer also stable and positive returns over short investment horizons. Therefore, it is also necessary to study the role of real-estate funds with respect to the long investment horizons, which are typical for pension investments.

2.2 Legal Environment and Regulation

Regarding their legal framework, real-estate mutual funds may be managed by an investment management fund company ("Kapitalanlagegesellschaft", subsequently referred to as KAG) which is a specialised bank in the field of asset management. A German KAG may be operated only in the legal form of a joint stock cooperation, or a limited liability company, and usually manages the assets of many different mutual funds. Its shareholders are not the investors in the funds, but typically banks or insurance companies. From a legal point of view, the mutual fund itself ("Sondervermögen") is a special asset pool funded by the investors' capital contributions and must be strictly separated from the investment company's own assets. The unit certificates held by the investors are not comparable to equities, but are special securities representing a contractual claim of the unit-holder against the investment fund. The fund is managed on the basis of a management contract by the investment management company and the unit holders.

Investment management companies that offer real-estate mutual funds are regulated by a comprehensive legal framework, primarily by the Investment Company Act ("Gesetz über Kapitalanlagegesellschaften", subsequently KAGG). The KAGG is a special law designed to provide investor protection, and is the statutory basis for the German investment fund market.

It regulates a number of legal aspects, such as licensing requirements, the organisational structure, the function and purpose of custodians, permitted investments, investment restrictions, valuation, accounting, auditing and publication requirements. The state supervision of the rules codified in the Investment Company Act is exercised by the federal financial supervisory authority ("BaFin"), a legal compliance supervision. The supervisory authority is not permitted to intervene with the business decision of an investment management company, as long as these are in conformity with the existing laws and regulations.[4] Special requirements of the Investment Companies Act belonging to real-estate mutual funds include the intra risk diversification of properties (i.e. no single property's value may exceed 15% of the fund's capital), a minimum investment weight into properties (i.e. at least 51% of the fund's capital must be invested in properties), a minimum liquidity reserve (i.e. 5% of the fund's assets), restriction on financial leverage (not more than 50% of the fund's property portfolio) and rules regarding the appraisal of the fund's properties by independent experts.

Since the implementation of real-estate mutual funds in the Investment Company Act in 1969, the law was subject to a number of important amendments, which extended the investment opportunities for real-estate mutual funds. The novel in 1990 allowed the funds to acquire properties in all EU-countries. Since 1998, real-estate funds have the possibility to invest in shares of property companies. The latest amendment was the 4th financial market improvement act ("Finanzmarkt Förderungsgesetz") in 2002, which facilitated the possibilities for real-estate funds to invest internationally outside the European Union. Before the act, it was only possible to invest 20% of the fund's capital outside the Euro zone. After the act, the funds are allowed to invest 100% of their capital internationally, as long as their un-hedged currency exposure does not exceed 30% of the fund's capital. Traditionally, the majority of the fund's properties are located in German cities. However, ever since the relaxation of investment regulations, the funds have been investing more in foreign countries, especially with the European Union where about one-third of the properties are located.

In addition to the Investment Company Act, investment funds are also subject to a number of other laws. For example, the promotion and public marketing of German real-estate mutual funds in foreign countries require notification of the national supervisory authorities. With respect to the notification process, one must distinguish between foreign funds situated in EU member states, or in states party to the European Economic Area, which set up the Directive 85/611/EEC (UCITS-funds) and other foreign funds (non UCITS-funds). While UCITS funds are subject to a simplified notification procedure, all other foreign funds publicly marketed in a member state must comply to more rigorous requirements for permission to sell outside the home country. UCITS funds must invest in bonds and/or equities that are quoted on the stock exchange. Hence, German real-estate mutual funds are currently inconsistent with the UCITS Directive.

2.3 Problems Resulting from the Open-End Architecture of Real-Estate Funds

In contrast to US-type Real-Estate Investment Trusts (REITs), the Swiss real-estate mutual funds and the property companies in U.K. or in France, there is a limited secondary market for units of German real-estate funds, since they are not quoted on a stock exchange. However, the fund units are liquid because investors can ask for redemption daily. To maintain the open-end principle, the funds continuously offer new shares to the public. The redemption price is based on the net asset value per unit. The issue prices are calculated likewise on the basis of the net asset value, plus an offering charge, which is usually 5%. The net

[4] See *Laux* and *Siebel* (1999), p. 67.

asset value is found by the actual market value of all assets held by the mutual fund, less any fund liability, divided by the number of issued units. Aside from properties, the assets of the funds consist of fixed income instruments (bonds, T-bills, and cash). While financial assets are valued according to their current market prices, the market value of the funds' property portfolio relies on estimations by independent experts. In general, the funds' properties are evaluated once a year at different points in time throughout the calendar year. There are two problems connected with estimating the value of properties which are not directly substantiated by sales. First, the valuation must reflect the current market value of the property asset so that unit holders redeeming do so at a price that does not penalize those unit holders who wish to remain invested long-term. Since real-estate funds are due to state supervision, the government regulates the valuation techniques. According to the "Wertermittlungsverordnung" property appraisals are (usually) gained by using the income approach. This means, the appraiser determines the stream of net-rents that are expected from the property and use a capitalisation rate to discount these cash flows.

A second problem associated with property appraisals is smoothing. Smoothing means that appraisal-based return series understate the true variability of returns in the property market.[5] In contrast to stocks and bonds, which are frequently traded in an auction market that adjusts rapidly to changes in information and expectations, real-estate is infrequently traded in a negotiated market. Most real-estate practitioners and academics believe that – as a result of appraisal anchoring to previous estimates and aggregation of information over time – property appraisals tend to lag movements in the property market and understate the true volatility of the underlying property values. Therefore, *Ross* and *Zisler* (1991) and *Geltner* (1989, 1991), among others, suggest comparing risk return statistics of appraisal-based returns to that of financial assets (e.g. stocks and bonds), only after correcting for appraisal smoothing. However, in contrast to direct property ownership, the smoothed prices of the German real-estate funds represent the amount at which the fund must redeem units at each point in time. Therefore, as *Hoesli* and *Hamelink* 1996 mentioned, despite the fact that the risk level of real-estate mutual fund units are probably artificially low, the smoothed return for unit holders is the actual holding period return which they receive.

The open-end structure of real-estate mutual funds causes an additional problem which is also typical for credit banks: the danger of a bank run resulting from long-term illiquid property investments in conjunction with short-term daily callable liabilities. *Little* (1992) reported for the Australian market, that a general decline in the property industry created a real crisis in investor confidence, which overflowed into a run on the redemption of unlisted open-end property trusts. Because of extensive redemption of unit holders rapidly consuming the funds' liquid asset, forced sales of property became necessary to produce the additional liquidity. At the end, the Australian government intervened and extended the redemption period for all unlisted property investments to 12 months.[6]

What are the features to address the structural liquidity discord concerning the assets and liabilities of an open-end real-estate fund? Besides the possibility to stop the re-purchase of shares for a maximum of two years, an important feature is to hold an appropriate cash

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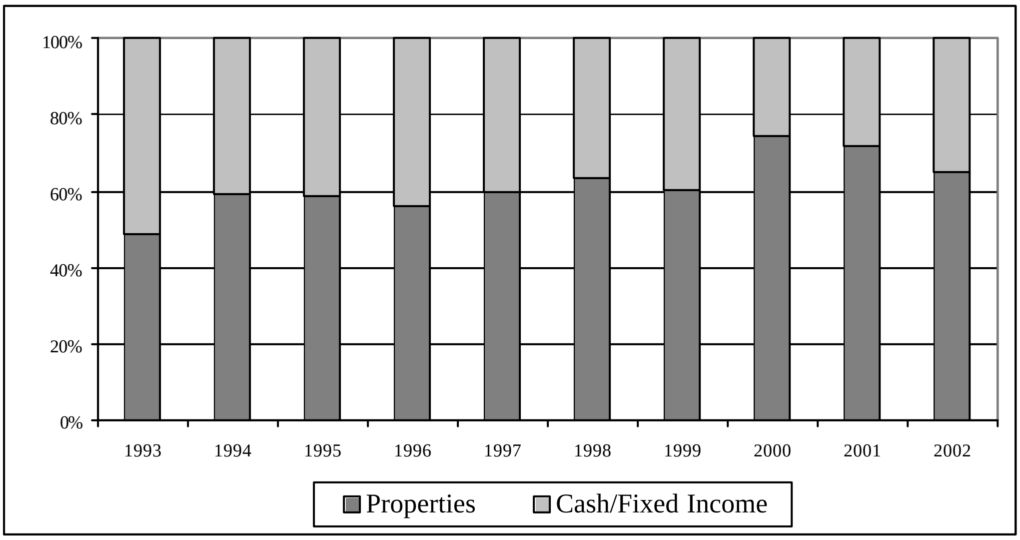
[5] See *Hoesli* and *MacGregor* (2000), p. 59.

[6] A similar run happened at the beginning of the last decade in the case of the Dutch Rodamco crisis (see *Helmer* 1997, p. 126). In the German market for open-end real-estate funds the A.G.I. Nr. 1 was closed in 1993, because unit-holders (mostly institutional investors) asked their money back. However, in contrast to the Australian and Dutch case this was not a crisis of the hole industry for open-end real-estate funds, but merely a problem of a single fund. At the end, the A.G.I. Nr.1 was merged with another open-end real-estate fund (see *Sebastian* 2003, p. 67).

reserve. The cash reserve can be used to meet the redemption guarantee in the case of unexpected cash outflows. It can also be used to invest money for the short term in case of unexpected cash inflows. As Exhibit 1 shows, German real-estate mutual funds typically hold about 25-49% of their assets in cash and fixed-income securities. Therefore, the risk and return characteristics of the fund units do not represent a pure property portfolio, but rather a multi-asset portfolio consisting of fixed-income instruments and properties. From the investor's perspective, this raises the question about the impact of this dilution effect with respect to the financial characteristics of real-estate fund returns.

Another instrument to avoid frequent trading with the fund units is the bid-ask spread between the sale and the redemption price. From an economic point of view, the offering premium of about 5% is not only raised to cover sales costs, but also to build an effective barrier which make short-term investment horizons, and therefore, frequent transaction with the fund units, unattractive.[7] From the investor's perspective, this raises the question about the required minimum investment horizon that is necessary to overcome the negative return effect of the bid-ask spread.

Exhibit 1: Portfolio Composition of German Real-Estate Mutual Funds



3 Analysis of Short-Term Returns

3.1 Data Collection and Description

In this section, the short-term return characteristics of open-end real-estate funds are analysed and compared with major asset classes, i.e. stocks, bonds, and cash. The data sample consists of the month-end unit prices $P_{i,t}$ adjusted for dividends, splits, and net of management fees of all real-estate funds that are publicly offered in the German market over the time period from January 1975 until December 2002. For each fund i, the monthly nominal (pre-tax) returns $R_{i,t} = P_{i,t} / P_{i,t-1} - 1$ are calculated. For each of the t = 1, ..., 336 months of the sample period, the monthly return of a real-estate fund index portfolio is determined according to:

$$R_{P,t} = \sum_{i=1}^{n_t} x_{i,t} \; R_{i,t} \qquad \textbf{(1)}$$

[7] See *Maurer* and *Sebastian* (2002).

Here, n_t stands for the number of companies within the index portfolio in month t, and $x_{i,t}$ for the portfolio weight of company i in month t with $\Sigma x_{i,t} = 1$. Finally, the discrete index returns were converted to log-returns. At the beginning of the sample period in 1975, $n_t = 8$, and at the end in 2002, $n_t = 22$. One fund was closed in 1993 (i.e. the A.G.I.V Nr. 1), hence the index is free from survivorship bias. In order to take market coverage into account, the assets under management were used as portfolio weights at the beginning of each year. The index could be a representative of a well-diversified index fund that invests in the different real-estate mutual funds under consideration.

