Inflation Risk Analysis of European Real Estate Securities

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Abstract The focus of this article is the analysis of the inflation risk of European real estate securities. Following both a causal and a final understanding of risk, the analysis is twofold. First, to examine the causal influence of inflation on short- and long-term asset returns, different regression approaches are employed based on the methodology of Fama and Schwert (1977). Hedging capacities against expected inflation are found only for German open-end funds. Secondly, different shortfall risk measures are used to study whether an investment in European real estate securities protects against a negative real return at the end of a given investment period.

Introduction

Since the purpose of investment is eventual future consumption, there can be little doubt that one of investors' essential objectives is to hedge their assets against inflation-triggered depreciation in real terms. In doing so, the investor faces the problem of future changes in the general price level (*i.e.*, the inflation rate) being uncertain from an ex ante point of view. Thus, the real return of an investment is uncertain, even for those 'safe assets' whose nominal cash-flow is certain, as for example default-free zero coupon bonds with a maturity equal to the length of the investment period. In most of the developed countries throughout the world inflation rates have been relatively low during the last decade, but this does not imply that the risk of inflationary erosion is unimportant for investors. Looking at the accumulation of assets, even low inflation rates on average could have high effects on the consumption level at the end of a long-term investment horizon. As the world's population ages over the next decades, unfunded defined-benefit pension plans, like most of the traditional social security systems in Europe, are being converted into funded defined contribution plans based on self-directed personal investment accounts. While funded systems have many advantages, the greater individual investment choices also pose greater potential risk. For example, in public social security plans, the benefits to the retirees are usually indexed to annual changes in the consumer price index (*i.e.*, insulated from inflation risk). In contrast, in private pension accounts the benefits to a retiree during the post-retirement phase of the life cycle could be exposed to inflation risk depending on the assets he or she has purchased at the moment of retirement (Brown, Mitchell and Poterba, 2001).

Traditionally, there is a general belief that real estate is an investment vehicle with low inflation risk. Intuitively, this can be justified by the fact that the nominal cash flow of a real estate investment, such as rent or selling prices, can be negotiated anew. Hence, the investor has the possibility of adjusting the nominal cash flow of the investment to increases in the general price level. Many empirical studies (*e.g.*, Fama and Schwert, 1977; Hoag, 1980; Fogler, Granito and Smith, 1985; Hartzell, Hekman and Miles, 1987; Gyouko and Linneman, 1988; Limmack and Ward, 1988; Hamelink, Hoesli and MacGregor, 1997; or Miles and Mahoney, 1997; among others) have found that representatives of well-diversified property portfolios display good inflation hedging characteristics, especially during periods of high inflation. In contrast, empirical results (*e.g.*, Fama and Schwert, 1977; Gultekin, 1983; and Barnes, Boyd and Smith, 1999) do not support the hypothesis that stock-portfolios are a good hedge against inflation. However, because of some adverse features of direct property investments, the possibility of creating and managing a well-diversified property portfolio is in practice limited to large institutional investors (*i.e.*, banks, pension funds or insurance companies). As Hoesli and MacGregor (2000) and Seiler, Webb and Myer (2001) point out, these problematic features include the large lot size of property investments, the lack of a central market where continuous information on property transaction is provided, the existence of high transaction costs, liquidity, the need for local market knowledge and the management requirements of direct property investments.

For smaller investors, one possibility to overcome these drawbacks of direct property investments might be to purchase units of property investment companies, which is the focus of this study. Property investment companies appear at international finance centers in different types, with respect to their legal form, their governance structure and their tax considerations. The basic idea of such an indirect property investment vehicle is to collect money via offering securities paid by many, in general private investors, and to invest this money in a portfolio of income-producing properties, such as housing, commercial properties or both. The units of property investment companies are liquid in the sense that they are traded on an active secondary market, or that investors can ask for redemption of their holdings to net-asset value prices at any point in time. In addition, securitization of real estate investments introduces disclosure requirements about risk and return, which enables investors to make financial decisions on the basis of comparable information as with stocks and bonds. A critical question, which has been the centerpiece of numerous empirical studies, is whether the returns of these financial claims ''backed'' by real-estate related assets exhibit comparable inflation hedging characteristics, as do direct property investments (see Park, Mullineaux and Chew, 1990).

The term ''inflation risk'' can be defined in mainly two different (but not mutually exclusive) ways, which results in distinct methodological approaches for examining the exposure to inflation risk of physical and/or financial assets (Bodie, 1975, 1995). The first approach, which is called inflation hedging, considers the co-movements of inflation rates and asset returns from period to period. In this sense, the less the real return of an investment is influenced by the inflation rate, the better the inflation hedging effectiveness of the investment is. This means an investment is a perfect hedge against inflation if a ceteris paribus change of the consumer price level leads to an equal change of the nominal rate of return. Based on a generalization of the well known hypothesis presented by Fisher (1930), in conjunction with assuming efficient capital markets in equilibrium, Fama and Schwert (1977) provide a theoretical foundation as well as an operational method based on regression analysis, which is widely used in literature to empirically test the inflation hedging effectiveness of assets. Following this line, the bulk of the empirical work, with respect to this definition of inflation hedging, generally uses (more or less sophisticated) regression models, with the nominal rate of return on property shares as the left-hand and an appropriate measure of the (total, expected and/or unexpected) inflation rate as the right-hand variable. The closer the estimated regression coefficient of the inflation rate is equal to one, the better the inflation hedging effectiveness of the asset.

A major shortcoming of the traditional approach to measuring the inflation hedging effectiveness of an investment is that only a part of the total variance of the return distribution is taken into consideration. Fama and Schwert (1977) already pointed out that non-inflation risk factors can generate variation in nominal returns, which can be largely relative to the variation associated with the rate of inflation. From the viewpoint of empirical decision making, it is questionable whether the average private investor is interested in one particular risk factor (*i.e.*, co-movements between asset return and inflation rates) or rather in the total risk of the investment. Most investors seek investments that offer 'insurance' against inflation risk, which in turn means the possibility of a negative real rate of return at the end of a given investment period, stemming from all risk sources, and not only from inflation. An alternative approach—called inflation protection—to examine the inflation risk of an asset, considers the downside-risk that the real return of the asset is lower than a specific target return (*e.g.*, zero) at the end of a given investment period. Accordingly, in order to examine the inflation protection effectiveness of different real estate investment vehicles in the United States and the United Kingdom, Hamelink, Hoesli and MacGregor (1997) calculate the shortfall-probability that the real return for various holding periods is negative. A shortcoming of this risk-metric is that it only takes into consideration the probability, but not the amount of negative deviations from the target return. However, there are substantial theoretical and empirical arguments in favor of the fact that in financial decision making investors take both the probability and the amount of a possible shortfall into consideration.

Most of the empirical work concerning the inflation risk on indirect property investment vehicles has focused on American Real Estate Investment Trusts (REITs) by performing—in the context of correlation or regression analysis—statistical tests on the short-term relationship of the inflation rate and the nominal return (see Gyourko and Linneman, 1988; Park, Mullineaux and Chew (1990) or Yobaccio, Rubens and Ketcham, 1995; among others). The result of these studies was that REITs do not in general represent a good hedge against inflation. Despite the fact that real estate investment vehicles have a long tradition and a high market importance in Europe, comparatively little work about their inflation hedging ability exists. Studies dealing with this question are Hoesli and Bender (1992); Hoesli (1996) considering the case of Swiss, Hoesli, MacGregor, Matysiak and Nanthakumaran (1997); Liu, Hartzell and Hoesli (1997) the case of U.K. and Maurer and Sebastian (1999) the case of German property shares. Additionally, only little theoretical and empirical work (*e.g.*, Hamelink, Hoesli and MacGregor, 1997) has been done considering the second (shortfall) approach to examine the inflation risk of property investment companies.

