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Inflation Risk Analysis of European Real Estate Securities

by

Raimond Maurer and Steffen Sebastian

Summary

Real estate is an important asset, but as a direct investment subject to several difficulties. Shares of public open end funds or of real estate stock corporations represent a possible way for an investor to avoid these problems. The focus of this paper is the analysis of inflation risk of European real estate securities. An overview of the institutional frameworks regarding these companies is given. The returns of real estate securities in France, Germany, Switzerland and the United Kingdom are examined for the period 1980:1-1998:12. Besides the classical *Fama/Schwert*-approach, shortfall risk measurements have been used. In this context, transaction costs in particular have been taken into account.

JEL classification: G11, G15

1. Introduction

One of inventors' essential aims is to protect their assets against inflation-triggered depreciation in real terms. In doing so, the investor faces the problem of future changes of the general price level (inflation rate) being uncertain from an ex ante point of view. Thus, the real return of investments is uncertain, even for those investments whose nominal cash-flows are contractually fixed, as for example zero bonds. Real estate is traditionally regarded as investment vehicle with a low inflation risk. Intuitively, this can be justified by the fact that all nominal returns of a real estate investment, such as rents or selling prices, can be negotiated anew. Hence, the investor has the possibility of adjusting the returns of his investment to increases in the general price level. Especially in times of drastic inflation, as occurred in Europe after both World Wars for example, this inflation protection characteristic becomes apparent. This argumentation is supported by a whole string of empirical studies. Although they differ in their conceptual as well as methodological approaches, most of the studies come to the conclusion that real estate evinces good inflation protection features, even in times of moderate inflation.[1]

However, for an ordinary private investor a direct acquisition of property may be problematic due to the large amounts of investment necessary, as well as high transaction costs. An alternative for avoiding these disadvantages of direct investments might be the acquisition of shares in investment companies specialized in real estate investment. These investment companies appear at international finance centers as open or close real estate investment trusts (REIT) or as real estate stock corporations. The inflation protection characteristics of shares in US-American Real Estate Investment Trusts (REITs) have been dealt with in many empirical studies.[2] However, for the European market only a few studies focusing on inflation protection features exist, although the existence of real estate companies has a long tradition in various European countries. Moreover, inflation has been a significant problem in Europe in the past. Therefore, the focus of this paper is the analysis of inflation risks of real estate companies in

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1) For US-American real estates see for example *Fama/Schwert* (1977), *Hoag* (1980), *Gyouko/Linneman* (1988), *Hartzell/Hekman/Miles* (1988), *Hamelink/Hoesli/MacGregor* (1997) or *Miles/Mahoney* (1997). *Felderer/Rippin* (1994) concentrate on inflation protection features of real estate direct investments in Germany.

2) See for example *Gyourko/Linneman* (1988), *Park/Mullineaux/Chew* (1990) or *Yobaccio/Rubens/Ketcham* (1995).

Germany, France, Switzerland and the United Kingdom which are countries with highly developed financial markets for real estate securities.

The study is structured as follows: in section two the institutional frameworks for real estate companies in the countries considered are described as well as the importance of real estate companies in these countries. Section three deals within the traditional *Fama/Schwert* approach with the hedging effectivity of real estate companies against risks of inflation. In section four the inflation protection features in the context of shortfall risk measures is analyzed. The final section summarizes the main results of the paper.

2. Real Estate Companies in Europe

2.1. History

In Europe, real estate companies have a long tradition. In the 19th century the industrial revolution created a dramatic rise in demand for housing for the workers near the business locations. Furthermore, the development of the stock exchanges in London and Paris helped to found listed residential building companies as institutional investors. Many of the companies founded in those days are still listed today, e.g. the founding of *British Land* dates back to 1856. The founding of real estate companies in the 20th century, too, was caused by an increased demand for housing. Especially in France, Germany and the United Kingdom both the devastation of World War II and the repatriations as a consequence of the independence of former colonies gave rise to the increased demand for housing.

In the second half of this century, all countries considered in this paper (France, Germany, Switzerland and United Kingdom) established specific supervisory and tax law regulations for real estate companies that specialized in the investment of private capital. The objective of these regulations has been to protect investors on the one hand and provide a fiscally equal treatment of direct investors and buyers of shares of real estate companies on the other hand. Comparable to US-American REITs, these companies have the possibility of distributing gains to their investors without corporate taxation. To do so, they have to meet specific requirements such as sources of earnings, structure of the assets and organization of the dividend policy. Investment companies exist in open or closed-end structure, some have the possibility of applying for official quotation.

In any of the examined countries, apart from these investment trusts, a certain number of stock corporations act as real estate investment companies. In general, they are not submitted to any special regulation or tax treatment. Many of today's companies were not originally founded as real estate companies. Frequently, the company's origin lies in mining or heavy industry. But since these industries were no longer able to achieve sufficient yield with their core business, they concentrated on managing their considerable real estate property.[3] A further possibility for the emergence of real estate companies was when companies or groups spun off their real estate property into an independent company.[4] Some of these companies are listed on stock markets and are in widespread share-holdings. Because of that, some shares have high liquidity given a sufficient daily turnover at the stock markets. Since there are no special supervisory or tax law regulations for these companies, they are subjected to the same taxes on income and property as all other stock corporations. On the other hand, their investment and management activities are not limited.

2.2. Characteristics in France, Germany, Switzerland and the United Kingdom

In this section the essential supervisory and tax law regulations of real estate investment funds are outlined for France, Germany, Switzerland and the United Kingdom. Here only open investment funds as well as listed companies have been taken into consideration.

- **France**

In 1958 the *Société Immobilière d'Investissment* (SII) was founded for residential building companies in France to support the procurement of capital. Comparable to the US-American REITs the SII were freed from corporate income taxation, as long as they met particular

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3) In Germany for instance, the *Hamborner AG* emerged from the *Hamborner Bergbau.* In France today's *Foncière de Piemont* emerged from the former *Manufacture de Faiences du Moulin de Loups.*

4) See *Scharpenack/Nack/Haub* (1998), pp. 681-684.

conditions. Above all, these conditions regulated the structure of the assets, the sources of taxable income and the dividend policy. For example, at least 75% of the total floor space had to be housing in France. The earliest possible date to sell real property was 10 years after the purchase, 75% of the sales revenues had to be re-invested into residential property. Furthermore, 85% of the annual profit had to be distributed to the shareholders.[5] For non-residental real estate, a complementary institution to the SII was the *Sociétés Immobilières pour le Commerce et l'Industrie* (SICOMI). To attain special tax treatment, requirements comparable to the SIIs had to be fulfilled.[6] Both institutions were designed as closed-end funds with the shares issued mainly as stocks. During the property crises at the beginning of the 1990s the promotion of real estate investment was cut back substantially. Tax privileges were reduced gradually in the period from 1991-1995. Today all companies have given up their status as tax privileged investment companies.