To represent the stock and bond markets, the index returns of two major indices, i.e. the DAX and the REXP, are used. The former is an index portfolio of German blue chips, while the latter represents a portfolio of German government bonds. Each of these indices are value-weighted, based on market capitalisation and adjusted for capital gains, as well as dividends and coupon payments (on a pre-tax basis). As a proxy for a money market fund, we used the one-month interest rates provided by the Deutsche Bundesbank (European Central Bank respectively). To reflect potential administration costs for managing an index portfolio, the equivalent of 0.5% p.a. was subtracted from the returns of the bond, stock, and cash investments.

The continuously compounded rate of inflation π_t from t-1 to t is formally defined by $\pi_t = \ln(CPI_t) - \ln(CPI_{t-1})$. CPI_t stands for the country's price level at time t, measured by an appropriate consumer price index (CPI). The real log-return for each index portfolio under consideration, $r_{P,t}$, is defined as the continuously compounded nominal return $R'_{P,t} = \ln(1 + R_{P,t})$, minus the observed inflation rate, formally $r_{P,t} = R'_{P,t} - \pi_t$.

Statistical properties of the monthly and yearly, as well as nominal and real log-returns for each of the four asset categories are reported in Table 2.

Regarding the mean returns and the standard deviations of the monthly and yearly nominal log-returns in panels A1 and A2, it can be observed that they are quite different among the four asset classes. Real-estate funds, on average, return 0.50% per month with a volatility of 0.20%, which indicates quite stable returns over time. With 0.76%, the monthly return on equities is about 50% higher than the return on real-estate funds. The monthly volatility of equities' returns, however, is about 30 times the volatility of real-estate fund returns. Bonds return 16% more and exhibit about 5.5 times more volatility than real-estate funds. The volatility of money market returns with 0.19% p.m. is only slightly lower compared to real-estate funds; however, the mean return is about 15% below that of real-estate funds. Due to front-end loads, the monthly average returns are not the expected returns for a potential investor willing to buy units of the various asset categories over a short investment horizon.

Assuming independent and identically distributed (iid) returns, the mapping from monthly to yearly log-returns is straightforward. Means are scaled up by factor twelve and the volatility of the yearly returns on risky assets is just:

$$\text{Volatility p.a.} = \sqrt{12} * \text{Volatility p.m.}$$

Deviations from this ratio may indicate serial correlation in the monthly return time series. While the empirical scaling factors between the average returns by construction remain equal among the various asset categories (i.e. scaled up by nearly the same factor twelve), those for the volatilities significantly differ (see Table 2, Panel C). Compared to equities and bonds, whose yearly volatilities are about 4.5 times the monthly, the volatility of real-estate fund returns increases (statistically distinguishable from $\sqrt{12}$ at the 1%-confidence level) by factor 7.75. However, real-estate funds still have the lowest volatility for nominal yearly log-returns, since the money market volatility increases by factor 11.8 when moving from monthly to yearly returns.

Table 2: Summary Statistics of Monthly and Yearly Returns (01/1975 - 12/2002)

	Real-Estate Funds	Cash	Bonds	Stocks
Panel A1: Monthly Nominal Returns				
Mean	0.50	0.42	0.58	0.76
STD	0.20	0.19	1.11	6.00
Panel A2 Yearly Nominal Returns				
Mean	6.06	4.99	6.91	9.05
Volatility	1.55	2.24	5.12	26.19
Panel B1: Monthly Real Returns				
Mean	0.28	0.19	0.35	0.53
STD	0.34	0.29	1.18	6.00
Panel B2: Yearly Real Returns				
Mean	3.40	2.33	4.26	6.39
STD	1.64	1.60	5.39	26.11
Panel C: Standard Deviation Ratio (SDE)				
Nominal Returns	7.75	11.79	4.61	4.37
Real Returns	**4.82**	**5.52**	4.57	4.35

Notes: Mean and volatility (STD) values in % per month. SDE is the ratio between the yearly and monthly return standard deviations. Bold values significantly deviate from $12^{0.5}$ at 1%-level, non-bold do not deviate from $12^{0.5}$ at any conventional level of significance.

In contrast to nominal returns, the observed volatility scaling factors for real returns are quite homogenous among the different asset categories, and much closer to the theoretical value under the iid assumption (i.e. about 3.46). For bonds (4.57) and stocks (4.35) the scaling factors are nearly the same as for nominal returns. On the other hand, for real-estate funds (4.97) and cash (5.52), the scaling factor is significantly lower as in the case of nominal returns. As *Fama* and *Schwert* (1977) pointed out, such heterogeneous serial correlation of nominal returns combined with relatively homogeneous serial correlations in real returns for different asset categories is due to the fact that “inflation-related variation in nominal returns is common to all assets”.

3.2 Stability of Mean Returns and Volatility

In the context of asset allocation decisions, stability of average returns and volatilities is essential, since they are among the most important input parameters in determining optimal portfolios. To gain a first impression, the stability of the means and the volatilities is assessed by re-calculating the monthly averages and volatilities, using rolling sampling windows of different lengths. Table 3 and Table 4 summarize the results for window lengths of 24, 60, and 120 months.[8] As can be seen, depending on the period length, the average monthly re-

[8] The entire period, 01/1975 – 12/2002 (i.e. 336 months), was divided into 313, 277, and 217 overlapping sub-periods of 24, 60, and 120 months, each shifted by one month (e.g. 01/1975–12/1976, 02/1975–01/1977, …). For each of these periods, the mean return and volatility were calculated.

turns change over time. Like the return on money market investments, the average real-estate fund returns vary only slightly, while the average return on bonds, and especially on equities, deviates significantly, depending on the period length. The results for the volatilities are even more extreme. The volatilities of real-estate fund and money market returns are virtually constant, whereas equity returns display considerable heteroscedasticity.

Table 3: Stability of Rolling Means for Monthly Nominal Returns (01/1975 - 12/2002)

		24 months	60 months	120 months
Real-Estate Funds	Mean	0.50	0.51	0.53
	STD	0.12	0.09	0.03
Cash	Mean	0.47	0.48	0.50
	STD	0.17	0.13	0.04
Bonds	Mean	0.60	0.60	0.62
	STD	0.30	0.15	0.03
Stocks	Mean	0.93	1.05	1.06
	STD	1.26	0.65	0.23

Notes: Values in % p.m. Mean (Std.Dev) represents the average over (the standard deviation of) the rolling mean returns for the respective asset class and window length.

Table 4: Stability of Rolling Volatilities for Monthly Returns (01/1975 - 12/2002)

		24 months	60 months	120 months
Real-Estate Funds	Mean	0.15	0.17	0.19
	STD	0.03	0.03	0.02
Cash	Mean	0.07	0.14	0.18
	STD	0.05	0.06	0.02
Bonds	Mean	1.05	1.12	1.11
	STD	0.33	0.24	0.15
Stocks	Mean	5.30	5.43	5.70
	STD	1.86	1.47	0.77

Notes: Values in % p.m. Mean (STD) represents the average over (the standard deviation of) the rolling volatilities for the respective asset class and window length.

The longer the rolling window, the more stable are the average returns and volatilities. This results from an increasing overlap, since the window is only shifted in monthly steps. Using a once-monthly shifted window increases the sample size, but only at the expense of high interdependencies between adjacent sub-periods.

The problem of interdependencies can be overcome by dividing the whole period into non-overlapping sub-periods, to provide a formal test of stability. Table 5 shows the monthly average returns and volatilities of real-estate fund investments in non-overlapping sub-periods of 7-years length. When dividing the sample period into sub-periods, a trade-off must be made between short sub-periods, which may adequately describe the inter-period relationships at the expense of an only small intra-period sample size, and longer sub-periods, which may be based on a sufficient number of intra-period observations, which, however, may also average out inter-period relationships. We found a sub-period length of 7 years to be a good compromise.

Parameter stability was scrutinized by pair-wisely testing each two sub-periods for the same mean return and volatility. Since the standard t- and F-tests heavily depend on the assumption of normality, non-parametric tests (*Levene* and *Brown-Forsyth* for testing the volatilities, *Wilcoxon* and *Kruskal-Wallis* for testing the medians that substitute the arithmetic means in the context of non-parametric tests) were used to test the stability of the parameters. However, in most cases, the standard parametric tests would have delivered the same results as the non-parametric tests.

Table 5: Stability of Monthly Average Returns and Volatilities over Non-Overlapping Sub-Periods (1/1975 – 12/2002)

	Sub-Period	Real-Estate Funds	Cash	Bonds	Stocks
Mean	1975-1981	0.50	0.47	0.53	0.59
	1982-1988	0.53	0.40	0.72	1.43
	1989-1995	0.61	0.54	0.59	0.69
	1996-2002	0.38	0.25	0.47	0.30
Volatility	1975-1981	0.17	0.24	1.39	3.69
	1982-1988	0.17	0.13	1.06	6.29
	1989-1995	0.21	0.14	1.06	5.37
	1996-2002	0.15	0.05	0.89	7.90

Notes: Values in % p.m.

Apart from one pair of sub-periods, the differences in mean returns on real-estate funds are highly significant for all other pairs of sub-periods. The same results are found for the money market. Although mean returns on bonds, and especially on stocks, strongly fluctuate over time, the tests failed to reject the null of constant mean returns on stocks and bonds for any pair of sub-periods. This statistical insignificance may be due to the high level of volatility compared to the level of mean returns. In the context of portfolio choice, however, these fluctuations are of high economic importance.

Looking at volatilities, the real-estate funds were found to exhibit significant differences for only one pair of sub-periods, while for the other pairs the null of constant volatilities could not be rejected at any common level of significance. Contrarily, constant volatilities were rejected for five pairs of sub-periods in the case of the money market, and for four pairs in the case of stocks. For bonds, the varying volatility was rejected for only one pair of sub-periods.

These results emphasize the importance of selecting the period for which the estimated parameters are considered representative for future returns, which is perennially required in the asset allocation process.[9]

3.3 A Closer Look to Serial Return Correlation of Real-Estate Funds

As seen above, the volatility of real-estate fund returns disproportionately increases when moving from a monthly to a yearly perspective. This gives reason to further analyses

[9] For insights into how to handle estimation risk in the context of portfolio choice, see e.g. *Best* and *Grauer* (1991), *Chopra* and *Ziemba* (1993), and *Herold* and *Maurer* (2002).

into the inter-temporal dependencies in real-estate returns. Table 6 displays the autocorrelation structure of monthly/yearly (nominal/real) real-estate fund returns for the lags 1 – 12. As can be seen in panel A, monthly nominal real-estate fund returns exhibit significant autocorrelation at all lags. The shape of the structure resembles an “autocorrelation smile”. Autocorrelation drops from 0.44 at lag 1 to 0.28 at lag 5, to then increase again to 0.42 at lag 12. Similar autocorrelation structures can be found when analysing the single real-estate fund return’s time series.

Table 6: Autocorrelation Structure of Real-Estate Fund Returns (1/1975 – 12/2002)

Lag	1	2	3	4	5	6	7	8	9	10	11	12
Panel A: Monthly Returns												
Nominal	**0.44**	**0.38**	**0.42**	**0.32**	**0.28**	**0.40**	**0.27**	**0.35**	**0.41**	**0.33**	**0.27**	**0.42**
Real	**0.22**	0.07	0.12	0.01	0.01	-0.04	0.02	0.07	**0.15**	0.02	**0.17**	**0.41**
Panel B: Yearly Returns												
Nominal	**0.69**	0.38	0.07	-0.26	-0.26	-0.33	-0.27	-0.07	0.06	0.17	0.19	0.03
Real	**0.50**	0.39	0.26	0.10	0.06	0.06	-0.16	-0.10	-0.14	-0.18	-0.31	-0.17

Notes: Values in bold type are significantly different from 0 at the 5%-level.