The main objective of this study is to fill the gap in empirical work dealing with the inflation hedging effectiveness of property investment companies in Europe. Therefore, the study evaluates the inflation hedging features of property shares in Germany, France, Switzerland and the U.K., which is a fairly original database. The traditional regression approach enables a comparison of the results with the existing empirical literature on the short-term relationship between the nominal returns of indirect real estate investments and inflations rates. Furthermore, the shortfall-approach introduced by Hamelimk, Hoesli and MacGregor (1997) is extended with respect to additional shortfall-risk measures, which takes the probability and the extent of a shortfall into consideration.

The article is organized into six sections. The next section provides the institutional backgrounds and an overview of the market of real estate companies in the countries considered. The data used in the empirical analysis follows. Next, the traditional Fama and Schwert (1977) approach as well as the extension of Yobaccio, Rubens and Ketcham (1995) is discussed, followed by the different shortfall risk measures used to examine the inflation protection ability of real estate companies. The final section summarizes the main results of the study.

Real Estate Companies in Europe

The countries considered in this study (France, Germany, Switzerland and the U.K.) established specific supervisory and tax law regulations for real estate companies that specialize in the investment of private capital. The objective of these regulations is to protect investors on the one hand, and to provide a fiscally equal treatment of direct investors and buyers of shares of real estate companies on the other. Apart from these regulated schemes, a certain number of stock corporations act as real estate investment companies. In general, they are not subject to any special regulation or tax treatment. In this study, only investment schemes that can be held by private investors and offer the possibility of desinvesting by either being open-end or stock quoted are taken into consideration. The specific legal forms, tax considerations and governance structure differ substantially among the countries.

France

In 1958, the Société Immobilière d'Investissement (SII) was founded for residential building companies in France to support the procurement of capital. Like REITs in the U.S., the SII were freed from corporate income taxation, as long as they met particular conditions. For example, at least 75% of the real estate portfolio had to consist of housing in France. For non-residential real estate, a complementary institution to the SII was the Sociétés Immobilières pour le Commerce et l'Industrie (SICOMI). Both institutions were designed as closed-end funds with the shares issued mainly as quoted stocks. In the period from 1991 to 1995, tax privileges were reduced gradually. Today, all companies have given up their status as tax privileged investment companies.

German Open-end Real Estate Funds

In Germany, real estate mutual funds (offene Immobilienfonds) are fiscally transparent open-end investment funds. They are subject to a number of special rules codified in the Investment Companies Act (Gesetz über Kapitalanlagegesellschaften), which are supervised by the Federal Banking Supervisory Authority. Requirements of these rules are, among others, property appraisal by independent experts, risk diversification and restrictions concerning the business activity. A quotation on stock exchanges is not possible due to federal law, but investors can ask for redemption of their fund units at any time. Therefore the investment companies have to publish daily redemption prices based on the net asset value of the fund. 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 value of each property is only estimated in yearly intervals. The evaluation date is normally different for each property, so the total value is, at any moment, updated only in part. To maintain the open-end principle, the German real estate funds continuously offer new shares to the public. The issue prices are calculated as well on the basis of the net asset value plus an offering charge, which is usually 5%. The offering premiums are raised to cover sales costs. In addition, these transaction costs build an effective barrier, which makes frequent (motivated by short-term speculation or arbitrage) transaction with their units unattractive. For open-end real estate funds, it is essential to avoid frequent changes in the capital volume because—in contrast to security based open-end funds—real estate funds cannot buy and sell their properties continuously. To be able to meet the repurchase guaranty to unit holders any time and to be able to invest money for the short-term, German real estate funds typically hold 25%–50% of their assets in fixed-income securities.

German Corporate Real Estate Companies

In Germany, as a matter of principle, there is no special tax treatment and regulation for real estate companies. The capitalization of these stock quoted companies increased about 50% between 1996 and 1998. Nevertheless, the volume of real estate companies is still noticeably smaller than the volume of open-end real estate funds.

Switzerland

The Swiss market for embodied real estate investment is especially characterized by so-called open-end real estate funds (offene Immobilienfonds). The investment restrictions, codified in Par. 36–37 Anlagefondsgesetz (AFG) are comparable to the corresponding regulations in Germany. Still, Swiss open-end real estate funds are different in terms of structure. First of all, they are not fiscally transparent, but are subject to taxes on income and capital. Second, investment companies in Switzerland are not obliged to redeem shares at any time. An investor has to notice twelve months before end of the fiscal year to call in his shares. To compensate for the disadvantage of the long period of notice, the shares are usually quoted at the stock market. On account of their limited redemption possibilities, Hoesli (1993) characterized the Swiss real estate funds as ''semi closed-end.'' Stock quoted closed-end real estate corporations exist but still show a very low market capitalization and therefore will not be examined.

United Kingdom

In the U.K., both open-end real estate funds (property unit trusts), which are only accessible to institutional investors, and quoted real estate corporations (property companies) without any specific legal form exist. The latter are subject to corporation income taxes. Besides renting, some companies act as developers and work with leverage on a considerable scale (Barkham, 1995; and Barkham and Geltner, 1995).

Exhibit 1 summarizes the institutional aspects illustrated above and shows the market capitalization at the end of 2000 for the European real estate investment companies that will be examined further in this study.

Data Collection and Description

Return on Assets

For the following empirical studies, time series returns of index portfolios of real estate investment securities in Germany, France, Switzerland and the U.K. were used. Since REITs have clear legal forms due to supervisory restrictions, these trusts are only examined with regard to sufficient market capitalization and liquidity during the sample period from 1:1980 to 12:2000. Other companies only qualify if their main business activity is investment in housing and/or commercial

Exhibit 1 | Characteristics of European Real Estate Securities

	France	Germany		Switzerland	United Kingdom
Type of company	Closed-end	Open-end	Closed-end	Open-end	Closed-end
Listed on exchange	Yes	No	Yes	Yes	Yes
Supervision	No	Yes	No	Yes	No
Fiscally transparent	No	Yes	No	No	No
Market capitalization (in billions of Euro)	8.3	43.1	7.7	4.8	33

Notes: Table data ends in 2000. The source is Bundesverband Deutscher Investment-und Vermögensueswaltungsellschuften (BUI), Datastream, Lipper Schweiz AG.

properties. Traders and developers are explicitly excluded. To identify suitable investment securities with respect to these criteria in Germany, France and the U.K., the business activities of more than 200 companies have been examined on the basis of whether or not their main nature of business was rentals from real estate royalties. For this 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 and national analysts were interviewed as to whether and for which period of time a company's dominant activity can be considered real estate investment.

For Switzerland, the Swiss Real Estate Fund Index (formerly Lipper or ISB Bopp Index) is used, which consists of the ten largest Swiss real estate mutual funds. For Germany, open-end real estate funds and listed stock corporations are recorded separately because of their fundamentally differing legal and financial characteristics. This study does not distinguish between the legal forms of the companies for the French property securities. One reason for this is that the legal forms of SII and SICOMI no longer existed during part of the investigation period. Second, all companies under consideration are listed stock corporations. For the U.K., only property companies are examined, since unit trusts are not directly accessible for private investors.[1] Return and capitalization data have been provided by Bundesverband Deutscher Investment-und Vermögensueswaltungesellschuften (BUI), Datastream and Société de Bourse de France.