- **German real estate trusts**

In Germany, the open-ended real estate funds (*offene Immobilienfonds*) are fiscally transparent investment trusts. Their legal framework is codified in the law about investment trusts, Kapitalanlagengesetz (KAGG). For protection of the investors, the tax privilege is attached to restrictions concerning the business activity.[7] For legal reasons, stock exchange trading of open-ended funds is not possible.[8] But the investors can ask for redemption of their investment fund shares at any time. Therefore the investment companies have to publish daily redemption prices, that are based on the market value of the underlying assets (§ 21 KAGG). To determine the market value, all financial assets (i.e. fixed-interest securities, money market papers) are valued on the basis of their current market prices. The estimation of current market values of the real estates are based on advisories' valuations (§ 34 KAGG). To maintain the open-ended principle, the German real estate funds continuously offer new shares to the public. The issue prices are calculated on the basis of the redemption prices plus an offering premium at the rate of usually 5 %. The offering premiums are primarily raised to cover sales costs. For competitive

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5) See *Laux/Ohl* (1988), p. 132; *Chauchard* (1993), p. 6; *IEIF* (1996), pp. 4-7.

6) See *Cohen* (1990), p. 10.

7) §§ 27 - 28 KAGG require that e.g. the assets of a fund must consist of at least ten pieces of real estate; only 20% of the real estate may be vacant lots.

8) See *Laux/Ohl* (1988), p. 28f.

reasons, security funds increasingly abstain from offering premiums. This is not the case with real estate funds, mainly because these transaction costs build an effective barrier which makes frequent transaction with shares unattractive.[9] Avoiding permanent changes of the funds capital is essential for real estate trust because they cannot buy and sell their asset continuously.[10] Additionally, to be able to meet the repurchase guaranty any time and to be able to invest money for short-terms, German real estate trusts typically held 25-50% of the total funds assets in fixed-interest securities.

- **German real estate stock corporations**

In Germany, as a matter of principle, there is no special tax treatment for real estate stock corporations, but the yields of companies which exclusively manage real estate, are not burdened with trade profit tax. Capital gains on properties are taxed, but if the company replaces the sold property with another object in the same fiscal year, taxation is deferred.[11] Since 1996, real estate corporations increasingly have become the focus of both investors and analysts. The capitalization increased about 50 % between 1996 and 1998. Nevertheless, the volume of real estate corporation is still noticeably smaller than the volume of open-ended real estate funds.

- **Switzerland**

The Swiss market for embodied real estate investment is especially characterized by so-called open-ended real estate funds (*offene Immobilienfonds*). The investment restrictions are comparable to the corresponding regulations in Germany.[12] Still, compared to the German investment products Swiss open-ended real estate funds are different in terms of structure. First of all, Swiss real estate funds are not fiscally transparent, but are subject to taxes on income and capital.[13] Secondly, investment companies in Switzerland are not obliged to redeem shares at

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9) Moreover, according to § 36 KAGG the investment company is allowed to refuse a redemption for one or even two years in situations of difficult market situations. But since the launching of the first open--ended real estate funds, the *iii Nr. 1* in 1959, no investment company has made use of this right. Furthermore, in order to stabilize capitalization, the funds management do usually not sell high amounts to institutional investors.

10) See *Rosenberg/Sack* (1975).

11) § 9 Nr.1 Gewerbesteuergesetz, § 6b Einkommensteuergesetz.

12) § 36-37 Anlagefondsgesetz (AFG) in combination with § 46-48 AFV (Anlagefondsverordnung).

13) See *Hess/Sigg* (1997), p.87.

any time. An investor has to meet a twelve months period of notice to the end of a year to call in his shares. Accordingly, an issue of new shares can only take place as an ordinary capital increase with the consent of the majority of shareholders. To compensate for the disadvantage of the long period of notice, the depository bank is obliged to act as a market maker, that is, to guarantee that the shares are traded on a regular basis. This may be obtained by a quotation at a stock exchange (§§ 41, 42 AFG).[14] All in all, due to their real shape, Swiss open-ended real estate funds are not open-ended funds. On account of their limited possibilities of redemption, they are called "semi closed-ended funds".[15] Non-open-ended real estate corporations often show a very low market capitalization. By the end of 1998, only one company was listed with an investment volume comparable to those of the funds.[16]

- **United Kingdom**

As in Germany, in the United Kingdom there are both open-ended real estate funds (*property unit trusts*) and real estate corporations without any specific legal form (*property companies*). Property unit trusts are specialized funds only accessible to institutional investors. Quoted property companies are subject to corporation income taxes at a level between 23 % and 31 %, depending on their corporate structure and the amount of profit. Realised profit due to increases in value are subject to tax, but reductions for inflation-losses during the holding period are possible.[17] Besides renting many companies act as developers and work with leverage on a considerable scale.[18]

2.3. Construction of Index Portfolios

For the following analysis, it has been necessary to determine the return of representative portfolios of real estate investment companies. Since real estate investment trusts have clear legal forms due to supervisory restrictions, these trusts were only examined with regard to

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14) See *Den Otter* (1996), pp. 79-81.

15) See *Hoesli* (1993), pp. 27-32.

16) *Intershop Holding AG*, see *Global Property Research* (1998), pp. 198-199.

17) See *Barkham/Geltner* (1995), p. 28, *Global Property Research* (1998), p. 240.

18) See *Barkham* (1995), p. 377.

sufficient market capitalization and liquidity during the investigation period from 1980-1998. Other companies were only chosen if they qualified on account of their main business activity being investment. Traders and developers were explicitly excluded. To identify suitable investment companies in Germany, France and The United Kingdom, the business activities of more than 200 companies were examined on the basis of whether or not their main nature of business was rentals from royalties of real estate. For the study, the annual financial statements of the potential companies were analyzed in the light of various criteria such as specification of the business activity, proportion of the rental and tenancy income of the annual turnover, etc. In addition, the companies were interviewed if they considered themselves real estate investment companies and for how long. Furthermore, national analysts were interviewed.

For Switzerland, the *ISB Bopp*-Index was used, which consists of the ten largest open-ended real estate funds. For Germany, open-ended real estate funds and listed stock corporations were recorded separately because of their fundamentally differing characteristics. For the French companies it was not necessary to distinguish between the legal forms of the companies. One reason for this was that the legal forms of SII and SICOMI no longer existed for a part of the investigation period. Secondly, all companies under consideration are listed stock corporations. For the United Kingdom only property companies were examined since unit trusts are not directly accessible for private investors.[19] Return and capitalization data had been provided by *Bundesverband Deutscher Investment-Gesellschaften*, *Datastream* and *Société de Bourse de France*. The following table summarizes the institutional aspects above illustrated and shows the number and the market capitalization of the European real estate investment companies selected by means of the said criteria.