Reasons for serially correlated monthly real-estate funds returns may be manifold. The real-estate fund returns can be separated into two components. The return on liquid financial assets on the one side (i.e. cash and bonds), the return on illiquid property on the other. From the liquid side, autocorrelation may be induced by money market investments, which tend to be highly auto-correlated on monthly basis. Serial correlation may also result from the illiquidity of property portfolios. Infrequent transactions lead to distorted market values and leave valuation to appraisers. As mentioned by *Hoesli* and *MacGregor* (2000, p. 59) among others, they in turn can only base their appraisals on insufficient information, such as the last reported value of the building and possibly recent transactions in comparable properties.

Autocorrelation may also result from inflation-indexed lease contracts. In general, the negotiated rental fee is subject to increase, if a specified price index rises above a certain level. Since rents are a major return driver for real-estate funds, this mechanism links inflation to their returns. Inflation is commonly known to be auto-correlated. Thus, the vehicle of inflation-indexed lease contracts may induce autocorrelation in real-estate fund returns. To eliminate inflation effects, the autocorrelation structure is again analysed using real return time series.

Adjusting monthly returns for inflation significantly reduces autocorrelation in the return time series for real-estate investments. Inflation-adjusted returns exhibit some autocorrelation at lag 1, but hardly any at higher lags. This may indicate that inflation has indeed an influence on the autocorrelation of real-estate fund returns. The practice of inflation adjustment codified in the lease contracts, however, leads to inflation only having delayed influence on lease prices and on returns, and therefore, on the autocorrelation at higher lags. The autocorrelation at lag 12, however, is not affected by the inflation adjustment. This may be evidence for annual events, e.g. appraisals of property, having an impact on the autocorrelation structure of returns.

Regarding yearly returns (Panel B), nominal and real returns on real-estate funds exhibit significant serial correlation only at lag 1. With a coefficient of autocorrelation of nearly 0.7

for nominal and 0.5 for real returns, these heavily depend on the return in the previous period. Up to lag 3, nominal returns show a positive autocorrelation. For lags 4 to 8, serial correlation is negative, only to then again become positive for lags 9 to 12, a phenomenon that will be looked at more closely in the following passage.

Autocorrelation in real-estate fund returns can also be caused by real-estate cycles.[10] Contrary to the familiar return characteristics of stock and bond markets, the real-estate fund index return series does not stagger regularly around its mean; it exhibits periods of several years with monthly returns below the long-term average, followed by years with above-average returns. The consideration of the cyclical behaviour of real-estate fund returns in strategic investment decisions is of great importance, especially due to the fact that real estate is a long-term investment.

Without having to specify a model that can economically explain this cyclical behaviour, harmonic analysis provides a formal means to study statistical properties of these cycles (see *Pyhrr*, *Roulac*, and *Born* (1999) for a review of real-estate cycle models and literature). Technically, a cyclical time series can be interpreted as a superposition of several sine and cosine curves (see *Crawford* (2001), p. 29). With simultaneous consideration of a linear trend, seasonality, and cyclical behaviour, the model

$$r_t = a_o + a_1(2pt) + a_2(Sin\left(\frac{2pt}{SL}\right)) + a_3(Cos\left(\frac{2pt}{SL}\right)) + a_4(Sin\left(\frac{2pt}{CL}\right)) + a_5(Cos\left(\frac{2pt}{CL}\right)) + e_t \quad \textbf{(2)}$$

can be fit to the respective real-estate time series via OLS-regression (see *Richardson* (2002)). The a_i are regression coefficients and t is the time index, i.e. t = 1, 2, 3, ... for the first, second, third, ... observation. SL is the season period parameter, and CL the cycle period ("cycle length") parameter, i.e. the cycle length is CL/12 years for monthly data. To estimate cycle length, the regression model is evaluated for different combinations of SL and CL, whereby the best fit provides the estimates for SL and CL.

Using different settings of the model above, with and without the trend component, and with and without the seasonal component, the pure sine/cosine representation, without trend and without seasonality, proves most adequate for the time series under consideration. The MAPE (mean percentage squared error) and the R^2-criterion are used to determine the quality of fit with the MAPE proving to be the most adequate criterion. The original real-estate fund index return time series and the fitted sine/cosine curve are given in Exhibit 2.

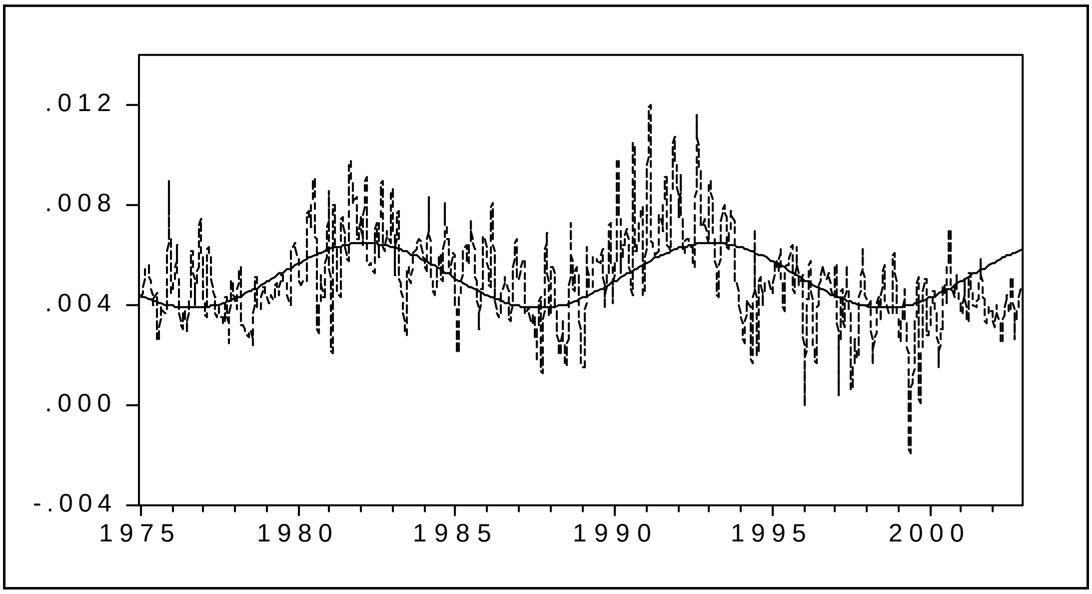
The sine/cosine curve provides a good fit for the original return series. The cycle length of this fit is 132 periods, i.e. 11 years. Since the real-estate fund index is an aggregate of many funds, this cycle may be artificial and result rather from index calculation than from real-estate fund economics. To explore the reasons for the cyclical behaviour of real-estate fund indexes, the cycle analysis is also applied to single real-estate funds.

Fitting sine/cosine curves to the return series of the single funds leads to similar results. Apart from the Grundwert-Fonds, which shows a cycle length of nearly 13 years, the single funds also have cycle lengths of about 11 years. This shows that cyclical behaviour is not an artificial characteristic of the real-estate fund index, but rather an inherent feature of real-estate fund returns, a property also exhibited by direct real-estate investments (see e.g.

[10] "Property cycles are recurrent, but irregular fluctuations regarding the rate of all-property total returns, which are also apparent in many other indicators of property activity, but with varying leads and lags against the all-property cycle." (*Royal Institution of Chartered Surveyors* Report 1994, p. 127.)

Maurer, *Reiner*, and *Sebastian* (2003), *Ball*, *Lizieri*, and *MacGregor* (1998)). The results are summarized in Table 7.

Exhibit 2: Real-Estate Market Cycles (01/1975 - 12/2002)



Notes: The intersected line represents the original return series, the solid line is the sine/cosine curve, which was fitted using the MAPE criterion.

The obviously high, persistent autocorrelation in and cyclicity of the real-estate fund return time series shows that these returns are only partially stochastic. Knowing that at time *t* the real-estate market is in an above (below) average cycle phase gives reason to expect an above (below) average return on real estate at time *t+1*. Thus, information about today's returns and the returns in the recent past can be used to obtain better estimates of the returns in the near future. Therefore, the returns of real-estate funds can be interpreted to follow a deterministic path that is superimposed by a stochastic error term.

Table 7: Cycle Lengths of Single Funds (01/1975 - 12/2002)

Funds	Length	Funds	Length
Aachener Grundfonds Nr. 1	11.25	Grundwert-Fonds	12.92
Deka-Immobilienfonds	10.67	Haus-Invest	11.00
DIFA-Fonds Nr. 1	11.00	iii-Fonds Nr. 1	11.33
Grundbesitz-Invest	11.70	iii-Fonds Nr. 2	10.67

Notes: Length specifies the length in years of one cycle defined as the time between two consecutive maxima or two consecutive minima.

The analytical instrument to model such series consists of the well-known manifold class of Autoregressive-Integrated-Moving-Average [ARIMA(p,d,q)] processes. Fitting these models to the data extracts the deterministic component with the residuals representing the stochastic error term. Standard tests for unit roots are applied to determine the level of integration in the time series of each single fund and the real-estate fund index. None of the series is found to have a unit root[11] and, therefore, simple ARMA(p,q) models are being applied in the modelling (i.e. d = 0). Aiming at optimising the fit of the model by using the R^2-criterion, as well as the information criteria by *Akaike* and *Schwarz*, models with varying lag-lengths *p* and *q* are estimated for all return series. Table 8 gives an overview about the optimal model for the respective series.

Table 8: ARIMA-Models fitted to the Return Time Series (1/1975 – 12/2002)

Funds	Model	Funds	Model
Aachener Grundfonds Nr. 1	AR(1)MA(1)	Grundwert-Fonds	AR(1)MA(1)
Deka-Immobilienfonds	AR(1)MA(1)	Haus-Invest	AR(1)MA(1)
DIFA-Fonds Nr. 1	AR(1)AR(12)	iii-Fonds Nr. 1	AR(1)MA(1)
Grundbesitz-Invest	AR(1)MA(1)	iii-Fonds Nr. 2	AR(1)MA(1)
		RE Fund Index	AR(1)AR(12)

Notes: Fitting models with lagged variables to return time series results in a loss of as many estimated values at the historic end as lags included in the model. Therefore, fitting an AR(1)AR(12) model will result in a loss of 12 values, i.e. using time series data from 1/1975 onwards will lead to the first estimate being available for 1/1976.

As can be seen, most return series can be adequately modelled using simple ARMA(1,1) models. Only the real-estate fund index and the DIFA-Fonds Nr. 1 series are best modelled by an AR-only approach, with lag 1 and lag 12 being taken into consideration. This, again, may reveal the significance of annual events, such as revaluation for the development of returns.

Assuming that the deterministic trend of the real-estate fund returns is known to an investor (at least in the short-run), the effective risk, i.e. the uncertainty about future returns, only results from the stochastic error term of the modelling, i.e. the residuals. Using adequate models, these residuals are mean zero. The effective risk of the investment, thus, corresponds to the volatility of these residuals.

From Table 9, this effective risk is significantly lower than the risk predicted by the unconditional (over-all) volatility.

Table 9: Conditional and Unconditional Volatility of Real-Estate Investments

	Real-Estate Funds			RE Fund Index
	Minimum (Grundwert-Fonds)	Median (iii Nr. 2)	Maximum (Difa Nr. 1)	
Unconditional	0,27	0,28	0,31	0,20
Effective	0,25	0,24	0,28	0,17
? %	-7,41	-14,29	-9,68	-15,00

Notes: Values represent the monthly volatilities in % of the original return time series ("unconditional") and of the residuals of the ARIMA estimation ("effective"). ?% represents the percentage change of the volatility when considering the effective instead of the unconditional volatility. Minimum, median, and maximum refer to the degree of unconditional volatility exhibited by the single funds.