For each selected company i in the five categories of property investment company, the monthly nominal (pre-tax) returns $R_{i,t}$, adjusted for dividend payments, stock splits and new equity issues, are determined for the $t = 1, ..., 252$ months of the sample period. In addition, the monthly return of an index portfolio is 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 index portfolio in month t, and $x_{i,t}$ for the portfolio weight of company i in month t with $\Sigma x_{i,t} = 1$. In order to take market coverage into account, the market value of outstanding shares is used as portfolio weights at the beginning of each year. The indices could be representative of a well-diversified domestic index fund, which invests in the different real estate investment securities under consideration.

If a country's price level at time t can be measured by an appropriate consumer price index[2] (CPI), then the continuously compounded rate of inflation π_t from $t - 1$ to t is formally defined by $\pi_t = \ln(\mathrm{CPI}_t) - \ln(\mathrm{CPI}_{t-1})$. By taking the viewpoint of a domestic investor holding shares in the local real estate index portfolio, the real return is defined as the continuously compounded nominal return $R'_{P,t} = \ln(1 + R_{P,t})$ minus the observed inflation rate for the period, formally:

$$r_{P,t} = R'_{P,t} - \pi_t. \tag{2}$$

Statistical Properties of the Index Returns

Statistical properties of the nominal and real monthly returns for each of the five index portfolios are reported in Exhibit 2.

Looking at the mean returns, standard deviations and sample autocorrelations presented in Exhibit 2, it may be observed that they are quite different among the real estate index portfolios under consideration. First, in comparison to all other index portfolios, the very low standard deviation of the returns for German real estate funds is striking. For example, the monthly volatility of the German property securities is 4.02%, which is more than twenty times higher than that of German real estate funds (0.20%). Second, the sample autocorrelation of the monthly holding period returns to German real estate funds is large for all reported lags and reliably statistically distinguishable from zero. In contrast, the autocorrelations of the returns on the other index portfolios are close to zero at all lags except lag one in the case of monthly returns. As reported in the literature (Barkham and Geltner, 1994, among others), real estate return series with such typical statistical properties (*i.e.*, low volatilities and a high level of serial correlation) are due to appraisal smoothing. The same is true for the German real estate funds, because the unit values are based on annual experts' appraisals of the properties held by the funds. It is well documented in real estate literature that appraisals are due to

Exhibit 2 | Summery Statistics for Monthly Nominal and Real Returns—1980:1–2000:12

	Nominal Returns					Real Returns				
	$\overline{R}$	Std. Dev.	ρ_1	ρ_2	ρ_{10}	$\overline{r}$	Std. Dev.	ρ_1	ρ_2	ρ_{10}
France	0.82	4.07	0.18*	0.08	0.09	0.48	4.10	0.18*	0.08	0.09
Germany (funds)	0.53	0.20	0.40*	0.37*	0.33*	0.31	0.34	0.19*	−0.04	−0.04
Germany (companies)	0.54	4.02	0.24*	−0.01	0.08	0.33	4.04	0.25*	−0.01	0.09
Switzerland	0.52	2.21	0.22*	0.13*	−0.05	0.30	2.24	0.22*	0.13	−0.04
U.K.	0.95	5.87	0.06	−0.02	0.02	0.53	5.88	0.07	−0.02	0.02

Notes: $\overline{R}$ ($\overline{r}$) is the arithmetic mean in % p.m., Std. Dev. the standard derivation and ρ_k the sample autocorrelation of lag k of the 252 monthly continuously compounded nominal (real) index returns in the period 1980:1–2000:12. Sample autocorrelation marked with an asterisk are statistically significant at the 5% level according to the *Q*-Statistic of Ljung and Box (1979).

the asynchronous and temporally aggregated processing of relevant information, resulting in smoothed short-term returns. In contrast, the returns of exchange traded property shares are determined in a stock market that adjusts rapidly to changes in information and expectations. However, the smoothed prices of the German real estate funds do 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 funds units is probably artificially low, for unit holders the smoothed return is the actual holding period return that they receive. Note, because of purchase transaction costs of about 5% of the initial unit price, the average return of 0.53% p.m. is not the expected return for a potential investor who is willing to buy units of real estate funds.

To investigate the descriptive short-term relationship between the monthly nominal asset returns and the inflation rates, the Pearson's correlation coefficient is calculated for each of the index portfolios in the different countries. It is apparent from these calculations that the returns from some quoted companies are negatively correlated with the inflation rate; *i.e.*, for the French real estate stocks the correlation coefficient is −0.03, for Germany it is −0.01, for the Swiss it is −0.02 and for the U.K. it is 0.03. However, in no case are the results significantly different from zero at a 5% level (according to the test statistic in Anderson, 1984: 109). This observation is in line with the bulk of the empirical literature about the short term relationship between equity market returns and inflation [*e.g.*, Barnes, Boyd and Smith (1999) for European equity markets]. On the contrary, correlation coefficients for nominal returns of German real estate funds with the inflation rate show positive values of 0.12, which are reliably statistically distinguishable from zero. This result is in line with the empirical literature on the relationship between the nominal returns of direct real estate investments and inflations rates.

The right part of Exhibit 2 shows the means, the standard deviations and the sample autocorrelations of the monthly real returns. Except for monthly returns with lag one, the autocorrelations of the real returns are statistically indistinguishable from zero. Heterogeneous serial correlation of nominal returns in combination with relatively homogeneous autocorrelations in real returns over different assets is consistent with the observation in Fama and Schwert (1977): ''because the inflation related variation in nominal returns is common to all assets, all real returns are serially uncorrelated.''

Inflation Hedging Effectiveness: Regression Analysis

Methodology

Fama and Schwert (1977) argue in their pioneering work with reference to the well known Fisher hypothesis that in efficient capital markets, the equilibrium price of any risky asset i is determined over all time horizons in such a way that given a certain set of information ϕ_{t-1}, used by the market at time $t-1$, the expected nominal rate of return $E(R_{i,t})$ from $t-1$ to t (or period t) will be equal to the expected real rate of return $E(r_{i,t})$ plus the expected rate of inflation $E(\pi_t)$ for the same time horizon. More formally:

$$E(R_{i,t}|\phi_{t-1}) = E(r_{i,t}|\phi_{t-1}) + E(\pi_t|\phi_{t-1}). \quad (3)$$

Under the assumption that the expected real return is independent of the expected rate of inflation, estimates of the following regression model:

$$R_{i,t} = \gamma_{i,0} + \gamma_{i,1}\pi_t^e + \gamma_{i,2}(\pi_t - \pi_t^e) + U_{i,t}, \quad (4)$$

are widely used to test the relationship between inflation and asset returns during a chosen period of time. In this model, $R_{i,t}$ stands for the nominal return of the ith asset in period t, $U_{i,t}$ is the random error term with a mean of zero, π_t denotes a measure of the inflation rate, which is disaggregated in a suitably chosen measure π_t^e of the expected rate of inflation at time $t-1$ until t and the unexpected inflation component $(\pi_t - \pi_t^e)$. Therefore, estimates of the regression coefficients $\gamma_{i,1}$ and $\gamma_{i,2}$ provide information about the hedging potential of an asset against the expected and unexpected component of inflation. If empirical estimates indicate that $\gamma_{i,1} = 1$, the nominal rate of return varies ceteris paribus one-for-one with the expected rate of inflation (*i.e.*, the investment is a complete hedge against expected inflation). If an estimate of $\gamma_{i,2}$ is indistinguishable from 1.0, the asset generates positive returns when inflation rises unexpectedly (*i.e.*, it is a complete hedge against shocks to the inflation rate). Finally, if the null hypothesis $\gamma_{i,1} = \gamma_{i,2} = 1$ cannot be rejected, then the price of the investment moves in tandem with the price level (*i.e.*, it could be regarded as a complete hedge against inflation.

