Open-ended Property Funds – A Real Estate Investment Vehicle between Liquidity Risk and Diversification Benefits

Lars Helge Haß

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Overview

Part I Introduction

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Part II Essays

Do Alternative Real Estate Investment Vehicles Add Value to REITs?

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Introduction

1 Introduction

Real estate is a central pillar of the portfolios of today's institutional and private investors. According to the latest available figures by Prudential Real Estate Investors and the European Public Real Estate Association (EPRA) the worldwide real estate market in 2005 is as large as 14 trillion U.S. Dollar (see Connor and Liang (2005) and Hughes and Arissen (2005)).

Recent real estate finance research has identified the following reasons why real estate investments should be included in a well-managed investor portfolio¹: 1) Real estate investments offer diversification benefits by responding differently to expected und unexpected events, 2) real estate absolute returns are comparable to other asset classes, 3) real estate can be used as a hedge against unexpected inflation, 4) real estate can constitute to a portfolio that is a reflection to the overall investment universe, and 5) real estate can deliver "strong" cash flows. Additionally, real estate investments are nowadays much more similar to investments in other financial assets like stocks and bonds in terms of access to individual private investors.²

Because of these benefits many countries have developed vehicles that make real estate investable for private investors for a long period of time. For example, the United States introduced real estate investment trusts (REITs) in the 1960s to allow for investments in real estate by private investors. REITs are listed companies whose main purpose is the purchase, ownership, management and sale of real estate and which enjoy favourable tax treatment. In order to qualify as a REIT, a company must invest at least 75% in real estate, pay dividends of

¹ See for example Hudson-Wilson et al. (2005) for more details.

² Bernstein (2007) gives a more detailed discussion about the differences of real estate and other asset classes.

at least 90% of the taxable income, derive 75% of its gross income from rents from real estate property or interest on real estate mortgages and its shares must be freely available.³ Furthermore, the founding of the National Council of Real Estate Investment Fiduciaries (NCREIF) and the initiation of the NCREIF index, as a representative benchmark of returns of commercial real estate investments, lead to additional popularity of real estate investments in the United States. Investments in real estate are also possible through closed-end funds and direct investments. In comparison to REITs and open-ended funds, which are attractive investment vehicles for private and institutional investors, closed-end funds and direct real estate investments are directed in general to institutional investors. These investors have the sophistication and required investment horizon in order to maintain illiquid asset positions.

Open-end fund structures were the first possibility for real estate investments for private investors with rather small investment amounts in Continental Europe. In Germany Openended Property Funds (OPFs) were first developed and introduced in 1959, with the creation of the first OPF by the "Internationales Immobilien Institut". A German OPF is a separate special asset, with an investment focus on property initiated and managed by a capital investment company. OPFs are subject to special regulations introduced in 1969 by the *Investmentgesetz* for identifying, diversifying, and controlling risks, as well as for realizing gains and fund liquidity. OPFs can be considered as a compromise between direct and listed real estate investments. Investors buy shares of OPFs directly from the fund management, and can redeem shares in principle at any time. Fund managers invest directly in an internationally diversified real estate portfolio, while holding a cash-equivalent position ranging from 5% to 49% of assets under management for daily liquidity. However, if fund liquidity falls below 5%, the fund management has to suspend share redemption. Fund managers then have a maximum of two years to either attract sufficient new asset inflows and/or liquidate portfolio

³ For more details see Chan et al. (2002).

properties to ensure fund liquidity again. During this time, investors cannot redeem shares, but starting in 2004 investors could sell their shares at a regional exchange (Börse Hamburg). In contrast, a REIT structure was not introduced in Germany until 2007.

After the beginning in 1959 investments in OPFs and the number of OPFs increased steadily reaching an investment volume of 8 billion Euro and twelve OPFs in 1990. In 2000, already 50 billion Euro had been invested in 19 OPFs. Investment in OPFs also continued to increase in the 2000s, eventually reaching 85 billion Euros invested in 44 OPFs in 2010. However, in 2005/2006 three OPFs had to suspend share redemption for the first time, causing a massive outflow of OPF investments of about 10 billion Euro. In the aftermath of the Lehman collapse up to 17 OPFs also had to suspend share redemption. Whereas in the first crisis all suspended funds opened again during a short period of time, three funds had to be liquidated, with significant losses, in the second crisis.

As of the end of 2010⁴, German OPFs invest in a diversified portfolio. Around 25% of investments are made in Germany, whereas 20% are made in France, 10% in United Kingdom, and 30% in other European countries. Around 15% is invested outside Europe. Also the value of the properties varies significantly. Properties of a value lower than 50 million Euro account for 25% of property investments. The majority of investments are made in properties with values between 50 and 200 million Euro. Finally, 20% of investments are made in properties with a value larger than 200 million Euro. Besides size and location, investments also differ in their type of use. Around 60% of investments go into office properties followed by retail properties with 20%. The remaining 20% are invested in hotels, industry and other properties.

⁴ Figures are taken from the webpage (www.bvi.de) of the German Investment and Asset Management Association (BVI e.V.), accessed on August 10, 2011.

OPFs are also available in other European countries. Switzerland introduced such a structure in 1938. A Swiss OPF, as regulated by the *Anlagefondsgesetz* of 1967 and adapted in 1991, however only allows redeeming shares after a notice period of twelve month. To ensure that investors can always sell their funds, it is required that the depository bank organizes a continuous trade of shares, typically by trading on the Swiss stock exchange. Therefore, Hoesli (1993) refers to these funds as "semi open-ended funds". Switzerland is, with investments of 24 billion Swiss Franc in OPFs⁵ (as of the end of 2010), the second largest OPF market in Europe.

The aim of this thesis is to give a rigorous and in-depth analysis of the asset class German OPFs. The starting point of the thesis is the investigation of diversification benefits when OPFs are included in multi-asset portfolios (first essay). For that reason we begin with a construct of a representative index for the OPF market. In order to do this, we de-smooth observed returns of OPFs as the annual valuation of properties can cause "appraisal smoothing". Afterwards we validate our results by considering different holding periods and errors in mean and standard deviation. Additionally, as there is no investable OPF index, we consider the consequences when investors have invested in single funds instead.

In the second essay we focus on the special liquidity risk inherent in OPF investments and relate it to the REIT market. This analysis starts with the comparison of market liquidity of OPFs and REITs using commonly used liquidity measures. We then investigate the special liquidity risk of OPFs, namely the risk of temporal suspension of share redemption which is unique to OPFs and cannot be found for REIT investments. In order to quantify this additional source of risk, we examine the short-run and long-run valuation consequences of the suspension of share redemptions.

⁵ According to the webpage (www.sfa.ch) of the Swiss Funds Association (SFA), accessed on August 13, 2011.

In the third essay we look at the relationship between liquidity and NAV impairment when share redemption is suspended. We analyze which of these two can explain the discounts observed on the share exchange when funds are suspended. Furthermore, we use the observed initial discounts to forecast the write-off probability and its magnitude.

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Essays

2 Open-ended Property Funds: Risk and Return Profile*,†

ABSTRACT

In addition to the well-established forms of real estate investing (direct and listed), investors can also choose Open-ended Property Funds (OPFs), which are considered a complementary real estate investment option. OPF fund managers generally provide daily liquidity, and these funds must maintain at least 5% liquidity. If liquidity falls below 5%, share redemptions will be temporarily suspended, for a period of up to two years. During this time, investors can only sell shares on the secondary market (exchange), and are thus subject to significant liquidity risk. The objective of this paper is to examine the impact of OPFs as an investment vehicle on the risk and return profile. OPFs in principle have the same underlying as direct and listed real estate investments, but they are subject to a different regulatory regime. Therefore, we analyze the diversification benefits of OPFs in mixed-asset portfolios for various risk measures, investor types, and holding periods. We find that OPFs are ideally suited to reduce portfolio risk. This result holds independent of the holding period and whether in- or out-of-sample Monte Carlo portfolio simulations are used. Also, our results are robust to errors in mean and standard deviation. However, single fund investment increases risk especially for short holding periods.

^{*} This chapter is based on Haß, Lars Helge, Lutz Johanning, Bernd Rudolph, and Denis Schweizer, 2011, Openended Property Funds: Risk and Return Profile – Diversification Benefits and Liquidity Risks, Revise and Resubmit, *International Review of Financial Analysis*.

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2.1 Introduction

Over the past two decades, investments in real estate have increased dramatically. This growth is at least partially driven by the perceived diversification benefits that real estate offers in multi-asset portfolios. Both direct and listed real estate investments can take advantage of these benefits. However, although the underlying asset is the same, direct and listed real estate investments have very different institutional setups and hence different risk-return profiles (for example, the volatility of respective indices for listed real estate is much higher than for direct real estate – see Table 3). Especially liquidity risk can be very different for varying real estate investments, and can potentially offset diversification benefits.

In this paper, we investigate Open-ended Property Funds (OPFs) as a further means – besides direct and listed real estate investments – to add real estate to institutional and private portfolios. Fund managers invest directly in an internationally diversified real estate portfolio, while holding a cash-equivalent position ranging from 5% to 49% of assets under management for daily liquidity. The resulting historical returns are attractive and quite consistent, with little risk and low correlation with other asset classes. However, the downside is that OPFs must temporarily suspend share redemptions if fund liquidity falls below 5% (see Maurer et al. (2004)). Fund managers will then have a maximum of two years to either attract sufficient new asset inflows and/or to liquidate portfolio properties to ensure fund liquidity again. During this time, investors cannot redeem shares, but can sell them in a secondary market. However, market prices can have discounts to the net asset value (NAV) of up to about 20%. Also, there is the risk that fund managers will not have enough liquidity to reopen within the two-year time limit, and may have to sell properties are highly uncertain. Thus, OPF investors bear liquidity risk.

The innovative thrust of this study is twofold. We aim to 1) analyze the impact on the return distributions of OPFs as a further investment option besides direct and listed real estate investments (see section 2.4), and 2) identify the suitability of German OPFs as an essential building block in private and institutional portfolios (section 2.5). We will thus determine the optimal weights of OPFs in mixed-asset portfolios by considering the trade-off between risk (as measured by standard deviation, lower partial moments, conditional value-at-risk, and maximum drawdown) and return using portfolio optimization.¹

In our analyses, we consider the special properties of OPFs, especially the positive autocorrelation that result from return-smoothing and the non-normality of the return distribution. Furthermore, we perform several Monte Carlo simulations (in- and out-of-sample) to evaluate OPF characteristics in mixed-asset portfolios for different holding periods. Additionally we analyze the effects of errors in mean and standard deviation as well as the fact that individual investors can only invest in single OPFs.

Ultimately, we find that OPFs can play an important role in a portfolio context for all investor types examined here, regardless of which risk measure is considered or which holding period is chosen. The remainder of this paper is structured as follows. Section 2.2 gives an overview of the related literature. Section 2.3 introduces OPFs and describes the construction of an appropriate market index. Section 2.4 provides descriptive statistics for the index and discusses other asset classes. Section 2.5 introduces the fundamentals of portfolio optimization, and examines how OPFs can impact the risk and return profile of efficient portfolios under several risk measures. It also illustrates the benefits of OPFs for different holding periods. Section 2.6 evaluates sensitivity of asset allocation results to errors in mean and standard deviation. Section 2.7 studies the consequences that investors cannot invest in an

¹ The use of downside risk measures is important to combat potential biases that may result from the violation of the normality assumption for many return distributions (see Sing and Ong (2000) for a detailed discussion).

OPF index but rather have to invest in single OPFs. In Section 2.8 we summarize our main results and give our conclusions.

2.2 Literature Review

Investors (such as insurance companies, banks, corporations and pension funds) interest in direct and listed real estate investments has increased dramatically in recent years. These instruments seem to provide attractive risk and return profiles, as well as high diversification potential for a mixed-asset portfolio. For that reason many researchers have studied and attempted to model the benefits of establishing diversification strategies for portfolio investments. Within this section we give a comprehensive overview of the evolution in the literature of diversification benefits for direct and listed real estate investments.

Several researchers studied the risk and return characteristics of stocks, bonds, and cash to real estate and analyzed optimal portfolio choice (diversification benefits) of direct real estate investments, including Ross and Webb (1985), Marks (1986), Webb and Rubens (1989), Ross and Zisler (1991).² Ziobrowski and Curcio (1991) extend this literature by exploring potential benefits by adding international real estate investments to a mixed-asset portfolio.

Later studies with direct real estate investments for more countries include Newell and Webb (1996), Quan and Titman (1997), Stevenson (1998), Quan and Titman (1999), Chua (1999), Cheng et al. (1999) and Hoesli et al. (2004). All these studies use the classical mean-variance approach and come to the conclusion that direct real estate provides diversification benefits.

² For a more detailed overview see the seminal paper by Worzala and Sirman (2003), Benjamin, Sirmans, and Zietz (1995, 2001) and Hudson-Wilson et al. (2005).

More recent studies analyze other issues of investments in direct real estate. Fugazza et al. (2007) study optimal real estate allocation for long-horizon investors (i.e. considering return predictability). This is of major importance for long run investors, as it is well known that when returns are predictable the mean-variance asset allocation may differ substantially from the long-term one (see Bodie (1995)) while the investor's planning horizon is irrelevant for portfolio choice when returns are independently and identically distributed. Hoovenaars et al. (2008) study direct real estate investments in an asset-liability framework.

Mixed-asset portfolio studies using listed real estate³ start with the work by Asabere et al. (1991) and Kleiman and Farragher (1992), who find diversification gains by including REITs in the portfolios. Further evidence on diversification benefits in more countries is given by Eichholtz (1996), Eichholtz and Koedjik (1996), Eichholtz (1997), Mull and Soenen (1997), Gordon et al. (1998), Liu and Mei (1998), Gordon and Canter (1999), Stevenson (1999), Stevenson (2000), Maurer and Reiner (2002), Conover et al. (2002) and Chen et al. (2005). Another strand of the literature studies real-estate-only portfolios using REITs. The diversification benefits of international investments in REITs are studied in Giliberto (1990), Addae-Dapaah and Kion (1996), Wilson and Okunev (1996), Eichholtz (1997), Pierzak (2001) and Bigman (2002).

Summarizing, these studies suggest that direct and listed investments in real estate are suitable for achieving diversification benefits. However, both investment vehicles have different risk and return profiles, even if the underlying property is equal. This is reflected in a much higher volatility for listed real estate than for direct real estate, which can be interpreted in a way that investment vehicle type also impacts the return distribution for an equal underlying.

³ For a more detailed overview see also Sirman and Worzala (2003).

As an example, comparable characteristics are found in the option market, where investors can choose to invest in a company share directly or indirectly, with an option based on the same company share as the underlying. Therefore, in this analogy, investment vehicles will significantly impact the risk and return profile because the optional investment alternative reshapes the original return distribution of the underlying.

2.3 The German OPF Market

2.3.1 Fundamental Features

From a legal perspective, an open-ended property fund is a separate special asset, with an investment focus on property initiated and managed by a capital investment company. For investor protection purposes, OPFs are controlled by regulations for identifying, diversifying, and controlling risks, as well as for realizing gains and fund liquidity.⁴

Open-ended property funds were first created in 1959, with the establishment of the "Internationales Immobilien Institut" (the international real estate institute, known as iii-investments). The first German OPF was iii-funds No. 1. Since 1991, there are enough OPFs for a meaningful index formation and statistical evaluation. Especially in recent years the growth of the market has been dramatic. In 1998, there were sixteen OPFs, with assets under management of 43.1 billion Euros. As of February 2009, the market had grown to thirty-five funds managing 82.1 billion Euros. The German OPF market is thus the biggest, and its market capitalization is about one-third of all European Union member countries.⁵

Table 2-1 provides an overview of the full sample of OPFs from 1991 through February 2009, as well as the subsamples of generally investable funds and retail-investable funds. We

⁴ See Investmentgesetz (InvG) and Klug (2008) for further details.

⁵ According to data from the BVI Bundesverband Investment, Asset Management e.V. (German Asset Management and Investment Association), and Deutsche Bundesbank (German Central Bank).

form subgroups to examine possible differences in the OPF market based on investability differences. We exclude from the investable OPF subsample any funds that are closed to new investments.⁶ Note also that some funds require minimum investments, which can be as much as 350,000 Euros or more. Because these funds are typically not suited for retail investors, we also exclude them from the retail-investable subsample.⁷

For our analysis, we use all OPFs that report their data to the "BVI Bundesverband Investment and Asset Management e.V." (the German Asset Management and Investment Association). To test for consistency, we compare the share prices from BVI with the prices obtained from Datastream. We find twenty-one pricing differences, for an accuracy rate of 99.9%. None of the differences exceeds 1% of the stock price. In the case of a pricing difference, we asked the capital investment company for the price.

For the further analyses, we use all OPFs that are or were covered by both, BVI and Datastream, which ensures the highest possible data accuracy and that the calculated indices are not affected by a survivorship bias. However, our results remain stable when all OPFs are included. This is not surprising, as our sample covers at least 94% of the market.⁸ Therefore, we find that the results are not affected from a biased data-generating approach.

⁶ The funds Aachener Grund-Fonds Nr. 1, DEGI German Business, DEGI Global Business, KanAm SPEZIAL grundinvest Fonds, and WestInvest ImmoValue are not open to all investors.

⁷ The UBS (D) Euroinvest Immobilien fund requires a 350,000 Euro minimum investment; the CS Property Dynamic fund requires a 3 million Euro minimum investment. The SEB ImmoPortfolio Target Return Fund and the SEB Global Property Fund follow the principle "cash on demand only," and are available only to large investors.

⁸ Tables and figures are available from the authors upon request.

Table 2-1: Overview of the German OPF Market

This table shows assets under management and the number of included OPFs, generally investable OPFs, and retail-investable OPFs. The number of included OPFs may differ from the number of available OPFs, as funds are only included when covered by BVI and Datastream. The representativeness of included funds is indicated in the "Market Share" column, which gives the ratio of available to reported OPFs. Assets under management are calculated at year-end, except for 2009, which is as of February. The data stem from BVI and Datastream.

	Total	Market of Rej	porting OPFs	Investal	ole OPFs	Retail-investable OPFs		
Year	Number	In€m	Market Share	Number	In €m	Number	In€m	
1991	13	10.032	100%	12	10.032	12	10.032	
1992	14	13.893	100%	13	13.563	13	13.563	
1993	14	21.866	100%	13	21.492	13	21.492	
1994	14	25.764	100%	12	25.226	12	25.226	
1995	14	29.694	100%	12	29.084	12	29.084	
1996	14	37.023	100%	12	36.347	12	36.347	
1997	15	40.493	100%	13	39.735	13	39.735	
1998	16	43.137	100%	14	42.305	14	42.305	
1999	16	49.987	99%	14	49.104	14	49.104	
2000	18	47.455	99%	16	46.535	16	46.535	
2001	18	54.485	98%	16	54.337	16	54.337	
2002	21	69.391	98%	19	69.242	19	69.242	
2003	23	83.234	98%	21	83.086	20	81.799	
2004	26	85.288	98%	24	84.985	23	83.145	
2005	27	80.404	94%	25	80.081	23	77.982	
2006	32	73.623	97%	29	72.230	25	69.630	
2007	35	80.948	97%	30	78.900	26	75.840	
2008	35	81.631	97%	30	79.140	26	75.565	
2009	35	82.144	96%	30	79.617	26	75.979	

In contrast with many other countries, German OPFs are preferred over real estate shares as an alternative investment. OPFs offer three significant advantages, and the regulatory design is similar to the OPF markets in European Union member countries:⁹

The OPF share price is not determined by supply and demand as long as the OPF provides liquidity. Therefore, share prices do not differ from the NAV per share reported by the capital investment companies when there is no temporary redemption suspension. This means that OPF returns tend to be quite smooth, because there is no additional influence from (equity) capital markets.

The number of issued shares varies, which generally ensures high liquidity. As in any investment fund, there is a daily issuance of new shares from buyers and a daily redemption of old shares from sellers.¹⁰

The rule of risk-spreading governs transactions.¹¹ This diversification significantly reduces unsystematic risk.

These specific features of OPFs substantially influence their risk-return profile. In general, portfolio returns are determined by rental income, maintenance costs, and value increases or decreases.¹² Rental income and maintenance costs are relatively easy to determine; the primary challenge is gauging changes in value if comparable properties do not trade regularly. Thus, German investment law (§70 para. 2 sentence 2 InvG) mandates that properties be evaluated at least once a year by an independent appraisal board to determine the true market

⁹ See, for example, Maurer et al. (2004).

¹⁰ Historically, there have been only two periods when share redemptions were temporarily suspended (2005/2006 and 2008/2010). Both are discussed in detail in section 2.5.