19) For a study of the inflation hedge characteristics of these companies see *Liu/Hartzell/Hoesli* (1997).

Table 1: Portfolios of selected European real estate securities (end 1998)

	France	Germany		Switzerland	United Kingdom
type of company	closed-end	open-end	closed-end	"semi closed-end"	closed-end
listed	yes	no	yes	yes	yes
fiscally transparent	no	yes	no	no	yes
market capitalization in billions of Euro	8.3	43.1	7.7	4.8	33
number of companies	20	16	22	10	39

Source: *Bundesverband Deutscher Investment Gesellschaften, Datastream, ISB Bopp AG.*

For each company i the dividend and capital measurement adjusted monthly returns $R_{i,t}$ were determined for each of the t = 1, ..., 228 months of the investigation period from 1980:1 to 1998:12. Dividend tax burdens were not taken into consideration. For each of the five types of real estate investment company a monthly portfolio return was determined according to:

$$R_{P,t} = \sum_{i=1}^{n_t} x_{i,t} R_{i,t} \tag{1}$$

Here n_t stands for the number of companies within the portfolio in month t and $x_{i,t}$ for the portfolio weight of company i in month t (with $\sum x_{i,t} = 1$). For each country considered we constructed one equal weighted index portfolio ($x_{i,t} = 1/n_t$) and one capital weighted index portfolio.[20] Table 2 gives descriptive statistics of the respective time series.

20) To this end, we determined the portfolio weights in accordance with the relative free float shareholdings at the beginning of each year.

Table 2: Descriptive statistics of index portfolios for European real estate investment securities

	capital weighted index portfolio					equal weighted index portfolio				
	$\overline{R}$	STD	ρ_1	ρ_2	ρ_{12}	$\overline{R}$	STD	ρ_1	ρ_2	ρ_{12}
France	0.78	5.18	0.28*	0.25	0.00	0.70	4.62	0.34*	0.20	0.00
Germany open-end funds	0.59	0.22	0.39*	0.35*	0.37*	0.52	0.20	0.40*	0.32*	0.43*
Germany stock corporations	1.17	4.83	0.24*	0.00	0.00	1.07	3.62	0.25*	0.10	0.13
Switzerland	0.62	2.19	0.25*	0.10	0.00	0.69	2.09	0.33*	0.12	0.00
United Kingdom	1.14	6.00	0.06	0.00	-0.20	1.12	5.36	0.20*	0.1	-0.10

$\overline{R}$ is the arithmetic mean (in % p.m.), STD the standard derivation and ρ_k the autocorrelation of lag k of the 228 monthly returns in the period 1980:1-1998:12. Values marked with "*" are statistically significant at the 5% level according to the Q-statistic of *Ljung/Box* (1979).

In comparison to all other index portfolios the extremely low volatility as well as the consistently high positive autocorrelation of the returns of the open-ended German real estate funds are striking. The monthly volatility of the capital-weighted Swiss index portfolio (2.19%) is nearly ten times higher than that of German real estate funds (0.22%). This can be explained by the fact that, due to a lack of stock exchange trading, short-term volatility at the capital markets influence the share prices of open-ended real estate funds only to a very small extent. Only financial investments (fixed-interest securities, money market instruments) are priced with the current stock exchange price and thus depend on short-term capital market volatility. By contrast, current market values of real estate is based on expert opinions. Revaluations of real estate are made as a rule only every twelve month. Thus, resulting monthly variations of shares, is caused by value changes of the financial investments on the one hand and on the other hand by the reevaluation of singular real estate assets. It is obvious that due to this asynchronous and temporally aggregated processing of relevant information, short-term fluctuations in value at the real estate and capital markets do not influence the share prices of the funds in the same extends as for quoted property companies.

3. Hedging effectivity of real estate companies against risks of inflation

3.1 Introduction

The inflation hedge capacity of real estate companies was analyzed in a large number of empirical studies especially in the US-American real estate literature.[21] From a conceptual point of view, most of these studies are based on a causal perception of risk. Here the uncertainty of the future real rate of return of an investment is traced back to different factors of risk - such as changing of the inflation rate. In this sense, the less an investment is influenced by the changing of the inflation rate, the less risky the investment is.[22] This means an investment is a perfect hedge against inflation when an (uncertain) change of the general price level leads to a change of the (uncertain) nominal rate of return in the same amount and direction.

If we state that the general price level of a country in time t can be measured by an appropriate consumer price index[23] (CPI), then the continuous compounded inflation rate for the period t is

$$\pi_t = \ln(CPI_t) - \ln(CPI_{t-1}). \qquad \textbf{(2)}$$

The correlation between the nominal rate of return and the inflation rate is a ad hoc-measure for the hedging effectivity of the examined real estate investment companies. The following table gives the coefficients of correlation of the continuous nominal returns with the corresponding inflation rate for the index portfolios in the different countries.

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21) See for example *Gyourko/Linneman* (1988), *Park/Mullineaux/Chew* (1990) or *Yobaccio/Rubens/Ketcham* (1995).

22) For this argumentation see *Bodie* (1976), p. 460.

23) For France, Switzerland and the United Kingdom the inflation rates had been corrected for seasonality (see *Cleveland/Tiao* 1976). The following price indices have been used: France: Indice de Prix (ensemble de menages), *Institut National de la Statistique et des Etudes Economiques*; Germany: Saisonbereinigter Preisindex für die Lebenshaltung aller Haushalte in Westdeutschland, *Statistisches Bundesamt*; Switzerland: Landesindex der Konsumentenpreise (Totalindex), *Bundesamt für Statistik*; United Kingdom: UK Retail Price Index, *Office for National Statistics*.

Table 3: Correlations of nominal returns and inflation rate for 1980:1-1998:12.

	capital weighted portfolios		equal weighted portfolios	
	monthly returns	quarterly returns	monthly returns	quarterly returns
France	-0.01	0.01	0.03	0.06
Germany real estate trusts	-0.04	-0.08	-0.07	-0.11
Germany real estate companies	0.18*	0.24*	0.23*	0.27*
Switzerland	-0.01	-0.02	-0.03	-0.05
United Kingdom	0.03	-0.01	0.01	-0.03

The values of *Pearson's* correlation coefficient marked with "*" are according to *Anderson* (1984, p. 109) statistically different from zero at the 5% level.

The results as given in table 3 show that the returns from some quoted companies are negatively correlated with the inflation rate, although in no case are the results statistically different from zero at a 5% level. On the contrary, the correlation parameters for nominal return of German real estate trusts are significant and positive. Therefore, the hedging effectivity of quoted real estate shares in this context will be rated as low, whereas those of German open end real estate trusts will be rated as high.