It should be noted that the assumption of an unrelated expected real return and expected rate of inflation is crucial, and can lead to biased results about the coefficient for inflation. Yobaccio, Rubens and Ketcham (1995) point out that during periods of high inflation (or disinflation) and therefore high economic times, investors become more risk averse [*i.e.*, they shift to less risky assets (“flight to quality”) and demand higher expected real returns on risky assets]. If the expected real return is not unrelated to inflationary expectations, an explicit model of the relationship between risk and expected real return in market equilibrium would be required. Therefore, Yobaccio, et al. suggests the following modified version of the capital asset pricing model under uncertain inflation (CAPMUI) to investigate the inflation hedging performance of real estate investments:[3]

$$E(R_{i,t}|\phi_{t-1}) = E(r_{f,t}|\phi_{t-1}) + E(\pi_t|\phi_{t-1}) + \beta_i E[r_{m,t}|E(\pi_t|\phi_{t-1}) - E(r_{f,t}|\phi_{t-1})]. \quad (5)$$

Here $r_{f,t}$ is the real return on the nominal risk free asset, $r_{m,t}$ the real return on the market portfolio and $\beta_i = \mathrm{Cov}(r_{i,t},r_{m,t})/\mathrm{Var}(r_{m,t})$ the measure of systematic risk of asset i relative to the market. This model can be tested by the empirical analog of Equation (5):

$$R_{i,t} = \gamma_{i,0} + \gamma_{i,1}\pi_t^e + \gamma_{i,2}(\pi_t - \pi_t^e) + \gamma_{i,3}(r_{m,t} - \pi_t) + U_{i,t}. \quad (6)$$

The model in Equation (6) expands Equation (4) by allowing the real return on the market portfolio to vary with inflation expectations. As in Equation (4), estimates of the regression coefficients $\gamma_{i,1}$ and $\gamma_{i,2}$ provide insights into the hedging potential of an asset against the inflation variable, which is disaggregated into expected and unexpected inflation. In addition, estimates of the parameter $\gamma_{i,3}$ provide useful information about the systematic risk relative to the market of common stocks and therefore about diversification potential of real estate securities.

Empirical Results

The models demonstrated in Equations (4) and (6) test the relationship between inflation, both expected and unexpected, and the returns of the property securities in the different countries. Both regression models, as mentioned, are estimated for the 252 months of the 1980:1–2000:12 period, as well as for the subperiods 1980–1989 and 1990–2000 with the nominal one-month returns of the different categories of real estate securities as dependent variable. To proxy for expected inflation, ex post inflation rates were used as predictors of inflation. Therefore, an ARIMA time series model was used, which was (re-)estimated at the beginning of each month t using the $t - 1, t - 2, \ldots t - 60$ previous monthly inflation rates as a database. Exhibit 3 contains the empirical relationship between inflation and the returns of the five different real estate securities using the approach of Fama and Schwert (1977).

From the results reported in Exhibit 3, it can be observed that for stock quoted real estate securities in all countries only one estimation for the parameters γ_1 for the anticipated inflation is significant at a 5% level, which indicates that Swiss real estate trusts seem to be a negative hedge for the subperiod 1980–1989. No significant results were found for the other samples. For real estate companies in

Exhibit 3 | Results of Regression Analyses Using the Approach of Fama and Schwert, 1977

Country	Period	γ_0	Std. Error	γ_1	Std. Error	γ_2	Std. Error	R^2
France	1980–2000	0.009*	0.004	−0.220	1.066	−0.874	1.031	−0.006
	1980–1989	0.021*	0.010	−1.463	1.521	−0.411	1.386	0.000
	1990–2000	0.006	0.005	−1.001	2.750	−1.655	1.783	−0.007
Germany (funds)	1980–2000	0.004*	0.000	0.365*	0.071	−0.066	0.044	0.198
	1980–1989	0.005*	0.000	0.241*	0.080	−0.115	0.053	0.167
	1990–2000	0.004	0.000	0.580*	0.088	−0.029	0.054	0.258
Germany (companies)	1980–2000	0.007	0.004	−0.923	1.074	0.302	1.022	−0.004
	1980–1989	0.018*	0.007	−2.030	1.422	1.052	2.097	0.009
	1990–2000	0.001	0.005	−0.721	2.010	0.200	0.877	0.877
Switzerland	1980–2000	0.006*	0.003	−0.372	0.587	−0.028	0.359	−0.006
	1980–1989	0.010*	0.003	−1.507*	0.616	0.208	0.354	0.027
	1990–2000	0.005	0.003	0.096	0.913	−0.395	0.716	−0.013
United Kingdom	1980–2000	0.010	0.006	−0.054	1.012	0.818	0.952	−0.004
	1980–1989	0.016	0.011	−0.065	1.567	0.962	1.135	−0.011
	1990–2000	0.008	0.007	−1.410	1.150	0.892	1.630	0.001

Notes: The regression model $R_t = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 (\pi_t - \pi_t^e) + U_t$ was OLS-estimated for each of the five capital weighted index portfolios using monthly returns in the period 1980:1–2000:12. Therefore, the expected inflation π^e was estimated with ARIMA time series models. The Newey and West (1987) procedure was used to correct t-Statistics respectively standard errors for heteroscedasticity and autocorrelation. R^2 is adjusted for numbers of regressors. Estimates marked with an asterisk are statistically distinguishable from zero at the 5% level.

other countries as well, no estimation shows significant results. The only evidence for positive hedge characteristics is given for German open-end funds, which are not quoted on a stock exchange. All estimations are positive and significant at least at the 5% level.

Furthermore, for the 1980–2000 period, the measure of goodness of fit R^2 is very low for all corporation types. Again, only for German real estate funds does the model show, with an adjusted R^2 of .198, a much superior explanatory power. As far as the unexpected inflation rate is concerned, no parameter estimation is significant at a 5% confidential interval for any of the index portfolios.

In the framework of the CAPMUI, there is again no evidence that stock quoted real estate securities have positive hedge characteristics against expected inflation. Comparing the results shown in Exhibits 3 and 4, the parameter for the Swiss portfolio in the period 1980–1986 is not statistically significant in the CAPMUI. For the unexpected inflation, Swiss real estate securities seem to be a negative hedge during the 1980–1986 period and in the U.K. during the 1980–2000 period, as well as for the subperiod 1987–1993, so that here as well no (positive) inflation hedge characteristics can be clearly attributed to any of the stock quoted securities. For the German funds, the estimated parameters support again the positive hedge capacities against expected inflation with almost unchanged values. Still, no hedge characteristics can be observed for the unexpected inflation.

The estimation of the parameter γ_3 for the market portfolio gave significant results for all stock quoted companies for the sample period as well as for all subsamples. All estimations are below 1.0, indicating the defensive character of an investment in a portfolio of real estate securities. In particular, the results for the Swiss real estate funds indicate a comparatively high diversification potential. The results for the German open-end funds do not indicate any influence from the market portfolio. Here the result of different pricing in the context of the institutional framework as mentioned is seen. Contrary to exchange traded securities, open-end structures seem to effectively exclude the market risk by providing appraisal-based returns to the investors.

The analysis over longer (*i.e.*, quarterly and annual) intervals to address the possibility that the high frequency monthly covariation between inflation and asset returns differ from lower-frequency correlation.[4] Furthermore, as elaborated in Fama and Gibbons (1984), different models have been constructed to extract inflation expectations from lagged inflation values (so-called time series model) and from lagged Treasury-bill returns (so called interest rate model).[5] Exhibit 5 shows the coefficients for the hedging parameters against expected and unexpected inflation from regression models of Equation (4) for the sample period 1980 to 2000. The results provide no clear evidence whether stock quoted property securities in France, Germany, the U.K. or Switzerland have been short- or long-term inflation hedges during the last twenty-one years. However, in the case of the non-quoted German open-end funds, the estimations for the expected inflation parameter have been found to be positive and significantly different from zero.

