Why volatility is an inappropriate risk measure for real estate

by

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prepared for

ERES Conference 2010, Milan, June 23-26, 2010

Abstract

The adequate measurement of real estate risk is of utmost importance for asset management and real estate portfolio management. Most real estate academics agree that volatility, commonly used as a measure of real estate risk, is inappropriate for that purpose. However, volatility is still a favored measure of many practitioners, especially for comparing the risk of real estate with other assets such as securities. And even real estate academics still use this measure due to its simplicity and because the perfect alternative has yet to be found.

This paper provides plausible reasons for the proposition that volatility should not be used for measuring the risk of real estate--neither within its asset class, nor in a multi-asset environment. It is based on an extensive literature overview, expert interviews, and new empirical evidence from Germany. Furthermore, the paper discusses whether qualitative risk measures might be more appropriate and provides some requirements for better real estate risk measures.

Keywords: risk management, volatility, portfolio management

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History and use of volatility as a risk measure for real estate

Even though the Modern Portfolio Theory (MPT) was developed already in the early 1950s by MARKOWITZ, it took more than a decade until MPT and its basic risk measures such as variance and standard deviation of returns were first employed within the field of real estate portfolio management.

Among the first to use MPT within a real estate portfolio management context was FRIEDMAN in 1971.[1] Based on historical returns and standard deviations, FRIEDMAN developed efficient real estate portfolios and common stock portfolios as well as mixed-asset portfolios. However, subsequently to the publication of FRIEDMAN's article, COOK challenged its results, mainly because of the poor data base.[2] In general, COOK also questioned whether MPT can be that easily adapted to real estate portfolio management.

Another early study that tried to capture real estate risk by identifying the probability distribution of returns was published in 1973 by PHYRR.[3] However, PHYRR, who defined risk as "the chance or probability that the investor will not receive his expected or required rate of return"[4], determined the probability distribution by using a Monte Carlo Simulation rather than using historical real estate returns. A problem regarding this approach was that the probability distributions for uncertain variables had to be estimated by experts.[5]

In 1980, after developing one of the first actual real estate return indices, HOAG compared the return and risk measured as standard deviation, of real estate to that of common stocks, bonds, and U.S. treasury bills.[6] In the following years, many authors published various studies that used different real estate market indices. Based on these indices, risk and return of real estate could be compared with that of other asset classes, and efficient real estate portfolios as well as efficient mixed-asset portfolios were constructed.[7] The general notion among most authors was that real estate, mainly due to its specific risk-return characteristics and its diversification potential, should play a major role in the mixed-asset portfolio.

[1] Cf. Friedman (1971). Although Friedman was the first to explicitly adopt MPT to real estate, authors such as Wendt/Wong (1965) had already used the standard deviation to compare the risk of real estate to other asset classes. For an overview of early studies regarding the comparison of real estate performance to that of other asset classes see, for example, Roulac (1976).

[2] Cf. Cook (1971). For another early article that challenged FRIEDMAN's approach see, for example, Findlay et al. (1979).

[3] Cf. Phyrr (1973).

[4] Phyrr (1973), p. 51.

[5] A few years later, Findlay et al. (1979) proposed a similar approach, even though they stated it would be desirable to use historical data as input parameters for the probability distribution.

[6] Cf. Hoag (1980). The author concludes that real estate is riskier than bonds and U.S. treasury bills and almost as risky as common stocks. In contrast, Webb/Sirmans (1980) state that real estate risk, when measured as historical volatility of the real estate returns of the American Council of Life Insurance, is comparably low.

[7] See, for example, Fogler (1984), Zerbst/Cambon (1984), Miles/McCue (1984a/1984b) Ibbotson/Siegel (1984), Webb/Rubens (1986), Webb/Curcio (1988). For an overview of other studies see, for example, Sirmans/Sirmans (1987).

Although various authors mentioned disadvantages, such as a poor data set and the so-called smoothing effect, when using the standard deviation as a real estate risk measure, its use was not fundamentally challenged in the 1980s.[1]

To confront the criticism that standard risk measures understate the actual real estate risk due to a smoothing effect, WEBB/RUBENS multiplied the risk measure for real estate by a factor of three and then by a factor of six.[2] The authors concluded that even when using the increased risk measures for asset allocation considerations in a mixed-asset portfolio, a substantial amount should be allocated to real estate. In a similar study, FIRSTENBERG/ROSS/ZISLER employed MPT when determining the within real estate diversification effect as well as the diversification benefit of real estate within a mixed-asset portfolio.[3] However, WEBB/RUBENS were also aware of the need to adjust the measured volatility and therefore stated: “In the data that follow, we make a correction that raises the volatility of the real estate returns to a level that seems more reasonable to us.”[4]

Among the first trying to quantify the smoothing effect and therefore the underestimation of the actual real estate volatility, was GELTNER in 1989.[5] GELTNER stated that smoothing in portfolio or index returns may enter at the disaggregate level of individual property appraisal over time as well as at the aggregate level when many properties are combined into a portfolio or in an index. Based on this understanding, he developed an empirically-based technique to account for the smoothing effect.

ROSS/ZISLER were among the first to relate a theoretical model for desmoothing real estate returns to practice.[6] The authors also assumed that the historical volatility of real estate indices, due to the smoothing effect, does in fact understate the actual real estate risk while the volatility of REIT returns overstates it. Based on these assumptions, the volatility of direct real estate indices was adjusted upwards while the volatility of the REIT index was adjusted downwards. The authors defined the adjusted volatility of direct real estate as the lower limit and the volatility of REIT returns as the upper limit of the actual real estate volatility and concluded a reasonable range for actual real estate risk of about 9 percent to 13 percent.

In the following years, various studies that used real estate risk measures calculated the volatility of desmoothed real estate indices.[7]

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[1] See, for example, Fogler (1984), p. 7, Zerbst/Cambon (1984), p. 20, Ibbotson/Siegel (1984), p. 222 f., Webb/Rubens (1986), p. 493. See, for example, Blundell/Ward (1987) for early critics regarding the random-walk hypothesis and the smoothing effect.

[2] Cf. Webb/Rubens (1987). Another study by Giliberto (1988) has also questioned the significance of risk measures derived from raw appraisal-based indices. Giliberto also stated that those measures are biased and therefore do not adequately capture the actual real estate risk.

[3] Cf. Firstenberg/Ross/Zisler (1988).

[4] Firstenberg/Ross/Zisler (1988), p. 24. This approach is in line with the results of a survey among various American real estate professionals that was published by Hartzell/Webb (1988). Only 18% of the respondents believed that the volatility displayed by the Frank Russell Company Index would capture actual real estate risk.

[5] Cf. Geltner (1989).

[6] Cf. Ross/Zisler (1991).

[7] See, for example, Newell/MacFarlane (1995), Byrne/Lee (1995), Newell/Webb (1996), Ziobrowski/Ziobrowski (1997), Boyd et al. (1998). However, other studies still used “smoothed“ real estate data. See, for example,

Yet, the smoothing effect has not been considered the only problem when using the standard risk measures and MPT in general for real estate portfolio management. For example, when WEBB/PAGLIARI compared the volatility of real estate returns to that of REITs, stocks and bonds, they identified various reasons why volatility as a risk measure for real estate should be seen with a degree of skepticism.[1] The authors stated that direct real estate investments exhibit different characteristics as do other asset classes which leads to the conclusion that comparing volatilities among different asset classes is not trivial at all. Beside the smoothing effect, the authors mentioned the poor real estate data base, and consequently the fact that real estate data do not capture the entire real estate cycle, as a major drawback when calculating real estate volatility.