¹¹ At the time of purchase, a property may not constitute more than 15% of the OPF's NAV. Furthermore, the total value of all properties with individual values of more than 10% of a fund's NAV may not constitute more than 50% of the fund's NAV. See InvG § 73 (1).

¹² More than 40% of OPF portfolio properties have leases with residual terms that are longer than January 1, 2014. See BVI press release from July 1, 2008.

value. The appraisal board members have technical expertise in the area of property market development (§77 para. 2 sentence 1 InvG).

The valuation by law allows the sales comparison approach, the cost approach, and the income approach for the appraisal of fair market value. The income approach is internationally accepted, and is the primary method for valuing OPFs. It appraises a property on the basis of objectively evaluated price and income forecasts, as well as dynamic capitalization rates on the valuation date. Therefore, the daily OPF NAVs are based on the annual expert appraisals since the last valuation date, but do not necessarily represent "true" daily property values.

This valuation approach aims to minimize subjective views about future expectations¹³ and to dampen over- and understatements of property values. However, because past appraisal reports are included in the determination of current NAVs, valuation returns are smoothed, an effect known as "appraisal-smoothing."¹⁴ This smoothing, as well as the less frequent valuations, result in positive autocorrelation of the OPF returns.^{15,16} The autocorrelation thus significantly underestimates OPF risk.

Thus, in this paper, we perform a de-smoothing of returns as a correction (see section 2.3 for more insights). We use Getmansky, Lo, and Makarov's (2004) method to recompute the return series so that it is free of autocorrelation. This method is based on the estimation of a general moving average process. It can detect arbitrary autocorrelation structures, and can thus cope with annual reappraisals.

¹³ See Archner (2006) for an extensive analysis.
¹⁴ See Ross and Zisler (1991) and Geltner (1991) for an extensive discussion.

¹⁵ Other, more secondary, reasons are inflation-linked lease contracts and the inclusion of inflation in the appraisal.

¹⁶ Maurer et al. (2004) show in this context that the autocorrelation of real returns is substantially lower.

A similar problem can also be seen by comparing real estate indices: Those based on expert appraisals at certain valuation dates exhibit less volatility than those based on transactions or new lease agreements.¹⁷ In addition to the positive autocorrelation, we must also consider the non-normality of return distributions for OPFs in our analysis.¹⁸

2.3.2 Construction of Open-ended Property Fund Indices

To construct an OPF index, we need to first calculate a representative index. We consider all funds covered by the BVI and Datastream¹⁹ beginning in February 1991 (because we have a sufficient number of funds from this date onward), and ending in December 2008. The monthly raw data from the OPFs contain share prices for each month-end. The data are adjusted for share splits and reported net of management fees. Therefore, further analysis is not biased favorably towards OPFs. Dividend payouts are reinvested in the respective fund (before taxes).

For all OPFs, we calculate a monthly pre-tax return based on adjusted share prices. Finally, using the continuous pretax returns of the individual funds, we calculate a value-weighted and an equal-weighted index. Our index can thus be considered a total return index. We use the equal-weighted index to evaluate the robustness of our results because it is not dominated by individual "fund heavyweights."²⁰

¹⁷ See McAllister et al. (2003) and Pagliari et al. (2004) for more detailed discussions.

¹⁸ See Coleman and Mansour (2005) for further details.

¹⁹ We compute three different indices because not all OPFs are investable, and some funds require a high minimum investment. The first index represents the total OPF market; the second includes only investable funds. The third index includes only funds investable for retail investors. There are only marginal differences between the three indices, and our results do not depend on which one is used. Therefore, we use the total market index in the following analysis. Tables are available upon request from the authors.

²⁰ Different calculation methods did not lead to any changes in our results. Thus, we use only the value-weighted index as per Maurer (2004). Tables are available from the authors upon request.

2.4 Portfolio Effects from the Addition of OPFs – A Descriptive Analysis

In this section, we examine other asset classes to analyze how integrating OPFs impacts asset allocation. We also discuss the effects of adjusting for "appraisal-smoothing" and illiquidity.

We use the Nikkei 500, the S&P 500, and the DJ Stoxx 600 to represent the equity markets of Japan, the U.S., and Europe, respectively. For fixed income, we use the Japanese, the U.S., the European, and the U.K. Government Bond Index bond indices from J.P. Morgan. We consider the U.K. Government Bond Index separately because the European Government Bond Index excludes U.K. bonds. We also allow LIBOR (London Interbank Offered Rate) investments, which is the short-term money market rate.

We do not consider the German market separately (as represented by the DAX and the REXP) because it is implicitly integrated via the European market.²¹ In terms of alternative investments, we use the FTSE EPRA/NAREIT Germany index to represent exchange-listed real estate investment trusts (REITs) as a potential alternative to OPFs.²² We also consider investments in hedge funds (HFRI Fund of Funds Composite Index) and commodities (S&P GSCI).

For all indices, we use total return indices including reinvested distributions. Note that we convert non-Euro-denominated indices into Euros. Finally, we test all indices for

²¹ For robustness, we repeated our analysis including the DAX and the REXP. We found no important effects. Tables are available upon request.

²² We would like to include an index of direct real estate in Germany to better analyze the "complementary" role of OPF to the two established forms. The data provider Investment Property Databank GmbH (IPD) publishes the DIX (Deutscher Immobilien Index) which tracks the performance of the German real estate market. Unfortunately the index is available on an annual base only. For that reason the data granularity does not match with our monthly observations. In case we would change the methodology to annual observations we would lose a lot of information.

autocorrelation effects. We expected to find a positive first-order autocorrelation in hedge fund return time series due to illiquid trading strategies.²³ However, we find autocorrelation only for the OPF indices (see Table 2-2).

Table 2-2: Autocorrelation Structure of OPFs

This table shows the autocorrelation coefficient for lags 1 through 12 of the monthly return distributions for the February 1991-December 2008 period for the value-weighted OPF index. Values in bold indicate statistical significance at the 99% confidence level.

Lag	1	2	3	4	5	6	7	8	9	10	11	12
	0.6140	0.5296	0.5192	0.5542	0.5085	0.4613	0.4314	0.4737	0.4839	0.4450	0.3910	0.4244

To adjust for appraisal-smoothing and for illiquidity, we use the Getmansky, Lo, and Makarov (2004) method, which incorporates the whole autocorrelation structure of the monthly return distribution (see Table 2-2). This method improves on Geltner's (1991) approach because the entire lag structure is considered simultaneously. In addition, there is no need for a de-smoothing parameter (see Byrne and Lee (1995) for the problematic determination of the de-smoothing parameter).

The intuition behind this method is as follows. The measurable return, R_t^o , is not the true return. Rather, it is a combination of the true return in previous periods R_t :

$$R_t^0 = \Theta_0 R_t + \Theta_1 R_{t-1} + \dots + \Theta_k R_{t-k}$$
⁽¹⁾

$$\Theta_j \in [0, 1], j = 0, ..., k \text{ and } l = \Theta_0 + \Theta_1 + ... + \Theta_k.$$

Therefore, the measurable return is the weighted sum of the true returns of the previous periods. It is obvious that the mean of the observable returns is equal to the mean of the true

²³ See Avramov et al. (2007) for further details.

returns. And the standard deviation of the measurable returns is smaller than that of the true returns. Equation (2) describes the relationship between the standard deviations of the true and observable returns:

$$Std\left[R_{t}^{0}\right] = \frac{1}{\Theta_{0}^{2} + \Theta_{1}^{2} + \ldots + \Theta_{k}^{2}} \sigma \leq \sigma,$$
(2)

where σ represents the standard deviation of the true returns (see Table 2-3 for the effect on the risk measures after de-smoothing).

In order to calculate the true returns, we can estimate the weighting factors θ_k by using a maximum likelihood estimation. We use the information that the measurable returns can be considered as a moving-average process where the weighting factors are constant. Finally, we can calculate the true returns using the estimated weighting factors.

Table 2-3 illustrates the influence of the autocorrelation on the OPF descriptive statistics. It also provides descriptive statistics for the various indices over our February 1991-December 2008 sample period.

Equity markets have average monthly returns ranging from -0.01% (NIKKEI) to 0.65% (S&P) 500. Bond markets show returns ranging from 0.57% per month for Japan to 0.63% for Europe over our sample period. The OPF average monthly return of $0.42\%^{24}$ is higher than the average money market return of 0.36% per month, and higher than the REIT return of 0.01%.

²⁴ As a robustness check, we replicated the OPF index of Maurer et al. (2004) for the January 1975-December 2003 time period, and compared the descriptive statistics (with autocorrelation). We found the same monthly mean (0.50%) and monthly standard deviation (0.20%).

Equity markets on average have the highest total risk as measured by monthly standard deviations, about 4.87% for Europe and 6.67% for Japan. Only commodities and REITs exhibit similarly high standard deviations.

Bond markets have substantially lower monthly standard deviations, about 1.13% for Europe and 3.54% for Japan. Hedge funds exhibit a comparable risk level, with a standard deviation of 1.53% per month.

Note that even after adjusting for the positive autocorrelation from appraisal-smoothing, OPFs have a very low standard deviation of 0.33% per month. Without the autocorrelation correction, this percentage would be only 0.21%. Only the money market exhibits a lower risk, at 0.17%.

Unlike OPFs, REITs exhibit a comparable risk to equity markets, with a standard deviation of 7.5%. When we consider additional (downside) risk measures like the square root of lower partial moments 2 (LPM), conditional value-at-risk (CVaR), and maximum drawdown (MaxDD), we find that the ranking of asset classes from lowest to highest risk remains the same. We are therefore able to account for the "fat tail" risks explicitly, which is not possible with the standard deviation.

Examining higher moments of the return distribution (skewness and excess kurtosis), we find that OPFs exhibit positive skewness. In contrast, European and U.S. equities, European and U.K. bonds, hedge funds, and REITs all exhibit negative skewness. The return distribution of commodities and hedge funds is almost symmetrical.

However, excess kurtosis is positive for all asset classes, especially for OPFs (2.33) and hedge funds (4.39).²⁵ This implies that the probability of extreme returns is higher than expected under a normal return distribution. Considering the Jarque-Bera statistic in Table 2-3, we reject the assumption of a normal distribution of monthly returns for all indices when the entire sample period is considered (except U.S. and Japanese equities).

Table 2-3: Descriptive Statistics for Monthly Return Distributions

This table gives the mean, standard deviation, skewness, kurtosis, square root of lower partial moment 2 with threshold 0 (LPM), conditional value-at-risk (CVaR) with a 95% confidence level, and maximum drawdown (MaxDD) for the monthly return distribution for the period February 1991-December 2008. All measures are based on monthly data. The assets considered are OPFs before and after an autocorrelation (AC) adjustment (using Getmansky, Lo, and Makarov's (2004) method), equity markets (Nikkei 500, S&P 500, DJ Stoxx 600), bond markets (J.P. Morgan Japan, U.S., Europe, and U.K. Government Bond Indices), money markets (MM) (LIBOR), and alternative investments (S&P GSCI, JFRO Fund of Funds Composite Index, FTSE EPRA/NAREIT Germany). All indices are total return (or their distributions were reinvested), and all are denominated in Euros. We found no autocorrelation effects for the time series of equity and bond markets or for alternative investments. We use the Jarque-Bera (1980) test to test the assumption of normally distributed monthly returns. ***, **, and * indicate that the assumption of a normal distribution of monthly returns is rejected at the 1%, 5%, and 10% significance levels, respectively. All statistics are based on continuous returns.

	Open-ended Property Funds		Equity Markets		Bond	Market	s and M	Alternative Investments					
	With AC	Without AC	NIKK EI	S&P 500	DJ STOXX 600	JPM Japan	JPM US	JPM Europe	JPM UK	MM	S&P GSCI	HFRI FoHF	REITs
Mean (%)	0.42%	0.42%	-0.01%	0.65%	0.37%	0.57%	0.61%	0.63%	0.57%	0.36%	0.30%	0.53%	0.01%
Std. Dev. (%)	0.21%	0.33%	6.67%	5.05%	4.87%	3.54%	2.98%	1.13%	2.47%	0.17%	6.35%	1.53%	7.50%
Kurtosis	4.31	5.33	3.05	3.21	4.08	6.29	3.42	3.23	3.55	3.66	4.07	7.39	7.85
Skewness	0.64	0.21	0.21	-0.26	-0.84	1.09	0.50	-0.32	-0.24	1.26	-0.48	-0.48	-0.26
LPM	0.00%	0.02%	2.66%	1.67%	1.71%	1.01%	0.88%	0.23%	0.71%	0.00%	2.27%	0.34%	2.51%
CVaR	0.05%	-0.30%	-13.14%	-10.52%	-12.66%	-5.50%	-4.54%	-1.85%	-4.98%	0.17%	-14.6%	-3.12%	-19.22%
MaxDD	0.21%	1.07%	73.13%	60.82%	58.20%	40.38%	25.28%	6.71%	19.27%	0.00%	61.11%	15.92%	84.30%
Jarque-Bera Statistic	30.2***	50.2***	1.53	2.80	35.5***	139***	10.5***	4.22*	4.78*	60.91***	18.6***	180***	212***

²⁵ The autocorrelation adjustment for appraisal-smoothing increases the kurtosis of OPFs from 4.31 to 5.33. We explain this increase as follows: As kurtosis increases, the probability of extreme returns also increases, which is interpreted as higher risk.

Table 2-4 shows the correlations of OPFs with the other asset classes. Note that OPFs have almost no correlation with equity markets and other alternative investments, which implies a high diversification potential. They also have a slightly positive and statistically significant positive correlation with bond markets, and a relatively high significant positive correlation (0.48) with money markets. These positive correlations result from investments in liquid money market instruments and in bond markets to ensure fund liquidity.²⁶

Table 2-4: Correlation Matrix

This table shows the correlations between the asset classes from Table 2-3. For OPFs, we use the value-weighted total market index; for equity markets, we use the Nikkei 500, the S&P 500, and DJ Stoxx 600; for bond markets, we use the J.P. Morgan Japan, U.S., Europe, and U.K. Government Bond Indices; for money markets, we use LIBOR; and for alternative investments, we use the S&P GSCI, the HFRI Fund of Funds Composite, and the FTSE EPRA/NAREIT Germany indices. Values in boldface are significantly different from zero at the 5% level.

				DJ								
			S&P	STOX	JPM	JPM	JPM	JPM		S&P	HFRI	
	OPFs	NIKKEI	500	X 600	Europe	U.S.	Japan	U.K.	REITs	GSCI	FoHF	MM
	1.00	0.01	0.4.5	0.00	0.00				0.00	0.04	0.01	0.40
OPFs	1.00	-0.01	0.15	0.09	0.39	0.29	0.22	0.29	-0.03	0.06	0.01	0.48
NIKKEI	-0.01	1.00	0.49	0.52	-0.02	0.22	0.38	0.14	0.16	0.30	0.10	-0.04
S&P 500	0.15	0.49	1.00	0.82	0.05	0.46	0.23	0.32	0.35	0.30	0.12	0.03
DJ												
STOXX	0.09	0.52	0.82	1.00	0.01	0.15	0.08	0.23	0.46	0.29	0.16	-0.05
600												
JPM						~						
Europe	0.39	-0.02	0.05	0.01	1.00	0.41	0.23	0.51	-0.12	-0.05	-0.14	0.18
JPM U.S.	0.29	0.22	0.46	0.15	0.41	1.00	0.50	0.52	-0.13	0.20	-0.01	0.14
JPM	0.00	0.20	0.00	0.00	0.00	0.50	1.00	0.01	0.00	0.02	0.07	0.00
Japan	0.22	0.38	0.23	0.08	0.23	0.50	1.00	0.21	-0.09	0.03	-0.07	0.20
JPM U.K.	0.29	0.14	0.32	0.23	0.51	0.52	0.21	1.00	-0.10	0.16	0.19	0.03
REITs	-0.03	0.16	0.35	0.46	-0.12	-0.13	-0.09	-0.10	1.00	0.01	0.11	-0.04
S&P	0.04	0.00	0.00	0.00	0.05	0.00	0.02	0.16	0.01	1.00	0.10	0.00
GSCI	0.06	0.30	0.30	0.29	-0.05	0.20	0.03	0.16	0.01	1.00	0.18	-0.02
HFRI	0.01	0.10	0.10	0.16	0.1.4	0.01	0.05	0.10	0.11	0.10	1.00	0.02
FoHF	0.01	0.10	0.12	0.16	-0.14	-0.01	-0.07	0.19	0.11	0.18	1.00	0.02
MM	0.48	-0.04	0.03	-0.05	0.18	0.14	0.20	0.03	-0.04	-0.02	0.02	1.00

²⁶ Typical German OPFs have 25% to 49% of their assets invested in money markets and bond markets (see Maurer et al. (2004)).

2.5 Efficient Asset Allocation under Different Risk Measures

2.5.1 Description of the Optimization Procedure

Because most return distributions are not normal (see Table 2-2), we must consider higher moments and downside risk measures. Any skewness effects, such as those measured for REITs, will otherwise be neglected, as well as the effects of extreme returns (positive excess kurtosis) that we can observe for hedge funds and OPFs (see again Table 2-3). We can thus incorporate into the optimization procedure characteristics such as downside risk that are caused by the higher moments of the return distribution. This will also help to reduce the likelihood of biased and suboptimal portfolio weights.

We consider four different risk measures. The last three are suitable for covering the risk in the tail (downside) of the distribution: 1) Std (Markowitz (1952)) 2) LPM (Harlow (1991)), 3) CVaR (Rockafellar and Uryasev (2000, 2002), and 4) MaxDD (Grossman and Zhou (1993)). Hence, LPM, CVaR, and MaxDD implicitly incorporate higher moments due to their calculation methods, and can be regarded as a robustness check on the validity of the results when higher moments are ignored.

Next, we use the four risk measures to calculate efficient mixed-asset portfolios for retail and institutional investors. A portfolio is characterized as efficient when no other combination of assets provides lower risk for the same expected return. For the following portfolio optimizations, we minimize the risk (for every risk measure separately) for the given expected portfolio returns $\mathbb{E}[r_p]$. We formulate the optimization problem as follows:

$$\min_{x} \mathbf{RM} \left(\mathbb{E} \left[r_{p} \right] \right)$$
(3)

subject to the restrictions

$$\mathbb{E}\left[r_{p}\right] = r \text{ and } x_{1} + \ldots + x_{n} = 1, \forall i = 1, \ldots, n$$

where r_p is the portfolio return, and x_i is the percentage weight invested in security *i*.

The optimization is restricted by budget constraints (full investment), and by non-negative weights (no short sales). Investments can be made in all assets considered in Table 2-3.

We differentiate among three investor types. The first two represent retail investors with different risk and return attitudes; the third is a representative institutional investor (life insurer). Depending on the risk and return attitudes (retail investors) and the regulatory framework (institutional investors), we set weight ranges for equities, bonds, and alternative investments or upper bounds (for institutional investors, these are set by German investment law).

The weight ranges for retail investors are set according to the average retail investor portfolio weight in Germany for the respective asset class, and depending on the risk and return attitude published by the BVI. We decided to set these ranges because retail investors tend to maintain their initial portfolio allocations, a phenomenon known as anchoring (see Tversky and Kahneman (1974)). However, the investment restrictions do not strengthen or drive the obtained results for the OPFs. We find that the implied optimal portfolio weights for OPFs are always higher when relaxing the restrictions.²⁷

The investment restrictions are as follows:

• For a traditional retail investor, we assume weights of 10% to 20% in equities, 45% to 65% in bonds, 0% to 5% in alternative investments, and 20% to 40% in money markets. This investor's portfolio structure is conservatively defensive.

²⁷ Tables and figures for the optimization without weight restrictions or different weight ranges are available from the authors upon request.
- For a modern retail investor, we assume a more aggressive portfolio, including weights of 15% to 35% in equities and 10% to 20% in alternative investments. Correspondingly, the weights for bond markets (35% to 55%) and money markets (5% to 25%) are lower.
- For a typical German institutional investor, we assume greater regulatory investment restrictions for life insurers. This implies a maximum investment of 20% in foreign exchange positions and 35% in risky investments (like equities and hedge funds). In addition, non-European equities and indirect commodity investments may not exceed 10%, and hedge funds are limited to 5%. The cumulative REITs and OPFs may not exceed 25%.

We use these three investor types and four different optimization risk measures to find the optimal portfolio within the stipulated investment limits. Initially, we perform the optimization without OPFs, adding them afterwards to evaluate the impact of expanding the universe. We further investigate the influence of the financial crisis on the robustness of the optimal portfolio weights.