Exhibit 4 | Estimation Results of the CAPMUI

Country	Period	γ_0	Std. Error	γ_1	Std. Error	γ_2	Std. Error	γ_3	Std. Error	R^2
France	1980–2000	0.004	0.004	0.165	1.010	−0.911	0.879	0.317*	0.044	0.203
	1980–1989	0.014	0.009	−0.904	1.427	−1.303	1.245	0.307*	0.055	0.203
	1990–2000	0.001	0.004	0.218	2.249	−0.733	1.473	0.320*	0.077	0.189
Germany (funds)	1980–2000	0.004*	0.000	0.372*	0.072	−0.062	0.044	0.004	0.002	0.203
	1980–1989	0.005*	0.000	0.257*	0.081	−0.082	0.057	0.006*	0.002	0.191
	1990–2000	0.004*	0.000	0.583*	0.008	−0.031	0.054	0.002	0.004	0.253
Germany (companies)	1980–2000	0.003	0.003	−0.161	0.802	0.769	0.960	0.386*	0.066	0.244
	1980–1989	0.013*	0.005	−1.111	1.029	2.971	2.090	0.355*	0.009	0.203
	1990–2000	−0.004	0.004	0.363	1.479	−0.455	0.659	0.441*	0.092	0.326
Switzerland	1980–2000	0.003	0.002	0.276	0.550	0.274	0.320	0.163*	0.034	0.123
	1980–1989	0.009*	0.003	−1.165*	0.634	0.319	0.328	0.084*	0.028	0.080
	1990–2000	0.001	0.003	1.077	0.839	0.196	0.631	0.224*	0.050	0.170
United Kingdom	1980–2000	0.000	0.005	0.590	0.845	1.450	0.673	0.824*	0.076	0.479
	1980–1989	0.001	0.009	0.569	1.370	1.022	0.922	0.856*	0.085	0.558
	1990–2000	−0.001	0.006	−0.124	0.953	2.348*	1.091	0.768*	0.136	0.364

Notes: The regression model $R_t = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 (\pi_t - \pi_t^e) + \gamma_3 (R_M - \pi_t) + U_t$ was OLS-estimated for each of the five capital weighted index portfolios using monthly returns in the 1980:1–2000:12 period. Expected inflation π^e was estimated with ARIMA time series models. The Newey and West (1987) procedure was used to correct *t*-Statistics respectively standard errors for heteroscedasticity and autocorrelation. R^2 is adjusted for number of regressors. Estimates marked with an asterisk are statistically distinguishable from zero at the 5% level.

Exhibit 5 | Unexpected Inflation and Real Asset Returns for Property Securities

Country	Measure of Expected Inflation	Quarterly Returns				Annual Returns			
		γ_1	Std. Error	γ_2	Std. Error	γ_1	Std. Error	γ_2	Std. Error
France	Time series	0.317	1.088	1.764	1.415	−0.025	1.188	0.313	4.604
	Interest rates	0.229	1.055	2.877	1.815	0.736	1.136	8.459	7.807
Germany (funds)	Time series	0.347**	0.098	0.008	0.064	0.305*	0.169	−0.642**	0.171
	Interest rates	0.353**	0.119	−0.204**	0.066	0.438**	0.153	−0.518*	0.252
Germany (companies)	Time series	−0.845	1.198	−1.692	1.754	0.596	2.021	4.643	7.287
	Interest rates	−1.334	1.246	−0.188	2.195	−0.524	0.898	0.441	4.552
Switzerland	Time series	−0.120	0.617	0.594	0.593	1.017	1.511	3.705	3.140
	Interest rates	−0.479	0.627	0.890	0.651	0.710	1.234	4.660*	2.457
United Kingdom	Time series	−0.030	1.255	1.237	1.674	1.771	2.958	5.722	7.231
	Interest rates	−0.254	1.586	0.767	1.296	1.635	2.158	6.399	6.444

Notes: The regression model $R_t = \gamma_0 + \gamma_1 \pi_t^e + \gamma_2 (\pi_t - \pi_t^e) + U_t$ was OLS-estimated for each of the five weighted index portfolios using monthly and annual returns in the 1980:1–2000:12 period. The expected inflation π^e was estimated with ARIMA time series of past inflation and the random walk interest rate model following the approach of Fama and Gibbons (1984:329–333). The Newey and West (1987) procedure was used to correct standard errors for heteroscedasticity and autocorrelation. Estimates marked with one (two) asterisk are statistically distinguishable from zero at the 10% (5%) level.

In summary, significant and robust results can only be obtained for German real estate funds. The examined index portfolio is found to be a positive hedge against the anticipated part of inflation. For the unexpected inflation, no hedge characteristics could be proved. The inflation characteristics of the German open-end funds are more in line with those funds in previous studies for Commingled Real Estate Funds (CREFs) in the U.S. (Brueggeman, Chen and Thibodeau 1984, 1992; and Hartzell, Hekman and Miles, 1987). Contrary to these types of investments, German open-end funds are available for private investors, thus offering a possibility for individual as well as for institutional investors to acquire inflation hedging. For quoted real estate securities, however, the empirical results suggest that the inflation hedging properties are limited. These results are broadly consistent with previous research about quoted real estate securities in the U.S. as well as in Europe. For example, Gyourko and Linneman (1988) and Park, Mullineaux and Chew (1990) for REITs in the U.S., Hoesli and Bender (1992), Hoesli (1994), Hoesli, MacGregor, Matysiak and Nanthakumaran (1997), Liu, Hartzell and Hoesli (1997) for Swiss quoted real estate funds and Maurer and Sebastian (1999) for German property securities. For none of the examined European stock quoted real estate vehicles could inflation hedge ability be ascertained.

Inflation Protection Effectiveness: Consumption Shortfall Risk

Methodology

Besides the inflation rate, additional risk factors exist, which cause variation in nominal asset returns. Such non inflation risk factors can generate variation in nominal returns, which is relatively large with respect to the variation associated with the rate of inflation. Looking at the coefficient of determination it is clear that, especially for listed property companies, the regressions employed earlier explain only a small fraction of the variation in the stock nominal returns. Therefore, if an asset is a complete hedge against inflation, in the sense that nominal returns vary on a one-to-one-correspondence with a ceteris paribus change of inflation, this does not imply that the real return on the asset is certain and insulated from the downside risk of a negative real return.

An alternative approach to the inflation risk of an asset, suggested in early papers of Reilly, Johnson and Smith (1970, 1971) and Bodie (1975), is labeled *inflation protection*. It considers the shortfall risk of inflationary erosion stemming from all sources of uncertainty, not only from the fluctuations of the inflation rate. In accordance with other fields of research, as well as with conventional wisdom, shortfall risk is associated with the possibility of ‘‘something bad happening,’’ in other words 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. In this sense, shortfall-risk-measures are called ''relative'' or ''pure'' measures of risk. 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 investment 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. In addition, 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) employ the downside risk framework to the asset allocation decision with stocks, bonds and real estate.