[11] Using the ADF test, the null of the time series having a unit root can be rejected at the 1% level for nearly every series. For the iii-Fonds Nr. 1 and the DIFA-Fonds Nr. 1 only, this hypothesis cannot be rejected. Using the KPSS test, however, the null of the time series being stationary cannot be rejected for the two series either; therefore, they are considered stationary.

Being able to use the residual instead of the overall volatility will reduce the risk of the real-estate fund index by 15%. Similar results can also be found for the single funds. The risk of the maximum-volatility real-estate fund can be reduced by almost 10% and even the risk of the minimum-volatility fund can be reduced by nearly 7.5%. Moreover, sub-period analyses show that the effective volatility is more stable than the unconditional volatility.

3.4 Worst-Case Risk Analysis

It is understood that measuring investment risk in terms of return volatility can be misleading, since volatility comprises both downward and upward deviations from the mean, and therefore, more appropriate gauges are needed to adequately measure downside and especially worst-case risk. Traditional worst-case measures include the return minimum and the lower return quantiles. *Grossman* and *Zhou* (1993) introduced a further measure for downside risk, the Maximum Drawdown (MaxDD), which was recently applied to real-estate data by *Hamelink* and *Hoesli* (2003). The Maximum Drawdown is the (positively defined) maximum loss realisable by investing into an asset at a local maximum price and disinvesting at the following local minimum price. The worst-case risk measures for the considered asset classes are presented in Table 10.

Table 10: Worst-Case Measures for Nominal Returns (1/1975 – 12/2002)

	Real-Estate Funds	Cash	Bonds	Stocks
Panel A: Monthly Returns				
Minimum	-0.19	0.17	-4.38	-25.45
MaxDD	0.19	-	6.01	40.23
5% Quantile	0.20	0.21	-1.29	-8.69
10% Quantile	0.28	0.23	-0.80	-5.72
Panel B: Yearly Returns				
Minimum	3.29	2.34	-3.00	-44.22
MaxDD	-	-	3.00	58.50
10% Quantile	4.63	2.79	0.68	-20.09
20% Quantile	4.96	3.19	2.85	-7.18

Notes: Values represent discrete[12] returns in %. MaxDD, the Maximum Drawdown, is the (positively defined) maximum loss realisable by investing into an asset at a local maximum price and disinvesting at the following local minimum price. "-": Time series does not show any draw-down.

When looking at monthly returns, as expected, bonds, and especially equities, exhibit poor worst-case characteristics compared to real-estate or money market investments. While equities showed a minimum return of –25.45% per month and consecutively lost up to 40.23%, bonds delivered a return of less than –0.80% in 10% of all months. The real-estate fund index, however, only yielded a negative monthly return once. –0.19% is the minimum return, as well as the MaxDD. In 95% of all months, the return on real estate was no less than 0.2%, and in 90% of all months, no less than 0.28%. The money market, on the other hand, never produced a negative monthly return, with 0.17% per month being the minimum. The

[12] The extreme losses that occurred on the stock market result in log-returns no longer being adequate to correctly describe the true returns. Therefore, discrete returns are used in this analysis.

5% quantile of money market returns is slightly higher than that of real estate. Combined with the minimum return being well above that of real estate, the probable density of money market returns is much steeper on the left-hand side than that of real-estate returns, and thereby limits worst-case returns to a much smaller interval. With respect to monthly returns, it can be concluded that money market investments are the least risky in a worst-case framework.

On a yearly basis, however, real estate has always yielded a positive return. With a minimum return of 3.29%, no drawdown has occurred over the sampling period. In 80% of all cases the yearly return on real estate was not below 4.96%. The money market also did not produce a drawdown with the minimum yearly return being 2.34%. Though, in 20% of all years the return on the money market was below 3.19%, which still is 0.1% short of the minimum yearly return on real estate. Comparing real estate to bonds and equities, this holds even stronger. Equities had a minimum yearly return of –44.22%, with a maximum drawdown of 58.50%, and in 1 out of 5 years they returned less than –7.18%. Bond returns fell short of 2.85% in 20% of all years. Therefore, in the context of the worst-case risk measures examined here, real-estate investments dominate all other asset classes when analysing yearly returns.

Looking especially at yearly returns, however, it can be questioned whether the terminology "worst-case risk" is actually adequate when analysing real-estate fund returns. With a minimum return significantly above 0, there is no worst case in real-estate fund investments, particularly compared to other asset classes.

3.5 Co-Movements of Real-Estate Funds with Stocks, Bonds and Cash

3.5.1 Correlation Analysis

The presence and structure of return interrelationships between different asset classes is of crucial importance, e.g. regarding asset allocation decisions.[13] One key measure of overall return interdependency is Pearson's Product Moment Correlation Coefficient, which quantifies the degree of linear interdependency. Table 11 shows the correlation matrix for short-term returns of the real-estate fund index, the money, bond, and stock markets.

The correlation between the real-estate fund index and the DAX, being 0.08, is not statistically significant different from zero.[14] However, the real-estate fund index shows significantly high positive correlations with the money and bond market, while the correlation between the money and the bond market is not significantly different from zero. This result is interesting, insofar as the correlation between direct real-estate investments and the bond

[13] See e.g. *Maurer* and *Reiner* (2002).

[14] The analyses in the previous sections showed that some of the time series used in this study are non-normal distributed and/or auto-correlated. Using a standard t-test for inferring if correlation coefficients are different from zero at a given level of significance is critical, in the presence of non-normal distributed or auto-correlated time series. Non-normality leads to an unknown distribution of the t-test statistic. To address this item, each correlation coefficient, for which both of the underlying series proved to be non-normal (see *Pitman*, 1937, p. 229), was tested with a simple t-test and additionally via a bootstrap BCa confidence interval with 10.000 bootstrap replications. In almost all cases both test-procedures provided the same conclusions regarding the rejection of the null, leading to the presumption that non-normality in the time series used here is less problematic for applying the usual t-test. The serial correlation in one or both of the underlying time series leads to a reduction in the degrees of freedom of the t-tests' t-distribution. To address the item of autocorrelation, especially in the real-estate fund series, a correction for the t-test suggested by *Dawdy* and *Matalas* (1964, p. 8/87) was applied, which at least allows for control for first-order autocorrelation. This correction is applied by adjusting the t-tests' t-statistic, and the degrees of freedom of the t-test-statistics' t-distribution.

market in Germany are approximately zero.[15] Once more, the high positive correlations between the real-estate funds and the money and bond market can be at least partly traced back to the real-estate funds' liquidity holdings.

Table 11: Contemporaneous Correlations for Monthly Nominal Returns (1975 – 2002)

	Real-Estate Fund	Cash	Bonds	Stocks
Real-Estate Funds	1			
Money Market	**0.60**	1		
Bonds	**0.45**	0.10	1	
Stocks	0.08	0.01	**0.13**	1

Notes: Correlation coefficients that proofed to be different from zero, at least at the 5% level, are printed in bold types.

Shifting to yearly returns, Table 12 shows that the correlations between the real-estate fund index and the stock and bond markets, respectively, are hardly altered relative to the monthly returns. On the other hand, the yearly correlation between the real-estate fund index and the money market, being 0.88, is much higher than in the monthly case. As a modified t-test showed, the difference between the correlation of the real-estate fund index and the money market on monthly and yearly basis is statistically significant at the 5% level. However, the test was not able to confirm that there is a difference between the monthly and yearly correlations of the real-estate fund index and the bond or stock market.

Table 12: Contemporaneous Correlations for Yearly Nominal Returns (1975 – 2002)

	Real-Estate Funds	Cash	Bonds	Stocks
Real-Estate Funds	1			
Cash	**0.88**	1		
Bonds	**0.40**	0.10	1	
Stocks	0,07	0.02	**0.14**	1

Notes: Correlation coefficients that proved to be different from zero, at least at the 5% level, are printed in bold types.

As shown earlier, real-estate investment fund returns exhibit cyclical behaviour, which could lead to an unstable correlation structure. To examine the stability of the correlation structure, short, medium, and long-term rolling correlations were calculated, i.e. the whole time period comprising 336 months was divided in 313, 277, and 217, overlapping sub-periods of 24, 60, and 120 months length, respectively. After that, correlation coefficients were calculated for each sub-period. In Table 13, the mean and standard deviation of the 24, 60, and 120 months correlation coefficients are tabulated.

Obviously, short-term correlations between the real-estate fund index and the other asset classes are relatively volatile, i.e. relatively unstable. Nonetheless, the longer the sub-period length, the more stable the correlations. Especially, the long-term (120 months) correlations between the real-estate fund index and all other asset classes are much less volatile, i.e.

[15] *Maurer*, *Reiner*, and *Sebastian* (2003) showed that for the US, UK, and Germany correlations between aggregated level direct real-estate investments and the bond markets are near zero.

more stable over time, than the 24-month correlations. However, it should also be mentioned again, that this stabilizing effect of longer sub-periods should be interpreted carefully. The stabilizing is also partly due to larger overlapping when considering longer sub-periods.

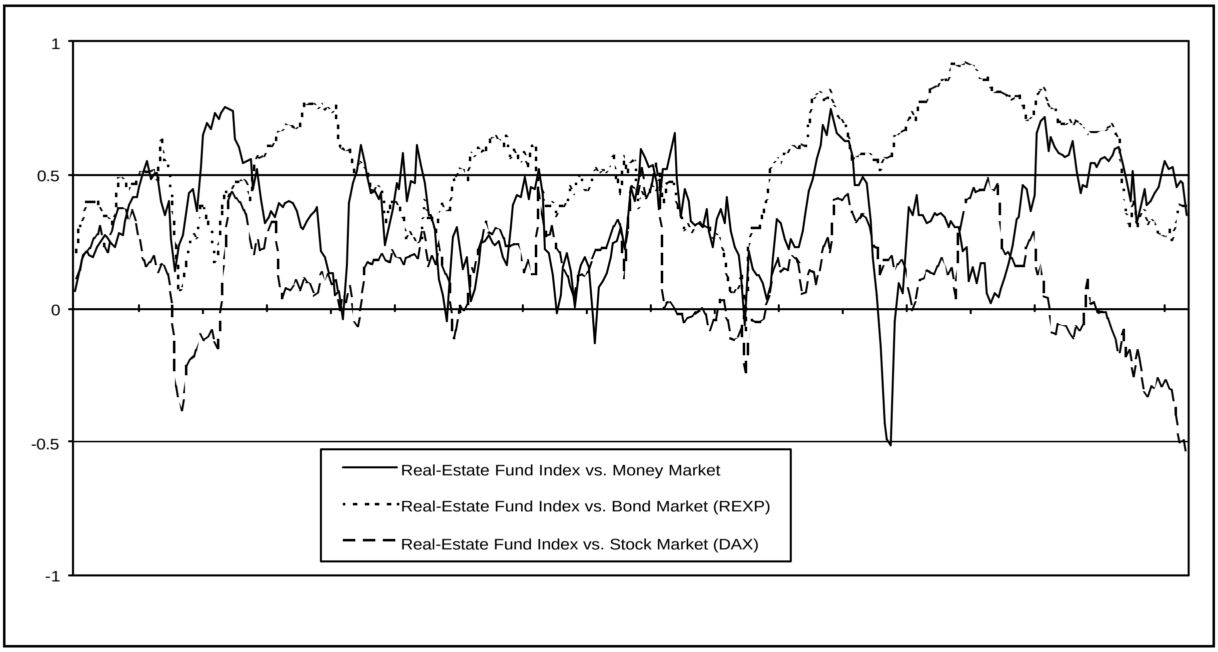
Interestingly, the mean correlations between the real-estate fund index and the stock and bond markets, respectively, seem to be quite unaffected by the sub-period length. On the other hand, the mean correlations between the real-estate fund index and the money market are considerably increasing, the longer the chosen sub-period length. While the mean 24-month correlation between the real-estate fund index and the money market is 0.35, it increases to 0.48 and 0.58 when shifting to 60 and 120-month correlations, respectively. Again the relations between the money market and the real-estate funds are qualitatively and quantitatively different from the relations between the stock/bond markets and the real-estate fund index.