The acceptance of standard risk measures for real estate portfolio management changed greatly with the publication of various studies that provided evidence for the non-normality of real estate returns. Among the first to question the normal distribution of real estate returns were MYER/WEBB in 1992.[2] Besides estimating the skewness and kurtosis parameters for the return series of different asset classes, the authors conducted three tests for normality. When comparing the results, the authors inferred that the distribution of quarterly real estate returns deviate most from a normal distribution.[3] A similar study by KING/YOUNG demonstrated that annual real estate returns of the Russell-NCREIF Property Index are not normally distributed.[4] Moreover, the authors concluded that “The patterns are *peaked*, have weak *shoulders*, and have thick *tails*“.[5] In the subsequent years until today, various studies were conducted that predominantly supported the non-normality assumption of real estate returns.[6]

Starting in 1999, WHEATON et al. published a series of articles that proposed a forward-looking approach to measure real estate risk.[7] The authors argue that historic risk can generally be decomposed into two components, a predictable and a non-predictable one. The authors’ opinion is that, based on the fact that real estate markets exhibit a significant degree of statistical predictability, real estate returns should be forecasted by using vector autoregressive models. The future real estate risk does now consist of the variability of the forecasted return and the uncertainty surrounding that forecast. In contrast to the general notion among real estate professionals WHEATON et al. claim that historical volatility does not understate but in fact overstates the future risk because it includes both the predictable and the unpredictable risk component.

Eichholtz et al. (1995), Gold (1996), Ziering/McIntosh (1999), Cheng/Liang (2000), Viezer (2000) und Lizieri/Baum/Scott (2000).

[1] Cf. Webb/Pagliari (1995). See also Pagliari/Webb/Del Casino (1995).

[2] Cf. Myer/Webb (1992).

[3] However, the authors also mentioned that this non-normality is eliminated for most of the real estate series when semi-annual or annual returns are used. The results of Myer/Webb (1992) are in line with results of a similar study by Liu/Hartzell/Grissom (1992).

[4] Cp. King/Young (1994).

[5] King/Young (1994), p. 10.

[6] See, for example, Myer/Webb (1994), Young/Graff (1995), Graff/Harrington/Young (1997), Maurer/Rainer/Sebastian (2004), Young/Lee/Devaney (2006) and Young (2008).

[7] Cf. Wheaton et al. (1999/2001a/2001b/2002).

Although this approach proposes a new methodology to measure real estate risk, it still builds on the understanding of risk as the volatility of returns. Besides this forward-looking use of real estate volatility, until today various academics measure risk as the historical volatility of real estate returns. Those studies that still use the historical volatility of real estate returns can be classified into two categories.

Authors who conduct studies that belong to category one are usually aware that standard risk measures are not appropriate for real estate, but they use them anyway. As an example, STALEY/STAKE/OZAKI mention that real estate return distributions are not symmetrical.[1] However, when constructing an optimal real estate portfolio, the authors still use the standard deviation as a risk measure. Other authors such as CHENG/ROULAC and HEYDENREICH describe the problems that occur when using appraisal-based indices.[2] Yet, they use the smoothed return data to illustrate the effectiveness of geographic diversification. In contrast, CHENG et al. demonstrate that real estate returns do not follow a random-walk but they eventually use the standard deviation to analyze the influence of varying holding periods on the measured real estate risk.[3] Another example belonging to this category is a study of KAISER/CLAYTON.[4] On the one hand the authors state that investors usually understand risk as the negative deviation of an expected return and therefore conclude that downside risk measures are more appropriate for assessing real estate risk. On the other hand the authors use the standard deviation when comparing the risk of various property types.

In studies that belong to the second group historical appraisal-based data is usually adjusted for the smoothing effect and for autocorrelation. For example, LEE and LEE/STEVENSON first adjust the appraisal-based data for smoothing before comparing real estate performance to that of other asset classes and before constructing an optimal mixed-asset portfolio.[5] Other authors such as HOESLI/LEKANDER/WITKIEWICZ and PAGLIARI/SCHERER do even use four respectively three different adjusted risk measures to correct for the smoothing effect when analyzing the importance of real estate within a mixed-asset portfolio.[6]

This foregoing literature overview reveals that despite some skepticism among real estate professionals and academics regarding the appropriateness of standard risk measures, volatility, in one way or another, is still frequently used in the real estate literature as a measure for real estate risk. This is also apparent when we look at the real estate risk measures that are used by practitioners. According to surveys and our interviews the vast majority of real estate managers still employ standard risk measures to estimate real estate risk—if they use quantitative measures at all.[7] Even though they know about the limitations of

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[1] Cf. Staley/Stake/Ozaki (2008).
[2] Cf. Cheng/Roulac (2007), Heydenreich (2010).
[3] Cf. Cheng et al. (2010).
[4] Cf. Kaiser/Clayton (2008).
[5] Cf. Lee (2003), Lee/Stevenson (2006).
[6] Cf. Hoesli/Lekander/Witkiewicz (2004), Pagliari/Scherer (2005).
[7] In a current survey among 180 major German real estate companies (housing companies, commercial real estate investors, corporates, and others), SCHWENZER (2008), for instance, found that 35% of all respondents use the standard deviation of expected returns as a risk measure. This percentage is higher than that of any other quantitative method, but much lower than qualitative measures such as the scoring technique.

the MPT and the volatility real estate professionals still seem to be hesitant to utilize alternative risk measures.

At this point we can only speculate about the reasons, but the preliminary results of our research project points to the following ones:

- The typical CEO in a large German real estate company made his career in real estate and is not up to date regarding the latest developments in the field of risk management. The typical risk controller on the contrary has a finance or other quantitative background, but lacks experience and knowledge in real estate management. The result of this "culture clash" is often that the decision-maker does not fully understand and thus ignores quantitative risk measures.

- Even if the decision-makers are open-minded and on one level with the latest research, there is a common feeling that the problems that researchers deal with are far detached from the problems that practitioners are facing. For most real estate executives risk management is not their first concern, and accordingly not much effort is put into the development of alternative risk measures. If quantitative methods are employed, simple ones such as scenario or sensitivity analysis or the calculation of the standard deviation of future cash flow returns prevail.

- That also explains why there is a great discrepancy in the topics of academic and professional risk management journals. While the international academic literature on real estate risks is mainly concerned with quantitative methods, the professional literature—in Germany at least—focuses more on qualitative methods. This finding corresponds with the widespread belief that properties are too complex to be judged without subjective input and soft data and that no single risk measure can adequately reflect the multi-dimensional risk of real estate.

The remainder of this article is structured as follows. The next section will determine whether volatility can theoretically be seen as an appropriate risk measure. In the next step, it will be analyzed whether the propositions on which the use of standard risk measures are generally based, do apply in the real estate context. Subsequently, we will present our own empirical evidence from German real estate data. Finally, we will deal with the question whether qualitative risk measures might be more appropriate to estimate future real estate risk and some requirements regarding more appropriate risk measures.

Assessment of the appropriateness of volatility as a risk measure

As mentioned before, this section deals with the question whether volatility, from a theoretical point of view, can be seen as an appropriate risk measure. To assess the appropriateness of risk measures, several authors developed sets of axioms that risk measures should satisfy.

One such set of axioms that defines four basic properties for an acceptable risk measure was developed by PEDERSEN/SATCHELL.[1] Since the authors understand risk as the deviation of returns from an expected return, this set of axioms is explicitly suitable for assessing risk measures that estimate the deviation of an expected return. The four basic properties which an acceptable risk measure should satisfy are nonnegativity, positive homogeneity, subadditivity, and shift-variance. The axiom of nonnegativity is already implied in the author's definition of risk as the deviation of an expected return. Furthermore, a risk measure satisfies the axiom of homogeneity if the risk increases proportionally, when increasing the invested capital in a risky investment. Therefore, the risk measure responds proportionally to scale changes. Subadditivity in this context means that the risk of a portfolio should not exceed the sum of the individual risks. The fourth basic property, shift-invariance, makes a risk measure invariant to the addition of a constant to the random variable.