2.5.2 Open-ended Property Funds in Retail Investor Portfolios

To identify the diversification potential of OPFs for retail investors (traditional and modern), we first apply a classical Markowitz optimization (subject to the weight limits discussed in the prior section). We then determine the portfolio weights of the minimum standard deviation portfolio without OPFs.

In the second step, we allow for OPFs, and compare the risk and the optimal portfolio weights of an identical expected return level portfolio (see Table 2-5). We also apply two robustness checks, as follows: 1) we use the risk measures LPM, CVaR, and MaxDD to

identify the downside protection potential for OPFs (see Figure 2-1), and 2) we calculate the results from a U.S. perspective (see Table 2-A1).

Both types of retail investors realize a substantial risk reduction (as measured by the standard deviation of portfolio returns) for the same return level when OPFs are added to the portfolio. Traditional retail investors, with a more defensive portfolio configuration, can lower their portfolio annual standard deviations from 3.33% to 2.59% (see Table 2-5). This translates to an approximately 20% risk reduction. Modern retail investors can reduce risk by about 32% by adding OPFs. Note from Table 2-5 that the standard deviation is reduced from 4.97% to 3.35% p.a.²⁸

In examining the portfolio composition of the traditional retail investor's optimal portfolio, we find that OPFs add a substantial weight of 25% (see again Table 2-5). Correspondingly, the weights of money markets and bonds are reduced by about 10 percentage points each.

For the more aggressive retail investor, the addition of OPFs is optimal with a 34% weight. OPF investment leads to a reduction in equity and money market weights of about 10% each, as well as a 5% reduction in hedge fund weights.

Interestingly, the weight of bonds is not reduced, but is actually slightly increased by 1 percentage point. For both investors, we do not consider REIT investments, because this asset class is completely dominated by OPFs. Table 2-5 provides a detailed breakdown of portfolio weights for all asset classes.

Because most return distributions are not normally distributed, we apply the above described analyses for three additional risk measures (LPM, CVaR, and MaxDD) to

²⁸ We repeat our analysis for different time series inception dates. The results show no significant differences. Furthermore, the results hold from a U.S. perspective, and are qualitatively comparable to the EU results (see Table 2-A1).

incorporate potential tail risks (see Figure 2-1). Similarly to the Std risk measure, we find that OPFs have higher portfolio weights in modern retail investor portfolios than in traditional investor portfolios. This is not surprising, however, since the traditional portfolio is already defensive.

However, the importance of OPFs decreases as risk measures focus more on the downside. This can be seen by the lower allocation to the LPM, CVaR, and particularly MaxDD risk measures. Nevertheless, we believe that OPFs should have a significant allocation (at least 9%) in the portfolios of both types of retail investors.

To determine whether OPFs significantly enhance portfolio performance, we conduct inand out-of-sample Sharpe ratio tests according to Jobson and Korkie (1981) and Ledoit and Wolf (2008). For the in-sample test, we use the portfolios constructed above and the historical returns for February 1991-December 2008. We then generate 5,000 time series of monthly returns for one year using Efron and Tibshirani's (1994) block-bootstrap method.

For the out-of-sample test, we use the historical returns for February 1991-December 1999 to determine portfolio weights. We then use returns for January 2000-December 2008 to generate 5,000 time series of future returns and find that OPFs lead to statistically significant higher Sharpe ratios (see Table 2-6).

In summary, we tested for the robustness of the obtained optimal portfolio weights for both types of retail investors and applied four risk measures. For downside protection, OPFs decreased in importance, but the optimal holdings were still significant. These results were confirmed by Sharpe ratio tests.

Table 2-5: Optimal Portfolio Weights and Risk Reduction Potential of all Asset Classes (Markowitz Approach)

This table shows the optimal portfolio weights for the minimum standard deviation (Std) portfolio and the annual Std subject to the weight limits discussed in section 2.4.1. We perform both analyses for the traditional and modern retail investors. The period is February 1991-December 2008.

	OPFs	NIKK EI	S&P 500	DJ STOXX 600	JPM Europe	JPM US	JPM Japan	JPM UK	REITs	S&P GSCI	HFRI FoHF	MM	Std
Traditional Retail Investor Without OPFs (%)	0%	3%	6%	5%	55%	0%	0%	0%	0%	0%	0%	30%	3.33%
Traditional Retail Investor With OPFs (%)	25%	0%	7%	3%	45%	0%	0%	0%	0%	0%	0%	20%	2.59%
Modern Retail Investor Without OPFs (%)	0%	5%	14%	6%	45%	0%	0%	0%	0%	0%	15%	15%	4.97%
Modern Retail Investor With OPFs (%)	34%	0%	12%	3%	36%	0%	0%	0%	0%	0%	10%	5%	3.35%

Figure 2-1: Optimal Portfolio Weights for Open-ended Property Funds for Different Risk Measures

This figure shows the optimal portfolio weights subject to the weight limits discussed in section 2.4.1 for OPFs in the traditional and modern retail portfolios by applying four different risk measures (Std, LPM, CVaR, and MaxDD). The period is February 1991-December 2008.



Table 2-6: Sharpe Ratio Test

This table shows the Sharpe ratios for the portfolios of the in- and out-of-sample analyses. Calculations are based on Efron and Tibshirani's (1994) standard block-bootstrap Monte Carlo simulation with five lags and 1,000 runs. For the in-sample analysis, we use the periods of February 1991-December 2008 to generate time series of future returns. For the out-of-sample analysis, we use the periods of February 1991-December 1999 to construct the portfolio, and January 2000-December 2008 to construct time series of future returns. For the in-sample analysis, the risk-free return is the average money market rate for February 1991-December 2008 (3.56% p.a.); for the out-of-sample analysis, the period is February 1991-July 1999 (2.69%). ***, **, and * denote that the assumption of equal Sharpe ratios is rejected at the 1%, 5%, and 10% significance levels, respectively, according to Jobson and Korkie (1981) and Ledoit and Wolf (2008).

	In-Sample	Out-of-Sample
Traditional Retail Investor Without OPFs	0.80***	0.23***
Traditional Retail Investor With OPFs	1.45***	0.38***
Modern Retail Investor Without OPFs	0.87***	-0.13***
Modern Retail Investor With OPFs	1.23***	0.02***

2.5.3 Open-ended Property Funds in Institutional Investor Portfolios

Figure 2-2 shows the efficient portfolios (efficient frontiers) when we optimize the institutional investor portfolios with and without OPFs, and following the institutional investor constraints described in section 2.4.1. The methodology chosen in the previous subsections for retail investors looks different to the presentation here, but it works in the same manner. For retail investors we choose for two types of risk aversion (traditional and modern) weight ranges for different investment types and apply a "point estimator" given the universe of investment opportunities and the restrictions. In comparison we conduct an optimization approach for institutional investors (represented exemplary by life insurers) given their regulatory investment restrictions (see § 88 InvG) and calculate an efficient frontier. When choosing representative optimal portfolios on the efficient frontier both approaches are directly comparable.

Note in Figure 2-2 that the efficient frontier is moved upwards by adding OPFs, especially for the defensive portfolios. Hence we find that OPFs improve the risk and return profile significantly.

To verify whether OPFs can also improve the efficient frontier significantly, we conducted a spanning test following Chiang and Lee (2007) and Kan and Zhou (2008). The likelihood ratio test indicates a significant increase in the risk and return profile by including OPFs. The exact value of the likelihood ratio is 23.78.

Figure 2-2: Efficient Portfolios for Institutional Investors (Markowitz Approach)



This figure shows the efficient frontiers with and without OPFs using Std as the risk measure and subject to the weight limits discussed in section 2.4.1. The observation period is February 1991-December 2008.

Figure 2-3 shows the portfolio composition along the efficient frontier, i.e., the weights of each asset class for the different expected return levels. OPFs are initially included at the regulatory limit of 25%. With an expected return of more than 6.9% p.a., however, their weight gradually decreases as they are replaced by assets with a higher expected return, such as hedge funds. Overall, we conclude that OPFs are important in defensive portfolios geared towards risk reduction, but are also essential in more growth-oriented portfolios.

Figure 2-3: Composition of Efficient Portfolios for Institutional Investors (Markowitz Approach)

This figure shows the portfolio weights in the portfolios on the efficient frontier for the asset classes we consider. We use Std as the risk measure that depends on the expected return (subject to the weight limits discussed in section 2.4.1). The observation period is February 1991-December 2008.



However, given the non-normality of some return distributions, a central assumption of the Markowitz approach is violated (see Table 2-2). Therefore, we evaluate the role of OPFs using three downside risk measures (LPM, CVaR, and MaxDD) (see Figure 2-A1 in the Appendix). When focusing on downside risk, we find that OPFs play a similarly important role as in a Markowitz approach.

2.5.4 The Suitability of Open-ended Property Funds for Different

Holding Periods

In the next step, we analyze the influence of OPFs on portfolio returns and risk for different holding periods (this is comparable to Liang, Myer, and Webb's (1996) bootstrap simulation approach). Our starting point is a benchmark portfolio with no OPFs that consists solely of predefined fractions of equities, bonds, and money market investments. Equity and bond allocations are determined by the minimum-variance portfolio for the proxy indices from Table 2-3 (obtained by a Markowitz portfolio optimization).

From these benchmark portfolios, we successively increase the proportion of OPFs from 0% to 25% in three steps (1%, 10%, and 25%). We simultaneously decrease the other asset class weights uniformly, so that the relative weights of the benchmark portfolio before the inclusion remain constant.

We simulate portfolio returns for the various holding periods (one, five, and ten years) using a bootstrap approach. As a robustness check, we conduct in- and out-of-sample analyses. For the in-sample, we use historical returns from February 1991-December 2008 to determine the allocations of the two asset classes (minimum-variance portfolios for bonds and stocks, respectively) to the benchmark portfolios. Afterwards, we construct time series of future returns from the same historical returns.

For the out-of-sample, we use historical returns from February 1991-July 1999 to construct the benchmark portfolios, and historical returns from August 1999-December 2008 to construct time series of future returns. We simulate 1,000 runs for each holding period.

To gauge how beneficial OPFs are in mixed-asset portfolios for different holding periods, we calculate risk-adjusted performance for every risk measure separately over the three holding periods. We use the same equation: (portfolio return – risk-free return)/risk measure. We calculate the Sharpe ratio (SR) for standard deviation, the Sortino ratio (SoR) for LPM, the return on conditional value-at-risk (RoCVaR) for CVaR, and the Sterling ratio (StR) for MaxDD.

Note from Table 2-A2 that the increase of OPF weights in the benchmark portfolio lowers expected returns in the in-sample analysis for all benchmark portfolios and for all holding periods. However, the successive inclusion of OPFs leads to a steady enhancement of risk-

adjusted performance for all risk measures and for all holding periods.²⁹ For the out-of-sample analysis, we find that OPFs not only enhance risk-adjusted performance, but also increase portfolio returns for all holding periods and initial benchmark compositions.³⁰

In summary, we show that the return distribution has favorable risk and return characteristics when OPFs provide daily liquidity. On this basis, OPFs are intensively allocated to investor portfolios (regardless of the optimization method used or the investor type considered). We also demonstrate the validity of our results for different holding periods.

2.6 Sensitivity Analysis

As a first robustness check for our results in the previous section we consider potential errors in mean and standard deviation. Results of portfolio optimization procedures heavily depend on input parameters such as mean, standard deviation and correlation. This is especially true for errors in means. Chopra and Ziemba (1993) show that errors in means are approximately ten times as severe as errors in standard deviation. In addition loss in errors in variances is approximately two times as severe as errors in correlations. Therefore it is important to analyze how sensitive our results of the previous section are to changes in mean and standard deviation of OPFs.

Errors in mean and standard deviation of OPFs can be caused by annual appraisal of OPFs portfolios as already discussed in section 2.2. As the portfolio valuation predominantly relies on estimation of property values and not on realized transaction, reported values can differ

²⁹ Note that the RoCVaR decreases as the weight of OPFs in the benchmark portfolio increases, in contrast to all other risk-adjusted performance measures. However, this indicates an increase in risk-adjusted performance as well, because a higher CVaR indicates lower risk. The interpretation of the RoCVaR is thus inverse compared to other risk-adjusted performance measures.

³⁰ This result remains valid when we use the August 1999-December 2008 period to construct the benchmark portfolios, and when we use the February 1991-July 1999 period to construct time series of future returns.

from actual values. Although we de-smoothed return time series with the method by Getmansky et al. (2004) means could still be afflicted with errors.

A further possible source for errors in means is neglected liquidity risk. OPFs bear substantial liquidity risks, especially when share redemption is temporarily suspended. Amihud and Mendelson (1986) show, that investors demand an excess return when investing in illiquid assets. Therefore, a proportion of the OPF returns reflect a liquidity premium. This might not be part of the "original" return source of OPF returns, but at least we should control for it to fairly compare OPFs with other (more liquid) asset classes in the asset allocation decision procedure. Summarizing, the high portfolios weights of OPFs could be driven by an illiquidity premium instead of an inherent return driver.

In the following we present the allocation to OPFs for the different investor types when the mean of OPF returns is incrementally decreased by 0.2% per annum and the standard deviation of OPF returns is incrementally increased by 1% per annum. Therefore, we can clearly see how optimal OPF portfolios holdings are affected by errors in means and standard deviations not covered by the method of Getmansky at al. (2004).

Table 2-7: Sensitivity of OPF Asset Allocation to Changes in Mean and Standard Deviation

This table shows the allocation to OPFs for the traditional and modern retail investor and institutional investor (minimum variance portfolio) when the mean of OPF returns are incrementally decreased by 0.2% per annum and the standard deviation is incrementally increased by 1% per annum. The period is February 1991-December 2008.

Standard Deviation / Mean	+1%	+2%	+3%	+4%	+5%	+6%	+7%	+8%	+9%	+10%
-0.2%	20,79%	17,97%	10,55%	6,86%	4,77%	3,75%	3,60%	3,26%	3,10%	2,78%
-0.4%	20,00%	11,86%	6,63%	4,35%	4,01%	3,87%	3,53%	3,19%	3,05%	2,73%
-0.6%	10,43%	4,66%	4,57%	4,25%	4,13%	3,79%	3,45%	3,31%	2,99%	2,85%
-0.8%	4,83%	4,77%	4,47%	4,37%	4,04%	3,70%	3,57%	3,24%	3,11%	2,79%
-1.0%	4,72%	4,66%	4,58%	4,27%	4,15%	3,82%	3,50%	3,36%	3,05%	2,74%
-1.2%	4,83%	4,77%	4,48%	4,38%	4,06%	3,74%	3,62%	3,30%	2,99%	2,86%
-1.4%	4,72%	4,67%	4,59%	4,29%	3,97%	3,86%	3,54%	3,23%	3,11%	2,81%
-1.6%	4,83%	4,78%	4,49%	4,41%	4,09%	3,78%	3,47%	3,35%	3,05%	2,76%
-1.8%	4,72%	4,67%	4,61%	4,31%	4,01%	3,70%	3,59%	3,29%	2,99%	2,70%
-2.0%	4,83%	4,79%	4,50%	4,21%	4,12%	3,82%	3,52%	3,22%	2,93%	2,83%

Traditional Retail Investor

Modern Retail Investor

Standard Deviation / Mean	+1%	+2%	+3%	+4%	+5%	+6%	+7%	+8%	+9%	+10%
-0.2%	28,56%	15,00%	15,00%	15,00%	15,00%	13,93%	11,18%	9,13%	7,64%	6,37%
-0.4%	15,00%	15,00%	15,00%	15,00%	15,00%	14,13%	11,13%	9,14%	7,69%	6,45%
-0.6%	15,00%	15,00%	15,00%	15,00%	15,00%	13,97%	11,40%	9,15%	7,48%	6,28%
-0.8%	15,00%	15,00%	15,00%	15,00%	15,00%	14,17%	11,35%	9,16%	7,53%	6,36%
-1.0%	15,00%	15,00%	15,00%	15,00%	15,00%	14,01%	11,30%	9,18%	7,59%	6,44%
-1.2%	15,00%	15,00%	15,00%	15,00%	15,00%	14,21%	11,24%	9,19%	7,64%	6,27%
-1.4%	15,00%	15,00%	15,00%	15,00%	15,00%	14,06%	11,19%	9,21%	7,70%	6,35%
-1.6%	15,00%	15,00%	15,00%	15,00%	15,00%	14,25%	11,46%	9,22%	7,49%	6,44%
-1.8%	15,00%	15,00%	15,00%	15,00%	15,00%	14,10%	11,41%	9,24%	7,55%	6,27%
-2.0%	15,00%	15,00%	15,00%	15,00%	15,00%	14,28%	11,36%	9,25%	7,60%	6,36%

Institutional Investor

Standard Deviation	+1%	+2%	+3%	+4%	+5%	+6%	+7%	+8%	+9%	+10%
	25,00%	25,00%	25,00%	25,00%	25,00%	24,33%	21,09%	18,47%	15,98%	14,01%

As can be seen from Table 2-7 OPFs allocation in the traditional retail investor's portfolios decreases significantly when returns are decreases and/or risk, measured by standard deviation, is increased. Compared with the allocation of 25% to OPFs in section 2.5 a decrease in mean by 0.2% (which equates to an estimation error of 5%) and increase of standard deviation by 1% (which equates to an estimation error of 300%) leads to an allocation of 20.79% to OPFs. Further decreases in mean and increases in standard deviation lowers the allocation to OPFs until a minimum allocation of roughly 3%. Thus, even for very large errors in mean and standard deviation OPFs are still part of the traditional retail investor's portfolio

The situation for the modern retail investor is slightly different. Although a decrease in mean by 0.2% and an increase in standard deviation by 1% reduce the allocation to OPFs from 35% to 28.56%, a further decrease/increase lowers the allocation to OPFs to 15%. Further decreases in mean and increases in standard deviation of up to 5% doesn't change the allocation to OPFs. This occurs because the maximum possible weight is given to the money market and the minimum weights to stocks, bonds and alternative investments. Therefore OPFs can only be replaced by the money market. Even if OPFs returns are almost halved they are still preferred by the modern retail investor to adding stocks, bonds or alternative investments. Hence our results for the modern retail investor are also robust to errors in mean and standard deviation.

Finally we consider errors in mean and standard deviation for institutional investors. In Table 2-7 we see the allocations to OPFs in the minimum-variance portfolio when the standard deviation is incrementally increased. We find that allocations to OPFs are rather robust, because even multiplying the original annual standard deviation of 1.14% by factor 5 doesn't change the allocation of 25% to OPFs. Thus the results of section 2.5 also hold for institutional investors when errors in mean and standard deviation are considered.

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2.7 Individual Investor's Perspective

In our second robustness check we study the consequences of a single fund investment. The analysis so far has been based on the OPF index as described in section 2.3. However, individual investors cannot directly invest in this index, like an Exchange Traded Funds (ETF), in contrast to the indices used to represent the other asset classes. Investors can only invest in single OPFs, without the implicit diversification benefits when investing in an index consisting of several funds, like our constructed index. Therefore, we analyze in this section the consequences when investors invested only in one single fund and compare the results with a (diversified) OPF index investment. Those "single fund" investors do not benefit from any diversification effects in the OPF management and/or property portfolio. For a better measurement of this effect the entire is represented by a single OPF or the OPF index and do not allow for investments in other asset classes which could possibly distort the results.

For the analysis we conduct the following Monte Carlo simulation: We simulate an investor who invests in a single fund (out of our index constituent list) or in the OPF index for holding periods ranging from 1 to 10 years. The selected fund is randomly drawn from all 35 OPFs existing in December 2008. The selection probability is proportional to fund volume compared market volume, to represent actual investors' choices. From the historical return time series of the selected fund we generate a future return time series for the holding period by drawing randomly 3-month blocks of historical returns using a block-bootstrap approach. We then repeat this analysis, i.e. draw of a fund and bootstrapping future returns, 1000 times. In case OPFs temporarily suspend share redemptions we take the prices from the secondary market instead of the NAVs.

Table 2-8: Distribution of Mean Returns of OPF Investment

This table shows the mean, standard deviation, Value-at-Risk (99%, 95% and 90% level) and Conditional Valueat-Risk (99%, 95% and 90% level) of the distribution of the mean monthly performance of an investor investing in a single OPF and the OPF index. Calculations are based on Efron and Tibshirani's (1994) standard blockbootstrap Monte Carlo simulation with five lags and 1,000 runs. Holding period is measured in years. Returns are drawn from the period February 1991-December 2008.