3.2 Analysis in the context of the *Fama/Schwert*-approach

Based on a modified version of the so-called *Fisher* equation, *Fama/Schwert* (1977) show that in efficient capital markets, the equilibrium price of any risky asset will be determined in such a way that the expected nominal return will be equal to the expected real rate of return plus the expected rate of inflation (given a certain level of information):

$$E(R) = E(R^{real}) + E(\pi). \qquad \textbf{(3)}$$

The *Fisher* hypothesis means that the expected real rate of return of any available asset will be mainly determined by real economy factors and not by the expected rate of inflation. If this hypothesis is valid, the anticipated inflation rate and the real rate of return will be independent values, without regards to the general equilibrium model. Under this assumption, the hedging effectivity of an asset can be examined in the context of the following regression model:

$$R_t = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 (\pi_t - \pi_t^e) + U_t \qquad \textbf{(4)}$$

where R_t is the nominal return on asset in period t, π_t the inflation rate, π^e_t the expected rate of inflation at t-1 until t and U_t is white noise with $E(U_t) = 0$. The regression parameter γ_1 gives information about the hedging potential of an investment against changes in the expected rate of inflation.[24] If $\gamma_1 = 1$, the nominal rate of return changes (on average) in the same amount as the anticipated inflation, i.e. the investment is a perfect hedge against anticipated inflation. If $0 < \gamma_1 < 1$, the hedging capabilities are less than proportional, and if $\gamma_1 > 1$ more than proportional. Furthermore, if the hypothesis $\gamma_1 < 0$ can not be rejected the investment will be rated as negative hedge against inflation risks. Then a short position will protect against inflation. The seconds regressor of the model above (π - π^e_t) is not based on the *Fisher* hypothesis, but will show information[25] about the sensitivity of the nominal rate of return of an investment against the unexpected part of the inflation rate. If the related regression parameter γ_2 is not statistically different from 1, the corresponding investment will not hedge perfectly against the unexpected inflation. Finally, if the hypothesis $\gamma_1 = \gamma_2 = 1$ cannot be rejected, then the investment is a perfect inflation hedge. Thus, the real rate of return will be uncorrelated with the inflation rate.

3.3 Empirical results

The regression model as mentioned above is now estimated for the 228 month of the period 1980:1-1998:12 with the one-month returns of a capital weighted portfolio of the different types of real estate investment companies as dependent variable. As proxy of the unknown anticipated rate of return, a time series model was used to determine the expected rate of return in t from the

24) Furthermore the regression model estimates the hypothesis that the examined capital market is efficient respectively such that the *Fisher* relationship is valid. In this case the regression parameter γ_1 should not be significantly different from 1, see *Fama/Schwert* (1977), pp. 116-117.

25) *Fama/Schwert* (1977, p. 117) note that the elemination of (π - π^e_t) from the regression model will not achieve better results in the light of the *Fisher*-Hypotheses, because the unexpected part of inflation is by definition uncorrelated with the anticipated inflation.

historical inflation rates of periods *t*-1, *t*-2, ...[26] Table 4 contains the estimation results for the different regression models.

Table 4: Results of regression analyzes of capital weighted index portfolios

	γ_0 (t_0)	γ_1 (t_1)	γ_2 (t_2)	R^2	$\rho_1(U)$ (Q_1)	$\rho_2(U)$ (Q_2)	$\rho_{12}(U)$ (Q_{12})
France	0.002 (-0.658)	0.622 (-0.511)	-2.395* (-2.006)	0.011	0.287* (-19.085)	0.258* (-34.539)	-0.501 (-46.042)
Germany real estate trusts	0.004* (-13.464)	0.776* (-5.829)	-0.025 (-0.400)	0.16	0.264* (-16.126)	0,205* (-25.896)	0,271* (-118.100)
Germany real estate companies	0.018* (-2.398)	-3.074 (-1,175)	-0.143 (-0,086)	0.005	0.232* (-12.426)	-0.022 (-12.543)	0.002 (-20.719)
Switzerland	0.004 (-0.907)	0.729 (-0.485)	-0.19 (-0,475)	0.002	0.244* (-13.790)	0.104 (-16.322)	-0.051 (-23.853)
United Kingdom	0.008 (-0.888)	0.84 (-0.515)	0.106 (-0.111)	0.001	0.059 (-0.807)	-0.013 (-0.847)	-0.187 (-13.634)

The regression model $R_t = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 (\pi_t - \pi_t^e) + U_t$ was estimated for each of the five capital weighted index portfolios using monthly returns in the period 1980:1-1998:12. Therefore, expected inflation π^e was estimated with ARIMA time series model. The results of table 4 are OLS estimates based on monthly data for 1980:1-1998:12 where γ_j is the estimate for regression parameters j = 1,2,3. *Newey-West* (1987) procedure was used to correct *t*-statistics (in parentheses) for heteroscedasticity and autocorrelation. ρ_k represents the autocorrelation of lag k; Q_k is the *Ljung-Box* (1979) *Q*-statistics. All estimates marked with "*" are statistically different from zero at the 5% level.

Table 4 shows that securitized real estate in France, Switzerland and United Kingdom as well as German real estate trusts represent positive hedges against anticipated inflation. Thus, the German real estate companies seem to be a negative hedge. Therefore, all estimation with the exception of the German trusts are not statistically significant on the usual 5% level. As far as the unexpected inflation rate is concerned, only the British property companies show positive hedge characteristics, while for all other types γ_2 is negative. But only the parameter for the French index portfolio is significantly different from zero. Furthermore, the measure of goodness of fit R^2 is very low for all corporation types, with the exception of German real estate

26) Using the *Box/Jenkins*-procedure, the following model specifications proved to have the best in- and out-of-the-sample characteristics: France: monthly : ARIMA (1, 1, 1), quarterly: ARIMA (2, 1, 1); Germany: monthly ARIMA (1, 0, 1), quarterly ARIMA (2, 1, 0); Switzerland: monthly ARIMA (1, 0, 1), quarterly ARIMA (0, 1, 1).

trusts. The auto-correlation of residuals becomes insignificant for higher lags, again with the exception of German trusts where even the auto-correlation at lag twelve is significant and positive. Here we observe the result of different pricing in the context of the institutional framework as mentioned above.