Since the standard deviation, and therefore the volatility, does satisfy all defined axioms, PEDERSEN/SATCHELL consider the standard deviation an acceptable risk measure.[2]

Another set of axioms that is widely used in the literature was defined by ARTZNER et al.[3] The authors consider a risk measure acceptable and coherent if it satisfies four specific axioms. As PEDERSEN/SATCHELL do, ARTZNER et al. also consider subadditivity and positive homogeneity necessary requirements for an acceptable risk measure. However, a fundamental distinction between these two sets of axioms is the underlying understanding of risk. ARTZNER et al. do not define risk as the deviation from a target value but as the "minimum extra capital, which, invested in the reference instrument, makes the future value of the modified position become more acceptable."[4] This different understanding of risk is the reason why ARTZNER et al. defined two axioms that were not included in the set of axioms by PEDERSEN/SATCHELL. These axioms are translation invariance and monotonicity. Translation invariance in this context means that investing capital in a risk free investment reduces the risk of the portfolio by the additionally invested risk-free amount.[5] Therefore less minimum capital is needed to cover the risk. Monotonicity means that if a random variable X, under all scenarios, has better values than a random variable Y, the risk of X should be less than the risk of Y.

When considering the appropriateness of volatility as a risk measure following the set of axioms by ARTZNER et al., as mentioned before, volatility satisfies the basic properties of subadditivity and positive homogeneity. However, it does not satisfy the axiom of monotonicity.[6] If, for example, the random variable X has with absolute certainty a value of $X=0$ under all scenarios and the value of another random variable Y would be $Y=1$ with a probability of p (with $0 < p < 1$) and $Y=0$ with a probability $1-p$, it applies that VOLA(X) <

[1] Cf. Pedersen/Satchell (1998). The set of axioms defined by Pedersen/Satchell actually adopted axioms defined by Kijima/Ohnishi (1993) and Bell (1995).
[2] Cf. Pedersen/Satchell (1998), p. 108. However, variance does not satisfy the axiom of homogeneity.
[3] Cf. Artzner et al. (1997/1999).
[4] Artzner et al. (1999), p. 204.
[5] Cf. Bürkler/Hunziker (2008a), p. 7.
[6] Cf. Weiß (2008), p. 271, Romeike/Hager (2009), p. 148.

VOLA(Y) although Y ≥ X under all scenarios.[1] Therefore, according to the set of axioms by ARTZNER et al., volatility cannot be considered an appropriate or coherent risk measure.[2]

As can be inferred from the preceding analysis, it depends on the chosen set of axioms whether volatility should be considered an appropriate risk measure or not.[3] The selection of the set of axioms thereby highly depends on the investor's understanding of risk.

Even though, according to the most popular set of axioms by ARTZNER et al., the volatility cannot be considered an appropriate risk measure, it is widely used as a risk measure for real estate. The following section now identifies whether the underlying assumptions of the volatility are satisfied when using it in the real estate context.

Do the volatility's underlying assumptions apply in a real estate context?

As mentioned before, this section deals with the question whether the most important assumptions on which the use volatility is based, do apply in a real estate context. The most important assumption when using the volatility as a risk measure is that returns are normally distributed. Therefore, this section will give an overview of various studies that have analyzed the distribution of real estate returns. Furthermore, it will be determined whether other prepositions namely the existence of a significant data base, an efficient real estate market implying the random-walk of returns and the investors' understanding of risk as the variation of returns, do apply in the real estate context.

Assumption of normally distributed returns

In the mid-1980s authors such as MILES/MCCUE and HARTZELL/HEKMANN/MILES began to find evidence that real estate returns are not normally distributed.[4] HARTZELL/HEKMANN/MILES, for example, stated that "The measures of skewness and kurtosis for the quarterly returns indicate that the distribution of the returns is not normal."[5] However, those studies did not delve deeper into this issue and it was not until the early 1990s that the normal distribution of real estate was fundamentally questioned by authors such as MYER/WEBB and LIU/HARTZELL/GRISSOM[6], who challenged the exclusive use of standard risk measures for real estate decision making.[7] In the following years various studies were published that dealt with the distribution of real estate returns. Following YOUNG/LEE/DEVANEY, these studies can be classified as either time-series analyses or cross-sectional analyses.[8]

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[1] Cf. Hanisch (2006), p. 76.

[2] To reject the appropriateness of a risk measure, only one axiom has to be rejected. However, Hanisch (2006, p. 76) also suggests the failure of volatility to satisfy translation invariance.

[3] Besides these two sets of axioms Rockafellar/Uryasev/Zabarankin (2002) defined two additional sets of axioms. However, these are similar to those defined by Pedersen/Satchell and Artzner et al.

[4] Cf. Miles/McCue (1984b) and Hartzell/Hekman/Miles (1986).

[5] Hartzell/Hekman/Miles (1986), p. 234.

[6] Cf. Myer/Webb (1992), Liu/Hartzell/Grissom (1992).

[7] See, for example, a quotation by Liu/Hartzell/Grissom (1992, p. 311): "finding of systematic skewness implies that we are not considering an important ingredient in the measurement of real estate risk. It also suggests that … three moments are important in the portfolio formation process."

[8] Cf. Young/Lee/Devaney (2006), p. 111.

By employing a cross-sectional analysis, KING/YOUNG identified the return distribution of about 2,000 properties listed in the Russell-NCREIF that is illustrated in figure 1a.[1]

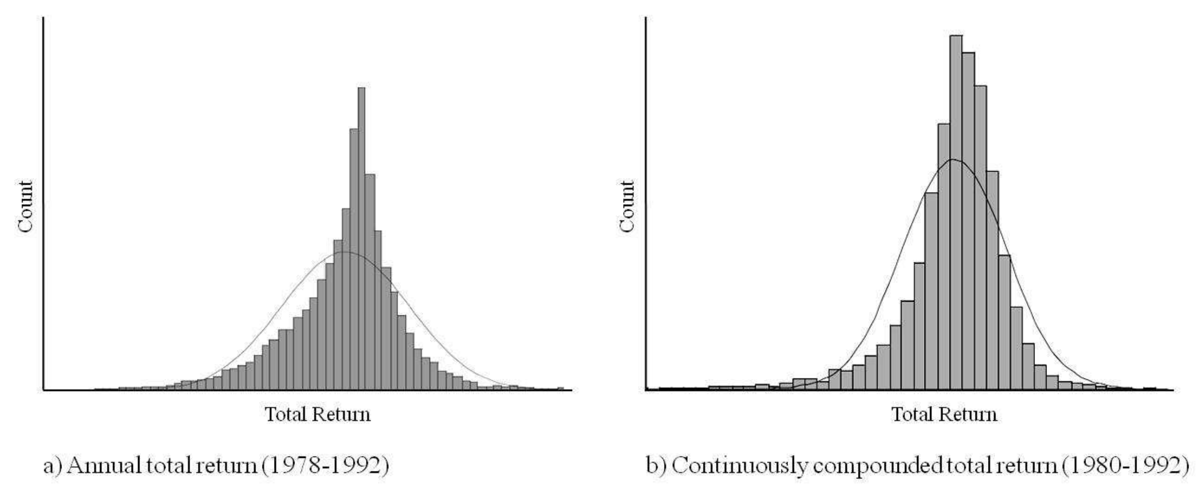

Figure 1: Distribution of real estate returns of the Russel-NCREIF Property Index[2]