Holding Period	Mean	Std. Dev.	VaR 99%	VaR 95%	VaR 90%	CVaR 99%	CVaR 95%	CVaR 90%
1	0,35%	0,58%	-1,90%	-0,32%	0,02%	-3,72%	-1,40%	-0,76%
2	0,36%	0,45%	-1,73%	-0,15%	0,11%	-2,63%	-1,08%	-0,53%
3	0,36%	0,36%	-1,22%	-0,08%	0,13%	-1,92%	-0,77%	-0,37%
4	0,38%	0,33%	-0,88%	0,01%	0,16%	-1,91%	-0,61%	-0,25%
5	0,40%	0,20%	-0,24%	0,08%	0,19%	-0,45%	-0,11%	0,02%
6	0,37%	0,17%	-0,22%	0,09%	0,18%	-0,40%	-0,09%	0,03%
7	0,38%	0,16%	-0,17%	0,10%	0,19%	-0,35%	-0,06%	0,04%
8	0,39%	0,13%	0,03%	0,14%	0,22%	-0,03%	0,07%	0,13%
9	0,39%	0,13%	0,02%	0,15%	0,21%	-0,03%	0,07%	0,13%
10	0,39%	0,13%	0,05%	0,15%	0,21%	0,00%	0,08%	0,13%

Single Fund Investment

Index Investment

Holding Period	Mean	Std. Dev.	VaR 99%	VaR 95%	VaR 90%	CVaR 99%	CVaR 95%	CVaR 90%
1	0,35%	0,08%	0,11%	0,20%	0,24%	0,06%	0,14%	0,18%
2	0,36%	0,06%	0,20%	0,25%	0,28%	0,17%	0,22%	0,24%
3	0,35%	0,05%	0,22%	0,27%	0,29%	0,20%	0,24%	0,26%
4	0,38%	0,04%	0,28%	0,31%	0,33%	0,26%	0,29%	0,30%
5	0,40%	0,02%	0,36%	0,37%	0,38%	0,35%	0,36%	0,37%
6	0,38%	0,02%	0,34%	0,35%	0,36%	0,33%	0,34%	0,35%
7	0,38%	0,02%	0,34%	0,35%	0,36%	0,34%	0,35%	0,35%
8	0,39%	0,01%	0,36%	0,37%	0,37%	0,35%	0,36%	0,37%
9	0,39%	0,01%	0,36%	0,37%	0,37%	0,36%	0,36%	0,37%
10	0,39%	0,01%	0,36%	0,37%	0,38%	0,36%	0,37%	0,37%

When comparing single and index investment in Table 2-8, we observe that the mean of the distribution of the mean monthly returns, i.e. the average performance, does not differ. This is obviously not surprising. However, the dispersion measures for the distributions are distinct. If we compare the increase in standard deviation with the numbers of Table 2-7,

where we calculated allocations to OPFs for different assumed standard deviations, we see that the increase of Table 2-8 would only slightly lower the allocation to OPFs. Therefore the necessity to invest only in single funds instead of investing in a diversified index does not change our results from section 2.5. OPFs still add significant value to investors' portfolios.^{‡31} However, investors should be aware of increased down-side as VaR and CVaR increases especially for short holding periods.

2.8 Conclusion

In this study, we aimed to determine how OPFs, an alternative investment vehicle to direct and listed real estate investments, contribute to asset allocation. The specific regulatory framework of OPFs shifts the return distribution of the underlying real estate investment towards relatively steady and smooth returns with low variation. However, investors are subject to substantial liquidity risk when share redemptions are temporarily suspended. Our main results are as follows.

OPFs contribute significantly to investor portfolios by increasing expected portfolio returns, decreasing portfolio risks (as per several risk measures), and increasing diversification in private and institutional investor portfolios. These results hold for different optimization approaches and holding periods, and with an adjustment for autocorrelation in return time series (along with the resulting substantial increase in risk).

We also tested our results for robustness with several Monte Carlo simulations (in- and out-of-sample). Furthermore we showed that OPFs are still represented in all investor type portfolios when we control for errors in mean and standard deviation. Additionally, we considered the constraint that investors can't invest in an OPF index but rather have to invest

³¹ To further verify our results, we calculated the correlations of individual funds to the OPF index, as correlation are besides mean and standard deviation an important input to portfolio optimization. We found a minimum correlation between a single fund and the OPF index as high as 0.93.

in single funds. However we found that OPFs are also in this case included in the investors' portfolio.

In conclusion, we show that OPFs offer a high diversification potential for investor portfolios. We believe OPFs are an attractive alternative to the well-established direct and listed real estate market investments.

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2.10 Appendix

---- Commodities

Figure 2-A1: Efficient Portfolios and the Respective Portfolio Holding for Institutional Investors with Downside Risk Measures

These figures illustrate 1) the efficient frontiers with and without OPFs using LPM, CVaR, and MaxDD as the risk measures of choice, and 2) the portfolio weights for the asset classes in the portfolios on the efficient frontier with LPM, CVaR, and MaxDD as risk measures dependent on the expected return. All calculations are subject to the weight limits discussed in section 2.4.1. The observation period is February 1991-December 2008.



Money Market

Hedge Funds

Expected Return-LPM





Table 2-A1: Optimal Portfolio Weights and Risk Reduction Potential of all Asset Classes for U.S. Investors (Markowitz Approach)

This table shows the optimal portfolio weights for the minimum standard deviation (Std) portfolio and the annual Std subject to the weight limits discussed in section 2.4.1. All time series have been converted into U.S. dollars. We perform both analyses for the traditional and the modern retail investor. The period is February 1991-December 2008.

	OPFs	NIKK EI	S&P 500	DJ STOXX 600	JPM Europe	JPM US	JPM Japan	JPM UK	REITs	S&P GSCI	HFRI FoHF	MM	Std
Traditional Retail Investor Without OPFs (%)	0%	0%	15%	0%	54%	1%	0%	0%	0%	0%	0%	30%	4.69%
Traditional Retail Investor With OPFs (%)	20%	0%	10%	0%	10%	32%	3%	0%	0%	0%	5%	20%	2.43%
Modern Retail Investor Without OPFs (%)	0%	0%	25%	0%	44%	1%	0%	0%	0%	0%	15%	15%	4.51%
Modern Retail Investor With OPFs (%)	25%	0%	15%	0%	15%	17%	3%	0%	0%	0%	20%	5%	2.94%

Table 2-A2: Portfolio Return and Risk for Various Holding Periods

This table shows the expected return, standard deviation, square root of lower partial moment 2 with threshold 0 (LPM), CVaR with confidence level 95%, and maximum drawdown for one- to ten-year holding periods with increasing OPF weights in the benchmark portfolio. The first column gives the initial composition of the benchmark portfolio, which consists only of equities, bonds, and money market investments. Allocations to the three asset classes are determined by the Markowitz portfolio selection process, where the minimum-variance portfolio is selected. When OPFs are included, the equity, bond, and money market weights are reduced accordingly. Calculations are based on Efron and Tibshirani's (1994) standard block-bootstrap Monte Carlo simulation with five lags and 1,000 runs. For the in-sample analysis, we use the February 1991-December 2007 period to construct the benchmark portfolio and a time series of future returns. For the out-of-sample analysis, we use the February 1991-December 1999 period to construct the benchmark portfolio, and January 2000-December 2008 to construct a time series of future returns. To evaluate risk-adjusted portfolio performance, we calculate a corresponding risk-adjusted performance measure for each risk measure. For the standard deviation, we calculate the Sharpe ratio (StR), for LPM, we calculate the Sortino ratio (SoR), for CVaR, we calculate the return on conditional value-at-risk (RoCVaR), and for MaxDD, we calculate the Sterling ratio (StR). All risk-adjusted performance measures are calculated using the same arithmetic equation: (portfolio return – risk-free return)/risk measure. For the in-sample analysis, the risk-free return is the average money market rate for February 1991-December 2008 (3.58% p.a.); for the out-of-sample analysis, it is February 1991-December 1999 (2.56%). Results remain stable when using 0% or 3% for the risk-free return.

Benchmark					In-Sam	ple					Out-of-	Sample		
Portfolio			Pe	ortfolio Performa	ince	Risk-A	djusted Perfor	mance	Port	folio Performa	ance	Risk-A	djusted Perfor	rmance
		OPFs	1 Year	5 Years	10 Years				1 Year	5 Years	10 Years			
	Exp. Return	0%	6.62%	33.34%	68.53%				2.12%	11.42%	25.42%			
		1%	6.60%	33.27%	68.38%				2.14%	11.52%	25.60%			
%		10%	6.48%	32.63%	67.02%				2.34%	12.43%	27.20%			
50		25%	6.26%	31.53%	64.66%				2.65%	13.90%	29.77%			
ket	Std	0%	5.35%	12.72%	18.77%	0.57	1.11	1.40	4.67%	10.01%	13.02%	-0.09	-0.21	-0.26
larl		1%	5.30%	12.60%	18.60%	0.57	1.11	1.41	4.63%	9.91%	12.88%	-0.09	-0.20	-0.25
v v		10%	4.84%	11.54%	17.12%	0.60	1.16	1.45	4.21%	8.98%	11.66%	-0.05	-0.12	-0.14
one.		25%	4.06%	9.75%	14.60%	0.66	1.26	1.54	3.51%	7.46%	9.66%	0.02	0.06	0.10
Mc	LPM	0%	2.12%	5.08%	7.46%	1.43	2.77	3.53	1.80%	3.83%	4.92%	-0.24	-0.54	-0.69
1 I		1%	2.10%	5.03%	7.40%	1.44	2.79	3.54	1.78%	3.79%	4.87%	-0.23	-0.52	-0.66
%0		10%	1.92%	4.61%	6.80%	1.51	2.91	3.65	1.62%	3.44%	4.40%	-0.14	-0.31	-0.36
ls 5		25%	1.61%	3.89%	5.79%	1.66	3.16	3.88	1.35%	2.85%	3.63%	0.06	0.14	0.27
onc	CVaR	0%	0.12%	-1.87%	-2.64%	24.64	-7.53	-9.99	-0.88%	-2.38%	-2.75%	0.50	0.87	1.23
B		1%	0.13%	-1.85%	-2.61%	24.02	-7.58	-10.04	-0.87%	-2.35%	-2.72%	0.48	0.84	1.17
- %		10%	0.15%	-1.66%	-2.37%	19.40	-8.07	-10.50	-0.76%	-2.09%	-2.43%	0.30	0.51	0.66
0,00		25%	0.19%	-1.34%	-1.95%	14.30	-9.19	-11.50	-0.59%	-1.67%	-1.95%	-0.14	-0.25	-0.50
och	MaxDD	0%	3.26%	7.09%	9.39%	0.93	1.99	2.80	3.96%	7.99%	9.20%	-0.11	-0.26	-0.37
St		1%	3.22%	7.00%	9.28%	0.94	2.01	2.82	3.91%	7.87%	9.05%	-0.11	-0.25	-0.35
		10%	2.83%	6.18%	8.29%	1.02	2.17	3.00	3.44%	6.80%	7.78%	-0.07	-0.16	-0.21
		25%	2.20%	4.85%	6.63%	1.22	2.53	3.39	2.67%	5.12%	5.81%	0.03	0.08	0.17
e o	Exp. Return	0%	7.58%	38.63%	77.71%				1.41%	8.27%	20.66%			
300 5 25% 100 y		1%	7.56%	38.52%	77.50%				1.44%	8.42%	20.90%			
H V Z		10%	7.36%	37.52%	75.57%				1.71%	9.69%	23.08%			

		25%	7.02%	35.76%	72.16%				2.15%	11.73%	26.53%			
	Std	0%	7.96%	18.55%	26.57%	0.50	1.05	1.34	7.07%	15.23%	19.89%	-0.16	-0.34	-0.41
		1%	7.88%	18.38%	26.34%	0.50	1.05	1.34	6.99%	15.07%	19.67%	-0.16	-0.34	-0.40
		10%	7.18%	16.84%	24.29%	0.53	1.09	1.37	6.35%	13.64%	17.75%	-0.13	-0.28	-0.32
		25%	6.02%	14.25%	20.79%	0.57	1.16	1.44	5.29%	11.29%	14.63%	-0.08	-0.16	-0.15
	LPM	0%	3.15%	7.42%	10.60%	1.27	2.61	3.35	2.72%	5.85%	7.56%	-0.42	-0.89	-1.08
		1%	3.12%	7.35%	10.51%	1.28	2.62	3.36	2.69%	5.79%	7.48%	-0.42	-0.88	-1.06
		10%	2.84%	6.73%	9.68%	1.33	2.71	3.45	2.44%	5.23%	6.73%	-0.35	-0.73	-0.85
		25%	2.38%	5.69%	8.27%	1.44	2.90	3.62	2.03%	4.32%	5.53%	-0.20	-0.41	-0.41
	CVaR	0%	0.01%	-2.90%	-3.89%	410.30	-6.68	-9.13	-1.47%	-3.77%	-4.33%	0.78	1.39	1.88
		1%	0.01%	-2.87%	-3.86%	291.27	-6.71	-9.16	-1.45%	-3.72%	-4.28%	0.77	1.36	1.85
		10%	0.05%	-2.60%	-3.52%	77.91	-7.04	-9.48	-1.29%	-3.33%	-3.83%	0.66	1.14	1.49
		25%	0.11%	-2.13%	-2.95%	32.65	-7.75	-10.16	-1.02%	-2.69%	-3.09%	0.41	0.65	0.73
	MaxDD	0%	5.27%	11.36%	14.44%	0.76	1.71	2.46	6.48%	13.84%	16.19%	-0.18	-0.38	-0.50
		1%	5.21%	11.23%	14.29%	0.76	1.72	2.47	6.40%	13.64%	15.95%	-0.18	-0.37	-0.49
		10%	4.64%	10.05%	12.91%	0.82	1.82	2.59	5.70%	11.92%	13.82%	-0.15	-0.32	-0.41
		25%	3.69%	8.08%	10.56%	0.93	2.05	2.84	4.54%	9.15%	10.48%	-0.09	-0.19	-0.22
	Exp. Return	0%	6.76%	34.44%	69.63%				2.83%	14.95%	32.18%			
		1%	6.74%	34.36%	69.47%				2.84%	15.02%	32.28%			
2%		10%	6.59%	33.60%	67.96%				2.96%	15.56%	33.17%			
t 2;		25%	6.34%	32.29%	65.35%				3.16%	16.46%	34.63%			
rkei	Std	0%	4.36%	10.42%	15.37%	0.73	1.46	1.79	3.48%	7.50%	9.94%	0.08	0.20	0.34
Ma		1%	4.32%	10.32%	15.24%	0.73	1.47	1.79	3.44%	7.42%	9.84%	0.08	0.21	0.35
ey l		10%	3.94%	9.46%	14.04%	0.76	1.52	1.84	3.13%	6.73%	8.92%	0.13	0.31	0.49
one		25%	3.32%	8.03%	12.02%	0.83	1.62	1.93	2.61%	5.61%	7.42%	0.23	0.53	0.79
Σ	LPM	0%	1.74%	4.21%	6.18%	1.82	3.61	4.44	1.34%	2.89%	3.82%	0.20	0.51	0.88
- %		1%	1.72%	4.17%	6.13%	1.83	3.62	4.45	1.32%	2.86%	3.78%	0.21	0.53	0.92
203		10%	1.57%	3.82%	5.64%	1.91	3.76	4.57	1.20%	2.59%	3.42%	0.33	0.80	1.28
qs		25%	1.32%	3.23%	4.81%	2.09	4.04	4.82	1.00%	2.15%	2.83%	0.60	1.38	2.06
Son	CVaR	0%	0.20%	-1.37%	-1.95%	15.98	-11.06	-14.07	-0.56%	-1.53%	-1.82%	-0.47	-0.96	-1.86
<u>н</u> -		1%	0.20%	-1.36%	-1.93%	15.76	-11.13	-14.13	-0.55%	-1.51%	-1.80%	-0.51	-1.01	-1.94
2%		10%	0.22%	-1.21%	-1.75%	13.92	-11.86	-14.73	-0.47%	-1.34%	-1.59%	-0.85	-1.55	-2.74
(2)		25%	0.24%	-0.96%	-1.44%	11.41	-13.55	-16.05	-0.34%	-1.05%	-1.26%	-1.74	-2.84	-4.62
ock	MaxDD	0%	2.23%	4.75%	6.37%	1.42	3.20	4.31	2.49%	4.74%	5.36%	0.11	0.31	0.63
St		1%	2.20%	4.69%	6.30%	1.43	3.23	4.33	2.46%	4.66%	5.27%	0.11	0.33	0.66
		10%	1.92%	4.11%	5.59%	1.57	3.49	4.61	2.13%	3.98%	4.49%	0.19	0.52	0.97
		25%	1.46%	3.17%	4.42%	1.90	4.12	5.24	1.60%	2.94%	3.30%	0.38	1.01	1.77
t	Exp. Return	0%	6.04%	30.90%	62.83%				2.44%	12.83%	27.55%			
rke		1%	6.03%	30.85%	62.72%				2.46%	12.92%	27.70%			
Bor Ma		10%	5.95%	30.38%	61.75%				2.62%	13.67%	29.05%			
ey]		25%	5.81%	29.58%	60.07%				2.88%	14.90%	31.25%			
0% 0%	Std	0%	4.02%	9.79%	14.74%	0.61	1.19	1.40	3.48%	7.43%	9.65%	-0.03	-0.09	-0.13
k 5(- M		1%	3.98%	9.70%	14.61%	0.62	1.20	1.41	3.45%	7.36%	9.55%	-0.03	-0.08	-0.11
ocl % -		10%	3.64%	8.88%	13.43%	0.65	1.26	1.46	3.14%	6.68%	8.66%	0.02	0.03	0.03
St 505		25%	3.06%	7.52%	11.45%	0.73	1.38	1.56	2.62%	5.57%	7.20%	0.12	0.25	0.34
	LPM	0%	1.60%	3.91%	5.85%	1.54	2.98	3.53	1.34%	2.84%	3.64%	-0.09	-0.23	-0.34

		1%	1.58%	3.87%	5.80%	1.55	3.00	3.54	1.33%	2.81%	3.60%	-0.08	-0.20	-0.30
		10%	1.44%	3.54%	5.32%	1.64	3.14	3.68	1.21%	2.55%	3.26%	0.05	0.07	0.08
		25%	1.21%	3.00%	4.53%	1.83	3.45	3.95	1.01%	2.12%	2.70%	0.31	0.66	0.91
	CVaR	0%	0.17%	-1.35%	-2.00%	14.19	-8.62	-10.31	-0.60%	-1.69%	-1.97%	0.20	0.39	0.63
		1%	0.18%	-1.34%	-1.98%	13.98	-8.69	-10.37	-0.59%	-1.67%	-1.95%	0.17	0.34	0.56
		10%	0.19%	-1.19%	-1.79%	12.22	-9.39	-10.96	-0.51%	-1.48%	-1.73%	-0.11	-0.12	-0.15
		25%	0.22%	-0.94%	-1.46%	9.96	-10.99	-12.26	-0.37%	-1.16%	-1.37%	-0.84	-1.21	-1.79
	MaxDD	0%	2.19%	4.99%	6.90%	1.12	2.34	2.99	2.71%	5.28%	6.04%	-0.04	-0.12	-0.21
		1%	2.16%	4.92%	6.81%	1.14	2.36	3.01	2.68%	5.20%	5.94%	-0.04	-0.11	-0.18
		10%	1.88%	4.32%	6.04%	1.26	2.58	3.24	2.33%	4.46%	5.07%	0.02	0.04	0.05
		25%	1.43%	3.33%	4.77%	1.55	3.10	3.75	1.77%	3.30%	3.74%	0.18	0.43	0.66
	Exp. Return	0%	5.76%	29.25%	59.12%				3.98%	20.19%	40.85%			
		1%	5.75%	29.21%	59.04%				3.98%	20.19%	40.85%			
%		10%	5.69%	28.85%	58.28%				3.99%	20.24%	40.91%			
33		25%	5.58%	28.23%	56.99%				4.01%	20.32%	41.01%			
ket	Std	0%	1.97%	4.70%	6.89%	1.11	2.13	2.46	1.71%	3.92%	5.66%	0.83	1.71	2.13
Aar		1%	1.95%	4.66%	6.83%	1.11	2.14	2.47	1.69%	3.89%	5.60%	0.84	1.73	2.15
y N		10%	1.80%	4.31%	6.33%	1.17	2.23	2.54	1.54%	3.54%	5.10%	0.93	1.91	2.38
one		25%	1.56%	3.76%	5.52%	1.28	2.39	2.68	1.29%	2.98%	4.29%	1.12	2.30	2.85
Ŭ	LPM	0%	0.76%	1.84%	2.70%	2.85	5.44	6.27	0.68%	1.59%	2.30%	2.09	4.21	5.24
1		1%	0.76%	1.82%	2.68%	2.87	5.47	6.30	0.67%	1.58%	2.28%	2.12	4.25	5.30
33%		10%	0.70%	1.68%	2.47%	3.02	5.71	6.51	0.61%	1.43%	2.07%	2.35	4.71	5.85
st		25%	0.60%	1.46%	2.15%	3.31	6.14	6.87	0.51%	1.20%	1.74%	2.84	5.68	7.03
one	CVaR	0%	0.30%	-0.45%	-0.68%	7.24	-22.40	-24.99	-0.10%	-0.57%	-0.73%	-13.56	-11.65	-16.47
B		1%	0.30%	-0.44%	-0.67%	7.20	-22.67	-25.19	-0.10%	-0.57%	-0.72%	-14.11	-11.84	-16.71
- %		10%	0.31%	-0.38%	-0.59%	6.86	-25.51	-27.17	-0.07%	-0.49%	-0.63%	-21.91	-13.91	-19.24
33		25%	0.31%	-0.27%	-0.47%	6.34	-32.96	-31.49	-0.01%	-0.35%	-0.48%	-170.19	-19.29	-25.40
ock	MaxDD	0%	0.68%	1.37%	1.76%	3.18	7.29	9.62	0.69%	1.22%	1.48%	2.05	5.51	8.13
Stc		1%	0.67%	1.35%	1.74%	3.23	7.37	9.71	0.68%	1.19%	1.45%	2.09	5.63	8.31
		10%	0.57%	1.18%	1.52%	3.68	8.15	10.58	0.56%	0.97%	1.18%	2.57	6.96	10.27
		25%	0.42%	0.93%	1.21%	4.76	9.71	12.22	0.37%	0.66%	0.79%	3.88	10.42	15.41

3 Do Alternative Real Estate Investment Vehicles Add Value to REITs? Evidence from German Open-ended Property Funds^{*,†}

ABSTRACT

Besides the more commonly used REITs, German investors can also invest in a lesserknown real estate vehicle, Open-ended Property Funds. OPFs are considered a compromise between listed and direct real estate investments. OPF fund managers generally provide daily (perfect) liquidity. However, if liquidity falls below 5%, share redemptions in these funds can be temporarily suspended for a period of up to two years. During this time, investors will only be able to sell shares on the secondary market (exchange), and are thus subject to significant liquidity risk. The objective of this paper is to analyze whether OPFs add value to investor portfolios above that provided by REITs. We show that OPFs have a diversification advantage over REITs in low-risk portfolios, despite their larger potential liquidity risk. REIT liquidity is comparable to that of ordinary common stock, but OPFs exhibit an average initial discount to funds' NAV of about 6% when share redemptions are temporarily suspended. However, in the long-run, this potential redemption suspension does not negatively influence OPF performance (in case OPFs reopen again). This makes OPFs an attractive investment alternative to REITs for investors who have a high level of risk aversion and a long-term investment horizon, such as endowments, insurance companies, and pension funds.