Following this line, Hoesli (1993, 1996) and Hamelink, Hoesli and MacGregor (1997) calculate the shortfall-probability of a negative real return for various holding periods in order to examine inflation protection features of different real estate investment vehicles. More formally, let $r_0(k)$ denote the cumulative continuous compounded (multiyear) real return of a lump sum investment starting at time $t = 0$ and ending at time $t = k$; then the shortfall probability is defined as:

$$SP = \text{Prob}[r_0(k) < z_0(k)], \tag{7}$$

where $z_0(k)$ is the target (benchmark) return, which translates the total investment returns into gains or losses. In this study, $z_0(k) = 0$ *i.e.*, risk is understood as losing the status quo of the consumption level attainable at the beginning of the investment horizon (consumption shortfall). As Bodie (2001:308) points out, a major shortcoming of this popular risk-metric is that it ''completely ignores how large the potential shortfall might be.'' If the same investment strategy can be repeated many times, the shortfall probability answers the question ''how often'' but not ''how badly'' a loss occurs.

To provide information about the potential extent of a loss, the Mean Excess Loss (MEL) was calculated as an additional risk measure. Formally this risk metric is given by:

$$MEL = E[z_0(k) - r_0(k) | r_0(k) < z_0(k)], \tag{8}$$

and 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 badly on average.''[6] In this sense the MEL can be characterized as a worst case risk measure, which is highly sensitive with respect to realizations at the tail of the distribution (*i.e.*, large-scale shortfalls).

A shortfall-risk measure that connects the probability and the extent of the conditional shortfall in an intuitive way is the shortfall expectation:

$$\text{SE} = E[\max(z_0(k) - r_0(k), 0)] = \text{SP} \cdot \text{MEL}. \tag{9}$$

The shortfall expectation is the sum of losses weighted by their probabilities, therefore it is a measure of the unconditional "average loss." As Equation (9) 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 of this section, the inflation protection features for a buy-and-hold lump sum investment are compared assuming full reinvestment in the different local property index portfolios for holding periods from one to twenty-one years. Therefore, an ex post and ex ante approach is employed. The ex post approach exclusively uses historical return data over different (overlapping) investment periods to gain information about the shortfall-risk, and does not have any explicit assumptions about the random patterns of the real return. On the other hand, the shortfall risk measures are obtained on an ex ante basis by imposing an exogenous structure on the probability distribution governing the uncertainty of future asset returns.

Ex Post Results

The ex post approach exclusively uses historical return data over different (overlapping) investment periods to gain information about the shortfall-risk, and does not make any explicit assumptions about the random patterns of the real return. The total investigation period from 1980–2000 was divided into twenty-one (non-overlapping) one-year periods, twenty (overlapping) two-year periods and so forth, ending with only one period for a twenty-one-year investment horizon. Assuming a $1 lump sum investment in the different property index portfolios at the beginning of each year, the cumulative real return of the initial investment is calculated after one year, two years and for all subsequent years for which there are data. To summarize the results on the possible $(22 \times 21)/2 = 231$ real returns, the average cumulative real return, averaged across all real returns of a specific investment period and the corresponding empirical shortfall-risk measures of this real return are calculated. For example, the shortfall probability for a one-year investment horizon is calculated by the number of periods with a negative real return divided by twenty-one. Correspondingly, the shortfall expectation and mean excess loss was calculated by the sum of all losses (*i.e.*, negative cumulative real returns), divided by the observed twenty-one yearly investment periods in the case of the SE or the number of periods with a negative real out of the twenty-one one year investment periods in the case of the MEL, respectively. The results of these calculations appear in Exhibit 6.

The results presented in Exhibit 6 suggest holding U.K. closed-end property companies worth \$1 initially in 1980 would have a real value of \$1 · exp(1.446) = \$4.25 after twenty-one years on average. For France, a \$1 initial investment in property companies would have increased in real value by a factor of 3.34, for Germany, the factor is 2.22 for real estate funds and 2.55 for property companies, and for Switzerland it is 2.11. As noted by Siegel (1998) and Brown, Mitchell and Poterba (2001), this implies that an investor would have the potential to receive a substantial positive real return over long horizons. However, purchasing such an investment exposes the investor to the volatility and therefore the downside risk of financial markets.

Looking at the shortfall frequency, the well-known effect of time diversification is seen (*i.e.*, the longer the holding period is, the fewer negative real returns and therefore better inflation protection features are observable). Given the example

Exhibit 6 | Ex Post Shortfall Risk and Cumulative Real Return (in %) After Various Holding Periods

Investment Period (years)		1	2	3	4	5	10	15	21
France	Return	5.7	11.2	19.3	26.2	31.4	49.4	84.2	120.5
	SP	38.1	35.0	36.8	27.8	23.5	8.3	—	—
	MEL	15.0	21.9	11.3	9.5	11.8	12.3	—	—
	SE	5.7	7.7	4.2	2.6	2.8	1.0	—	—
Germany (funds)	Return	3.8	7.7	11.9	16.1	20.4	41.1	61.8	79.6
	SW	—	—	—	—	—	—	—	—
	MEL	—	—	—	—	—	—	—	—
	SE	—	—	—	—	—	—	—	—
Germany (companies)	Return	4.5	10.5	16.2	21.1	25.5	61.3	81.3	93.7
	SP	47.6	35.0	26.3	33.3	29.4	16.7	—	—
	MEL	12.1	12.3	16.9	14.0	18.8	5.2	—	—
	SE	5.8	4.3	4.4	4.7	5.5	0.9	—	—
Switzerland	Return	3.6	7.9	13.3	28.7	23.4	45.2	70.4	74.7
	SP	38.1	25.0	15.8	5.6	—	—	—	—
	MEL	7.6	9.4	8.6	8.8	—	—	—	—
	SE	2.9	2.3	1.4	0.5	—	—	—	—
United Kingdom	Return	6.9	12.4	18.6	27.5	34.8	58.7	100.7	144.6
	SP	38.1	35.0	15.8	11.1	11.8	—	—	—
	MEL	14.8	20.6	29.3	33.5	19.8	—	—	—
	SE	5.6	7.2	4.6	3.7	2.3	—	—	—

Notes: Average cumulative real return and shortfall risk measures of an investment in real estate securities calculated for holding periods between one and twenty-one years in the 1980:1–2000:12 period. SP is the shortfall probability, MEL is the mean excess loss and SE is the shortfall expectation.

of property stocks in the U.K., in eight out of the twenty-one (= 38.1%) one-year holding periods, the realized nominal return was lower than the rate of inflation. For the holding periods of five years, a shortfall appears in only two of sixteen cases (= 11.8%), and no negative real return is observable for holding periods of ten years. This is in line with the findings of Hamelink, Hoesli and MacGregor (1997), who report similar results for exchange traded property securities in the U.S. and the U.K. with respect to the eighteen-year period from 1978 to 1995.

When looking at the development of the MEL for increasing holding periods, the effect of time diversification is not so clear. Looking at the MEL for U.K. property stocks, a holding period of one year has a value of 14.8% (*i.e.*, for the eight holding periods with a negative real return, the investor loses on average 14.8% of his wealth). Note that up to a holding period of four years, the MEL increases substantially to 33.5%. Hence, for this worst case risk measure, the effect of time diversification is not clear. The same is true for the shortfall expectation that started with a value of 5.6% for a one-year holding period and increased to 7.2% for two-year holding periods.

For the exchange traded property securities in the other countries, the magnitude and the development of the shortfall risk measure are very close to the French case. In all cases, for short-term investment periods of one to five years, a relatively high downside risk can be observed, which decreases to zero for investment periods of more than fifteen years. In contrast, for the German real estate mutual fund, no shortfall can be observed for any of the investment horizons under consideration.