Based on this return distribution and further calculations of values for skewness and kurtosis, the authors concluded that real estate returns are not normally distributed.[3] For a similar study, YOUNG/GRAFF also examined the annual returns of properties listed in the NCREIF Index, however, after replacing each discrete annual return with its continuously compounded equivalent.[4] As can be reasoned out of figure 1b, they identified a non-normal distribution similar to that when using discrete returns. In fact, the authors found that the density functions, whether analyzing all property types combined or on the level of individual property types, are more peaked near the mean, have weaker shoulders, fatter tails and are negatively skewed. They also found that annual property returns are not normally distributed for any calendar year during the analyzed period 1980-1992 and that returns are heteroscedastic, meaning that skewness and magnitude of real estate risk change over time. Given these results, the authors argue that without modification standard risk measures are inapplicable in the real estate context. GRAFF/HARRINGTON/YOUNG found similar results when analyzing the Australian real estate market.[5]

Among the first to analyze real estate returns of the UK market were LIZIERI/WARD and LEE.[6] After analyzing the IPD data for the period 12/1986-12/1998 and 12/1986-12/2000 respectively, the authors conclude that monthly UK returns are non-normally distributed and leptokurtic. Furthermore, LEE discovered that distributions for individual property types or

[1] Cf. King/Young (1994).
[2] Cf. King/Young (1994), p. 12 and Young/Graff (1995), p. 238.
[3] In contrast see, for example, Myer/Webb (1994) who, by employing a time-series analysis on the NCREIF-Index, found out that semi-annual and annual real estate returns are approaching a normal distribution. Solely quarterly returns, as confirmed by Byrne/Lee (1997), are not normally distributed.
[4] Cf. Young/Graff (1995).
[5] Cf. Graff/Harrington/Young (1997)
[6] Cf. Lizieri/Ward (2001), Lee (2002). In the following years, various studies with similar results were published; see, for example, Brown (2004), Byrne/Lee (2004), Lee (2005), Coleman/Mansour (2005), Marcato/Key (2007).

geographic regions in the majority of cases exhibit positive skewness and are only distributed symmetrically when aggregated to an index. Maybe the first who analyzed return distributions of individual properties were BROWN/MATYSIAK.[1] Based on the IPD data for individual properties, the authors demonstrated that these returns, when employing a time-series analysis, are also skewed and leptokurtic. However, the authors further concluded that the return distributions of individual properties are much closer to being normal when using quarterly or annual return data. Also when analyzing the monthly, quarterly, and annul returns on a portfolio or index level, BROWN/MATYSIAK discovered a similar phenomenon. Furthermore, they concluded that "combining properties into portfolios also increases the probability that the distribution of returns will approach normality."[2]

One of only a few studies that analyze the distribution of German real estate returns was conducted by MAURER/REINER/SEBASTIAN.[3] Based on the data of a self-made German real estate index, the IPD-Index, and the NCREIF-Property-Index, the return distributions of German, U.K., and U.S. properties were compared. The authors concluded that "some evidence for German real estate returns to be not normally distributed were found."[4] The authors found out that German *quarterly* returns exhibit significant positive skewness and a long right tail.[5] However, when analyzing *annual* returns, no significant skewness or excess kurtosis was detected. When correcting the German data for the smoothing effect, the normality assumption could not be rejected for both the quarterly and the annual returns.[6]

In 2006, YOUNG/LEE/DEVANEY analyzed the continuously compounded annual returns of properties listed in the IPD data base by using the same cross-sectional approach that was previously employed by YOUNG/GRAFF and GRAFF/HARRINGTON/YOUNG.[7] The authors found out that for the period from 1981 thru 2003 the density functions for the whole sample and for each property type were more peaked near the mean than the corresponding normal distributions, had weaker shoulders and fatter tails, and were negatively skewed. When analyzing the return distributions per year, the authors further detected that stable infinite-variance skewed asset-specific risk functions with characteristic exponents differing from the characteristic exponents of normal distributions best modeled the observed distributions. The analysis further implied that real estate risk is heteroskedastic because the skewness and magnitude of real estate asset-specific risk change over time.

YOUNG detected the same real estate return characteristics for the U.S. as before for the U.K. and Australia.[8] When YOUNG compared the results, he concluded that the samples were statistically almost identical and that all return distributions could not be described by a normal distribution.

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[1] Cf. Brown/Matysiak (2000), p. 211-225.
[2] Brown/Matysiak (2000), p. 225.
[3] Cf. Maurer/Rainer/Sebastian (2004).
[4] Maurer/Rainer/Sebastian (2004), p. 74.
[5] In contrast, according to the authors' findings, the U.S. real estate returns are skewed significantly leftward and are considerably leptokurtic. However, the quarterly U.K. returns approach a normal distribution.
[6] The normality assumption could be rejected for the quarterly returns for the U.K. and the U.S. indices, while it couldn't be rejected for annual returns.
[7] Cf. Young/Lee/Devaney (2006).
[8] Cf. Young (2008).

Summing up, it can be observed that most studies reject the normality assumption for individual property returns and for most market indices.[1] Even though some authors that analyzed index returns found out that it is more likely for the returns to show a normal distribution when longer holding period data are used, it seems precarious to assume a normal distribution for real estate returns. Subsequently, since the measure of volatility builds on the normality assumption, volatility is likely to be an inaccurate real estate risk measure.

Significant data base

Another important preposition regarding the appropriateness of volatility as a risk measure for real estate is that the data is sufficient in terms of quality as well as quantity. However, this is often doubted, both for the individual property level and for the portfolio and index level.

In this context it is frequently argued that historical return series are not long enough to serve as a basis for risk estimations.[2] Other asset classes can draw on data series that cover various decades and business cycles, but this is not the case for real estate data. As mentioned before, the fact that real estate data does usually not cover a whole real estate cycle is a major drawback when using volatility as a measure for real estate risk. Conclusions regarding real estate risk that are drawn from a too small data base are likely to be incorrect.

Another problem with the existent real estate return data is its accurateness. A problem that occurs when appraisal-based data is used as a proxy for the property's value is that it usually differs from the actual market value. The use of appraisal-based data results in the so-called smoothing effect that was already mentioned before. According to GELTNER, this smoothing effect is "due to the combined effects of appraisers' partial adjustments at the disaggregate level plus temporal aggregation in the construction of the index at the aggregate level." [3]

It is often presumed that appraisers, to some extent, follow optimal updating strategies of previous values and therefore do not fully capture the actual movement of the property value.[4] Therefore, the value fluctuation based on the appraised values is likely to understate the real volatility of property values. The extent of the smoothing effect mainly depends on the availability of current market information and on the degree of caution exercised by the appraiser. The more cautious the appraiser and the less market information available, the more will the appraiser refer to previous values and hence intensify the smoothing effect. Another effect may come into play when properties are appraised every quarter. The so-called seasonality effect may appear when properties are appraised three quarters a year by *inside* appraisers and only one time a year by an *outside* appraiser. In this case, there might be "a tendency for the *inside* appraisers to simply stick with the most recent *outside* appraisal of each property (perhaps adjusted for inflation)." [5]

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[1] See, for example, Young/Lee/Devaney (2006), p. 113.
[2] See, for example, Wheaton et al. (2002), p. 8, Coleman/Mansour (2005), p. 39, Ducoulombier (2007), p. 31.
[3] Geltner (1993), p. 325.
[4] See, for example, Gleißner/Leibbrand (2007), p. 8, Webb/Pagliari (1995), p. 216, Corgel/deRoos (1999), p. 282.
[5] Geltner (1989), p. 471.

Additionally to the smoothing effect that occurs on the individual property level, smoothing also appears when aggregating values on a portfolio or index level. The problem here is that values of properties that are appraised at different points in time are averaged together which results in the index value being a moving average of the appraised values.