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3.1 Introduction

Over the past two decades, investments in real estate have increased dramatically. This growth is at least partially driven by the perceived diversification benefits that real estate offers in multi-asset portfolios. Both direct and listed real estate investments can take advantage of these benefits. However, although the underlying asset is the same, direct and listed real estate investments have very different institutional set-ups and hence different risk-return profiles (for example, the volatility of respective indices for listed real estate is much higher than for direct real estate – see Table 3-A1).

Surprisingly, the preferred real estate investment type differs significantly across countries. For example, U.S. and U.K. investors prefer to invest in listed real estate, while German investors invest almost exclusively in a hybrid real estate portfolio investment vehicle called Open-ended Property Funds (OPFs).¹

OPFs are generally considered a compromise between direct and listed real estate investments. Fund managers invest directly in an internationally diversified real estate portfolio, while holding a cash-equivalent position ranging from 5% to 49% of assets under management to ensure daily liquidity. The resulting historical returns are appealing to investors in terms of *attractive* risk-adjusted returns, with little risk and low correlation with other asset classes.

However, these advantages come with the downside that OPFs must temporarily suspend share redemptions if fund liquidity falls below 5%. In this case, fund managers have a maximum

¹ See the BVI Bundesverband Investment and Asset Management e.V. press release from June 22, 2010 for a detailed composition of OPFs' portfolio structures.

of two years to either attract sufficient new asset inflows and/or to sell portfolio properties to regain fund liquidity. During this time, investors cannot redeem shares, but they can sell them in a secondary market (stock exchange). There is the additional risk that fund management may again be unable to guarantee liquidity, and may even have to sell all the properties at a loss (this is referred to as a "fire-sale"). Such controlled liquidation may become necessary because the liquidation prices are likely to be lower than the going-concern prices.

The liquidation proceeds would then be distributed pro rata to the fund investors. In this case, the realized prices for the sold properties, however, are highly uncertain. Thus, OPF investors bear substantial liquidity risks, as follows: 1) the reduced marketability when funds temporarily suspend share redemptions, and 2) the realized property sale prices in case of a "fire-sale" or a controlled liquidation.

The aim of this paper is to compare two types of real estate investments, and to determine whether the German OPF structure adds value relative to the more widely used REIT structure. If this is the case, we believe there could be extensive implications for other countries, who may also want to consider introducing this structure. We thus need to not only compare the risk-return characteristics of both structures, but also their different liquidity properties.

We first examine the diversification benefits of OPFs. Then, we contrast the liquidity characteristics of REITs with the potential liquidity risks of OPFs caused by the suspension of share redemptions, and explore the impact on investors.

Our results indicate that OPFs can add further diversification benefits to investors that they would not obtain from REIT investments, especially in low-risk portfolios. However, there is a

significant difference in liquidity risk between OPFs and REITs. While the liquidity of REITs is similar to that of ordinary common stocks, the liquidity of OPFs depends on whether shares are currently redeemable. OPF investments are thus especially favorable for investors with a high level of risk aversion and a long-term investment horizon, such as endowments, insurance companies, and pension funds. These investors have more freedom to withstand a suspension period, and can better take advantage of the value-added of OPFs.

The remainder of this paper is structured as follows: Section 3.2 introduces Open-ended Property Funds and describes the construction of an appropriate market index. Section 3.3 illustrates their diversification benefits, while section 3.4 discusses REIT liquidity. Section 3.5 compares OPF liquidity to REIT liquidity and analyzes the special liquidity risk when share redemptions are temporally suspended. Section 3.6 summarizes our main results, and gives our conclusions.

3.2 The German OPF Market

3.2.1 Fundamental Features

From a legal perspective, an OPF is a separate special asset, with an investment focus on property initiated and managed by a capital investment company. For investor protection purposes, OPFs are controlled by regulations for identifying, diversifying, and controlling risks, as well as for realizing gains and fund liquidity.²

² See Investmentgesetz (InvG) and Klug (2008) for further details.

OPFs were first created in 1959, with the establishment of the "Internationales Immobilien Institut" (the international real estate institute, known as iii-investments). The first German OPF was iii-funds No. 1. Since 1991, there have been enough OPFs for a meaningful index formation and statistical evaluation, but in recent years, the growth of the market has exploded. For example, in 1998, there were sixteen OPFs, with assets under management of 43.1 billion Euros. As of April 2010, the market had grown to forty-five funds managing 90 billion Euros.

Real estate investment vehicles similar to OPFs exist in several European Union member countries. However the German OPF market is by far the biggest, and its market capitalization is about one-third that of all European Union member countries.³

Table 3-1 provides an overview of the full sample of OPFs from 1991 through April 2010. For our analysis, we use all OPFs that report their data to the "BVI Bundesverband Investment and Asset Management e.V." (the German Investment and Asset Management Association). To test for consistency, we compared the investment share prices from BVI with the prices obtained from Datastream. We found twenty-one pricing differences, for a 99.9% accuracy rate. None of the differences exceeded 1% of the stock price. In the case of a pricing difference, we asked the capital investment company for the price.

For the further analyses, we used all OPFs that are or were covered by the BVI and Datastream, which ensures the highest possible data accuracy and that the calculated indices are not affected by survivorship bias. However, our results remained stable when all OPFs were

³ According to data from the BVI Bundesverband Investment, Asset Management e.V. (German Asset Management and Investment Association), and Deutsche Bundesbank (German Central Bank).

included. This is not surprising, as our sample covers at least 94% of the market.⁴ Therefore, we

find that our results are not affected by a biased data-generating approach.

Year	Number	In €m
1991	12	9,807
1992	14	13,690
1993	14	21,840
1994	14	25,764
1995	14	29,694
1996	14	37,023
1997	15	40,493
1998	16	43,137
1999	17	50,403
2000	19	47,919
2001	19	55,868
2002	22	71,165
2003	23	85,172
2004	26	87,191
2005	30	85,129
2006	35	75,545
2007	39	83,426
2008	42	84,252
2009	44	87,076
2010	45	90,043

Table 3-1: Overview of the German OPF Market

This table shows the number of active OPFs in the German market and their assets under management, which are calculated as of year-end. Except for 2010, the reference date is April. Data come from BVI and Thomson Financial Datastream.

In contrast with many other countries, in Germany, OPFs are preferred over real estate shares as an alternative investment. OPFs offer three significant advantages, and their regulatory design is similar to the OPF markets in European Union member countries:5

 ⁴ Tables and figures are available from the authors upon request.
 ⁵ See, for example, Maurer, Reiner, and Rogalla (2004).
- (1) The OPF share price is not determined by supply and demand as long as the OPF provides liquidity. Therefore, share prices do not differ from the NAV per share reported by the capital investment companies when there is no temporary redemption suspension. This means that OPF returns tend to be quite smooth, because there is no additional influence from (equity) capital markets.
- (2) The number of issued shares varies, which generally ensures high liquidity. As in any investment fund, there is a daily issuance of new shares from buyers and a daily redemption of old shares from sellers.⁶
- (3) The rule of risk-spreading governs transactions.⁷ This diversification significantly reduces unsystematic risk.

These specific features of OPFs substantially influence their risk-return profile. In general, portfolio returns are determined by 1) rental income, 2) maintenance costs, 3) value increases or decreases, and 4) payments from fixed income investments.⁸ (1), (2), and (4) are relatively easy to determine; the primary challenge is gauging changes in value if comparable properties do not trade regularly. Thus, German investment law (§70 para. 2 sentence 2 InvG) mandates that properties be evaluated at least once a year by an independent appraisal board to determine true

⁶ Historically, there have only been two periods when share redemptions were temporarily suspended (2005/2006 and 2008/2010). Both are discussed in more detail in section 3.5.

⁷ At the time of purchase, a property may not constitute more than 15% of the OPF's NAV. Furthermore, the total value of all properties with individual values of more than 10% of a fund's NAV may not constitute more than 50% of the fund's NAV. See InvG § 73 (1).

⁸ More than 40% of OPF portfolio properties have leases with residual terms that extend longer than January 1, 2014. See the BVI Bundesverband Investment and Asset Management e.V. press release from July 1, 2008.

market value. The appraisal board members have technical expertise in the area of property market development (§77 para. 2 sentence 1 InvG).

This valuation by law allows the sales comparison approach, the cost approach, and the income approach for the appraisal of fair market value. The income approach is internationally accepted, and is the primary method for valuing OPFs. It appraises a property on the basis of objectively evaluated price and income forecasts, as well as dynamic capitalization rates on the valuation date. Therefore, the daily NAVs of an OPF are based on the annual expert appraisals since the last valuation date, but do not necessarily represent "true" daily property values.

This valuation approach aims to minimize subjective views about future expectations⁹ and to dampen over- and understatements of property values. However, because past appraisal reports are included in the determination of current NAVs, valuation returns are smoothed, an effect known as *"appraisal-smoothing."*¹⁰ Smoothing, as well as the less frequent valuations, results in positive autocorrelation of the OPF returns.¹¹ The autocorrelation thus significantly underestimates OPF risk (e.g., volatility).

In this paper, we perform an unsmoothing of returns as a correction using Getmansky, Lo, and Makarov's (2004) method to recompute the return series so that it is free of autocorrelation. This method is based on the estimation of a general moving average process. It can detect arbitrary autocorrelation structures, and can thus cope with annual reappraisals.

⁹ See Archner (2006) for an extensive analysis.

¹⁰ See Ross and Zisler (1991) and Geltner (1991) for an extensive discussion.

¹¹ Other, more secondary, reasons are inflation-linked lease contracts and the inclusion of inflation in the appraisal Maurer, Reiner, and Rogalla (2004) show in this context that the autocorrelation of real returns is substantially lower.

We note a similar problem when comparing real estate indices: Those based on expert appraisals at certain valuation dates exhibit less volatility than those based on transactions or new lease agreements.¹²

3.2.2 Construction of Open-ended Property Fund Indices

To construct an OPF index, we first need to calculate a representative index. We consider all funds covered by the BVI and Datastream¹³ beginning in February 1991 (because we have a sufficient number of funds from this date onward), and ending in April 2010. The monthly raw data from the OPFs contain share prices ($P_{i,t}$) for each month-end. The data are adjusted for share splits and reported net of management fees. Therefore, further analysis is not biased favorably toward OPFs. Dividend payouts are re-invested in the respective fund (before taxes).

For all OPFs, we calculate a monthly pre-tax return based on adjusted share prices as follows:

$$R_{i,t} = \frac{\left(P_{i,t} - P_{i,t-1}\right)}{P_{i,t-1}}, \text{ for all funds } i \text{ at time } t.$$
(1)

Next, using the pre-tax returns of the individual funds, we calculate a value-weighted index and an equal-weighted index as follows:

¹² See McAllister et al. (2003) and Pagliari, Scherer, and Monopoli (2004) for more detailed discussions.

¹³ As a robustness check, we compute three different indices, because not all OPFs are investable, and some funds require a high minimum investment. The first index represents the total OPF market, the second includes only investable funds, and the third includes only funds investable for retail investors. There are only marginal differences among the three indices, and our results do not depend on which one is used. Therefore, we use the total market index in the following analysis. For the other index concepts, tables are available upon request from the authors.

$$R_t^{value weighted} = \sum_{i=1}^{n_t} W_{i,t} \cdot R_{i,t} \text{ with } W_{i,t} \le 0.25 \text{ and } R_t^{equally weighted} = \frac{1}{n_t} \sum_{i=1}^{n_t} R_{i,t}, \qquad (2)$$

where n_t is the number of funds at time t, and $w_{i,t}$ is the weight of fund i at time t. The weight of each fund is calculated by dividing the assets of the fund by the total assets of all funds (see Table 3-1 for more details). Our index can thus be considered a total return index. We use the value-weighted index in the following analyses,¹⁴ and we use Getmansky, Lo, and Makarov's (2004) method to correct for autocorrelation.

3.3 Diversification Benefits of Real Estate

To compare the diversification benefits of REITs and OPFs, we perform a standard Markowitz portfolio optimization. We include our OPF index and the FTSE NAREIT Index as a proxy for REITs, as well as international standard indices for stock, bond and money markets and alternative investments (see Table 3-A1 for a detailed listing).

Examining the descriptive statistics for the monthly return time series, we find that OPFs have an average monthly return of 0.49%, while REITs have a higher average monthly return of 1.09% (see Table 3-A1). However, OPFs with a 3.15% monthly standard deviation have a much lower risk than REITs at 6.35%. Note that OPFs and REITs both exhibit positive kurtosis. However, OPFs also exhibit positive skewness, while REITs have a negative skewness, which indicates the potential for tail risks.

¹⁴ Different calculation methods did not lead to any changes in our results, so we use only the value-weighted index as per Maurer, Reiner, and Rogalla (2004). Tables for an equally weighted index are available from the authors upon request.

Furthermore, by comparing the correlation structures of both products, we note that OPFs are almost uncorrelated with all other asset classes. REITs show a significant correlation with stock markets. This is thus a distinct diversification advantage for OPFs (see Table 3-A2).

Figure 3-1 shows the portfolio composition resulting from the Markowitz portfolio optimization of the efficient frontier.

Figure 3-1: Composition of Efficient Portfolios

This figure shows the portfolio weights for the asset classes in the portfolios on the efficient frontier, with standard deviations as risk measures dependent on the expected return. For the calculations, every index portfolio weight is restricted to the range of 0%-20%. The observation period is February 1991-April 2010.





decreases slowly as expected return increases. On the other hand, the REITs allocation starts at 0% and steadily increases to the maximum level.

This indicates that OPFs offer better diversification benefits for low-risk portfolios, and REITs offer better diversification benefits for higher-risk portfolios.¹⁵ Consequently, despite being based on the same underlying asset, the benefits to investors for both products are quite different. In the next two sections, we emphasize how their different institutional setups cause their differences in liquidity.

3.4 REIT Liquidity

Public REITs are listed on stock exchanges like shares of common stock in other firms. However, their institutional characteristics differ. We would thus also expect to find differences in the market microstructure of REITs compared to common stocks. However, a priori, it is not clear whether these differences should also lead to liquidity differences.

Although there is an enormous amount of literature on liquidity in financial markets, there is no single measure of liquidity. According to Kyle (1985), liquidity of financial assets includes three transactional characteristics: 1) tightness, the cost of liquidating a position over a short period of time; 2) depth, the ability to buy or sell large quantities of shares with minimal price

¹⁵ We used three robustness checks to determine the stability of the results from the Markowitz portfolio optimization: 1) additional risk measures such as conditional value at risk, lower partial moment 2, and maximum drawdown to address potential tail risks from non-normally distributed return distributions, 2) a February 1991-September 2007 observation period to test for the influence of the financial crisis on our results, and 3) weight restrictions. All the checks showed that our results for REITs and OPFs remain qualitatively stable. Tables and figures are available from the authors upon request.

impact; and 3) resilience, the propensity of prices to recover quickly from a random shock to the market.

Early results on the differences between REIT and non-REIT stock liquidity have been mixed. For example, Ghosh, Miles, and Sirmans (1996) find that REIT liquidity is less than comparable non-REIT liquidity. But Nelling et al. (1996) find that REIT liquidity is similar to that for non-REIT stocks.

Another strand of the literature examines the development of REIT liquidity during the rapid growth of the REIT market during the 1990s. Bhasin, Cole, and Kiely (1997) and Below, Kiely, and McIntosh (1996) find that REIT liquidity increased in the early 1990s. In contrast, Clayton and MacKinnon (2000) documented the opposite.

These studies, however, used different liquidity measures. The first two used the bid-ask spread as the relevant liquidity measure, and hence found a measure of tightness. The latter study used ask or bid depth, respectively, and hence found a measure of depth. This potentially explains their conflicting findings. Furthermore, Clayton and MacKinnon (1999) and Glascock, Michayluk, and Neuhauser (2004) found that REIT liquidity decreased in declining markets.

International evidence on REIT liquidity is provided by Brounen, Eichholtz, and Ling (2009). Their study compares REIT liquidity for the U.S., the U.K., Continental Europe, and Australia, and finds significant differences across countries and between REIT and non-REIT liquidity. However, they do not determine conclusively whether REIT or non-REIT liquidity is larger.

Determinants of REIT liquidity is another important topic in the literature. Bhasin, Cole, and Kiely (1997) find that bid-ask spreads are a decreasing function of share prices. Many studies also found that liquidity is negatively related to insider ownership (see, e.g., Nelling et al. (1995), Below, Kiely, and McIntosh (1996), Bhasin, Cole, and Kiely (1997), and Benveniste, Capozza, and Seguin (2001)). However, Cole (1998) and Chiang and Venkatesh (1998) found no such relationship.

Finally, Bertin et al. (2005) examine intraday REIT liquidity. They find a U-shaped pattern similar to the pattern commonly observed for non-REIT stocks.

In summary, there is no clear evidence of whether REIT or non-REIT liquidity is larger. However, all the studies tend to conclude that the range of REIT liquidity is comparable to that of non-REIT liquidity, and that it decreases in declining markets.

3.5 Comparison of OPF and REIT Liquidity

In contrast to REITs, OPF liquidity must be investigated in two different regimes. In the first, when the fund management accepts share redemptions, investors have perfect liquidity (as long as the redemption amount is smaller than the liquidity reserve) and can redeem at fund NAVs. In the second, when share redemptions are temporarily suspended, investors can only sell shares on a stock exchange (Börse Hamburg) at market prices instead of the NAV. Market prices are naturally a function of trading activity, and are therefore affected by (potential) liquidity risks.