Table 13: Rolling Correlations for Monthly Nominal Returns (1975 – 2002)

			24 months	60 months	120 months
RE Fund versus	Cash	Mean	0.35	0.48	0.58
		STD	0.20	0.12	0.08
	Bonds	Mean	0.52	0.53	0.49
		STD	0.19	0.13	0.06
	Stocks	Mean	0.12	0.13	0.12
		STD	0.20	0.10	0.06

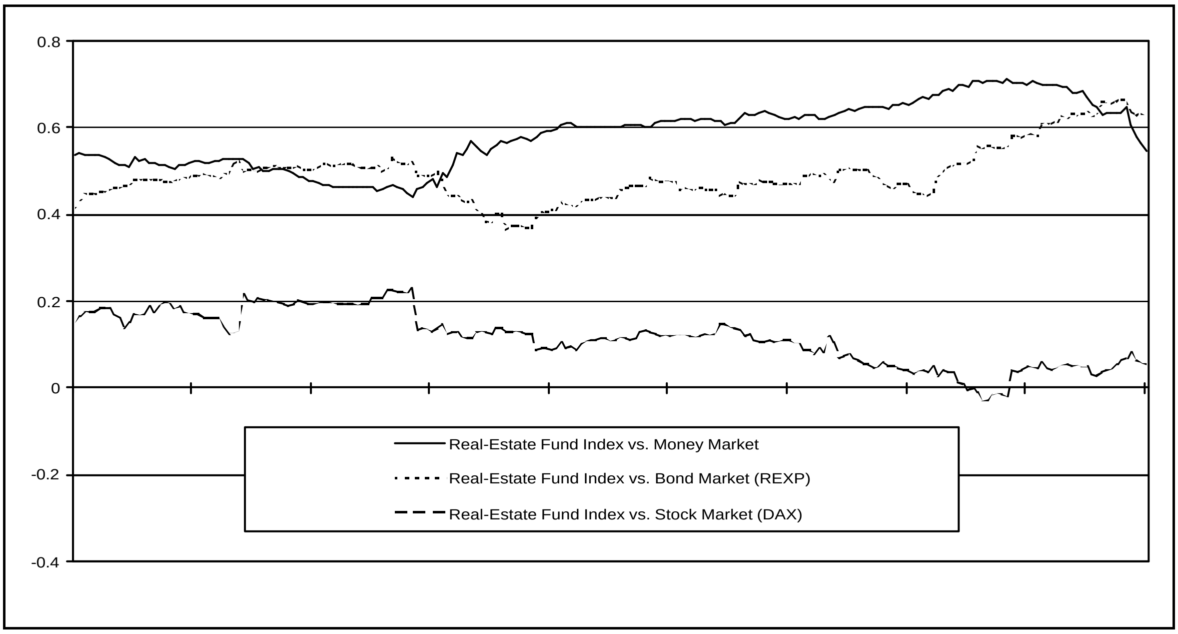
The graphs in Exhibit 3 and Exhibit 4 show the 313 and 217 correlation coefficients for the 24 and 120-month sub-periods.

Exhibit 3: Rolling Correlations for 24-Month Sub-Periods on the Basis of Monthly Nominal Returns (1975 – 2002)



Despite the relatively low volatility, i.e. stability, of long-term correlations, the graphs in Exhibit 4 demonstrate that there are slight changes in the correlation structure over time. These changes seem to be more of systematic than of random nature. Long-term correlations between the real-estate fund index and the stock market fairly decreasing over the whole time period. Moreover, the correlations between the real-estate fund index and the bond and money market, respectively, increased in the last two decades, even if there is evidence for the correlation between the real-estate fund index and the money market to recently decrease.

Exhibit 4: Rolling Correlations for 120 Months of Monthly Returns (1975 – 2002)



To formally test the stability of the correlation structure, the correlations between the real-estate fund index and the other asset classes in four non-overlapping sub-periods of equal length were calculated and tabulated in Table 14.

Table 14: Contemporaneous Correlations for Monthly Nominal Returns in Different Sub-Periods

Real-Estate Funds versus	Cash	Bonds	Stocks
1975-1981	0.58	0.41	0.06
1982-1988	0.51	0.48	0.23
1989-1995	0.57	0.47	0.08
1996-2002	0.36	0.67	-0.05

As is apparent from the previous analysis and Table 14, the monthly correlations between the real-estate fund index and the other asset classes are, in part, considerably dissimilar in different time periods. Especially the correlation in the period of 1996-2002, for the money market and the bond market, and the sub-period 1982-1988 for the stock market are considerably different from the other sub-periods. However, a pair-wise comparison of the different sub-period correlation coefficients, via a modified t-test, was only able to detect a 5% significant difference in one case. This was the correlation of the real-estate fund index and the bond market, in the first versus the last sub-period.

3.5.2 Residual Return Correlations

As shown earlier, the real-estate fund and the money market one-full-period returns are only partly of stochastic nature. As cyclical analysis suggests, these one-month returns can be separated in a deterministic and a stochastic component. Table 15 shows the correlation coefficients after removing the deterministic return component from the real-estate fund index and money market returns.

Table 15: Contemporaneous Correlations for Monthly Nominal (Residual) Returns (1975 – 2002)

	Real-Estate Funds	Cash	Bonds	Stocks
Real-Estate Funds	1			
Cash	**0.21**	1		
Bonds	**0.42**	0.04	1	
Stocks	0.05	0.01	**0.13**	1

Notes: Correlation coefficients that proved to be different from zero - at least at the 5% level - are printed in bold types.

It is obvious that the correlations between the pure stochastic return component of the real-estate fund index and the stock and bond market returns, respectively, are nearly the same for full returns. However, the correlation between the real-estate fund index and the money market is much lower after eliminating the deterministic return components from both indices. While the correlation for the full returns was 0.60 (see Table 11), the correlation for the pure stochastic return components is only 0.21. This finding is interesting, insofar as it indicates that the high (full return) correlation between the real-estate investment funds and the money market seems to be mainly driven by deterministic developments, i.e. pro-cyclical behaviour between the real-estate funds and the money market.

3.5.3 Co-Movements in Stress Situations

As observable especially for stock and bond markets, co-movements between different assets are often stronger in extreme situations, such as financial market crises, than under normal conditions. Economically, this implies that diversification potentials in stress situations are often of lower magnitude than under normal conditions. To address this important issue, this section only analyses return co-movements in the tails of the total bivariate return distributions. Due to the limited availability of data, the key focus will be on probabilities, rather than on co-movement structures.[16]

To measure the co-movement of two random variables in some part of their bivariate distribution, without considering the structure of the co-movement, the concept of conditional probability proves useful. One can define LCP(c):= $P(X = x_c \mid Y = y_c)$ as the (conditional) probability that a random variable X (here, real-estate fund index returns) has a realisation equal to, or below, its c%-percentile under the condition that, at the same time, another random variable Y (here, money, stock, and bond market returns, respectively) has a realisation equal to, or below, its c%- percentile. UCP := $P(X = x_c \mid Y = y_c)$ can be defined equivalently. If X and Y are two independent random variables, the conditional probability LCP(c) := P(X

[16] Determining the structure of dependency in the tails of a bivariate distribution requires higher frequency data than available here. For structural measures of extreme dependencies see *Malevergne* and *Sornette* (2002).

$= x_c \mid Y = y_c$) is equal to the absolute probability P($X = x_c$) that X has a realisation below, or equal to, x_c, and equivalently, $P(X = x_c \mid Y = y_c) = P(X = x_c)$. The LCP(c) and UCP(c) do not, per se, allow for inferences about the statistical dependence and independence of two random variables. Nevertheless, LCP(c) and UCP(c) are useful measures to quantify the risk and opportunity that, e.g., given that one asset market is in bad (good) condition, the other is too.

The conditional probabilities, LCP(c) and UCP(c), can be estimated through the corresponding conditional frequencies, eLCP(c) and eUCP(c). It should be mentioned that the e.CP's are estimations of the true .CP's. Due to the small monthly database, these estimations have high standard errors. So, the eCP's should be interpreted carefully.

In Table 16, the (conditional) relative frequencies for the considered real-estate fund index returns are tabulated to be equal to, or lower (higher) than, their 5%, 50%, 90%, and 95% percentile returns, under the condition that the corresponding stock and bond market returns respectively satisfy the same conditions.

As can be seen from Table 16, the eLCP (10) and eLCP (5) for the real-estate fund index are of considerable magnitude, depending on the bond market, i.e. in months where the bond market returns are low to very low, there is also a considerably high probability that the real-estate fund index returns are also relatively low to very low. In other words, open-ended real-estate funds often cannot provide a perfect alternative investment in times of poor bond market performance.

Table 16: Conditional Relative Frequencies in Several Percentiles of the Monthly Nominal Real-Estate Funds Index Return Distribution (1975 - 2002)

	eLCP(5%)	eLCP(10%)	eUCP(10%)	eUCP(5%)
Cash	0.00	15.15	20.59	22.22
Bonds	23.53	33.33	26.47	27.78
Stocks	5.88	12.12	23.53	11.11

Notes: All numbers are in percent.

Interestingly, despite the high correlation between the real-estate fund index and the money market (see Table 11), the eLCPs are low. The probability of a poor or very poor real-estate fund performance is low to zero, if the money market performs poorly or very poorly. In other words, in times of poor money market performance, real-estate funds may provide an alternative investment. Nearly the same can also be observed, if the real-estate fund index returns are conditioned on the stock market returns.

No significant difference can be observed for the eUCP(10%)s, and eUCP(5%)s, i.e. the relative frequencies that the real-estate fund index performance is good or very good, conditioned on a good or very good money, bond, or stock market performance. All eUCP(10%)s and eUCP(5%)s are about 25%, which indicates that there is a considerable probability for a good or very good real-estate fund performance if the money, bond, or stock market performance is also good or very good. The only exception is the eUCP(5%) conditioned on the stock market, which is about 11%.

Again, a consideration of the purely random component of the real-estate fund index returns and money market returns carried out in Table 17 shows interesting changes, relative to the case of full returns.

Table 17: Conditional Relative Frequencies in Several Percentiles of the Monthly Nominal Real-Estate Fund Index Residual Return Distribution (1975 - 2002)

	eLCP(5%)	eLCP(10%)	eUCP(10%)	eUCP(5%)
Cash	29.41	36.11	42.86	21.05
Bonds	17.65	32.35	37.14	33.33
Stocks	17.65	8.82	22.86	0.00

Notes: All numbers are in percent. For the real-estate funds index returns and the money market returns the (AR) residual time series was used.

Obviously, while the full return eLCPs for the real-estate fund index returns conditioned on the money market were relatively low, they are much higher considering the pure random components of returns only. eLCP(10%) and eLCP(5%) are now 36.11% and 29.41%, respectively, indicating that there is actually a substantially higher probability for poor or very poor real-estate fund index performance, if money market performance is also poor or very poor.

Also noteworthy is the very high eUCP(10%) of the pure random return component of the real-estate fund index conditioned on the bond markets' pure random return component. While the eUCP(10%) for full returns was 20.59%, it increases significantly to 42.86%, using only the pure random component of returns. The same can be observed for the eUCP(10%) of the pure random component of the real-estate fund index returns that are conditioned on the bond market.