The general opinion among real estate academics is that the actual real estate volatility is understated when appraisal-based values are used.[1] To solve the problem of the smoothing effect, two alternatives are discussed in the real estate literature. While one possibility is to "desmooth" appraisal-based returns, another possibility is to construct transaction-based real estate indices.[2] To desmooth appraisal-based indices, various methods are suggested in the literature. Most authors calculate smoothing-factors which express the ratio of volatility of desmoothed return data compared to the volatility of original appraisal-based data.[3] However, there will always be a difference between the appraised value and the market price which will not be observed until the property is sold.[4] Furthermore, no model to desmooth the appraisal-based data is perfect and the calculated smoothing factors depend on both the chosen model and its calibration.[5]

Another alternative to address the smoothing issue is to use transaction-based indices instead of appraisal-based indices.[6] However, due to a limited and time-varying number of transactions, the use of such indices is problematic as well.[7]

The small number of transactions causes another problem when estimating real estate risk as the volatility of historical real estate data series, whether they are appraisal or transaction-based. The liquidity risk, which is usually higher for real estate than for other asset classes, is not captured when the volatility is calculated based on historical returns. Thus, the marketing period for investment grade real estate is highly variable and is potentially extending for several months, thereby exposing the real estate investor to an additional risk that is not captured by the historic volatility of real estate returns.[8]

In summary, it can be recorded that the real estate return data base exhibits another major problem when the volatility is used as a real estate risk measure. This is mainly due to the comparably small data base, the smoothing effect as well as the liquidity risk that is not captured in the historical volatility.

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[1] See, for example, Ibbotson/Siegel (1984), p. 222, Geltner (1991), p. 327, Newell/MacFarlane (1995), p. 51, Ducoulombier (2007), p. 6.

[2] Few authors such as Cheng/Liang (2000) follow a third alternative and, despite the before mentioned disadvantages, still use appraisal-based indices without correcting for smoothing. They argue that "with respect to the within-real estate diversification … the appraisal bias becomes a systematic error because it has similar impact on all the properties in the indices." (Cheng/Liang, 2000, p. 10)

[3] For an overview of various smoothing-factors that are used in practice see, for example, Hoesli et al. (2002, p. 11), Geltner/MacGregor/Schwann (2003, p. 1057), Wang (2006, p. 509 f.).

[4] Cf. Wang (2006), p. 498.

[5] Cf. Lee/Stevenson (2006), p. 126, Marcato/Key (2007), p. 96, Wang (2006), p. 501.

[6] See, for example, Feldman (2003), Fourt/Gardner/Matysiak (2006), Gardner/Matysiak (2006), Fisher/Geltner/Pollakowski (2007).

[7] Furthermore, Cheng/Roulac (2007, p. 34) mention additional problems such as the "sample selection bias", that affect appraisal-based as well as transaction-based indices.

[8] Cf. Bond et al. (2007), p. 448.

Market efficiency and random-walk

A third assumption for using the volatility of historical real estate returns as a proxy for real estate risk is that real estate markets are efficient and that returns follow a random-walk. This further implies that it is not possible to forecast risk and return.

However, the smoothing effect and the comparatively high liquidity risk suggest that real estate markets are not efficient. Since it is difficult and costly for appraisers to gather current market information it is reasonable to "adjust previous valuations in the light of new evidence by an intuitive process of Bayesian adjustment."[1] Sufficient market data that is available to all market participants, however, is a basic requirement of an efficient market. Furthermore, reasons such as the fact that real estate transactions occur infrequently and do not take place on central markets lead to the often stated notion that real estate markets are, at best, weak form efficient.[2]

Due to significant autocorrelation that was found in various studies, academics also negate the random-walk hypothesis of real estate returns since they are, at least partly, predictable and therefore not random.[3]

It can be concluded that there is growing evidence that real estate markets are not efficient and that real estate returns do not follow a random-walk. It is therefore very questionable to use historical volatility as a risk measure.

Investor's definition of risk as the variation of returns

Whether the fourth assumption, the investor's definition of risk as the variation of returns, does apply in the real estate context obviously depends on the individual investors' perspective.

However, despite the intuitive appeal and computational convenience of standard risk measures, the definition of risk as a positive or negative deviation from an expected return is increasingly questioned. It is often argued that investors are far more concerned with the downside of the return distribution.[4] Therefore investors are more concerned with the chance to sustain a loss than with the chance to realize excess profit of the same amount. Thus, CHENG states "most investors perceive risk as only the chance of earning less than certain target rate of return. The potential of earning better-than-expected returns, on the other hand, is viewed as favorable upside potential."[5] This behavior can, in parts, be explained by the diminishing marginal utility.[6]

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[1] Lizieri/Ward (2001), p. 50.
[2] See, for example, Byrne/Lee (1995), p. 72, Sanders/Pagliari/Webb (1995), p. 129, Clayton (1998), p. 42.
[3] See, for example, Roulac (1976), p. 38, Wheaton et al. (1999), p. 16, Coleman/Mansour (2005), p. 40. For studies that found autocorrelation in real estate return series see, for example, Myer/Webb (1992), Newell/Webb (1996), Englund/Gordon/Quigley (1999), Cheng et al. (2010).
[4] See, for example, Keppler (1990), p. 610, Coleman/Mansour (2005), p. 40, Ducoulombier (2007), p. 33, Gleißner/Leibbrand (2007), p. 19.
[5] Cheng (2005), p. 89.
[6] This behavior is in line with the so-called prospect theory which states that people, due to psychological effects, are more concerned with downside risks than with upside chances.

Even though it cannot be generally stated whether the variation of returns is in line with the investors understanding of risk or not, many academics and professionals refuse this definition of risk. Therefore, employing volatility as a risk measure that captures upside as well as downside potential will lead to results that are not in line with the investors' actual understanding of risk.

Analysis of German real estate return distributions

This section can be further subdivided into three parts. In part one, distributional characteristics of individual property returns, provided by a large German real estate management company, are analyzed by applying a time-series analysis. The next part employs a cross-sectional analysis of real estate returns of two German real estate portfolios. Finally, the distributional characteristics of two German real estate performance indices are analyzed in order to provide some information on the market's return distribution.

To analyze the distributional characteristics we have mainly focused on the measures for skewness and kurtosis. The skewness measure indicates the degree of asymmetry of the analyzed return data respectively the degree to which the distribution differs from a symmetrical distribution. The skewness value of a normal distribution equals zero. However, a positive skewness value indicates a distribution with an asymmetric tail extending towards more positive values while a negative skewness indicates a distribution with an asymmetric tail extending towards more negative values. In contrast, the kurtosis of a distribution describes how peaked or flat a distribution is. A normal distribution has a kurtosis value of three. A kurtosis measure in excess of three characterizes a distribution as more peaked with fat tails compared to a normal distribution. A kurtosis value of less than three, however, indicates a flat distribution with narrow tails. A frequently used test to assess whether the analyzed data comes from a normal distribution is the Jarque-Bera (JB) test for normality. The underlying intuition of this test is that both the values for skewness and excess kurtosis for a normal distribution would equal zero. The JB-test assesses for each return series whether these values are jointly equal to zero. The critical value for rejecting normality of a return distribution that will be used in the following analyses equals 5.99 and is derived for a level of significance of 5%.[1]

Time-series analysis of individual properties returns

As mentioned before, this part analyzes the historical returns on properties of a major German real estate asset manager who is responsible for a well-diversified portfolio of about 100 properties located in Germany with a total market value of roughly 2.5 billion Euro.[2] The company provided us with the annual total returns from 2003 thru 2007. However, the time series was too short for significant results. Therefore we also used semi-annual market values for the five year period and the semi-annual capital growth return data. Using the semi-annual

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[1] This level of significance and the corresponding critical value for the JB test are commonly used for analyses of return distributions. See, for example, Brown/Matysiak (2000), p.216, Maurer/Rainer/Sebastian (2004), p. 64, Poddig (2008), p. 336.

[2] Due to data confidentiality we cannot disclose more information about the portfolio.

capital growth return data, we now have nine historical data points that can be analyzed.[1] For further analyses of individual properties return distributions we used annualized capital growth return data and subsequently converted the data to its continuous compounded equivalent.[2]

To analyze the return distributions of 100 properties for the period 12/2003 to 12/2007, we estimated the average return, standard deviation, skewness and kurtosis measures as well as the JB statistic. The following tables 1 and 2 provide an overview of the results.