OPFs are also traded on the stock exchange when redemption of shares is not suspended. This is due to the following two reasons. First, price fixing by the fund management of OPFs only occurs once per day. Therefore the share exchange opens the possibility for more frequent price fixing. Second, investors typically have to pay an issue surcharge when buying OPFs directly from the fund. Thus, by buying OPFs at the share exchange buyer and seller can benefit from saved issue surcharges, which can be partitioned between the two parties.

3.5.1 General Liquidity of OPFs and REITs

In the first step we analyze "normal" liquidity of OPFs and compare it with the liquidity of REITs. However liquidity cannot be observed directly and has several dimensions that cannot be captured by one single measure. To quantify the liquidity risk we use the following two commonly used liquidity measures: Amihud's (2002) and Rolls's (1984) measure.

Roll's liquidity measure is an order-based measure. In the absence of intraday data the spread, the difference between bid and ask, can be approximated by the serial covariance of price changes. In detail it is calculated as follows:

$$S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}, \qquad (3)$$

where ΔP_t is the price change on day *t*. Thus a higher value for *S* means a higher average spread and therefore lower liquidity.

In comparison Amihud's liquidity measure is a trade-based measure. It measures the price impact and is defined as absolute price change per euro of trading volume:

$$ALM = \frac{|r_t|}{Volume_t},\tag{4}$$

where r_t is the return on day *t* and *Volume_t* is the euro trading volume on day *t*. Also for this measure a higher value is associated with lower liquidity.

In order to measure the valuation effects of the suspensions, we obtained detailed data from the regional exchange Börse Hamburg, where all secondary market transactions of OPFs take place. The data contain for every transaction for all traded OPFs the trading price and number of traded shares for all trading days over the January 2, 2004-June 1, 2010 period, which includes both crisis periods. Data for REITs is taken from the daily CRSP files for the same period.

Figure 3-2: Roll Liquidity Measure for OPFs and REITs

This figure shows the Roll Liquidity Measure for all OPFs traded at Börse Hamburg and all REITs with data available at CRSP. The observation period is January 2004-May 2010.



As can be seen from Figure 3-2 Roll's liquidity measure is for REITs lower than for OPFs before the financial crisis, however comparable in magnitude. Starting in mid-2007, liquidity for REITs declines sharply and is in October 2010 approximately 15 times lower than before the

financial crises. In contrast, Roll's liquidity measure is for OPFs almost stable during the complete observation period.

Figure 3-3: Amihud Liquidity Measure for OPFs and REITs

This figure shows the Amihud Liquidity Measure (scaled by the factor 10⁶) for all OPFs traded at Börse Hamburg and all REITs with data available at CRSP. The observation period is January 2004-May 2010.



The differences in liquidity between OPFs and REITs are more pronounced for the Amihud liquidity measure. As can be seen from Figure 3-3 price impact, measured by the Amihud Liquidity Measure, is much lower for REITs than for OPFs. However, with the start of the financial crisis liquidity of REITs sharply declines whereas liquidity for OPFs remains relatively unaffected by the financial crisis. However, we see from Figure 3-3 that the Amihud liquidity measure is very volatile, with many peaks, for OPFs.

Although liquidity for REITs was higher before the financial, the situation changed during the financial crises. Whereas REIT liquidity falls dramatic in fall 2008, OPF liquidity remains stable. Investors sold REITs in a flight to quality during the financial crisis and shifted their investments to safer assets like bonds. In comparison, OPFs were still regarded as safe investments, as liquidity was not affected. Investors preferred to hold their investments, even when share redemption has been suspended. Thus, the investors expect that, NAVs will not be written-down as much as share prices would go down when selling them through the stock exchange. This possibility does not exist for REIT investors. Therefore they sold a large amount of their shares causing a massive decrease of liquidity. Therefore the study of general liquidity of OPFs and REITs shows that these two asset classes are perceived very different by the market. Whereas REITs are seen as more risky investment like equities, OPFs are more perceived as safe investments like bonds.

3.5.2 Special OPF Liquidity Risk

However OPFs bear an additional risk. To analyze this special OPF liquidity risk, we gauge performance during the temporary suspension of share redemption (short-term valuation effects), and when investors hold instead of selling the OPFs on a stock exchange (long-term valuation effects). But before we present those results, we must first introduce the German OPF regulatory framework.

3.5.2.1 Institutional Background

In principle, OPFs must redeem shares on a daily basis, so they always hold a certain level of liquid assets because property cannot be sold quickly. German investment law requires that OPFs

hold a minimum of 5% (and a maximum of 49%) of their assets in cash or easily liquefied investments (§ 80 InvG). This liquidity reserve, which is typically invested in money market instruments and bonds, theoretically guarantees the redemption of outstanding shares at all times. Hence, the risk-return profile of OPFs does not correspond to a pure property position, but is positively correlated with bond markets (see Table 3-A2).¹⁶

With daily share redemption, however, comes the risk that investors may redeem too many shares over too short a period, and may render the liquidity position too small to satisfy all the redemptions. As we have noted if the liquidity reserve falls below 5%, share redemption may be suspended in order to raise money by, e.g., selling property investments. This temporary suspension may last up to two years (§ 80c para. 2 InvG and § 81 InvG).¹⁷

Crises in the real estate markets, which are the main cause of temporary suspensions of share redemptions, often occur after a capital markets crisis. If old rental contracts expire, for example, new contracts may yield lower rental income, and past sale prices may no longer be realizable. For OPFs, this lagged impact is even more pronounced, because OPF management has an incentive to maintain the (probably) "high valued appraisals" and successively adjust the NAV to market developments. If investors anticipate such a development, it is possible that substantially more shares may be redeemed than issued, and over a shorter than usual time period.

¹⁶ See Maurer, Reiner, and Rogalla (2004) and Gullett and Redman (2005) for more extensive discussions.

¹⁷ By law, a fund may only suspend redemptions for a maximum of twelve months. By contractual agreement, this can be extended to twenty-four months. Alternatively, management may opt to only partially suspend redemptions, so that shares can only be redeemed monthly instead of daily.

When OPFs temporarily suspend share redemptions, investors have the option of selling their shares in the secondary market. However, the prices in the secondary market do not necessarily correspond to the NAVs calculated by the capital investment companies. In fact, they tend to be lower because of, e.g., slower value adjustments by management, earnings management, appraisals, and liquidity reduction. Therefore, the secondary market is truly reflective of the market's assessment of share value, because the NAV might not be. We assess the consequences for investors over the short- and long-term in the next three subsections.

In the more than fifty-year history of German OPFs, the temporary suspension of share redemptions has happened only twice (2005/2006 and 2008/2010).¹⁸ Because each period had a different impetus for the suspension, we analyze each separately.

Prior to the 2005/2006 suspension, the market feared that some funds would need to revalue at least part of their property portfolios. This high appraisal uncertainty led to massive share redemptions in a short period, and three funds temporarily suspended redemptions.

On December 13, 2005, Deutsche Bank Real Estate suspended share redemptions in its OPF Grundbesitz-Invest until March 3, 2006, in order to conduct a complete revaluation of property. This followed a massive outflow of investments (more than 1 billion Euros, or 300 million Euros in the three days before the suspension), as fund management expected a devaluation of several hundred million Euros.

¹⁸ For a detailed description of events during the 2005/2006 period, see, e.g. Bannier, Fecht, and Tyrell (2007).

On January 17 and 19, 2006, KanAm temporarily suspended share redemptions in two of their OPFs, Grundinvest US and Grundinvest, after investors redeemed more than 700 million Euros worth of shares within a few days. The apparent reason was a negative rating agency report, which led to a panic among investors. KanAm, however, did not need a property revaluation, and used the three-month suspension to regain the required liquidity. No devaluation followed, and, in fact, some properties were sold at great gains. The funds were reopened on March 31, 2006, and April 13, 2006.

In comparison, the 2008/2010 temporary suspension was much more dramatic and affected the entire OPF market. It occurred in the aftermath of the global financial crisis, when investors increased their preference for liquidity and were fearful of tying up capital in the OPF market for an uncertain time (up to two years). Thus, this second crisis proved to be a global one.

During the short time period of October 27-30, 2008, twelve OPFs announced temporary suspensions of share redemptions. In January 2009, the first OPF reopened, and, through December 2009, eight more followed suit. However, in November 2009 and May 2010, five OPFs that had reopened were forced to temporarily suspend share redemptions once again.

3.5.2.2 Estimation of Short-term Valuation Effects

Figure 3-4 illustrates that the average number of traded funds in the secondary market as well as the average trading volume increased significantly during the crisis periods (see Table 3-2 for statistical significance). However, trading volume decreased sharply again as the suspensions continued. Note further that the second crisis had an especially high impact on trading volume,

which increased to an average daily peak of about 10 million Euros (compared to an average daily peak of about 4 million during the first crisis).



This figure shows the daily five-day average number of traded OPFs and the five-day average trading volume from January 2004-June 2010. See Table 3-A3 for a detailed listing of temporarily suspended OPFs.



We next measure market reactions to the share suspensions by calculating their discounts on the secondary market compared to the net present value (NPV) calculated around the disclosure date (t_0) by the OPFs themselves. Following Brown and Warner (1985) and Fuller, Netter, and Stegemoller (2002), we use standard event study methodology to calculate the average discounts as follows:

$$AD_{t} = \frac{1}{I} \sum_{i=1}^{I} \left(\frac{NAV_{t}^{(i)} - SP_{t}^{(i)}}{NAV_{t}^{(i)}} \right) \qquad \forall t = t_{0} - \tau_{1}, \dots, t_{0} + \tau_{2},$$
(5)

where $NAV_t^{(i)}$ is the NAV of a traded OPF *i* at time *t*, as reported by the OPF, $SP_t^{(i)}$ equals the secondary market price of the traded OPF *i* at time *t*, and AD_t stands for the average discount for all suspended traded OPFs (*I*) at time *t*.

In our next step, we aim to calculate the average abnormal discount (AAD_t) . In other words, we are interested in determining the difference between the discounts from the traded temporarily suspended OPFs, and those that remained open.

Let I_1 denote the OPFs that suspended share redemptions, and I_2 denote the OPFs that continued to accept share redemptions. We calculate the difference for the average discount within the subgroup at time *t* as follows:

$$AAD_{t} = \frac{1}{I_{1}} \sum_{i_{1}=1}^{I_{t}} \left(\frac{NAV_{t}^{(i_{1})} - SP_{t}^{(i_{1})}}{NAV_{t}^{(i_{1})}} \right) - \frac{1}{I_{2}} \sum_{i_{2}=1}^{I_{2}} \left(\frac{NAV_{t}^{(i_{2})} - SP_{t}^{(i_{2})}}{NAV_{t}^{(i_{2})}} \right) \qquad \forall t = t_{0} - \tau_{1}, \dots, t_{0} + \tau_{2}.$$
(6)

We use a standard t-test statistic to draw statistical inferences about the different event windows for the average discounts (AD) and the average abnormal discounts (AAD) (see Table 3-2). Note from Table 3-2 and Figure 3-5 that the AD and the AAD increase significantly for OPFs that announce they are suspending share redemptions. These results hold for all event windows.¹⁹

The average discount was about 0% before the suspension announcement, and it increased to approximately 6%. This increase clearly reflects investors' liquidity preference, and that investors

¹⁹ We also calculate AD_t and AAD_t based on capital instead of equal weighting. The results remain stable. Tables are available upon request from the authors.

price temporarily suspended OPFs at a discount. There are three sources of uncertainty for investors surrounding temporary share redemptions: 1) when the funds will begin to accept share redemptions again (note again that the time period can be up to two years), 2) whether OPF management will be forced to sell portfolio properties to ensure liquidity (fractional selling or controlled liquidation), which can result in uncertainty about potential selling prices ("fire-sale"), and 3) the fact that investors can only use the secondary market when they suspect that OPF portfolio properties may depreciate.

The discount thus reflects 1) a premium for reduced OPF liquidity (perfect liquidity versus secondary market liquidity) and uncertainty over the duration of the suspension period (up to two years), and 2) the write-off potential if funds are forced to sell or revalue properties. Investors react to the uncertainty by incorporating into (secondary) market prices the new information that some OPFs have temporarily halted share redemptions.

Figure 3-5: Average Discount of Suspended OPFs relative to Temporary Share Redemptions

This figure shows the average abnormal discount of suspended OPFs for both the 2005/2006 and the 2008/2010 crisis periods (as calculated in Equation (4)) relative to the suspension date t0. See Table 3-A3 for a detailed listing of temporarily suspended OPFs.



Table 3-2: Secondary Market Comparison of Market Phases when all OPFs are Redeemable and When some are Temporarily Suspended

This table shows the average abnormal discount (AAD) for different event windows, both tested for statistical significance. In the columns "Abnormal Trading Volume" and "Traded OPFs," we test the hypotheses that we will find higher trading volume and a higher number of OPFs traded during the specific event windows than when no OPF is temporarily suspended.

Event Window	AAD	Abnormal Trading Volume	Traded OPFs	Nobs
[-10, +10]	3.18%***	2.65•10 ⁶ ***	3.77***	17
[-10, +30]	4.56%***	3.38•10 ⁶ ***	3.37***	17
[-1, +1]	2.98%***	3.03•10 ⁶ ***	4.09***	17
[0, +5]	5.29%***	$4.10 \cdot 10^{6} * * *$	4.24***	17
[0, +30]	5.89%***	4.05•10 ⁶ ***	4.25***	17

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Furthermore, we can see that the dynamics in the secondary market for OPFs change when some funds announce suspensions (see Table 3-2 and Figure 3-4). During both crisis periods, trading volume and the number of traded OPFs in the secondary market increased significantly, which indicates that investors use the secondary market more frequently when OPFs stop providing liquidity.

However, the observed discounts can reflect either reduced liquidity or expected NAV depreciations. For this reason, we need to determine whether the initial discount (defined as the average of the [0,+5] event window) in response to the change in marketability has forecasting ability, and whether it can be explained partially by market expectations about future developments.

Using a logit model, we first analyze whether the initial discount implies that the OPF management depreciates (writes down) property values during the suspension period (see Table 3-3). Next, we examine the accumulated depreciations²⁰ during the suspension, and we use standard ordinary least square regressions to determine whether the initial discount explains these depreciations (see Table 3-4).

The logit model illustrates that the magnitude of the initial discount can explain whether OPF management will conduct depreciations during the suspension period (see Table 3-3). This

²⁰ We calculate accumulated depreciation by checking press releases and semiannual and annual reports of OPFs. When no or insufficient information was provided, we asked public relations departments directly for the information, and we cross-checked the material with their press releases, reports, and newspaper articles found in LexisNexis and Factiva.

finding supports the fact that observed discounts are not due solely to decreased liquidity, but are also a proxy for investor perceptions of the future depreciation potential.

However, we find that the controlling variable "size" is not statistically significant. Remarkably, the size of the OPF does not affect the depreciation probability. One could argue that bigger OPFs may have aggressively written up portfolio properties in the past, and therefore showed above-average returns. This in turn could have attracted substantial new fund inflows, which would have a higher write-off potential. However, we cannot demonstrate such a relationship here. Furthermore, whether the suspension occurred during the first or second crisis period also does not significantly affect the depreciation probability.

When explaining accumulated depreciation, we find a slightly different picture (see Table 3-4). The initial discount can still explain the depreciation behavior (meaning a higher initial discount results in higher depreciations during the suspension period). The period dummy is also statistically significant with a negative sign, which suggests that the depreciation potential during the first crisis period was lower than that for the second crisis period.

Table 3-3: Logit Model Predicting Depreciation of Property Portfolio Value within the Period of Temporary Share Redemption Suspension

We run the logit regressions so that the dependent variable equals 1 if the OPF depreciated the value of its portfolio properties within the redemption suspension period (and 0 when no depreciation took place). The exogenous variables are 1) the initial discount, as calculated in Equation (3) after the announcement of the redemption suspension (the first ten-day average), 2) ln(Size), calculated as the logarithm of the OPFs' assets under management, and 3) a period dummy variable indicating that the event occurred during the first crisis period. We include all OPFs that have reopened or were suspended for longer than six months. See Table 3-A3 for a detailed listing of the included temporarily suspended OPFs. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Coefficient	t-statistic
Constant	14.1130	0.3365
Initial Discount	0.9523^{*}	1.8257
Ln(Size)	-1.1061	-1.1639
Period Dummy	-3.3685	-1.6665
McFadden R ²	36.30%	
LR-Ratio	7.6854	
Number of Observations	17	

Table 3-4: Ordinary Least Squares Regression Explaining the Depreciation of OPF Portfolio Property Values

For this estimation, we use depreciation in absolute terms during the suspension period as a dependent variable in both regressions. The exogenous variables are 1) the initial discount, as calculated in Equation (3) after the announcement of the redemption suspension (the first ten-day average), 2) ln(Size), calculated as the logarithm of the OPFs' assets under management, and 3) a period dummy variable indicating that the event occurred during the first crisis period. We include all OPFs that have reopened or were suspended for longer than six months. See Table 3-A3 for a detailed listing of the included temporarily suspended OPFs. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Coefficient	t-statistic
Constant	2.4073	1.3090
Initial Discount	0.1770^{**}	2.1814
Ln(Size)	-0.1602	-1.3011
Period Dummy	-0.1602*	-1.9257
R ²	42.64%	
Number of Observations	17	

3.5.2.3 Estimation of Long-Term Valuation Effects

In contrast to the short-term valuation analysis where we analyzed the discounts in the secondary market, we now compare the short-term results with a buy-and-hold alternative. We focus on the group of OPFs that suspended share redemptions and then reopened again. We calculate performance for investors who held their shares instead of selling them on the secondary market. We also calculate the abnormal returns of the temporarily suspended OPFs compared to the overall OPF market for 1) the twelve months prior to the suspension, 2) the suspension period itself, and 3) the twelve months afterward (see Barber and Lyon (1997) for a detailed introduction of the applied methodology). We use buy-and-hold abnormal returns (BHARs) to maintain an investor perspective. Based on the BHARs, we can infer how the suspended OPFs performed compared to the overall market.

From Table 3-5, we note that the average BHARs are positive for all three time periods, which implies that the sample of suspended OPFs performed better than the overall market before, during, and after the suspension. The significantly positive performance of 2.40% during the twelve months after the suspension illustrates that the suspended OPFs outperformed the market even when depreciations occurred during or after the suspension period.

These results indicate that investors did not redeem their shares before the suspension because of poor performance. Also, the overall positive performance during and after the suspension indicates that no asset "fire sales" occurred. One caveat is that the performance during the suspension should be examined with caution, because not all OPFs reopened again. Performance would likely be overestimated if OPF management were forced into a controlled

liquidation.

Table 3-5: Buy	v-and-Hold Abnor	mal Returns for Tei	mporarily Susr	ended OPFs
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This table shows buy-and-hold abnormal returns (BHARs) for all temporarily suspended OPFs that subsequently reopened. Abnormal returns are calculated relative to all open OPFs. See Table 3-A3 for a detailed listing of the included temporarily suspended OPFs.

Average of all Suspended Funds	BHAR	Number of Observations		
12 months before suspension	0.48%	12		
During suspension	0.79%	12		
12 months after suspension	$2.40\%^{***}$	5		
***.**. and * indicate statistical significance	e at the 1%. 5%, and 10%	levels, respectively.		

In summary, the results from our short- and long-term analyses paint different pictures. The short-term analysis highlights that, during temporary redemption suspensions, investors who opt to sell their shares in the secondary market must accept substantial discounts off the NAV. However, the results from our long-term analysis imply that investors were better off holding their shares than selling them in the secondary market. Because the more recent crisis period has not fully ended, holding shares until a suspended OPF reopens will only be beneficial when OPF reopen again within the two-year time limit, however. Otherwise, investors may face a high level of uncertainty about the liquidation prices of portfolio properties within the controlled liquidation.

3.6 Conclusion

In this paper, we demonstrate that OPFs can provide diversification benefits to investors that they cannot obtain by investing solely in other real estate vehicles such as REITs. This is especially true for low-risk portfolios.

However, there is a significant difference between the liquidity of OPFs and REITs. Before the financial crisis liquidity for REITs was higher than for OPFs. However, as REITs were perceived as common equity by the market, liquidity decrease dramtically during the financial crisis. In comparison OPFs were more regarded as safer investments comparable to bonds, as market liquidity of OPFs remained stable during the financial crisis. However OPFs bear an additional liquidity risk. If share redemptions have been temporarily suspended, however, investors can face on average an initial discount of about 6% from fund NAVs. This discount reflects not only the decreased liquidity, but also expectations about future depreciations of fund NAVs.