In order to test the robustness of the results further regressions have been estimated. First, not only the period 1980-1998, but also the subsamples 1980-1984, 1985-1991 and 1992-1998 were examined. Furthermore, capital and equally weighted portfolios have been used as independent variables. Finally, as elaborated in *Fama/Gibbons* (1984) three models have been constructed as proxy for the unexpected inflation: (i) a time-series model (ii) a random-walk model (iii) a naive interest rate model.[27] In total, the regression model as defined above has been estimated for every type of securitized real estate with four time series of rates of return as the independent variable and three time series of inflation rates as regressor. For the results of these twelve regressions for each type and period, means and standard derivations as well as the number of significant parameters have been calculated. These values, as well as mean and standard derivation of R^2 are given in table 5:

27) For the naive interest rate model the expected rate of inflation has been predicted as the difference between the actual monthly (quarterly) interest rate and the arithmetic mean of the n preceding real rates of return: France: monthly $n = 4$, quarterly $n = 4$; Germany: monthly $n = 11$, quarterly $n = 11$; Switzerland: monthly $n = 23$, quarterly $n = 7$; United Kingdom: monthly $n = 12$, quarterly $n = 8$. The estimation of the time series model to anticipate the real interest rate with an ARIMA (0,0,1) determined the following coefficients for the MA-term: France: monthly 0.624, quarterly 0.531; Germany: monthly 0.857, quarterly 0.792; Switzerland: monthly 0.920, quarterly 0.874; United Kingdom: monthly 0.934, quarterly 0.804.

Table 5: Summary of regression analyzes

	period	$\overline{\gamma_1}$	STD (γ_1)	n°	$\overline{\gamma_2}$	STD (γ_2)	n°	$\overline{R^2}$	STD (R^2)
France	1980 - 1998	0.483	0.353	-	-0.983	0.740	1	0.005	0.004
	1980 - 1984	-3.819	0.880	8	-0.704	1.352	-	0.157	0.104
	1985 - 1991	4.933	1.549	-	-4.074	2.932	-	0.041	0.033
	1992 - 1998	-0.522	3.451	1	1.319	1.256	-	0.021	0.044
Germany real estate trusts	1980 - 1998	0.487	0.130	12	-0.051	0.088	-	0.224	0.096
	1980 - 1984	0.113	0.131	-	-0.212	0.093	6	0.203	0.153
	1985 - 1991	0.514	0.177	9	-0.030	0.108	-	0.190	0.139
	1992 - 1998	1.378	0.266	12	0.155	0.124	-	0.464	0.148
Germany real estate companies	1980 - 1998	-0.139	2.270	2	0.178	2.047	1	0.023	0.031
	1980 - 1984	0.076	3.273	-	-1.416	2.776	-	0.088	0.058
	1985 - 1991	0.129	1.553	-	0.414	2.236	-	0.033	0.047
	1992 - 1998	3.797	8.512	3	4.043	2.548	-	0.113	0.153
United Kingdom	1980 - 1998	-0.043	0.416	-	0.182	0.143	-	0.002	0.001
	1980 - 1984	1.025	1.077	-	0.969	0.971	-	0.041	0.014
	1985 - 1991	-3.674	2.174	-	-1.771	0.415	-	0.050	0.020
	1992 - 1998	-11.066	6.339	8	0.462	1.192	-	0.171	0.108
Switzerland	1980 - 1998	0.483	0.353	-	-0.983	0.740	-	0.005	0.004
	1980 - 1984	-3.819	0.880	8	-0.704	1.352	-	0.157	0.104
	1985 - 1991	4.933	1.549	-	-4.074	2.932	-	0.041	0.033
	1992 - 1998	-0.522	3.451	1	1.319	1.256	-	0.021	0.044

The regression model $R_t = \gamma_0 + \gamma_1\pi_t^e + \gamma_2(\pi_t - \pi_t^e) + U_t$ was estimated for each of the five types of investment companies in twelve different variations. The Table gives the means and the standard standard derivations (STD) of OLS estimates for expected inflation (γ_1), unexpected inflation (γ_2), goodness of fit (R^2) and the number(n°) of estimates statistically different from zero at the 5% level.

For France, Switzerland and the United Kingdom 8 of 12 model estimates had significant results. In all cases the means indicate perverse hedge characteristics against anticipated inflation. But, especially for the United Kingdom, the (average) value of the parameter γ_1 does not allow a reasonable economical interpretation. Furthermore, the standard derivation accounts for about 60% of the mean, which additionally indicates a lack of robustness for the result. For German real estate companies only 3 of 12 parameters in one subsample are significant, so that here as well no inflation hedge characteristics can be attributed. These results are consistent with other comparable studies of quoted real estate securities in Europe and the USA.[28] The results for German real estate trusts are significantly different. In the whole period as well as in the

28) For the USA see *Gyourko/Linneman* (1988), *Park/Mullineaux/Chew* (1990) and *Yobaccio/Rubens/Ketcham* (1995); for Europe see *Hoesli/Bender* (1992), *Hoesli et al.* (1996, 1997), *Liu/Hartzell/Hoesli* (1997), *Liu/Hartzell/Hoesli* (1997) and *Maurer/Sebastian* (1999).

subsamples 1980-1984 most or all of the regression parameters have been positive and statistically significant. In the period 1980-1984, no parameter was significant either for the German trusts. As far as the unexpected inflation is concerned, almost no results have been significant for the quoted real estate companies. For German real estate trusts, 6 of 12 regressions had significant parameters. Yet the mean of the parameters is negative, what indicates a perverse hedge.

In summery, significant and robust results could only be shown for German real estate trusts indicating that they may be a positive hedge against the anticipated part of inflation. For the unexpected inflation, no hedge characteristics could be found. Very few results for quoted real estate securities are significant, and in addition, the result showed a lack of robustness with regards to variations of examination design (i.e. method of inflation forecast, period, portfolio weighting).

4. Inflation Protection Features of Real Estate Investment Companies

4.1 Basics

Besides the inflation rate, there regularly exist other risk factors such as the level interest rates, exchange rates, economic conditions, etc, which influence the development of the return of an investment.[29] Now the question is, if, in empirical decisions the average private investor is interested in one particular risk component (e.g. inflation rate) or rather in the total risk of his investment. On the basis of a final understanding of risk *Reilly/Johnson/Smith* (1970, 1971), *Bodie* (1976) and as of late *Hamelink/Hoesli/MacGregor* (1997) suggest an alternative definition of inflation risk. According to this suggestion, the inflation risk implies the risk that the real return of an investment

$$R_t^r = R_t - \pi_t \tag{5}$$

29) See *Chen/Roll/Ross* (1986).

is negative at the end of a specific investment period *t*. Let R_t define the nominal return of the investment and π_t the difference between the price level of today till the point of time t. Such an intuitive understanding of risk as the danger of missing an exogenously determined target, is very common in decision-theoretical literature. For example *Mao* (1970), *Libby/Fishburn* (1977), *Kahneman/Tversky* (1979), *Laughhuun/Payne/Crum* (1980) or *March/Shapira* (1987) proved that whenever it comes to an empirical decision-making process, many individuals judge the risk of an alternative relative to a reference point. Especially *Fishburn* (1977, 1982, 1984) created a theoretical basis for loss measurements. In the insurance and banking literature shortfall risk measurements play an important role, especially so called Value-at-Risk approaches as a means of solvenceny control. In the investment literature, *Asness* (1996), *Bodie* (1995), *Butler/Domian* (1991), *Leibowitz/Krasker* (1988) or *Zimmermann* (1991, 1993) use shortfall approaches to judge the risks of stock and bond investments over various investment horizons.