Sector	# Properties		Average return per year	Average Standard deviation per year	Skewness	Kurtosis	JB statistics
All property	100	Mean	-0.69%	11.01%	-0.13	1.10	4.86
		Min	-12.09%	3.66%	-2.42	-2.11	0.75
		Max	14.26%	29.86%	2.34	7.41	19.62
Residential	34	Mean	0.64%	9.35%	-0.07	0.99	5.85
		Min	-7.14%	4.14%	-2.98	-2.46	0.48
		Max	8.09%	23.26%	2.33	8.91	26.43
Office	51	Mean	-1.89%	13.01%	-0.22	1.25	4.44
		Min	-16.98%	2.92%	-2.42	-2.15	0.86
		Max	21.04%	39.41%	2.68	7.61	18.72
Retail	7	Mean	2.03%	5.39%	-0.27	0.32	4.30
		Min	-3.77%	3.10%	-1.18	-1.08	1.19
		Max	7.10%	8.62%	0.67	2.83	6.25
Others	8	Mean	-1.12%	10.21%	0.30	1.22	3.80
		Min	-9.24%	6.82%	-1.17	-1.29	0.75
		Max	3.52%	15.61%	1.72	3.70	8.09

Table 1: Distributional characteristics of annualized and continuously compounded real estate returns

As can be inferred from the foregoing table, the values of the average skewness and kurtosis measures are relatively close to zero respectively three. Furthermore, the average JB statistics indicate measures below the critical value of 5.99 and therefore suggest that for the majority of return distributions, normality cannot be rejected. This presumption is strengthened by the following table that indicates the number of properties for which normality cannot be rejected at the 5 % level.

Sector	# Properties	Properties with normally distributed returns (total/in %)	
All property	100	74	74%
Residential	34	20	59%
Office	51	41	80%
Retail	7	6	86%
Others	8	7	88%

Table 2: Number of properties with normally distributed returns

[1] Using capital growth return data instead of actual total return data seems plausible to us. On the one hand, this is based on the general notion that capital growth contributes a major portion to the total return. On the other hand our calculations reveal that the total return values which exist for the five year period are perfectly correlated with the annualized capital growth return data for the same years.
[2] We analyzed only those properties for which at least seven data points were available.

This overview indicates that for most cases, normality cannot be rejected.[1] Even though these results are in line with results of other studies that investigated annualized or annual return distributions on the property level, the significance of these results is questionable, due to the relatively short time period.[2]

In order to arrive to more meaningful results, we further conducted a cross-sectional analysis to determine the distributional return characteristics per year.

Cross-sectional analysis of individual properties returns

Here we used the annual total return data for the five year period as opposed to the data for capital growth we used before.[3] As YOUNG/LEE/DEVANEY assumed when employing a cross-sectional analysis, we also assume "that expected variations in annual property returns due to differences in property type account for all of the differences in returns on individual properties"[4] in the portfolios. An overview of the results is given in the following table.

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2003	-2.44%	13.60%	-1.0624	2.6225	14.7468	rejected	76
2004	-1.87%	14.49%	-2.5564	10.1542	248.0752	rejected	77
2005	3.83%	7.50%	-0.0528	9.3961	122.7624	rejected	72
2006	3.09%	9.41%	-4.0178	23.1644	1374.2595	rejected	70
2007	7.45%	19.42%	-4.1653	21.4451	1058.1910	rejected	62

Table 3a: Distributional characteristics of log annual total returns per year of portfolio 1: All properties

As can be inferred from table 3a, for no year of the five year period the returns follow a normal distribution. Furthermore, for each year the skewness measures indicate that the distributions are negatively skewed while, in four of five cases, the kurtosis measures indicate that the distributions are more peaked near the mean and have weaker shoulders as well as fatter tails than a corresponding normal distribution. Consequently, when applying the JB test as a test for normality, normality is rejected for each of the five years. Similar distributional characteristics can be seen in table 3b that breaks the above mentioned results down for the individual property types.[5]

[1] Other normality tests, such as the Shapiro-Wilk test, the Anderson-Darling test and the Kolmogorov-Smirnov test, that were also employed to analyze the distributional characteristics of the return data, suggest similar results. Also, when analyzing the annual total return data over the five year period we reached similar results.

[2] The results might be of little significance since the available data is unlikely to cover a whole real estate cycle. Furthermore, the significance of the normality tests increases with the number of observations.

[3] Even though it is favorable to draw on as long data series as possible, for the purpose of cross-sectional analysis it is not as important as it is for time-series analysis because the data is analyzed per year and not over the whole period. Therefore, using actual total returns instead of capital growth returns as a proxy for total returns seems more plausible to us.

[4] Young/Lee/Devaney (2006), p. 114.

[5] As can be seen in the tables, also for individual property types, kurtosis and skewness values deviate from those values of a normal distribution. The fact that normality for some property types, for example retail, can still not be rejected according to the JB test might be due to the little number of properties included in the analysis.

Residential

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2003	4.66%	6.73%	-1.9119	6.9027	42.2917	rejected	34
2004	-0.13%	5.97%	-0.2144	0.0535	12.1905	rejected	33
2005	3.79%	4.25%	-0.9449	1.4781	6.6238	rejected	27
2006	5.57%	3.65%	1.1315	2.6972	6.0821	rejected	28
2007	12.88%	7.54%	0.2589	-0.2380	12.0968	rejected	27

Office

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2003	-9.36%	15.89%	-0.1976	1.8658	2.1640	not rejected	36
2004	-4.70%	19.33%	-1.8545	4.6788	26.2441	rejected	38
2005	3.27%	9.46%	0.1738	6.5851	21.0828	rejected	39
2006	2.99%	7.60%	-1.7313	8.1033	55.4640	rejected	35
2007	1.71%	27.00%	-3.0138	10.1004	101.2059	rejected	28

Retail

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2003	-1.24%	4.33%	-0.3364	-1.5295	5.2422	not rejected	6
2004	6.50%	5.71%	-0.0274	-0.2983	2.7204	not rejected	6
2005	7.58%	2.35%	-0.3530	0.3149	1.9271	not rejected	6
2006	-6.39%	22.32%	-2.3720	5.8196	8.8827	rejected	7
2007	9.48%	3.89%	-0.2856	-1.2662	5.4038	not rejected	7

Table 3b: Distributional characteristics of log annual total returns per year of portfolio 1: By property type

The distributional characteristics described before are also shown by the following figure that includes the distribution of continuously compounded returns for the period 2003-2007, for all properties combined. Furthermore, the figure exhibits a Normality (Q-Q) Plot. The deviation of the dots from the line indicates that normality is likely to be rejected when analyzing all properties combined.