Ex Ante Results

Although the ex post approach is common in studies about the risk and return characteristics of long-term real estate investments, there are, however, two fundamental pitfalls in applying this methodology. First, the used returns are derived, except for holding periods of one year, from overlapping periods. Therefore, the historical observed long-term holding period returns cannot be regarded as independent sample observations of a corresponding sequence of random variables. Especially for small samples (*i.e.*, long investment periods), the use of overlapping holding period returns can produce a considerable bias in estimating shortfall-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 in general too short to obtain a sufficient data basis, especially for long-term investment periods. In this sense, Navon (1998) points out: ''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.''

A second problem is that any kind of transaction cost incurred when purchasing or selling the property fund units is not included in the previous calculations.

However, as Sullivan, Cassidy and Ermer (1991) point out, assuming zero transaction costs can lead to model misspecification that overstates the risk-adjusted returns. This is especially the case for low volatility returns that are due to sluggishness caused by appraisal smoothing, such as real estate. Therefore, it is important to analyze to which extent the inclusion of transaction costs influences the results.

A possibility for overcoming both problems simultaneously is to specify an exogenous structure on the ex ante probability distribution governing the financial uncertainty of future returns and estimate the parameters of such a model from independent (*e.g.*, yearly) historical observations of real returns. With such a model in place, it is possible to look into the future and compute the shortfall risk measures and therefore the inflation protection features of the different real estate investment vehicles the study is interested in. More formally we assume that the value of property index portfolios can be modeled as a Geometric Brownian Motion, which is standard in financial economics and can be traced back to Bachellier (1900). This implies, that continuously compounded one-year real returns r_t are i.i.d. and normally distributed[7] with parameters μ and σ. Assuming purchasing transaction costs of $a > 0$ proportional to the initial unit price of an asset at time $t = 0$ then the continuous compounded (multiyear) real return $r_0(k) = \Sigma r_t - \ln(1 + a)$ is normally distributed:

$$r_0(k) \sim N[\mu_0(k), \sigma_0(k)], \tag{10}$$

with an expected return $\mu_0(k) = \mu k - \ln(1 + a)$ and standard deviation of $\sigma_0(k) = \sigma\sqrt{k}$. For the shortfall-probability, the closed form solution is:

$$\text{SP} = P[r_0(k) \leq z_0(k)] = \Phi\left(\frac{z_0(k) - \mu_0(k)}{\sigma_0(k)}\right) = \Phi(m_N), \tag{11}$$

where $m_N = [z_0(k) - \mu_0(k)]/\mu_0(k)$ and Φ denotes the standard normal distribution. If $\nu(x)$ is the density function of the standard normal distribution, the shortfall-expectation (see Winkler, Roodman and Britney, 1972) is:

$$\text{SE} = [z_0(k) - \mu_0(k)]\Phi(m_N) + \sigma_0(k)\varphi(m_N). \tag{12}$$

Finally, combining Equations (11) and (12) generates the Mean Excess Loss expression:

$$\text{MEL} = \frac{SE}{SP} = [z_0(k) - \mu_0(k)] + \sigma_0(k)\,\frac{\varphi(m_n)}{\Phi(m_N)}. \quad (13)$$

With these formulas, it is possible to study the ex ante shortfall risk in conjunction with the impact of the purchasing transaction cost over various holding periods. To estimate the parameters μ and σ we use the sequence $\{r_t\}_{t=1,\dots,T}$ of continuous one-year real returns (before purchasing transaction costs) is used, which are sample observations of a corresponding sequence of random variables. In the case of a geometric Brownian motion, the real log returns $r_t \sim N(\mu,\sigma)$ are i.i.d. normally distributed. Thus, the parameters in question can be estimated by their sample counterpart (*i.e.*, the arithmetic sample mean and the adjusted sample standard deviation of yearly log returns adjusted for inflation). In the case of France, $\mu = 5.74\%$ and $\sigma = 20.72\%$, for German real estate mutual funds $\mu = 3.79\%$ and $\sigma = 1.54\%$, for German property stocks $\mu = 4.46\%$ and $\sigma = 20.70\%$, for Switzerland $\mu = 3.56\%$ and $\sigma = 12.60$ % and for the U.K., $\mu = 6.89\%$ and $\sigma = 21.39\%$.

These formulas are employed to calculate the shortfall-risk measures for the different categories of indirect property investment in two steps. First, to study the differences of the ex post and ex ante approach directly, assume zero transaction costs. Second, to analyze to what extent the inclusion of transaction costs influences the results, the purchasing transaction costs of 5% proportional to the initial unit price are considered, which are the usual market conditions for the average individual investor buying fund units with a specialized investment objective in properties securities.

If the shortfall probability is stressed as risk measures, the risk of missing real capital maintenance decreases monotonously with an increasing investment period for all property index portfolios. However, the rate and extent of the risk reduction noticeably differ among the various categories of indirect property investment vehicles. For the German open-end real estate funds, the shortfall-probability is, with a value of 1%, close to zero even for a yearly investment, while for German real estate stocks the shortfall probability is 25% for a ten-year investment period. In contrast to the shortfall probability, for exchange traded real estate stocks, the MEL increases monotonously with the length of the investment period. Looking at the German real estate stocks, the conditional expected loss is 15% for an investment period of one year, while for a holding period of twenty-one years this risk metric is increased to 50%. 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 is in line 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 real estate stocks after some periods of increasing risk, the shortfall expectation monotonously decreases with the length of the investment period. However, this is what Leibowitz and Krasker (1988)

Exhibit 7 | Ex Ante Shortfall Risk and Mean Real Return (in %) for Various Holding Periods (transaction costs a = 0%)

Investment period (years)		1	2	3	4	5	10	15	21
France	Return	5.74	11.48	17.22	22.95	28.69	57.38	86.08	120.51
	SP	39.09	34.76	31.57	28.98	26.78	19.05	14.17	10.22
	MEL	5.71	6.84	7.32	7.53	7.57	6.88	5.81	4.61
	SE	14.61	19.66	23.20	25.97	28.27	36.08	41.00	45.14
Germany (funds)	Return	3.79	7.58	11.38	15.17	18.96	37.92	56.88	79.63
	SW	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	MEL	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01
	SE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Germany (companies)	Return	4.46	8.92	13.38	17.84	22.30	44.61	66.91	93.67
	SP	41.47	38.03	35.45	33.32	31.49	24.78	20.19	16.17
	MEL	6.22	7.75	8.59	9.10	9.41	9.65	9.06	8.09
	SE	14.99	20.39	24.25	27.32	29.89	38.93	44.86	50.04
Switzerland	Return	3.56	7.12	10.67	14.23	17.79	35.58	53.37	74.72
	SP	38.89	34.49	31.24	28.62	26.39	18.60	13.71	9.79
	MEL	3.45	4.11	4.39	4.50	4.52	4.06	3.39	2.66
	SE	8.87	11.92	14.06	15.73	17.11	21.81	24.75	27.23
United Kingdom	Return	6.89	13.77	20.66	27.54	34.43	68.86	103.29	144.60
	SP	37.37	32.44	28.85	25.98	23.58	15.43	10.62	7.00
	MEL	5.53	6.41	6.69	6.71	6.60	5.44	4.22	3.04
	SE	14.79	19.76	23.18	25.84	28.01	35.27	39.70	43.35

Notes: Average cumulative real return and ex ante shortfall risk measures of an investment in real estate securities calculated for holding periods between one and twenty-one years in the 1980–2000 period. SP is the shortfall probability, MEL is the mean excess loss and SE is the shortfall expectation. No transaction costs have been taken into account.