4.2. Quantification of inflation protection features in the context of shortfall risk measures

Regarding a particular investment horizon, the risk of a negative real return becomes smaller the better the inflation protection features of the considered investment are. To be able to compare the inflation protection features of various investments as described above on a quantitative basis, one has to specify an appropriate risk measure. The focus of lower partial moments (LPM) as risk measures is the possibility of getting a return that is below some critical target specified by the investor. Returns below the target (losses) are considered to be undesirable or risky, while returns above the target (gains) are desirable or non-risky. In this sense, lower partial moments are called "relative" or "pure" measures of risk. Let R^r_t denote the random dependent real return of an investment, then the LPM is defined as:

$$\text{LPM}^n(z_t) = E[\max(z_t - R_t^r, 0)^n], \tag{6}$$

where z_t is the target return and $n \geq 0$ determines the weights attached to negative deviations from the target. *Fishburn* (1977) shows that by varying the degree *n* of the lower partial moments, the utility function defined can accurately reflect the preferences of an individual towards risk for below-target returns. Additionally *Fishburn* shows that there is a strong relationship between the LPM risk measurements and the concepts of stochastic dominance.

For the special case $z_t = 0$ (real value maintenance) and n = 0 we obtain the shortfall probability LPM^0 which only takes into consideration the probability but not the amount of negative deviations from the target return.[30] If the same investment strategy can be repeated many times, the shortfall probability answers the question "how often" and not "how badly" a loss occurs. Therefore, the shortfall probability is an appropriate risk index if even small negative deviations from the target lead to drastic consequences for the investor. However, if small negative deviations from the target are relatively harmless, the shortfall probability is an incomplete risk index due to neglect concerning the extent of the loss. If $n = 1$ we obtain the shortfall expectation LPM^1, a measure of the average loss amount. Thus the following mathematical equation is valid:

$$\mathrm{LPM}^1(z_t) = \mathrm{TCE}(z_t) \cdot \mathrm{LPM}^0(z_t), \qquad \textbf{(7)}$$

with the Tail Conditional Expectation $\mathrm{TCE}(z_t)$

$$\mathrm{TCE}(z_t) = \mathrm{E}[z_t - R_t^r \mid R_t^r < z_t] \qquad \textbf{(8)}$$

indicating the average loss amount under the condition that a shortfall is given.[31] In the sense of the formal features (axioms) of a good risk measure developed by *Artzner et al.* (1999) the TCE is in contrast to the shortfall probability a coherent risk measure.

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30) *Hoesli* (1993, pp. 122-128), *Hoesli* (1996) and *Hamelink/Hoesli/MacGregor* (1997) used the shortfall probability to examine inflation protection features of Swiss, American and British real estate investment companies.

31) See *Albrecht/Maurer* (2000), pp. 10-13.

4.3 Results of the Shortfall Analysis

On the basis of the shortfall risk measures introduced above, we compare inflation protection features of the index portfolios for the different types of real estate companies for holding periods from 1 to 19 years.[32] From a methodological point of view an empirical approach was chosen that does not have any explicit assumptions about the random patterns of the real return. On the other hand, risk measures are obtained on an analytical basis assuming that the real returns follow a geometric *Wiener*-Process. The starting point is a buy-and-hold investment strategy for the corresponding index portfolios whose construction is presented in section 2. For the open-ended real estate funds and the companies traded on a stock exchange respectively, we consider transaction costs while buying to the amount of 5% of the investment amount and 1% respectively.

•Empirical Approach

We have first subdivided the total investigation period from 1980-1998 into 19 one-year periods, 18 two-year-periods and so forth. Each of the (19*20)/2 = 190 periods can be interpreted as an individual investment period. Then, for each of the possible investment periods the continuous real return was calculated. As a proxy for the shortfall probability of a specific holding period the relative frequency of the periods with a negative real return was used. Correspondingly, the average below target return in case of a negative real return multiplied by the relative frequency of the loss periods was taken as a proxy for the shortfall expectation. The following table contains the average real returns as well as the empirical shortfall risk measures for the capital weighted index portfolios[33] for the different holding periods.

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32) See *Hamelink/Hoesli/MacGregor* (1997), pp. 66-69.

33) For the equally weighted index portfolios see appendix B.

Table 6: real returns μ and shortfall risks (in % p.a.) of capital weighted portfolios 1980-1998

length of investment (years)		1	2	3	4	5	10	15	19
France	mean	2.2	4.1	8.6	13	16.8	27.5	52.5	60.2
	LPM^0	42.1	38.9	47.1	37.5	26.7	20	-	-
	LPM^1	9.2	12.4	10	6.3	4.1	5.9	-	-
	TCE	21.9	31.9	21.2	16.8	15.5	29.5	-	-
Germany real estate trusts	mean	-0.2	4.5	9.6	14.7	19.8	44.7	69.3	83.2
	LPM^0	52.6	5.6	-	-	-	-	-	-
	LPM^1	0.7	0.1	-	-	-	-	-	-
	TCE	1.4	1.1	-	-	-	-	-	-
Germany real estate companies	mean	9.1	17.8	27	35.8	44.7	115.2	136.2	190.7
	LPM^0	42.1	27.8	23.5	25	13.3	-	-	-
	LPM^1	4	2.7	2.5	1	1.7	-	-	-
	TCE	9.5	9.8	10.5	4.1	13.1	-	-	-
United Kingdom	mean	5.2	12	19	26.3	32.7	58.8	100	116
	LPM^0	47.4	33.3	23.5	12.5	13.3	-	-	-
	LPM^1	6.6	7.6	5.4	4.4	2.7	-	-	-
	TCE	13.8	22.7	23	35.3	20.2	-	-	-
Switzerland	mean	3.4	8.5	13.5	18.3	22.5	42.9	69.4	82.8
	LPM^0	36.8	22.2	17.6	6.3	6.7	-	-	-
	LPM^1	3.1	2.1	1.1	0.6	0	-	-	-
	TCE	8.3	9.4	6.5	9.8	0.5	-	-	-

The shortfall probability of one year holding periods is relatively high for all corporate forms. Out of all, Swiss real estate stocks have the lowest shortfall probability (36.8 %) whereas German open-ended real estate funds have the highest (52.6 %). The high shortfall frequency of the open-ended investment funds is a result in particular of the comparably high transaction costs which arise with the purchase of the shares. The corresponding figures for listed companies are due to their high return volatility. As soon as the amount of loss is also taken into account, noticeable differences result. Here, German open-ended real estate funds show substantially lower risk values than listed real estate investment companies. Of all listed companies, the Swiss funds show the lowest average loss with a LPM^1-value of 3.1 %. However, this is still 4.4 times higher than the risk value of the German open-ended funds. Regarding the TCE-measure, listed companies have an exposure to risk that is 6 times higher than the exposure of listed funds. If the empirical shortfall probability and the shortfall average are taken as risk measures, the risk to miss real capital maintenance decreases with an increasing investment period for all index portfolios. However, the rate and the extent of the risk reduction noticeably differ among the various company types. For example, for the German open-ended real estate funds at an investment period of more than two years, no negative real returns can be seen. For Swiss companies the same is true for investment periods of more than five years. In France, this effect does not occur until an investment period of ten years. Regarding the development of the empirical TCE-measurement, no systematic conclusions for listed companies can be drawn.