But over the long-run, we find positive abnormal performance for funds that temporarily suspended share redemptions and then subsequently reopened. Combining our diversification and liquidity results, we find that OPFs add value for investors with a high level of risk aversion and a long-term investment horizon, such as endowments, insurance companies, and pension funds. Investors who have more freedom to wait out a suspension period and not resort to selling on the secondary market will not be as affected by the reduced liquidity, and can reap greater diversification benefits. We believe one promising avenue for future research could be to explore how other countries besides Germany could begin to start offering OPF-type investments alongside REITs.

3.7 References

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3.8 Appendix

Table 3-A1: Descriptive Statistics for Monthly Return Distributions

This table gives the mean, median, standard deviation, the square root of lower partial moment 2 with threshold 0 (LPM), the conditional value-at-risk (CVaR) with a 95% confidence level, maximum drawdown (MaxDD), skewness, kurtosis, minimum, and maximum for the monthly return distribution for the February 1991-April 2010 period. All measures are based on monthly data. The asset classes considered are real estate (OPFs after an autocorrelation adjustment using Getmansky, Lo, and Makarov's (2004) method and REITs - the FTSE NAREIT Index), equity markets (Nikkei 500, S&P 500, DJ Stoxx 600), bond markets (J.P. Morgan Japan, U.S., Europe, and U.K. Government Bond Indices), money markets (LIBOR) and alternative investments (S&P GSCI and the HFRI Fund of Funds Composite Index). All indices are total return (or their distributions were reinvested), and all are denominated in U.S. dollars. We found no autocorrelation effects for the time series of equity and bond markets or for alternative investments. We use the Jarque-Bera (1980) test to test for the assumption of normally distributed monthly returns. ***, **, and * indicate that the assumption of a normal distribution of monthly returns is rejected at the 1%, 5%, and 10% significance levels, respectively. All statistics are based on continuous returns.

	Real	Estate	Equity Markets				Bond Markets	s	Alternative Investments		Money Market	
	OPFs	REITs	NIKKEI	S&P 500	DJ STOXX 600	JPM Europe	JPM US	JPM Japan	JPM UK	S&P GSCI	HFRI FoHF	LIBOR
Mean (%)	0.49%	1.09%	0.26%	0.82%	0.73%	0.64%	0.55%	0.58%	0.61%	0.47%	0.63%	0.63%
Median (%)	0.18%	1.69%	0.06%	1.25%	1.11%	0.71%	0.66%	0.42%	0.73%	0.86%	0.77%	0.80%
Std. Dev. (%)	3.15%	6.35%	6.50%	4.44%	5.23%	3.01%	1.38%	3.47%	3.09%	6.27%	1.73%	1.74%
LPM	0.95%	1.49%	2.41%	1.30%	1.60%	0.87%	0.31%	0.99%	0.89%	2.15%	0.38%	0.38%
CVaR	-5.54%	-14.85%	-11.47%	-10.29%	-12.43%	-5.90%	-2.54%	-6.65%	-6.58%	-13.64%	-3.65%	-3.71%
MaxDD	30.65%	70.38%	66.71%	53.11%	60.65%	23.16%	5.41%	31.45%	25.05%	69.95%	22.20%	22.23%
Skewness	0.53	-0.38	0.42	-0.55	-0.51	-0.02	-0.10	0.80	-0.26	-0.41	-0.69	-0.68
Kurtosis	4.25	17.83	3.28	5.14	4.73	3.65	4.50	7.61	4.01	5.03	6.98	6.97
Minimum	-9.22%	-33.73%	-16.04%	-16.64%	-20.72%	-8.34%	-4.49%	-10.25%	-10.55%	-29.53%	-7.47%	-7.50%
Maximum	12.49%	42.29%	19.76%	15.99%	15.00%	10.03%	6.46%	18.35%	9.42%	19.53%	6.85%	22.23%
Jarque-Bera	25.74	2123.76	7.71	55.46	38.71	4.14	21.92	229.61	12.55	46.16	170.98	170.17

Table 3-A2: Correlation Matrix

This table shows the correlations between the asset classes from Table 3-A1. Values in **boldface** are significantly different from zero at the 5% level.

					DJ							
				S&P	STOXX	JPM	JPM	JPM	JPM	S&P	HFRI	
	OPFs	REITs	NIKKEI	500	600	Europe	U.S.	Japan	U.K.	GSCI	FoHF	LIBOR
OPFs	1.00	0.18	0.10	0.17	0.07	-0.07	-0.07	0.05	-0.05	-0.09	0.08	0.08
REITs	0.18	1.00	0.21	0.59	0.55	0.24	-0.02	-0.03	0.20	0.20	0.12	0.08
NIKKEI	0.10	0.21	1.00	0.45	0.52	0.16	-0.06	0.32	0.15	0.29	0.08	0.08
S&P 500	0.17	0.59	0.45	1.00	0.82	0.13	-0.07	0.03	0.17	0.24	0.08	0.08
DJ STOXX												
600	0.07	0.55	0.52	0.82	1.00	0.37	-0.11	0.11	0.37	0.32	0.11	0.11
JPM												
Europe	-0.07	0.24	0.16	0.13	0.37	1.00	0.47	0.41	0.81	0.21	-0.05	-0.06
JPM U.S.	-0.07	-0.02	-0.06	-0.07	-0.11	0.47	1.00	0.29	0.40	-0.07	-0.15	-0.15
JPM Japan	0.05	-0.03	0.32	0.03	0.11	0.41	0.29	1.00	0.26	-0.02	-0.13	-0.13
JPM U.K.	-0.05	0.20	0.15	0.17	0.37	0.81	0.40	0.26	1.00	0.20	0.11	0.10
S&P GSCI	-0.09	0.20	0.29	0.24	0.32	0.21	-0.07	-0.02	0.20	1.00	0.16	0.12
HFRI FoHF	0.08	0.12	0.08	0.08	0.11	-0.05	-0.15	-0.13	0.11	0.16	1.00	0.16
LIBOR	0.08	0.08	0.08	0.08	0.11	-0.06	-0.15	-0.13	0.10	0.12	0.16	1.00

Table 3-A3: Summary of Suspension Dates of Temporary Share Redemptions and Related OPF Names

This table shows the suspension date, the reopening date (if applicable), and the fund name for all the OPFs that have temporarily suspended share redemptions. We exclude the DEGI EUROPA because no price data was available from Thomson Financial Datastream, BVI, or the capital investment company itself.

No.	OPF	Suspension Date for Share Redemptions	Date of Reopening
1	Grundbesitz-Invest	December 13, 2005	March 3, 2006
2	KanAm US-grundinvest Fonds	January 17, 2006	March 31, 2006
3	KanAmgrundinvest Fonds	January 19, 2006	April 13, 2006
4	AXA Immoselect	October 28, 2008	August 28, 2009
5	CS EUROREAL	October 29, 2008	June 30, 2009
6	DEGI EUROPA	October 30, 2008	-
7	DEGI INTERNATIONAL	October 30, 2008	January 30, 2009
8	Focus Nordic Cities	October 28, 2008	January 28, 2009
9	KanAm US-grundinvest Fonds	October 27, 2008	-
10	KanAmgrundinvest Fonds	October 28, 2008	July 8, 2009
11	Morgan Stanley P2 Value	October 30, 2008	-
12	SEB Immoinvest	October 29, 2008	May 29, 2009
13	TMW Immobilien Weltfonds UBS (D) 3 KontinenteImmobilien	October 28, 2008	December 11, 2009
14	[renamed to UBS (D) 3 Sector Real Estate Europe] UBS (D) EuroinvestImmobilien	October 30, 2008	October 27, 2009
15	[investable for institutional investors only]	October 30, 2008	August 6, 2009
16	DEGI INTERNATIONAL	November 16, 2009	-
17	AXA Immoselect	November 17, 2009	-

4 What drives Contagion in Financial Markets? Liquidity Effects versus Information Spill-Over^{*,†}

Abstract

The objective of this paper is to study how contagion works in financial markets by identifying the mechanisms which drive the spill-over of shocks from one market to other markets. To address this question we use Open-ended Property Funds (OPFs) as they offer a unique institutional setting which allows separating between the effects of the two main mechanisms discussed in the contagion literature, i.e. liquidity and information spill-over. OPFs are funds that provide daily liquidity (based on the net asset value (NAV) of funds' property) as long as these funds still maintain at least 5% liquidity. If liquidity falls below the 5% threshold, share redemptions will be temporarily suspended for a period of up to two years. During this time, investors can only sell shares on the secondary market (exchange) at significant price discounts compared to the redemption price. This allows us to disentangle the initial price shock into liquidity risk and impending NAV impairment to study how contagion works in financial markets. In our setting, liquidity risk refers to a deterioration of the marketability and trading conditions while *impending NAV impairment* measures the expected write-off potential driven by e.g. a revaluation of the underlying portfolio properties due to worsened economic conditions. We find that that *liquidity risk*, computed by an option-theoretic, upper bound approach formulated in Longstaff (1995) captures the observed discounts very well when the danger of potential future impairments is low. Once the impending NAV impairments become very likely, also this component matters and attributes for a fraction of the total discount.

^{*} This chapter is based on Haß, Lars Helge, Christian Koziol and Denis Schweizer, 2011, What Drives Contagion in Financial Markets? Liquidity Effects versus Information Spill-Over, Under Review, *European Financial Management*.

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4.1 Introduction

The collapse of the well-established investment bank Lehman Brothers in September 2008 marked the starting shot for the subsequent US subprime crisis which turned into a global financial crisis. During the past years, markets have suffered catastrophic losses from the ongoing crisis, which was initially triggered by the growing threat of extensive defaults by subprime borrowers in the mortgage markets (Fabozzi, Shiller and Tunaru (2010)). Even at the early stages, the markets feared that the subprime crisis might spill-over into other sectors of the economy (Stein (2010)). As the crisis has unfolded, a number of these fears have been realized as large negative shocks have occurred in the housing, equity, municipal bond, real estate and corporate debt markets etc. This development shows quite plainly how contagion can affect global financial markets stemming from a more local crisis (see, for instance, Longstaff (2010)).

The issue of contagion in financial markets is of fundamental importance and there is an extensive literature addressing its causes and effects.²⁸ The contagion literature identifies two major and possible mechanisms by which shocks in one market may spill-over into other markets. The first strand in contagion literature outlines the mechanisms in which negative shocks in one market can be regarded as new economic information which directly affects the underlying value and/or linked cash flows associated with securities in other markets (see, for instance, Kiyotaki and Moore (2002), Kaminsky, Reinhart and Vegh (2003)). In this mechanism, contagion can be viewed as the transmission of information from more liquid markets or markets with more rapid price discovery to other markets (mechanism 1). The

²⁸ Detailed surveys can be found in Kindleberger (1978), Dornbusch, Park and Claessens (2000), and Kaminsky, Reinhart and Vegh (2003).

second strand by e.g. Allen and Gale, (2000) and Brunnermeier and Pedersen (2005) determines how investors who suffer losses in one market may find their ability to obtain funding impaired, potentially leading to a downward spiral in overall market liquidity and other asset prices via a "flight to quality." In this mechanism, contagion occurs through a liquidity shock across other financial markets. Vayanos (2004), Acharya and Pedersen (2005), and Longstaff (2008) among others extend the argumentation by implying that a negative shock in one market may be associated with an increase in the (liquidity) risk premium in other markets for a reduction in marketability. In this mechanism, contagion occurs as negative returns in the distressed market, which affects subsequent returns in other markets via the time-varying (liquidity) risk premium (mechanism 2).

Our objective in this paper is to analyze how the two types of contagion information spill-over and liquidity risk premium initiated by the crisis in the US subprime segment have affected the price determination in other markets and which source of contagion is the predominant source (see Gorton (2009) for an excellent chronological sequence of the crisis and the responsible drivers). A market segment, for which both types of contagion are a major issue, is the Open-ended Property Funds (OPFs) market. OPFs can be regarded as a compromise between direct and listed real estate investments. Fund managers invest directly in an internationally diversified real estate portfolio, while holding a cash-equivalent position ranging from 5 percent to 49 percent of assets under management for daily liquidity. Once the OPF's liquidity falls below 5 percent, the fund must temporarily suspend share redemptions so that investors can no longer redeem their shares at the redemption price (net asset value (NAV) of the portfolio properties plus to the cash/bonds position). Fund managers will then have a maximum of two years to either attract sufficient new asset inflows and/or liquidate portfolio properties to ensure fund liquidity again. During this time, investors can only sell their shares in a secondary market for the exchange price. Actually the share prices in the secondary market quote below the redemption price (discount) during times of temporal suspension of share redemption. If fund managers do not have enough liquidity to reopen within the two-year time limit to restore liquidity again, they have to sell properties within a so called controlled liquidation (even at a loss) to ensure liquidity ("fire-sell") or have to profoundly revalue (depreciate or write-off) portfolio properties due to worsened market conditions where revaluations can take place already during the two years.

As a result, OPF investors are exposed to two types of risk *liquidity risk*, which comes from a worsened marketability of their funds, as well as the *impending NAV impairment* due to revaluations of the property value and uncertain selling prices when share redemptions are temporarily suspended. While *impending NAV impairment* is closely related to mechanism 1 of the contagion literature, *liquidity risk* is related to mechanism 2 of contagion.

Due to the properties of the OPFs funds, the observed discounts are a relevant and interesting object of investigation to figure out the true drivers for a price discount and to decompose it into *liquidity risk* (worsened marketability) and *impending NAV impairment* (information spill-over). The beauty of the OPF market is that (i) the underlying asset class, i.e. properties, is closely related to the subprime market which caused the crisis and that (ii) both types of contagion *liquidity risk* (worsened marketability) and *impending NAV impairment* (information spill-over) are supposed to have a relevant price impact in this market. In particular, a worsened marketability can be easily observed as it is triggered by a fund's suspension. Due to the structure of the restricted trading opportunities for a given maximum time period, we use the well-known option-theoretic formula of the liquidity discount proposed by Longstaff (1995). A fruitful extension of the Longstaff approach is
provided by Hou and Lowell (2011) who also account for uncertainty about the used implied volatility.

We find that the discount in response to the temporal suspension of share redemption is about 5 percent and that both mechanisms of contagion can be observed. At the beginning of the crisis we find that overall discount is explainable by *liquidity risk* (mechanism 2), which is conclusive as investors cannot redeem their shares to the investment company (liquidity shock) and have no clear evidence about how commercial real estate portfolios are affected by the mortgage crisis. When times passes and OPF management starts writing-off property values then *liquidity risk* is not able to fully explain the increased discount and *impending* NAV impairment as a second driver is responsible for the remaining part of about 30% of the discount (mechanism 1). Therefore, at the beginning of the suspension period the reduction in marketability is the key driver of the discount. When rumors about necessary portfolio revaluation appear and OPF management writes-off parts of the real estate portfolios discounts increase sharply and can no longer be solely explained by liquidity risk. However, when temporarily suspended OPFs start re-opening again (without writing-off property values significantly) this information is immediately reflected in secondary market prices by a discount decrease in the way that *liquidity risk* is again sufficient to explain the entire discount. Summarizing, at the beginning of a suspension period investors are concerned about the reduction in marketability (mechanism 2). However, with the appearance of uncertainty about the properness of the reported portfolio property values (NAVs) and the threat that OPF management is not able to recover the required liquidity within the two year time limit again to avoid a controlled liquidation, impending NAV impairment also accounts for a fraction of the discount (mechanism 1). Consequently we can support former results in the literature that liquidity and information spill-over are the main drivers of financial contagion. However this literature is restrained in analyzing both mechanisms isolated. In our setting we are able to integrate both mechanisms simultaneously. We find that the mechanisms play different roles in the evolution of financial crises. Whereas *liquidity risk* is most important at the beginning of financial crises we find that information spill-over is a major driver in the further development of financial crises. Even if the relations in other markets might be different, the decomposition of the pricing discounts for the considered OPF market is one meaningful starting point and the approach carried out in the paper might be adopted into other markets.

The remainder of this paper is structured as follows. Section 4.2 introduces the fundamental features of the OPF market. Section 4.3 analyzes the capital market reactions triggered by the temporal suspension of share redemption. In section 4.4, the *liquidity risk* and the *impending NAV impairment* is empirically estimated and its forecast ability is tested. Section 4.5 summarizes our main results and concludes.

4.2 The German OFP Market – Fundamental Features

From a legal perspective, an OPF is a separate special asset, with an investment focus on property initiated and managed by a capital investment company. For investor protection purposes, OPFs fall under the control of regulations for identifying, diversifying, and controlling risks, as well as for realizing gains and for fund liquidity.²⁹

OPFs were first created in 1959 with the establishment of the "Internationales Immobilien Institut" (the international real estate institute, known as iii-investments). The first German OPF was iii-funds No. 1. However, in recent years, the growth of the market has been dramatic. In 1998, there were sixteen OPFs with assets under management of 43.1

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See Investmentgesetz (InvG) and Klug (2008) for further details.

billion Euros. As of April 2010, the market had forty-five funds, managing 90 billion Euros. This makes the German OPF market with a market capitalization of about one-third of all European Union member countries the biggest.³⁰ Table 4-1 provides an overview of the full sample of all OPFs from 1991 to April 2010. Interestingly new fund inflows to OPFs even over compensated fund outflows during the financial crisis.

For our analysis, we consider all OPFs that report their data to the "BVI Bundesverband Investment and Asset Management e.V." (the German Asset Management and Investment Association) and are covered by Thomson Financial Datastream. We double checked the prices from BVI for the investments shares with prices obtained from Datastream to test for consistency. 21 pricing differences between BVI and Datastream occurred, for a total accuracy rate of 99.9%. None of the differences exceeded 1% of the stock price. In case of pricing difference we asked the capital investment company for the price. Therefore, the results are not affected from a biased data generating approach.

³⁰ According to data from the BVI Bundesverband Investment, Asset Management e.V. (German Asset Management

and Investment Association), and Deutsche Bundesbank (German Central Bank).

Table 4-1: Overview of the German OPF Market

This table shows the number of active OPFs in the German market and the assets under management. Assets under management calculated at year-end. Except for 2010, the reference date is April. The data source is BVI and Thomson Financial Datastream.

Year	Number	In €m
1991	12	9,807
1992	14	13,690
1993	14	21,840
1994	14	25,764
1995	14	29,694
1996	14	37,023
1997	15	40,493
1998	16	43,137
1999	17	50,403
2000	19	47,919
2001	19	55,868
2002	22	71,165
2003	23	85,172
2004	26	87,191
2005	30	85,129
2006	35	75,545
2007	39	83,426
2008	42	84,252
2009	44	87,076
2010	45	90,043

OPFs offer three significant advantages over real estate shares – the following regulatory design is similar to the OPF markets in the European Union member countries:³¹

- (4) The OPF share price is *in general* not directly determined by supply and demand as long as the OPF provides liquidity. Therefore, share prices do not significantly differ from NAV per share reported by the capital investment companies when there is no temporary share redemption (see Figure 4-2 and 4-A1 in the appendix). This feature is responsible that during times when management accepts share redemptions the OPF returns are quite smooth because there is no additional influence from (equity) capital markets.
- (5) The number of outstanding shares varies, which generally ensures high liquidity. As in any investment fund, there is a daily issuance of new shares from buyers and a daily redemption of old shares from sellers.³²
- (6) The rule of risk-spreading governs transactions.³³ This diversification reduces unsystematic risk.
- (7) OPFs have to temporarily suspend share redemptions when the fund liquidity is going to fall below the 5%-level.

These specific features of OPFs substantially influence their risk-return profile. In general, portfolio returns are determined by rental income, maintenance costs, and value

³¹ See, for example, Haß et al. (2010) and Maurer, Reiner, and Rogalla (2004).

Historically, there have been only two periods when share redemptions were temporarily suspended (2005/2006 and 2008/2010). Both are discussed in detail in section 4.3.
 At the time of a value of

At the time of purchase, one particular property may not constitute more than 15% of the net asset value of the OPF. Furthermore, the total value of all properties with individual values of more than 10% of the fund's net asset value may not constitute more than 50% of the fund's net asset value. See InvG § 73 (1).

increases or decreases.³⁴ Rental income and maintenance costs directly observable; the big challenge is gauging changes in value if comparable properties do not trade regularly. Thus, German investment law (§70 para. 2 sentence 2 InvG) mandates that properties must be evaluated regularly by an independent appraisal board (at least once a year) to determine the *fair* market price. The appraisal board members must have technical expertise in the area of property market development (§77 para. 2 sentence 1 InvG).

The valuation by-law allows the sales comparison approach, the cost approach, and the income approach for the appraisal of fair market value. The income approach is internationally accepted and is the primary method used to value OPFs. It appraises a property on the basis of objectively evaluated price and income forecasts, as well as dynamic capitalization rates on the valuation date. Therefore, the daily net asset values of OPFs are based on the annual expert appraisals since the last valuation date, but do not necessarily represent "true" daily property values.