4 Analysis of Long-Term Returns

4.1 Motivation

Analysing monthly and yearly returns, the previous sections showed that real-estate funds exhibit return characteristics that are different to that of other asset classes. Additionally, it was shown that real-estate funds are, to some extent, linked to the bond and money market. Furthermore, the short-term risk/return profile of investments in the money market is somehow similar to that of real-estate funds. Consequently, this section deals with two other important issues: first, the risk/return characteristics of real-estate fund investments for a long-term investor, and second, the possibility of tracking these long-term risk/return characteristics through simple portfolio strategies, using cash and bonds.

In the context of long-term investments, inflation is a main factor that negatively affects future consumption possibilities implied by an investment. Especially for pension investments, identifying assets that offer "insurance" against inflation risk is important, because they support a stable standard of living in the long run. Therefore, the following analyses will be based on real returns.

For analysing long-term risk/return characteristics of real-estate fund investments and replication possibilities, the multi-period development of real-estate funds, the money market, and bond market are considered in ex ante and ex post frameworks. More concretely, the risk and return development for the different asset categories, for holding periods between one and twenty years, are computed and compared with each other. We assume a buy-and-hold lump sum investment, i.e. rebalancing is not possible within the investment horizon.

Despite the traditional risk measure variance, the main focus is on shortfall risk measures. The use of such risk measures for evaluating the risk of the different investments is in line with other research, and with conventional wisdom.[17] Shortfall risk is associated with the possibility of "something bad happening", i.e. falling below a required target return. Returns below the target (losses) are considered to be undesirable or risky, while returns above the target (gains) are desirable or non-risky. Therefore, shortfall risk measures are called "relative" or "pure" measures of risk.

One key shortfall risk measure used here is the shortfall probability. In our context, let $r_0(k)$ be the cumulative continuously compounded real return of a lump sum investment, starting at time $t = 0$ and ending at time $t = k$. Then the shortfall probability, SP, of the investment is defined as

$$\mathrm{SP}(\, r_0(k)\,) = \mathrm{Prob}[\, r_0(k) < z_0(k)\,], \tag{3}$$

where $z_0(k)$ is the target (benchmark) return, which divides the total possible investment returns into gains or losses. In the following, $z_0(k) = 0$, i.e., risk is understood as losing the status quo of the real consumption level attainable at the beginning of the investment horizon (consumption shortfall).

Despite the popularity of this risk measure in the investment industry, it has the major shortcoming that it "completely ignores how large the potential shortfall might be" (c.f. Bodie 2001, p. 308). If the same investment strategy can be repeated many times, the shortfall probability only answers the question "how often" a loss might occur, but not "how bad" such a loss might be.

To provide information about the potential extent of a loss, we calculate the Mean Excess Loss (MEL) as an additional measure. Formally, this risk index also, known as conditional shortfall expectation, is defined as

$$\mathrm{MEL}(\, r_0(k)\,) = \mathrm{E}[\, z_0(k) - r_0(k) \mid r_0(k) < z_0(k)] \tag{4}$$

and it indicates the expected loss with respect to the benchmark, under the condition that a shortfall occurs. Therefore, given a loss, the MEL answers the question "how bad on average" the loss will be.[18] In this sense, the MEL can be considered a worst case-risk measure, since the measure only considers the consequences of the mean shortfall-level assuming that a shortfall happens.

A shortfall risk measure which connects the probability and the extent of the conditional shortfall in an intuitive way is the shortfall expectation (SE):

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[17] The concept of shortfall risk was introduced in finance by *Roy* (1952) and *Kataoka* (1963), and expanded and theoretically justified by *Bawa* (1975) and *Fishburn* (1977, 1982, 1984). It was widely applied to asset allocation by *Leibowitz* and *Kogelman* (1991) and used by *Asness* (1996), *Bodie* (1995), *Butler* and *Domian* (1991), *Leibowitz* and *Krasker* (1988) or *Zimmermann* (1991, 1993) to judge the long-term risk of stocks and bonds. Additionally, *Mao* (1970), *Libby* and *Fishburn* (1977), *Kahneman* and *Tversky* (1979), *Laughhuun*, *Payne* and *Crum* (1980) and *March* and *Shapira* (1987) show that, in empirical decision-making, many individuals judge the risk of an alternative, relative to a reference point. In real-estate literature, *Sing* and *Ong* (2000), and *Maurer* and *Reiner* (2002) employ the downside risk framework to the asset allocation decision with stocks, bonds and real estate.

[18] The MEL is closely connected with the Tail Conditional Expectation, which is given by TCE = $\mathrm{E}(R \mid R < z) = z - \mathrm{MEL}$. The TCE has some favourable features, e.g. it is (in contrast to the shortfall probability) a coherent risk measure with respect to the axioms developed by Artzner et al. (1999).

$$SE(\ r_0(k)\ ) = E[\max\{z_0(k) - r_0(k), 0\}] = SP{*}MEL \qquad \textbf{(5)}$$

The shortfall expectation is the probability-weighted sum of all potential shortfalls, and therefore, a measure of the unconditional „average loss“. As equation (3) shows, the mean shortfall level is simply the product of the shortfall probability and the mean level of shortfall given the occurrence of a shortfall.

In the remainder, for holding periods from one to twenty years, the risk and return characteristics of a buy-and-hold lump sum real-estate fund investment are evaluated assuming full reinvestment in the various index portfolios.

Beside management fees, investments in real-estate and other funds cause additional purchasing transaction costs, especially front-end loads, which reduce the terminal returns. Particularly for shorter holding periods, assuming zero transaction costs can lead to delusive results. To account for this problem, we assume purchasing transaction costs proportional to an assets' initial unit price of 5% for real-estate fund and stock market investments, 3% for a bond market investment, and 0% for a money market investment. The various purchasing transaction costs are subtracted from the holding period returns.

4.2 Ex Post Analysis

For the historical (ex post) analyses the mean returns and risk measures for the different investments are calculated solely from historical data over different (overlapping) investment period lengths. Thus, the ex post analysis does not make any explicit assumptions about the random patterns of returns.

Technically, the total period under consideration from 1975 to 2002 was divided into 28 (non-overlapping) one-year periods, 27 (overlapping) two-year periods, and so forth, ending with 8 (overlapping) twenty-year investment periods. Assuming a lump sum investment in the various portfolios under consideration at the beginning of each period, the cumulative real return of the initial investment was calculated for each possible period. Subsequently, using these historical cumulative returns of the respective investments, the mean return and the risk measures for the different investment alternatives for every specific period length can be computed. The results are presented in Table 18.

Table 18 shows that real-estate funds exhibit, on average, negative real returns and a high shortfall probability (78.57%) for one-year investment horizons. Both result from the relatively high purchasing transaction costs of real-estate funds. Nevertheless, for two-year and longer holding periods, the mean real return of real-estate funds is positive and increasing. Due to the relatively low return fluctuations, the shortfall probability, shortfall expectation, and mean excess loss for real-estate funds are rapidly decreasing, when shifting to longer holding period lengths. For four-year and longer holding periods, the shortfall probability and shortfall expectation, calculated from the historical data, are zero.

Comparing the money, bond, and stock market investments with the real-estate fund investment, it is obvious that the money market investment exhibits for shorter holding period lengths higher, and for longer holding period lengths lower mean returns than the real-estate funds. For five-year holding periods, the effect of having higher transaction costs for real-estate funds than for a money market investment is overcompensated by the higher mean returns of real-estate funds. Thus, for five-year and longer holding periods, the mean real return of real-estate funds is higher than the mean real return of the money market investment. The bond market investment, on the other hand, and especially the stock market investment, provide higher mean returns for all holding period lengths than the real-estate fund investment.

All-in-all, the long-term mean return of real-estate funds is between the mean real return of the money and bond market investment.

Table 18: Ex Post Risk and Return Profiles of Cumulative Real Returns (in %) for Different Holding Period Lengths (Target Return: Zero)

Investment Horizon (years)		1	2	3	4	5	10	15	20
Real-Estate Funds	Mean	-1.48	2.04	5.61	9.28	13.09	33.95	53.98	71.75
	STD	1.63	2.83	3.95	4.95	5.79	6.60	6.48	4.50
	SP	78.57	25.93	15.38	0	0	0	0	0
	SE	1.28	0.11	0.02	0	0	0	0	0
	MEL	1.62	0.43	0.12	-	-	-	-	-
Money Market	Mean	2.33	4.80	7.39	10.11	12.99	28.62	43.59	56.41
	STD	1.60	2.84	3.83	4.65	5.24	5.64	5.71	2.56
	SP	7.14	3.70	3.85	4.00	0	0	0	0
	SE	< 0.01	< 0.01	< 0.01	< 0.01	0	0	0	0
	MEL	0.04	0.04	0.02	< 0.01	-	-	-	-
Bond Market	Mean	1.30	5.36	9.35	13.14	17.38	40.81	60.55	83.33
	STD	5.39	7.67	9.69	10.75	10.92	5.63	11.25	8.23
	SP	35.71	22.22	15.38	12.00	8.33	0	0	0
	SE	0.61	0.31	0.17	0.07	0.01	0	0	0
	MEL	1.71	1.41	1.11	0.60	0.16	-	-	-
Stock Market	Mean	1.51	9.51	19.32	29.95	39.90	90.79	131.55	185.84
	STD	26.11	36.38	41.05	43.25	45.74	31.03	36.89	41.72
	SP	39.29	44.44	26.92	24.00	29.17	0.00	0.00	0.00
	SE	3.62	4.52	1.96	1.27	1.27	0.00	0.00	0.00
	MEL	9.21	10.16	7.29	5.31	4.35	0.00	0.00	0.00

Notes: All numbers are in percent. Average cumulative real return (Mean), volatility (STD), and shortfall risk measures of the different investments are calculated for holding periods between one and twenty years in the 1975/01 – 2002/12 period. SP is the shortfall probability, MEL is the mean excess loss, and SE is the shortfall expectation. Target return for the different shortfall risk measures is zero, i.e. here, a shortfall is defined as a negative real return. Front-end loads: 3% for bonds, 0% for money market, and 5% for real-estate funds and stocks.

Considering investment risk, the money market investment exhibits a much lower shortfall probability for one to three-year holding periods than the real-estate fund investment, which is also true for the shortfall expectation and mean excess loss. However even if the shortfall expectation and mean excess loss of the money market investments are very low for four-year holding periods, there is still a shortfall probability of 4%, while this was zero for the real-estate funds investment. The bond market investment displays high and persistent shortfall probabilities, shortfall expectations, and mean excess losses up to five-year or longer holding periods, which is also the case for the stock market investment. Additionally, the stock market investment shows relatively high shortfall probabilities and mean excess losses up to at least 5 years.

4.3 Ex Ante Analyses

4.3.1 Real Capital Maintenance

Although the ex post approach is common in studies about the risk and return characteristics of long-term investments, there is a fundamental drawback in applying this methodology. The holding period returns are derived - except for holding periods of one year - from overlapping periods. Therefore, the observed historical long-term holding period returns cannot be regarded as independent sample observations. Especially for small samples (i.e. long investment periods), the use of overlapping holding period returns can produce a considerable bias in estimating risk measures. The use of independent investment periods provides a better way to estimate risk measures from historical data. But the existing return history is generally too short to obtain a sufficient data basis, especially for long-term investment periods.

A possible solution to this problem is to specify an exogenous structure on the ex ante probability distribution, governing the financial uncertainty of future returns. The parameters to fit such a model can subsequently be estimated from historical (e.g., yearly) observations of real returns. With such a model, it is possible to look into the future and compute the risk measures we are interested in.