• Analytical Approach

However, the above empirical approach for quantifying shortfall risks results in the problem that the used returns are derived from gradually overlapping periods, except the one-year returns. This implicates a high autocorrelation of the rolling returns. Especially for long investment periods this can cause considerable distortions. The use of independent periods guarantees a much better quality for the estimation. But the existing return history is far too short to obtain a sufficient data basis, especially for long-term investment periods.[34]

It would be an alternative to specify an appropriate probability theoretical model for the development of prices and returns with parameters determined from independent observations. Then, the respective risk measures could be obtained analytically or by stochastic simulation respectively. Following the approach of *Leibowitz/Krasker* (1988) and *Zimmermann* (1993) the standard model of mathematical finance implies that all inflation-adjusted prices of the index portfolios considered follows a geometric *Brown*ian motion with constant drift and diffusion. This standard hypothesis implies a normal distribution of the (continuous) returns so that an analytic study of the shortfall risk measurements is possible.[35] The following table contains the relevant shortfall risk measurements according to the investment period:

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34) See *Navon* (1998, p. 67) who commented: "We mere mortals live only one life. And we haven't had sufficient ten-, twenty- or thirty year periods that are independent of another to derive statistically significant conclusions from history."

35) For the mathematical derivations and the estimators for the relevant parameters see appendix A.

Table 7: real returns μ and shortfall risks (in % p.a.) of capital weighted portfolios in 1980-1998

length of investment (years)		1	2	3	4	5	10	15	19
France	μ	2.2	5.4	8.7	11.9	15.1	31.2	47.3	60.2
	LPM^0	46.6	44.2	42.5	41.1	39.9	35.4	32.1	30.0
	LPM^1	9.4	12.3	14.2	15.6	16.7	19.9	21.4	21.9
	TCE	20.2	27.8	33.4	38.0	41.9	56.3	66.4	72.9
Germany real estate trusts	μ	-0.2	4.4	9	13.7	18.3	41.5	64.7	83.2
	LPM^0	56.2	2.3	0	0	0	-	-	-
	LPM^1	0.8	0	0	0	0	-	-	-
	TCE	1.3	0.8	0.7	0.6	0.6	-	-	-
Germany real estate companies	μ	9.1	19.2	29.3	39.4	49.5	99.9	150.4	190.7
	LPM^0	34.3	27.4	22.7	19.1	16.3	8.1	4.3	2.6
	LPM^1	5.2	5.4	5.1	4.8	4.4	2.6	1.5	1.0
	TCE	15.1	19.6	22.6	24.9	26.7	32.4	35.6	37.4
United Kingdom	μ	3.4	7.8	12.2	16.6	21.1	43.1	65.2	82.8
	LPM^0	39.6	33.5	29.3	26.1	23.4	14.7	9.7	7.2
	LPM^1	3.6	4.1	4.1	4.1	4.0	3.1	2.3	1.8
	TCE	9.2	12.1	14.1	15.7	17.0	21.1	23.7	25.1
Switzerland	μ	5.2	11.3	17.5	23.6	29.8	60.6	91.4	116.0
	LPM^0	40.8	36.0	32.6	29.8	27.5	19.5	14.5	11.6
	LPM^1	6.6	7.7	8.2	8.4	8.4	7.6	6.4	5.5
	TCE	16.0	21.5	25.3	28.2	30.7	39.1	44.4	47.5

Per constructionem, the expected values are the same as in table 6 for all holding periods. Furthermore, for short-term investment periods the analytical risk measurements do not significantly differ from their empirical counterparts. Even, still, the course of both the shortfall probability and the shortfall expectation is a monotonous decrease in the lapse of time. Nevertheless, the differences for listed real estate investment companies become larger within an increasing investment period. At the same time, the level of the analytic LPM^0 and LPM^1 measures are substantially higher than those of the empirically derived values. For example, the probability of a negative real return for the British index portfolio is 14.5 % for an investment period of 15 years. For the same portfolio table 6 shows a value of zero for an investment period of only 8 years. Consequently, the inflation protection features of listed real estate investment companies are positively. Regarding the worst case risk measure TCE, this becomes extremely obvious. Given a shortfall, i.e. the real capital maintenance missed, the average loss amounts of the listed real estate companies considerably increased.

5. Summery and Conclusions

In this study, portfolios of European real estate companies have been analyzed according to their inflation risk. In accordance with a causal understanding of risk, we followed a regression approach and analyzed it empirically in various forms. The German open-ended real estate funds showed significant and robust inflation hedge characteristics against the anticipated inflation rate. For all other companies, no statistically reliable results were obtained.

On the basis of a final understanding of risk, we analyzed portfolio returns in the context of a shortfall approach. Therefore the shortfall probability, the shortfall expectation and the tale condition expectation were both empirically calculated and theoretically derived on the basis of a normal distribution. In all, both the empirical and the theoretical shortfall analyzes show a substantially lower shortfall risk for a negative real return on German open-ended real estate funds than listed real estate investment companies. This is especially true for middle- and long-term investment periods. Looking at the average real returns one can easily see that, except for France, in accordance with the capital market theory higher inflation risks are compensated by higher return potentials.