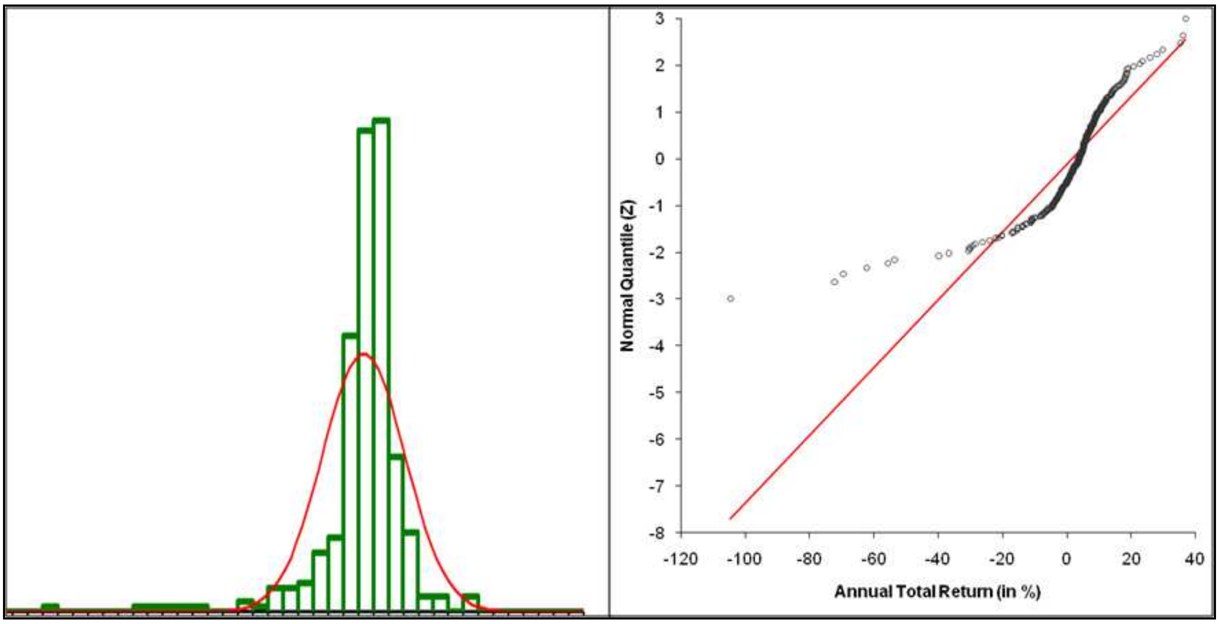

Figure 2: Density function and QQ-Plot of log annual total returns for all properties of portfolio 1 over the five year period

For a second portfolio the results were similar. This portfolio consisted of 123 properties with a market value of about 2.2 billion Euro.[1] However, for this portfolio total return data for only three years (2006-2008) was available. The following table shows the results of the same kind of cross-sectional analysis as for the first portfolio.

[1] Again the portfolio can be considered well-diversified, but further information cannot be disclosed.

All Properties combined

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2006	5.94%	6.64%	-1.2161	8.6535	192.5464	rejected	122
2007	6.63%	6.72%	-1.0879	4.5583	36.7064	rejected	123
2008	6.23%	9.07%	0.0461	8.0128	128.8246	rejected	123

Residential

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2006	6.88%	4.82%	1.2464	2.8116	19.7902	rejected	76
2007	6.42%	5.57%	-0.4358	3.1263	2.4883	not rejected	77
2008	6.37%	5.14%	1.0133	2.6948	13.4748	rejected	77

Office

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2006	4.20%	9.33%	-1.4494	5.3718	21.6281	rejected	37
2007	6.11%	8.95%	-1.2218	3.3247	9.3679	rejected	37
2008	3.68%	11.94%	-1.2268	1.4110	13.1738	rejected	37

Retail

Year	Mean	Standard deviation	Skewness	Kurtosis	JB statistics	Normality	Number of properties
2006	5.16%	5.82%	-0.1995	0.2962	2.8012	not rejected	9
2007	10.53%	3.61%	0.4329	0.0146	3.6233	not rejected	9
2008	15.53%	15.36%	1.9565	4.7163	6.8462	rejected	9

Table 4: Distributional characteristics of log annual total returns per year of portfolio 2: All properties combined and by property type

Although less data is available than for the first portfolio, it can be inferred that the returns are similarly distributed and, when combining all properties, are not normally distributed.[1] This is also shown in the following figure that includes the distribution and the Q-Q Plot of continuously compounded returns for the period 2006-2008, for all properties of the second portfolio combined.

[1] As in the first portfolio, kurtosis and skewness values deviate from those of a normal distribution, but normality can not be rejected in any case, probably due to the small sample size.

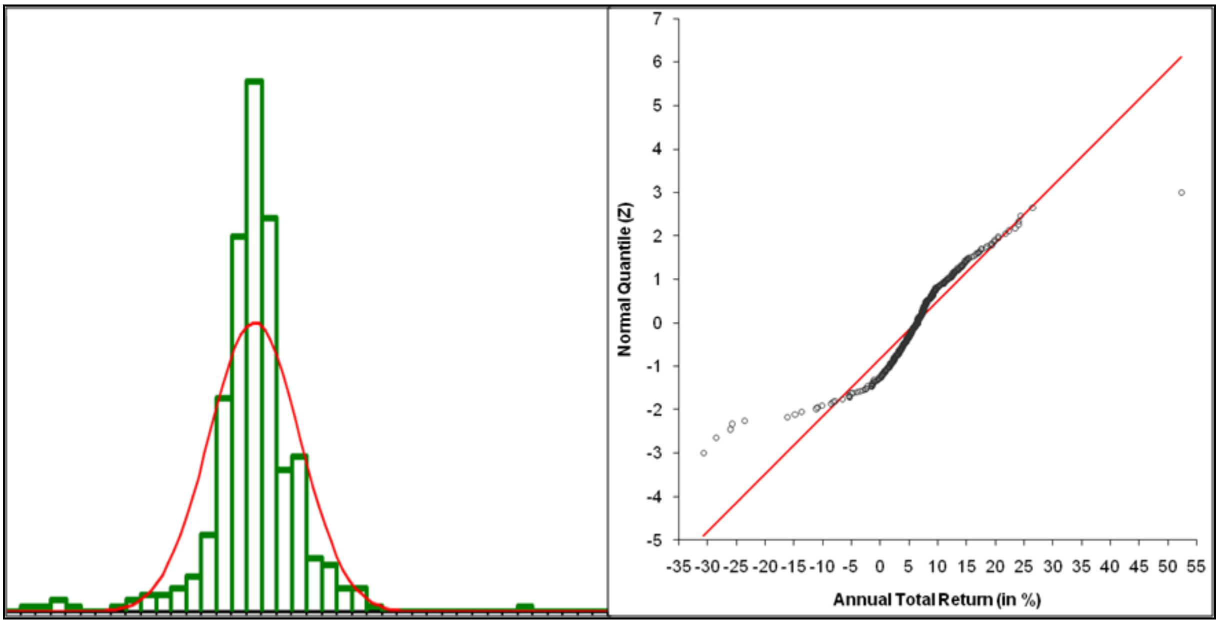

Figure 3: Density function and QQ-Plot of log annual total returns for all properties of portfolio 2 over the three year period

Figure 3 indicates that returns of the second portfolio are not normally distributed and, in fact, are negatively skewed, are more peaked near the mean and have weaker shoulders as well as fatter tails than the corresponding normal distribution.

For the cross-sectional analysis we can conclude —on the basis of a very small time series— that normality is likely to be rejected for both portfolios for all years that were analyzed.

Analysis of German real estate market return distributions

A last analysis was conducted by determining the distributional characteristics of the two major German real estate market indices. For that purpose, BulwienGesa provided us with the German Property Index (GPI) data for the period 1991-2008 and the IPD Investment Property Databank GmbH provided us with the German IPD Index, the Deutscher Immobilienindex (DIX) for the period 1996-2009. To analyze the distributional characteristics, we used annual total returns and further converted them into their continuously compounded equivalents.[1] The following table reveals that, when employing four different normality tests, normality could not be rejected for both indices for most of the tests. These results are in line with the results found by MAURER/REINER/SEBASTIAN[2] when they analyzed annual German real estate market return data.

[1] We did not correct the annual data for possible further smoothing by following Coleman/Mansour (2005, S. 38) who conclude that "the application of a statistical model to *unsmooth* returns - has the effect of increasing the size of the second moment (variance). In effect, this will *widen* the distribution of returns, increasing the volatility. But it will not, in general, transform a non-normal return distribution into a normal one."

[2] Cf. Maurer/Rainer/Sebastian (2004).