Applying several normality and serial correlation tests to the yearly real returns for the stock and bond market, neither deviations from normality and nor serial correlation could be detected on a statistically reliable level of confidence. Thus we assume that the real values of the bond and stock market investments can be modelled as a Geometric Brownian Motion, which is standard in financial economics and can be traced back to *Bachellier* (1900). This implies, that one-year real log returns r_t are iid, and normally distributed with parameters μ and s. Assuming purchasing transaction costs of $a > 0$ are proportional to the initial unit price of an asset at time $t = 0$, the mapping from single-period log returns to k-period real log return $r_0(k)$ = S r_t – ln(1+a) is straightforward, since all means and variances are scaled up by the same factor k. This implies that the multi-year real log return is normally distributed

$$r_0(k) \sim \mathrm{N}[\mu_0(k)\,,\, s_0(k)], \tag{4}$$

with an expected return $\mu_0(k)$ and standard deviation $s_0(k)$:

$$m_0(k) \;=\; m \cdot k - \ln(1+a) \quad \text{and} \quad s_o(k) \;=\; s \cdot \sqrt{k} \tag{5}$$

On the other hand, for the yearly real log returns for money market and real-estate fund investments, statistically significant positive first order serial correlation can be observed (see Table 6). Thus we assume that the continuous real returns of the money market and real-estate funds can be modelled through an AR(1)-processes with normal distributed residuals, i.e. $r_t = c + d \cdot r_{t-1} + \mathrm{e}_t$, with $\mathrm{e}_t \sim \mathrm{N}(0\,,\,\sigma_e)$. Hence, the continuously compounded one-year real returns r_t are also normally distributed with parameters $\mu = c/(1-d)$ and s = $[s_e^2/(1-d^2)]^{1/2}$. Considering again purchasing transaction costs of $a > 0$ proportional to the initial unit price of an asset at time $t = 0$, the continuously compounded (multi-year) real return $r_0(k)$ = S r_t – ln(1+a) is, again, normally distributed with:

$$m_o(k) \;=\; m \cdot k - \ln(1+a) \quad \text{and} \quad s_0(k) \;=\; s \cdot \sqrt{\left[k + 2\sum_{t=1}^{k}\sum_{s>t}^{k} d^{\,s-t}\right]}. \tag{6}$$

Since the multi-year real returns of all investments under consideration are assumed to be (multivariate) normally distributed, closed-form solutions for all shortfall risk measures applied here can be found. For the shortfall-probability, the closed-form solution is:

$$\mathrm{SP}(r_0(k)) \;=\; \mathrm{Prob}[r_0(k) \le z_0(k)] \;=\; \Phi\!\left(\frac{z_0(k) - m_0(k)}{s_0(k)}\right) \;=\; \Phi(m_n)\,, \tag{7}$$

where $m_n = [z_0(k) - \mu_0(k)] / s_0(k)$ and ϕ denotes the cumulative density function of the standard normal distribution. If f is the density function of the standard normal distribution, the shortfall expectation (see *Winkler, Roodman* and *Britney*, 1972) is:

$$\mathrm{SE}(r_0(k)) = [z_0(k) - z_0(k)] \cdot \Phi(m_n) + s_0(k) \cdot j(m_n). \tag{8}$$

Finally, combining equations (9) and (10) generates the mean excess loss expression:

$$\mathrm{MEL}(r_0(k)) = \frac{SE}{SP} = [z_0(k) - z_0(k)] + s_0(k) \cdot \frac{j(m_n)}{\Phi(m_n)}. \tag{9}$$

To estimate the required parameters, the sequence $\{r_t\}_{t=1,\dots,T}$ of continuous one-year real returns (before purchasing transaction costs) was used.

In the case of the bond and stock market investment, we assumed a Geometric Brownian Motion. The real continuous returns $r_t \sim N(\mu, s)$ are iid normally distributed. Thus, the required parameters can be estimated by their sample counterparts, i.e., the arithmetic sample mean and the adjusted sample standard deviation of yearly real continuous returns as reported in Table 2.

For the yearly real continuous returns of the real-estate fund and money market investment, an AR(1)-model was assumed: $r_t = c + d \cdot r_{t-1} + e_t$, with $e_t \sim N(0, s_e)$. For the real-estate funds' yearly real continuous returns, we estimated: $c = 0.017$, $d = 0.502$, and $s_e = 1.32\%$. For the yearly money market real log returns, we estimated $c = 0.009$, $d = 0.601$, and $s_e = 1.15\%$.

In Table 19 the real mean return, real volatility and the different shortfall risk measures (target real return is zero) for the respective buy-and-hold lump-sum investments are tabulated.

If the shortfall probability is stressed as risk measure, the risk of missing real capital maintenance decreases monotonously with an increasing investment period for all investments under consideration. However, the rate and extent of the risk reduction differs noticeably among the investments. Due to relatively high transaction costs of real-estate funds, compared to their relatively low yearly mean real return, real-estate funds exhibit a very high shortfall probability (83.3%) for one-year investment horizons. Nonetheless, the shortfall probability decreases rapidly for longer investment horizons and is lower than 1% for investment periods of five years and longer.

In contrast to the shortfall probability, the mean excess loss (MEL), for two-year and longer holding periods of all investment opportunities, increases steadily with the length of the investment period. This increase is slight for the real-estate fund investment, which exhibits a MEL of about 1.6% for two-year holding periods, and about 1.8% for twenty-year holding periods. For the money and bond market investment, the increase in MEL is moderate. While the money (bond) market investment exhibits a MEL of about 0.6% (3.9%) for one-year holding periods, this increases to about 2.9% (6.2%) for twenty-year holding periods. For the stock market investment, the increase of MEL through longer holding periods is high. The MEL is about 20.3% for an investment period of one year, while for a holding period of twenty years, this risk metric increases to about 60.1%. Hence, with respect to the magnitude of a potential shortfall, the popular argument that stocks are less risky in the long run than in the short is not true. This result concurs with the work of *Samuelson* (1963) about the fallacy of large numbers for the investment risk in the long run.

Regarding the shortfall expectation of the real-estate fund and bond market investment, the shortfall expectation gradually decreases with the length of the investment period. On the other hand, for the money and stock market investment, the shortfall probability increases for holding periods up to approximately 10 and 8 years respectively, and decreases thereafter. This is what *Leibowitz* and *Krasker* (1988) called risk-persistence (i.e., even for long-time horizons), the shortfall expectation remains at a substantially high level. In other words, the decreasing shortfall probability is (nearly) perfectly offset by an increasing conditional expected loss, if the length of the holding period increases. In contrast, the shortfall expectation for real-estate funds is close to zero if the holding period is longer than three years.

Table 19: Ex Ante Risk and Return Profiles of Cumulative Real Returns (in %) for Different Holding Period Lengths (Target Return: 0% p.a.)

Investment Horizon (years)		1	2	3	4	5	10	15	20
Real-Estate Funds	Mean	-1.48	1.92	5.33	8.73	12.13	29.14	46.15	63.16
	STD	1.53	2.65	3.59	4.39	5.10	7.81	9.81	11.46
	SP	83.33	23.36	6.87	2.35	0.87	0.01	< 0.01	< 0.01
	SE	1.61	0.36	0.11	0.04	0.01	< 0.01	< 0.01	< 0.01
	MEL	1.93	1.55	1.58	1.65	1.70	1.86	1.87	1.80
Money Market	Mean	2.33	4.66	6.99	9.32	11.65	23.30	34.96	46.61
	STD	1.44	2.57	3.55	4.42	5.20	8.20	10.42	12.24
	SP	5.23	3.48	2.46	1.75	1.25	0.22	0.04	0.01
	SE	0.03	0.04	0.03	0.03	0.02	0.01	< 0.01	< 0.01
	MEL	0.60	1.02	1.34	1.60	1.80	2.42	2.70	2.86
Bond Market	Mean	1.30	5.56	9.82	14.07	18.33	39.62	60.90	82.19
	STD	5.39	7.62	9.33	10.78	12.05	17.04	20.87	24.09
	SP	40.46	23.28	14.64	9.58	6.41	1.00	0.18	0.03
	SE	1.56	1.04	0.70	0.48	0.34	0.06	0.01	< 0.01
	MEL	3.86	4.45	4.81	5.06	5.25	5.77	6.03	6.17
Stock Market	Mean	1.51	7.90	14.29	20.68	27.07	59.03	90.98	122.93
	STD	26.11	36.93	45.23	52.23	58.39	82.58	101.14	116.78
	SP	47.69	41.53	37.60	34.60	32.14	23.74	18.42	14.62
	SE	9.68	11.12	11.79	12.11	12.22	11.51	10.16	8.79
	MEL	20.30	26.77	31.36	34.99	38.01	48.47	55.19	60.12

Notes: All numbers are in percent. Average cumulative real return (Mean), volatility (STD), and shortfall risk measures of the different investments are calculated for holding periods between one and twenty years. SP is the shortfall probability, MEL is the mean excess loss, and SE is the shortfall expectation. Target return for the different shortfall risk measures is zero, i.e. here a shortfall is defined as a negative real return. Front-end loads: 3% for bonds, 0% for money market, and 5% for real-estate funds and stocks.

Interestingly, if comparing the risk and return profile of the real-estate fund and money market investment, it can be seen that for shorter holding periods, i.e. one, two, and three years, there is a risk/return dominance of the money market investment. For these holding period lengths, the money market investment provides higher mean returns and lower risk (STD, SP, SE, MEL) than the real-estate fund investment. However for five-year and longer holding periods, the dominance relation is vice versa. Now the real-estate fund investment dominates the money market investment.

A comparison of the ex post results (Table 18) with the ex ante results (Table 19) shows that for short-term investment horizons, the ex ante risk measures do not differ significantly from their ex post counterparts. Nevertheless, the differences between ex ante and ex post shortfall-risk become larger within an increasing investment period. Therefore, employing overlapping historical return series substantially underestimates the level of volatility and shortfall risk in the long run.

4.3.2 Real Capital Growth

The previous analyses considered shortfall risk relative to the target of real capital maintenance. While real capital maintenance is a natural reference point for investors, the different investment alternatives showed considerable risk in missing this target. Additionally, since 1981, a growing market for inflation-linked bonds exists. These bonds are comparable with conventional bonds, however the interest rate and/or maturity value are fixed in real terms, i.e. these bonds guarantee a positive real interest rate. This raises the question about shortfall risk relative to a no-risk positive real return target. To study the effects of such a positive real return target, the shortfall probability, shortfall expectation, and mean excess loss of the different investments relative to the real target 1.5% p.a. have been tabulated in Table 20.

Table 20: Ex Ante Risk Profiles of Cumulative Real Returns (in %) for Different Holding Period Lengths (Target Return: 1.5% p.a.)

Investment Horizon (years)		1	2	3	4	5	10	15	20
Real-Estate Funds	SP	97.40	65.46	40.52	26.39	17.92	3.40	0.76	0.18
	SE	2.98	1.66	1.04	0.70	0.50	0.10	0.02	0.01
	MEL	3.06	2.54	2.57	2.67	2.76	3.08	3.23	3.32
Money Market	SP	27.89	25.62	23.87	22.33	20.91	15.24	11.28	8.46
	SE	0.25	0.40	0.50	0.57	0.61	0.65	0.57	0.47
	MEL	0.89	1.55	2.09	2.55	2.94	4.26	5.06	5.61
Bond Market	SP	51.39	36.74	28.32	22.56	18.31	7.33	3.23	1.48
	SE	2.24	1.92	1.64	1.41	1.20	0.56	0.26	0.13
	MEL	4.37	5.23	5.80	6.23	6.56	7.60	8.16	8.53
Stock Market	SP	49.97	44.70	41.40	38.90	36.84	29.65	24.86	21.25
	SE	10.41	12.40	13.55	14.29	14.78	15.47	14.98	14.10
	MEL	20.83	27.75	32.74	36.75	40.13	52.18	60.23	66.32

Notes: All numbers are in percent. The shortfall risk measures of the different investments are calculated for holding periods between one and twenty years. SP is the shortfall probability, MEL is the mean excess loss, and SE is the shortfall expectation. Target return for the different shortfall risk measures is 1.5% p.a. Front-end loads: 3% for bonds, 0% for money market, and 5% for real-estate funds and stocks.