Appendix A: Analytical Evaluation of Shortfall-Risk Measures

In this appendix we have developed analytical formulas which can be used to calculate the expected value, the first two lower partial moments and the TCE according to shortfall inflation risk over different investment periods. For this purpose we assume that the real price process (i.e adjusted for inflation) of an investment $\{P_t;\ t \geq 0\}$ with start value p_0 follows a geometric *Wiener*-process with constant drift u and constant diffusion s. In this case the random price of the investment P_t at time $t > 0$ is lognormally distributed (see *Hull* 1993, p.210), i.e. $P_t \sim \mathrm{LN}(m_t, v_t)$, with parameters $m_t = \ln(p_0) + (u - s^2/2)t$ and $v_t = s\sqrt{t}$. If transaction costs in the case of buying the investment of ap_0 $(a > 0)$ are taken into consideration, the continuous return of the investment

$$R_t = \ln(P_t) - \ln(p_0) \qquad \textbf{(A1)}$$

is normally distributed $R_t \sim \mathrm{N}(\mu_t, \sigma_t)$ with expected return $\mu_t = (u - s^2/2)t - \ln(1 + a)$ and volatility $\sigma_t = s\sqrt{t}$. Let z_t denote the target (benchmark) return, then we obtain for the shortfall-probability at time $t \geq 0$

$$\mathrm{LPM}^0(R_t, z_t) = \mathrm{P}(R_t \leq z_t) = \Phi\left(\frac{z_t - \mu_t}{\sigma_t}\right) = \Phi(m_N). \qquad \textbf{(A2)}$$

where $m_N = (z_t - \mu_t) / \sigma_t$ and Φ denotes the distribution function of the standard normal distribution. If $\varphi(x)$ is the density function of the standard normal distribution we obtain with *Winkler/Roodman/Britney* (1972) for the shortfall-expectation:

$$\begin{aligned} \mathrm{LPM}^1(R_t, z_t) &= \mathrm{E}[\max(z_t - R_t, 0)] \\ &= (z_t - \mu_t)\Phi(m_N) + \sigma_t\varphi(m_N). \end{aligned} \qquad \textbf{(A3)}$$

Finally, combining (A1) and (A2) we have for the Tail Conditional Expectation

$$\mathrm{TCE}(R_t, z_t) = \mathrm{E}[(z_t - R_t \mid R_t < z_t)] = \frac{\mathrm{LPM}^1(R_t, z_t)}{\mathrm{LPM}^0(R_t, z_t)} \qquad \textbf{(A4)}$$

The starting point for the statistical estimation of the parameters of a *Wiener*-process is the sequence $\{x_t\}_{t=1,\dots,T}$ of yearly continuous returns, i.e. $x_t = \ln(p_t) - \ln(p_{t-1})$ being a realization of corresponding sequence of i.i.d. random variables $\{X_t\}_{t=1,\dots,T}$. In the case of a geometrical *Wiener*-process $X_t \sim N(u, s)$ is normally distributed. Therefore (see *Hull* 1993, p. 215)

$$\hat{u} = \bar{x} = \frac{1}{T}\sum_{t=1}^{T} x_t \qquad \textbf{(A5)}$$

is a distribution free and unbiased sample estimator for the drift parameter and

$$\hat{s} = s_x = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(x_t - \bar{x})^2} \qquad \textbf{(A6)}$$

for the diffusion parameter. The estimations of the parameters for the corresponding real rates of return are given in the following table (in % p.a.):

	capital weighted portfolio		capital weighted portfolio	
	$\hat{u}$	$\hat{s}$	$\hat{u}$	$\hat{s}$
France	3.22	26.35	2.58	24.26
Germany real estate trusts	4.64	1.56	3.63	1.48
Germany real estate companies	10.09	22.55	9.44	16.79
Switzerland	4.41	12.98	5.33	12.97
United Kingdom	6.16	22.3	6.35	25.23

Appendix B1: equally weighted portfolios - empirical approach

length of investment (years)		1	2	3	4	5	10	15	19
France	mean	1.6	2.6	5.2	7.9	10.2	14.6	32.7	47.9
	LPM^0	52.6	44.4	47.1	43.8	46.7	30.0	-	-
	LPM^1	8.9	12.0	10.2	7.6	9.7	11.2	-	-
	TCE	17.0	27.0	21.8	17.3	20.8	37.2	-	-
Germany real estate trusts	mean	-1.2	2.5	6.4	10.4	14.3	32.9	52.7	64.2
	LPM^0	89.5	11.1	-	-	-	-	-	-
	LPM^1	1.3	0.2	-	-	-	-	-	-
	TCE	1.5	2.0	-	-	-	-	-	-
Germany real estate companies	mean	8.4	18.2	28.5	40.1	51.8	125.9	157.3	178.3
	LPM^0	47.4	27.8	17.6	-	-	-	-	-
	LPM^1	1.7	1.5	1.1	-	-	-	-	-
	TCE	3.6	5.4	6.4	-	-	-	-	-
Switzerland	mean	4.3	10.5	16.5	22.2	27.5	53.4	84.3	100.3
	LPM^0	36.8	16.7	11.8	6.3	-	-	-	-
	LPM^1	2.9	1.9	0.9	0.1	-	-	-	-
	TCE	7.8	11.2	8.0	1.2	-	-	-	-
United Kingdom	mean	5.4	12.0	19.1	26.4	33.2	57.3	101.6	119.7
	LPM^0	47.4	33.3	17.6	12.5	13.3	-	-	-
	LPM^1	7.3	9.2	7.6	6.1	4.5	-	-	-
	TCE	15.4	27.6	42.8	49.1	34.0	-	-	-

Appendix B2: equally weighted portfolios - analytical approach

length of investment (years)		1	2	3	4	5	10	15	19
France	mean	1.6	4.2	6.7	9.3	11.9	24.8	37.6	47.9
	LPM^0	47.4	45.2	43.6	42.4	41.3	37.3	34.4	32.5
	LPM^1	8.9	11.7	13.6	15.1	16.2	19.8	21.6	22.5
	TCE	18.8	25.9	31.2	35.5	39.2	53	62.8	69.1
Germany real estate trusts	mean	-1.2	2.4	6.0	9.7	13.3	31.5	49.6	64.2
	LPM^0	80.0	12.7	0.9	0.1	0.0	0.0	-	-
	LPM^1	1.4	0.1	0.0	0.0	0	0.0	-	-
	TCE	1.8	1.0	0.9	0.8	0.7	0.5	-	-
Germany real estate companies	mean	8.4	17.9	27.3	36.8	46.2	93.4	140.6	178.3
	LPM^0	30.8	22.6	17.4	13.7	10.9	3.9	1.5	0.7
	LPM^1	3.3	3.1	2.7	2.3	2.0	0.8	0.4	0.2
	TCE	10.8	13.7	15.6	17.0	18.1	21.4	23.1	24.1
Switzerland	mean	4.3	9.7	15.0	20.3	25.7	52.3	79.0	100.3
	LPM^0	36.9	29.9	25.2	21.7	18.8	10.1	5.8	3.8
	LPM^1	3.3	3.5	3.4	3.2	3.0	2.0	1.2	0.9
	TCE	8.9	11.6	13.4	14.8	15.9	19.5	21.5	22.7
United Kingdom	mean	5.4	11.7	18.1	24.4	30.8	62.5	94.3	119.7
	LPM^0	41.6	37.1	34.0	31.4	29.3	21.7	16.7	13.8
	LPM^1	7.6	9.1	9.9	10.2	10.4	9.9	8.7	7.7
	TCE	18.3	24.6	29.1	32.6	35.5	45.6	52.0	55.9

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