Index	Period	Mean	SD	Skewness	Kurtosis	Normality according to ...			
						JB test	Shapiro-Wilk test	Anderson-Darling test	Kolmogorov-Smirnov test
BulwienGesa GPI	1991-2008	7.93%	5.92%	1.22617	1.90490	not rejected	not rejected	not rejected	not rejected
IPD Index	1996-2009	3.39%	1.54%	-0.51447	-0.77687	rejected	not rejected	not rejected	not rejected

Table 5: Distributional characteristics of German real estate market returns

The findings can be also illustrated by the following figure that shows the QQ Plots of both, the GPI as well as the IPD data.

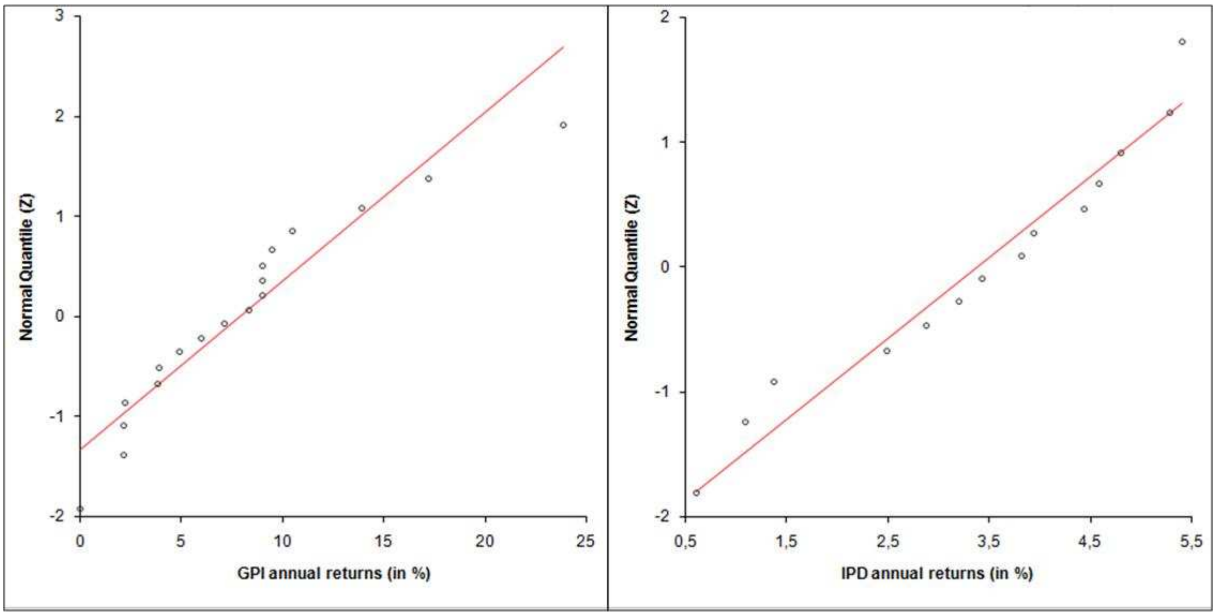

Figure 4: QQ-Plots for GPI and IPD annual total returns

Summing up, it can be concluded, that even though normality cannot be rejected for annual German market returns, some evidence was found that normality is likely to be rejected at the individual property level. This is the result when applying a cross-sectional analysis on the property return of two large German real estate managers. Only when applying a time-series analysis for a relatively short period, in most cases it seems unlikely to reject normality.

Although the results of our analysis are based on a small data base that has to be expanded for further research in order to arrive at more significant results, the foregoing analysis reveals that it is questionable to assume normality and to use volatility as a risk measure, at least on the individual property level.

Conclusion

This paper supports the thesis that volatility is not an appropriate risk measure for real estate. This proposition is based on various facts. In general, according to the most popular set of axioms by ARTZNER et al., volatility cannot be considered an appropriate, or coherent, risk measure, due to its failure to satisfy the axiom of monotonicity. Furthermore, fundamental assumptions for the use of volatility as a risk measure do not apply in the real estate context.

As explained above, empirical evidence exists that real estate returns are not normally distributed. Also the second assumption regarding a significant data base is violated in the real estate context. Besides the fact that only little return data is available which is consequently unlikely to cover a whole real estate cycle, the data is biased because of the smoothing effect. Furthermore the volatility that is estimated based on this data does not account for the liquidity risk, which is in fact a major component of real estate risk. This article also points out that there is growing evidence for the assumption that real estate returns are predictable and do not follow a random-walk as assumed when using historical volatility as a risk measure. Finally, it is stated that the definition of risk as the variation of returns does not seem to be in line with the common understanding of risk of most investors.

The frequent use of volatility as a risk measure, even though major drawbacks are apparent, is due to the perceived lack of alternatives. However, some alternatives do exist:

The easiest alternative is to shift the focus from one single risk measure to a set of risk and return measures which—in combination—yields a more comprehensive picture of the riskiness of an investment. Well-established figures are, for example, the lowest return in any period, the probability to make a loss in one period, the average loss of all loss periods, and the highest number of subsequent loss periods.

More sophisticated are the downside risk measures value at risk (VaR), cash flow at risk, lower partial moments, and maximum drawdown, to name but a few. Many real estate professionals and academics propose the VaR or the related conditional value at risk as more appropriate risk measures.[1] Although the use of the VaR is more in line with the investors' common understanding of risk, it is still exposed to the other drawbacks that apply to the use of volatility as a risk measure. Furthermore, the use of this measure is seen with some skepticism since it does not satisfy the axiom of subadditivity defined by ARTZNER et al. and is therefore not considered a coherent risk measure. Further disadvantages of such measures are that they are difficult to interpret and need a sufficient database.

A different approach is to use qualitative risk measures in addition to or instead of quantitative measures. Among the most popular qualitative risk measures are scores and rating grades. The goodness of fit of these instruments largely depends on the qualification and experience of the people who develop them, the methods they apply, the quality of the available data, and last but not least on the qualification and experience of the people who use the scoring or rating instrument.

In the last decade, great progress was made in this field, mainly due to the huge effort that financial institutions had to put into improving their rating systems in order to comply with the rules of the new Basel Accord. Interestingly, the best results were achieved when qualitative and quantitative methods were combined, for example by using a cash flow forecast to determine the probability of default in any one period with the subjective opinion on the location quality of a property. Until today the ratings for commercial real estate loans

[1] See, for example, Sivitanides (1998), Sing/Ong (2000), Byrne/Lee (2004), Hamelink/Hoesli (2004), and Voigtländer (2010).

of the leading European banks constitute the state of the art for qualitative risk management in real estate.[1]

However, as our own research reveals,[2] the rating and scoring methods which are currently used in the real estate industry do not meet this standard and are not appropriate to assess actual real estate risk. Based on the data of the two aforementioned real estate portfolios, we found no evidence for ex ante scoring measures to be valid indicators for actual ex post risk. We arrived at this conclusion after correlating the scoring measures with various quantitative ex post risk measures.

Another approach to measure future risk was proposed by BÜRKLER/HUNZIKER.[3] The authors developed an extended risk rating approach that can be applied to measure the ex ante risk of various asset classes. The rating approach estimates the risk on an index level and breaks down the overall risk measure into various risk indicators such as maximum drawdown, deviation from normality, and recovery potential. Based on defined formulas, the risk for each category is assessed and the overall risk can be expressed when combining the individual measures.

The foregoing overview made clear that several alternatives for measuring risk in real estate do exist. However, since alternative risk measures are not without drawbacks, a generally accepted risk measure has yet to be found. And even though the conclusion of this paper is that volatility is not an appropriate measure for real estate risk, further research is necessary to arrive at an ideal measure for real estate risk.

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[1] Cf. Lausberg/Wiegner (2009).
[2] This work is another part of our research project on real estate risk measures. The preliminary results have not been published yet.
[3] Cf. Bürkler/Hunziker (2008b).

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