Considering first the shortfall probability, it is clear that higher target returns lead to higher shortfall probabilities for all investments and all holding period lengths than was the case for the zero target. Additionally, the effect of decreasing shortfall probabilities for longer investment periods is much less than before. However, both effects of having a higher return target return are noticeably different for the various investments.

While the shortfall probabilities for the stock market investment are only slightly altered, the changes for the bond market are more apparent, yet still moderate. The strongest changes can be observed for the money market investment. For this, the shortfall probability for one-year investment horizons rise from approximately 5.2% to 27.9% for the target 1.5% real return. Additionally, the decrease of shortfall probabilities for longer holding periods is much weaker than for the other investments. For twenty-year holding periods the money market investment still exhibits a shortfall probability of about 8.5%, which was about 0% before. The effect of the higher real return target on the shortfall probability of the real-estate fund investment is also considerable strong, even if the effect is still weaker than for the money market investment. The shortfall probability for the real-estate fund investment is now 97.4% for one-year investment horizons, and rapidly decreases to about 0.2% for twenty-year investment horizons.

Considering the mean excess loss, using the target 1.5% real return consequently leads to higher MEL for all investments and all holding period lengths. Again the relative increase is comparably low for the stock and bond market investment, and relatively high for the money market and real-estate funds investment. The one-year holding period MEL for the real-estate funds increases by approximately 59% to the magnitude of 3.06%, the twenty-year holding period MEL increases about 84% to the magnitude of 3.32%. Despite this relatively high increase the MEL for the real-estate fund and money market investment is much lower than for the bond and especially the stock market investment.

Finally, the shortfall expectation of the different investments for all holding periods is higher than in the case of target zero. Again, the shortfall expectations for the stock and bond market investment are slightly altered. One the other hand, the shortfall expectation for the money market and real-estate fund investment, even so they are still relatively low, exhibit a relatively high increase for all holding periods. Additionally, although, in the case of the zero target, the shortfall expectation for the money market investment decreased for two-year and longer holding periods, it now increases for holding periods up to ten years.

4.4 Replicability the of Real-Estate Fund Performance

The previous sections showed that, for most holding period lengths, the bond market investment provided higher returns - accompanied by higher risk - than the real-estate funds. On the other hand, for short-term holding periods, the real-estate funds showed inferior risk return profiles relative to the money market, while the real-estate fund investment for medium and longer holding periods performed better. However, the weak short-holding period performance of real-estate funds is rather a consequence of the relatively high front-end loads than of low returns.

Now the following questions arise: can the risk return profile of real-estate funds be replicated by combined money and bond market investments? Which effect could lower front-end loads for real-estate funds have?

For this purpose, three simple buy-and-hold portfolios are considered with 25%/75% (portfolio 1), 50%/50% (portfolio 2), and 75%/25% (portfolio 3) investment weights in cash/bonds, respectively. The purchasing transaction costs for these portfolios are set to the weighted average of the purchasing transaction costs of a single money and bond market investment. These portfolios are compared by ex ante analyses with a pure real-estate funds investment, assuming again a 1.5% p.a. target real return for evaluating the shortfall risk measures. The results are given in Table 21.

Comparing the three simple replication portfolios with the 5% front-end load real-estate funds investment, it is obvious that none of the portfolios are able to simultaneously track the short and long-term risk/return profile of the funds investment exactly. Portfolio 1, which mainly consists of money market investments, exhibits lower shortfall risk (measured by SP, SE, and MEL) for holding period lengths, than the real-estate funds investment. Furthermore, portfolio 1 has also higher mean returns up to 5-year investment horizons; it also, however, has a higher volatility up to 3-year holding period lengths. Conversely, for holding periods longer than 5 years the real-estate funds provide higher mean returns.

On the other hand, the equally weighted money/bond market portfolio (portfolio 2) exhibits somewhat higher mean returns and volatilities than the real-estate funds. However the differences become smaller, the longer the investment horizon. Considering shortfall risk, portfolio 2 provides considerably lower shortfall probabilities and shortfall expectations for investment periods up to 15 years. Thereafter, the real-estate fund investment exhibits the lower shortfall probabilities and expectations, whereas they are, in any case, relatively low for both investments. Furthermore, portfolio 2 provides significantly higher and continuously increasing MEL than the real-estate funds investment.

Table 21: Ex Ante Risk and Return Profiles of Cumulative Real Returns (in %) for Different Holding Period Lengths (Target Return: 1.5% p.a.)

Investment Horizon (years)		1	2	3	4	5	10	15	20
Real-Estate Funds (5% Front end load)	Mean	-1.48	1.92	5.33	8.73	12.13	29.14	46.15	63.16
	Std.Dev.	1.53	2.65	3.59	4.39	5.10	7.81	9.81	11.46
	SP	97.40	65.46	40.52	26.39	17.92	3.40	0.76	0.18
	SE	2.98	1.66	1.04	0.70	0.50	0.10	0.02	0.01
	MEL	3.06	2.54	2.57	2.67	2.76	3.08	3.23	3.32
Real-Estate Funds (3% Front end load)	Mean	0.45	3.85	7.25	10.65	14.05	31.06	48.07	65.08
	Std.Dev.	1.53	2.65	3.59	4.39	5.10	7.81	9.81	11.46
	SP	75.27	37.11	21.88	14.25	9.76	1.91	0.43	0.10
	SE	1.27	0.68	0.45	0.32	0.23	0.05	0.01	0.00
	MEL	1.68	1.83	2.05	2.25	2.40	2.85	3.06	3.18
Portfolio 1 75% Cash / 25% Bonds	Mean	2.17	5.09	8.01	10.92	13.84	28.43	43.02	57.61
	Std.Dev.	2.12	3.00	3.67	4.24	4.74	6.70	8.21	9.48
	SP	37.38	24.06	16.74	12.05	8.84	2.16	0.58	0.17
	SE	0.55	0.42	0.33	0.25	0.19	0.05	0.02	< 0.01
	MEL	1.47	1.77	1.95	2.09	2.19	2.48	2.63	2.72
Portfolio 2 50% Cash / 50% Bonds	Mean	1.93	5.36	8.78	12.20	15.62	32.73	49.84	66.96
	Std.Dev.	3.21	4.54	5.57	6.43	7.19	10.16	12.45	14.37
	SP	44.50	30.04	21.93	16.56	12.75	3.95	1.35	0.48
	SE	1.07	0.87	0.70	0.56	0.46	0.16	0.06	0.02
	MEL	2.41	2.89	3.19	3.41	3.58	4.09	4.36	4.53
Portfolio 3 25% Cash / 75% Bonds	Mean	1.64	5.50	9.37	13.23	17.10	36.42	55.74	75.06
	Std.Dev.	4.33	6.13	7.50	8.67	9.69	13.70	16.78	19.38
	SP	48.62	34.01	25.69	20.06	15.96	5.81	2.33	0.97
	SE	1.65	1.39	1.16	0.97	0.81	0.34	0.15	0.06
	MEL	3.40	4.08	4.52	4.84	5.10	5.87	6.28	6.55

Notes: All numbers are in percent. Average cumulative real return (Mean), volatility (STD), and shortfall risk measures of the different investments are calculated, for holding periods between one and twenty years. SP is the shortfall probability, MEL is the mean excess loss, and SE is the shortfall expectation. Target return for the different shortfall risk measures is 1.5% p.a. Front-end loads: 3% for bonds, 0% for money market, 5% for stocks, and 5% (3%) for real-estate funds.

Finally the portfolio 3, which includes 75% bond market investments provides significantly higher mean returns and volatilities for all holding periods compared to the real-estate funds investment. While the MEL of portfolio 3 is always higher than for the real-estate fund investment, the shortfall probability up to 4-year holding periods and the shortfall expectation up to 2-year investment horizons for portfolio 3 are lower, than for the real-estate fund investment.

Especially for short-term investment horizons, the risk/return characteristics of the replication portfolios tend to be more favourable than the risk/return profile of the real-estate fund investment, even if they are not dominant. For longer-term investment horizons, the 75%/25% portfolio (portfolio 1) best fits the real-estate fund investments risk/return profile. However, there are still significant differences remaining, suggesting that the risk/return profile of real-estate funds cannot be easily replicated by simple cash/bond portfolio strategies.

5 Conclusion

German real-estate mutual funds play a major role in the German market for securitised real-estate investments. However, not much literature concerning their short and long-term financial characteristics exists. The aim of this paper was to demonstrate the special financial characteristics of these funds and to compare them with other major asset classes, like money market instruments, bonds, and stocks. For this purpose, a capital-weighted real-estate fund index comprising all traded German real-estate funds over the time period of January 1975 to December 2002 was constructed.

In the context of a short-term returns analysis, monthly and yearly return time series of the various index portfolios, which represent the different asset classes, were scrutinised in univariate and multivariate settings.

Univariate analyses showed that the German real-estate mutual funds clearly exhibit different risk/return-characteristics compared to stocks and bonds. In each case, their return volatility was significantly lower than volatility of stocks and bonds, but at the expense of lower returns. Mean returns, as well as return volatilities of the real-estate funds, were found to be more stable over time than those of the other asset classes. Additionally, open-end real-estate funds exhibited significant serial correlation in their returns. Further analyses showed that this serial correlation is probably partially attributable to the influence of inflation rates on real-estate funds returns. Like real-estate markets, a cyclical behaviour with cycle lengths of about 11 to 13 years was observed for all real-estate funds. Worst-case analyses showed that real-estate funds are as risk-free, in a worst-case framework, as cash; they even outperform cash with a high probability.

Multivariate analyses showed that there are no significant correlations between real-estate funds and the stock market. However, due to considerable liquidity holdings of open-end real-estate funds, a significantly positive correlation to the bond and money markets could be detected. Correlations were also found to considerably fluctuate over different periods in time.

Within the framework of an analysis of long-term returns, the study was extended to period lengths of up to 20 years, and additionally, shortfall risk measures were employed. Due to the major impact of inflation in the long-term, the focus was on real returns. In contrast to the short-term analysis, purchasing transaction costs were accounted for in this section. Besides ex post and ex ante risk/return comparisons between real-estate funds and the other asset classes, one aspect was the replication the of real-estate funds' risk/return characteristics by using cash and bond investments.

In the ex ante analysis stochastic processes were specified to simulate (future) asset performance. With respect to the shortfall probability, the ex ante results equal the ex post results. The MEL, however, is not successively decreasing, but increasing from a 2-year to a 20-year horizon. Here too, the long-term risk of real-estate is much lower than that of the other asset classes.

When trying to replicate the risk/return profile of real-estate funds by simple portfolios of cash and bonds, these portfolios tend to show more favourable characteristics than the real-estate funds in the short term. For longer time horizons, a portfolio of 75% cash and 25% bonds could somewhat approximate the risk/return profile of the real-estate funds, although clear differences remained.

All in all, this study showed that in order to be profitable, investments in real-estate funds have to be long-term. In the short term, investments in other asset classes are more favourable and possibly dominant. Only with an investment horizon of five or more years can the real-estate funds recover from the drawback of high front-end loads. Early disinvestments will likely result in capital losses. However, an investor holding real-estate fund units can, if he needs to quickly liquidate his assets, easily ask for redemption and, therefore, circumvent possible liquidity discounts.

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