Exhibit 8 | Ex Ante Shortfall Risk and Mean Real Return (in % p.a.) for Various Holding Periods (transactions costs a = 5%)

Investment period (years)		1	2	3	4	5	10	15	21
France	Return	0.9	6.6	12.3	18.1	23.8	52.5	81.2	115.6
	SP	48.3	41.1	36.6	33.1	30.4	1.1	15.6	11.2
	MEL	16.2	21.1	24.6	27.3	29.5	37.2	41.9	46.0
	SE	7.8	8.7	9.0	9.0	9.0	7.9	6.5	5.1
Germany (funds)	Return	−1.1	2.7	6.5	10.3	14.1	33.0	52.0	74.8
	SP	75.9	10.8	0.8	<0.01	<0.01	<0.01	<0.01	<0.01
	MEL	1.7	1.0	0.9	0.8	0.7	0.5	<0.01	<0.01
	SE	1.3	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Germany (companies)	Return	−0.4	4.0	8.5	13.0	17.4	39.7	62.0	88.8
	SP	50.8	44.5	40.6	37.7	35.3	27.2	22.0	17.5
	MEL	16.7	21.9	25.7	28.7	31.3	40.1	46.0	51.0
	SE	8.5	9.8	10.4	10.8	11.0	40.9	10.1	8.9
Switzerland	Return	−1.3	2.2	5.8	9.4	12.9	30.7	48.5	69.8
	SP	54.2	45.0	39.5	35.5	32.3	22.1	16.0	11.3
	MEL	10.6	13.4	15.5	17.1	18.4	22.9	25.7	28.1
	SE	5.7	6.0	6.1	6.1	5.9	5.0	4.1	3.2
United Kingdom	Return	2.0	8.9	15.8	22.7	29.6	64.0	98.4	139.7
	SP	46.3	38.4	33.5	29.8	26.8	17.2	11.7	7.7
	MEL	16.4	21.2	24.5	27.1	29.2	36.3	40.6	44.1
	SE	7.6	8.1	8.2	8.1	7.8	6.2	4.8	3.4

Notes: Average cumulative real return and shortfall risk measures of an investment in real estate securities calculated for holding periods between one and twenty-one years in the 1980–2000 Germany (funds). SP is the shortfall probability, MEL is the mean excess loss and SE is the shortfall expectation. Purchase transaction costs of a = 5% have been taken into account.

called risk-persistence (*i.e.*, even for very long time horizons), the shortfall expectation remains at a substantially high level. Looking at the stock quoted Swiss real estate funds for example, the shortfall expectation is nearly 3% for an investment horizon of one year or twenty years. 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 MEL and the SE are close to zero for all investment periods for German real estate mutual funds.

A comparison of the ex post results (Exhibit 6) with the ex ante results shows (Exhibit 7) that for short-term investment horizons, the ex ante risk measures do not significantly differ from their ex post counterparts. Nevertheless, for listed property stocks the differences between ex ante and ex post shortfall-risk become larger within an increasing investment period. At the same time, the level of the ex ante SP and SE measures are substantially higher than those of the ex post values. For example, the ex ante probability of a negative real return for the U.K. index portfolio shows, for an investment period of ten years, a not inconsiderable value of 15%, while the ex post results shows a shortfall-probability of zero for the same asset class and the same holding period. Therefore, in contrast to the multiyear real return, which is (by construction) the same as in Exhibit 7 for an investment horizon of one and twenty-one years, employing overlapping historical return series substantially underestimates the level of shortfall risk in the long run.

Exhibit 5 contains the compounded mean return and the shortfall risk measures for several investment periods, assuming purchasing transaction costs of $a = 5\%$. The most noticeable difference in the results reported in Exhibit 8, compared with those in Exhibit 7, is the development of the shortfall probability for the German open-end investment funds for short term investments of one and two years. The probability of a negative real return is 75.9% in the case of an investment horizon of one year, indicating the contrast of inflation protection. However, this shortfall-risk measure decreases rapidly to 10.9% for an investment horizon of two years and to 0.8% for a three-year investment horizon. Therefore, the extremely high shortfall probability for an investment horizon of one year is not the result of the high (downside) volatility of returns, but in particular of the comparably high transaction costs, which arise with the purchase of the fund units. In contrast, the corresponding figures for listed companies are due to the high (downside) volatility of their returns.

Conclusion

This study examines the inflation risk of European real estate securities using the returns of diversified portfolios in France, Germany, Switzerland and the U.K. for the 1980:1–2000:12 period. The risk analysis was twofold. The method developed by Fama and Schwert (1977) was used, as well as the extension of Yobbaccio, Rubens and Ketcham (1995) to test the relationship between asset returns and (expected/unexpected) inflation. In addition, the shortfall-risk of a negative real return was examined for various investment horizons using the probability and the magnitude of a potential loss.

Looking at historical returns over long horizons, traded real estate stocks in all countries have typically generated substantial positive real returns. However, extrapolating historical returns into the future must be done with caution, especially for risk analysis purposes. Using an ex ante approach, the findings show that the probability of a negative real return decreases if the investment horizon increases. In contrast, the expected magnitude of a potential shortfall increases with a longer investment period. This contradicts the proposition that real estate stocks have in general a lower inflation risk in the long run than in the short run, which is in line with the result of Samuelson (1963) about the fallacy of large numbers.

In addition, the analysis of the correlation between inflation and the returns of real estate stocks suggests that the inflation-hedging properties of these types of indirect property investment are limited. Therefore, the decreasing probability of a negative real return for an increasing investment horizon appears to be the result of a high average real return, rather than a positive correlation between inflation rates and equity returns.

In contrast, for the non-quoted German real estate mutual funds, the empirical findings show significant and robust inflation hedge features against the expected inflation rate. In addition, over the long run, the probability and the magnitude of a potential negative real return is close to zero. Stock quoted real estate companies in Germany show inflation risk characteristics comparable to those in France, Switzerland and the U.K. Apparently the reason for their different risk profile lies in their special design and not in the underlying assets. As the funds' returns are based on appraisals and the evaluation date is normally different for each property, temporal smoothing occurs, which leads to lower volatility. Positive correlations to inflation may be the result of a tendency to update past appraisals with respect to inflation. However, for an investor, the smoothed returns are those actually received (Hoesli and Hamelink, 1996:61). Therefore, it can be stated that German real estate mutual funds seem to be the only indirect real estate investment in the examined countries that provide simultaneously good inflation hedging and good inflation protection features for private investors.

Endnotes

[1] For a study of the inflation hedge characteristics of these companies see Liu, Hartzell and Hoesli (1997).

[2] For France, Switzerland and the U.K. the inflation rates have been corrected for seasonality (see Cleveland and 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: U.K. Retail Price Index, Office for National Statistics.

[3] See Roll (1973), Long (1974), Chen and Boness (1975) and Friend, Landskroner and Losq (1976), who have extended the original CAPM to incorporate the impact of uncertain inflation and derived similar versions of the CAPMUI.

[4] Boudoukh and Richardson (1993) present some evidence for both the U.S. and the U.K. suggesting that the nominal return on corporate equities may move together with inflation at long horizons.

[5] In order to test the robustness of the results in Exhibits 3, 4 and 5, further regressions have been estimated. The detailed results of these regressions are not included but are available from the authors.

[6] As demonstrated by Albrecht, Maurer and Ruckpaul (2001), the MEL is closely connected with the Tail Conditional Expectation TCE $= E(R|R < z) = z - $ MEL. The TCE is considered within the analysis and management of financial risk as an important risk measure. In the sense of the formal features (axioms) of a good risk measure developed by Artzner, Delbaen, Eber and Heath (1999), the MEL is, in contrast to the shortfall probability, a coherent risk measure.

[7] Employing the Jarque-Bera Goodness of fit tests, the null hypothesis of normal distributed yearly real returns cannot be rejected for any of the time series at the 5% level of significance.

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