This valuation approach aims to minimize subjective views about future expectations³⁵ and to dampen over- and understatements of property values. However, because past appraisal reports are included in the determination of current net asset values, valuation returns are smoothed, an effect known as *"appraisal-smoothing"*.^{36,37}And, consequently, the above described valuation process results in an underestimation of OPF risk. Hence, this underestimation is a major part of this paper since OPFs investors have to face a substantial

³⁴ More than 55% of the portfolio properties of OPFs have leases with residual terms that extend longer than January

^{1, 2015.} See BVI press release from June22, 2010.

⁵⁵ See Archner (2006) for an extensive analysis.

³⁶ See Ross and Zisler (1991) and Geltner (1991) for an extensive discussion.

³⁷ Other, more secondary, reasons are inflation-linked lease contracts and the consideration of inflation in the appraisal. For further details see Haß et al. (2010).

risk when share redemptions are temporarily suspended which is not fully covered by the reported NAVs from the capital investment company.

In principle, OPFs must redeem shares on a daily basis. They thus always maintain a certain level of liquid assets, because property cannot be sold quickly, German investment law requires that OPFs hold a minimum of 5% (and a maximum of 49%) of their assets in cash or easily liquefiable investments (§ 80 InvG). This liquidity reserve, which is typically invested in money market instruments and bonds, theoretically guarantees the redemption of outstanding shares at all times.

With daily share redemption, however, comes the risk that investors may redeem too many shares in a too short period, and may render the liquidity position too small to satisfy all the redemptions. If the liquidity reserve falls below the 5% minimum, the redemption of shares in the OPF have to be suspended in order to raise money by e.g. selling property investments and/ or new fund inflows. This temporary suspension may last up to two years (§ 80c para. 2 InvG and § 81 InvG).³⁸ When OPF management was not successful in restoring liquidity until the end of the time limit they will be forced to sell portfolio properties to ensure liquidity for the investors again (so called controlled liquidation), which can result in high uncertainty about potential selling prices ("fire-sell").

Crises in the real estate markets, which are the main cause of temporary suspensions of share redemptions, often occur after a capital markets crisis. Old rental contracts expire, new contracts yield lower rental income, and past sale prices are no longer realizable. For OPFs,

³⁸ By law, a fund may only suspend redemptions for a maximum of twelve months. By contractual agreement, this can be extended to twenty-four months (time limit). Alternatively, management may opt to only partially suspend redemptions, so that shares can only be redeemed monthly instead of daily.

this lagged impact is even more pronounced, because OPF management has an incentive to maintain the (probably) "high valued appraisals" avoiding to report drawdown returns and successively adjust the NAV to market developments. If investors anticipate such a development, it is possible that substantially more shares may be redeemed than issued in a shorter than usual time period. In these cases investors run the risk of a reduction in liquidity when OPF management is forced to temporarily suspend the share redemption.

When OPFs temporarily suspend share redemptions, investors have the option of selling their shares in the secondary market. However, the realized prices in the secondary market do not have to correspond to the redemption prices calculated by the capital investment companies. In fact, they are especially lower in times of redemption suspensions, because of, e.g., uncertainty about the true NAV due to slower value adjustments by management, earnings management, appraisals, and a reduction in liquidity for investors. Therefore, the secondary market is truly reflective of the market's assessment of share value, while the NAV may not be. In the next section we assess the consequences for investors when OPF temporarily suspend their share redemptions.

4.3 Capital Market Reactions to Temporal Suspensions of Share Redemptions

In the fifty-year long history of German OPFs, temporal suspensions of share redemptions happened only during two periods (2005/2006 and 2008/2010):³⁹

³⁹ For a detailed description of events during the 2005/2006 period, see, e.g., Bannier, Fecht, and Tyrell (2007).

Prior to the 2005/2006 suspension, the market feared that some funds would need to revalue at least part of their property portfolios. This high appraisal uncertainty led to massive share redemption in a short period, and three funds temporarily suspended redemptions.

On December 13, 2005, Deutsche Bank Real Estate suspended share redemptions in its OPF Grundbesitz-Invest until March 3, 2006, in order to conduct a complete revaluation of property. This event caused a massive outflow of investments (more than 1 billion Euros, or 300 million Euros in the three days before the suspension), as fund management expected a devaluation of several hundred million Euros.

On January 17 and 19, 2006, KanAm temporarily suspended share redemptions in two of their OPFs, Grundinvest US and Grundinvest, after investors redeemed more than 700 million Euros' worth of shares within a few days. The apparent reason was a negative ratings agency report which led to a panic among investors. KanAm, however, did not need a property revaluation, and used the three-month suspension to raise the required liquidity. No devaluation followed, and, in fact, some property sold at great gains. The funds were reopened on March 31, 2006, and April 13, 2006.

In comparison, the 2008/2010 temporal suspensions affected the entire OPF market much more dramatically. In the aftermath of the global financial crisis, investors increased their preference for liquidity, and were fearful of tying up capital in the OPF market for an uncertain time. Thus, compared to the 2005/2006 period, this second crisis proved to be a global one.

During the short time period of October 27-30, 2008, twelve OPFs announced temporary suspensions of share redemptions because their liquidity reserves had fallen below 5%. In January 2009, the first OPF reopened, and, through December 2009, eight more followed suit.

However, in November 2009, two OPFs that had reopened were forced to temporarily suspend share redemptions once again. In May 2010 again three further OPFs had to suspend share redemptions in the course of the proposal for amendment for OPF regulation by Federal Ministry of Finance (BMF). Therefore our sample exhibits the typical cluster structure as expected for the study of shocks in financial markets.

In order to measure valuation effects in response to suspensions, we use detailed data from the regional exchange Börse Hamburg, where all secondary market transactions of OPFs take place. The data contain every transaction for all traded OPFs for all trading days over the January 2, 2004-June 1, 2010 period, which includes both crises in the OPF market. For the further analyses, we use the number of traded shares and the trading price for all transactions.

Figure 4-1 illustrates that the average number of traded funds in the secondary market, as well as trading volume, increased significantly during the two crisis periods (see Table 4-2 for statistical significance) which indicates that investors use the secondary market more frequently when OPFs stop providing liquidity. This observation indicates that capital markets react to the new information and incorporate the change in liquidity into tradable share prices. However, trading volume decreased sharply again as the suspensions continued. We note further that the second crisis had an especially high impact on trading volume, which increased to an average daily peak of about 10 million Euros (compared to an average daily peak of about 4 million during the first crisis).

Figure 4-1: Number and Volume of Traded OPFs in the Secondary Market

This figure shows the daily five-day average number of traded OPFs and the five-day average trading volume from January 2004-June 2010. See Table 4-A1 for detailed listing of temporal suspended OPFs.



We next measure market reaction to the temporary suspensions of share redemptions by calculating their discount from the secondary market compared to the net asset value (NAV) – redemption prices – calculated by the OPFs themselves around the disclosure date (t_0). Following e.g. Brown and Warner (1985) and Fuller, Netter, and Stegemoller (2002), we apply standard event study methodology to calculate the average discounts (AD_t), as follows:⁴⁰

$$AD_{t} = \frac{1}{l} \sum_{i=1}^{l} \left(\frac{NAV_{t}^{(i)} - SP_{t}^{(i)}}{NAV_{t}^{(i)}} \right) \forall t = t_{0} - \tau_{1}, \dots, t_{0} + \tau_{2},$$
(1)

where $NAV_t^{(i)}$ is the NAV of traded and temporarily suspended OPF *i* at time *t*, as reported by the OPF. Note that even when every portfolio property is appraised in general once per year only (see section 4.2) that cannot be translated in a constant NAV during the appraisal dates (see Figure 4-A1). Investment companies report daily current NAVs, as they are affected by several factors like new portfolio properties, depreciations, value changes in

⁴⁰ Instead of an equal weighting of the average discounts we checked for robustness whether results change when using value weighting. The results remain qualitatively stable. Tables and figures are available from authors upon request.

the liquid portfolio, interest and rental income, maintenance costs etc. and therefore the NAVs are likely to change every day which means that we observe an updated NAV for every trading day. $SP_t^{(i)}$ equals the secondary market price of that OPF *i* at time *t*, and AD_t stands for the average discount for all suspended traded OPFs (*I*) at time *t*.

Both Table 4-2 and Figure 4-2 show that the average discount increases significantly for OPFs that announce suspension of share redemptions. These results hold for all event windows.⁴¹ Not surprisingly, the average discount was about 0 percent before the suspension announcement because at this time investors could still redeem their shares to the OPF for the redemption price.⁴² Afterwards, it increased to about 5 percent. This average discount clearly reflects investors' perception towards the increased risk of the OPFs.

There are two major sources of uncertainty for investors surrounding temporary share redemptions: (1) how long will be the suspension period until the funds will begin to accept share redemptions again. Recall that the time period can be up to two years depending on funds' liquidity. In the meantime they can only use the secondary market for selling their shares. That is what we term the *liquidity risk*, because for given market values of the properties (NAV) the trading conditions are worse. (2) Since portfolio properties are subject to potential revaluations, the current NAV of the fund might be negatively affected by future write-offs. This effect results in high uncertainty about potential selling prices (both the exchange price and the redemption value once the suspension is over). We denote this

⁴¹ We also calculated AD_t based on capital instead of equal weighting. The results remain stable. Tables are available upon request from the authors.

⁴² The discount is slightly negative before the announcement of temporal share suspension, because investors do not have to pay the up-front load when buying shares via exchange instead from directly buying from the capital investment company.

uncovering of market prices, as *impending NAV impairment* because it primarily comes from the true underlying value.

Summing up, the average discount thus reflects (i) an increase in the (liquidity) risk premium for reduced OPF marketability(perfect liquidity versus secondary market liquidity) and uncertainty about the length of the suspension period – *liquidity risk* (mechanism 2 of contagion), and (ii) the write-off potentials as a spill-over reaction from negative shocks (new economic information) in other real estate markets if funds are forced to sell or to revaluate portfolio properties – *impending NAV impairment* (mechanism 1 of contagion). Investors react to the ambiguity by incorporating into (secondary) market prices the new information that some OPFs have temporarily halted share redemptions.

The observed average discount reflects the total investors' reaction as response to the temporal share suspension. The goal of the following analysis is to disentangle the average discount into *liquidity risk* and *impending NAV impairment* in order to answer the question what essentially drives the investors' reactions in the secondary market which is done in the next section.

Figure 4-2: Average Discount of Suspended OPFs Relative to Temporary Share Redemptions

This figure shows the average discount of suspended OPFs for both the 2005/2006 and 2008/2010 crisis periods [as calculated in Equation (1)] relative to the suspension date t0. See Table 4-A1 for detailed listing of temporal suspended OPFs.



Table 4-2: Secondary Market Comparison of Market Phases when all OPFs are Redeemable and when some are Temporarily Suspended

This table shows the average discount (AD) for different event windows tested for statistical significance. In the columns Abnormal Trading Volume and Traded OPFs, we test the hypotheses that we will find higher trading volume and a higher number of OPFs traded during the specific event windows, compared to periods when no OPF is temporarily suspended.

Event Window	AD	Abnormal Trading Volume	Traded OPFs	Nobs
[-10, +10]	3,18%** *	$2,65 \cdot 10^{6*}$	3,77***	17
[-10, +30]	4,56%** *	3,38•10 ⁶ * **	3,37***	17
[-1, +1]	2,98%** *	$3,03 \cdot 10^{6} *$	4,09***	17
[0, +5]	5,29%** *	$4,10 \cdot 10^{6*}$	4,24***	17
[0, +30]	5,89%** *	4,05•10 ⁶ * **	4,25***	17

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

4.4 Empirical Estimation of the Liquidity Risk and from Impending NAV Impairment

The approach by Longstaff (1995) provides an intuitive proxy for a discount caused by restricted trading possibilities. It bases on the idea that in the absence of a trading possibility the assets need to be held until the end of the non-trading period, while in the other case with premature trading the assets might be sold at the optimal selling point. The difference between the values from holding the assets until a future date and optimally selling them before, results in the proxy for the liquidity discount by Longstaff.

We believe that the Longstaff view exhibits major parallels to the OPF market. During the suspension period share redemptions (to the redemptions price) are restricted but instead only sales of the shares in the secondary market for a substantial discount are possible. Thus, the value obtained from redeeming the OPF at the optimal selling date must obviously be an upper bound for the value of reduced marketability. The Longstaff discount would coincide with the discount in the case the redemption value reflects the fair market value, a secondary market does not exist at, the true volatility of the underlying assets of the OPFs is perfectly known and OPF investors have perfect timing ability for the sale of their assets. Hou and Lowell (2011) show in a related but more sophisticated approach accounting for uncertainty about the used implied volatility that liquidity spreads can be even higher than in the Longstaff case. On the other hand, Koziol and Sauerbier (2007) compute lower liquidity spreads when the illiquid asset can still be traded at few discrete dates rather than not at all during the illiquidity period. In fact, in the OPF market, we have uncertainty about the true volatility as taken into account by Hou and Lowell and there is a trading possibility at the secondary market (but clearly at non-favorable terms). As the Hou and Lowell extension increases the spreads, while the illiquid trading possibility at perhaps discrete dates in the spirit of Koziol and Sauerbier (2007) decreases the liquidity spread, we believe that the Longstaff spreads are a reasonable proxy for the true liquidity spreads.

Since the Longstaff discount addresses the trading conditions of the OPFs, it refers to the *liquidity risk*.

If the magnitude of the observed price discounts is larger than the upper bound for the *liquidity risk*, it can no longer be attributed to a restriction in marketability. In this case the remaining and unexplained part of the discount must come from another source of uncertainty such as *impending NAV impairment*.

4.4.1 Theoretical Background

In the following formula V stands for the current value of the OPF given that it is continuously marketable in a frictionless market, i.e. the redemption value. The dynamics of V are given by a geometric Brownian motion

$$dV = \mu V dt + \sigma V dz$$

where μ and σ are constants and Z is a standard Wiener process. Further, the constant riskless interest rate is r. Now, we consider an investor who holds shares of OPFs in his portfolio, who is restricted to redeem his shares during the suspension period \tilde{T} . The value of the OPF for an investor who must hold it until \tilde{T} equals the present value $V_{\tilde{T}}$ received at time \tilde{T} . We now compare this illiquid case to the liquid case where the investor can redeem his shares at the redemption price $V_{\tilde{T}}$ at an arbitrary date $t \leq \tau$. To introduce a trading motive, we equip the investor with perfect market timing ability which allows her to optimally sell the OPF shares and reinvest the proceeds in the riskless asset at time τ during the suspension period. Let $M_{\tilde{T}}$ denote the time- \tilde{T} payoff to this investor where the sale could be optimally timed with $M_{\tilde{T}} = max_{0 \le \tau \le \tilde{T}} \left(e^{r(\tilde{T}-\tau)} V_{\tilde{T}} \right)$. As long as the investor cannot sell the OPF prior to time \tilde{T} she cannot benefit from having perfect market timing ability.

This marketability restriction imposes an important opportunity cost on this investor since the OPF is only worth $V_{\tilde{T}}$ to the investor at time \tilde{T} if she is restricted from selling, but would be $M_{\tilde{T}}$ if she were allowed to sell earlier. In line with the view that the liquidity discount represents the value difference for the case with and without trading during the suspension period, the present value of the incremental cash flow is $M_{\tilde{T}} - V_{\tilde{T}}$ that the investor would receive if marketability restrictions were relaxed. The present value of $M_{\tilde{T}} - V_{\tilde{T}}$ can easily be determined by using standard Black-Scholes-like valuation approaches. The present value $F(V, \tilde{T})$ of the difference $M_{\tilde{T}} - V_{\tilde{T}}$ amounts to

$$F(V,\tilde{T}) = e^{-r\tilde{T}} \mathbb{E}[M_{\tilde{T}}] - e^{-r\tilde{T}} \mathbb{E}[V_{\tilde{T}}], \qquad (2)$$

where expectations are taken under the risk-neutral dynamics for V. Harrison (1995) provides a closed-form solution for this type of lookback option,

$$F(V,\tilde{T}) = V\left(2 + \frac{\sigma^{2}\tilde{T}}{2}\right)N\left(\frac{\sqrt{\sigma^{2}\tilde{T}}}{2}\right) + V\sqrt{\frac{\sigma^{2}\tilde{T}}{2\pi}}\exp\left(-\frac{\sigma^{2}\tilde{T}}{8}\right) - V, \qquad (3)$$

where $N(\cdot)$ is the cumulative standard normal distribution function. The upper bound $F(V,\tilde{T})$ for the value of the restricted marketability is proportional to the current value of V. Therefore, the bound on the value of marketability can be easily written as a percentage of the value of V (which can be interpreted as the discount from share prices to the NAV – comparable to Figure 4-2). One can show that the upper bound is an increasing function of the length of the suspension period \tilde{T} and the volatility σ of the true market value. Clearly, an increasing duration of temporal share redemption and a higher volatility of the underlying value result in a higher opportunity cost of not being able to trade (see Figure 4-3 for an illustration of this relation) as the limitations for an investor who cannot trade are more severe the longer the suspension period is and the more volatile the asset value is.

Moreover, Figure 4-3 provides us with a notion for the magnitude of the price discounts to marketability restrictions for different volatility levels. As this figure shows the discount related to non-marketability is quite small for a short time period of temporal suspension of share redemptions, but can increase up to almost six percent for volatile OPFs and for a suspension period of two years. The assumed volatilities for OPFs in Figure 4-3 correspond to the historical observed ones which range between two (based on NAVs only) and six (based on NAVs in periods where share redemptions are possible and on share prices during suspension periods) percent for individual OPFs (see, for instance, Maurer, Reiner, and Rogalla (2004) or Haß et al. (2011)).

Figure 4-3: Days of Non-Marketability and the Resulting Upper Bound for Liquidity

This figure shows the percentage discount (upper bound for liquidity) related to the days of non-marketability for different volatilities calculated with equation (3) equal to 0.5% (grey dashed line), 1% (grey solid line), 1,5% (black dashed line), and 2.0% (black solid line).



4.4.2 Calibration Exercise

We have seen in section 4.3 that investors react to temporal suspensions of share redemptions which are observable in the average discount (see again Figure 4-2). Now we have to bring the model framework by Longstaff (1995) and the average discount in line. In particular, we capture *liquidity risk* by the Longstaff liquidity discount and the residual component (given there is any) will be interpreted as *impending NAV impairment*. Since the Longstaff discount is apparently an upper bound for the true effect of a restricted marketability, we are well aware of the fact that our *liquidity risk* component might be overestimated while the *impending NAV impairment* component is underestimated.

Before, we can calibrate the model for every temporarily suspended OPF (equation (3)) we have to determine the volatility for every suspended OPF first. This implied volatility is the crucial parameter for calibrating the model, because it is on the one hand not straightforward to determine an appropriate implied volatility for the suspension period and on the other hand the calculated *liquidity risk* (and the thereupon based conclusions) is

sensitive to the used volatility – we subsequently apply two robustness checks to verify our results. For that reason we estimate the volatility based on a jump diffusion model, since OPF have a regime with comparably low volatility (share redemptions are possible) and another regime with high volatilities (share redemptions are temporarily suspended) – see Figure 4-A1 for a visualization of the two regimes. Therefore, the jump diffusion process for the instantaneous return dV/V of OPF shares has following structure:

$$dV/V = \mu \cdot dt + \sigma \cdot dz - \gamma \cdot dN,$$

where as z is a standard Wiener process, γ indicates the magnitude of a jump, and N represents a Poison process. The poison process is driven by a hazard rate λ – independent of the Wiener process meaning that with a probability of $(\lambda \cdot dt)$ the value N increases by one; otherwise with a probability of $(1 - \lambda \cdot dt)$ the value N remains constant.

Therefore, the variance for a time step dt of the instantaneous return is:

$$Var(dV/V) \cdot dt = Var(\sigma \cdot dz - \gamma \cdot dN) \cdot dt = Var(\sigma \cdot dz)dt + Var(\gamma \cdot dN) \cdot dt$$
$$= \sigma^{2} \cdot Var(dz) + \gamma^{2} \cdot Var(dN)$$
$$= \sigma^{2} \cdot dt + \gamma^{2} \cdot [\lambda \cdot dt(1 - \lambda \cdot dt)^{2} + (1 - \lambda \cdot dt)(0 - \lambda \cdot dt)^{2}]$$
$$= \sigma^{2} \cdot dt + \gamma^{2} \cdot [\lambda \cdot dt(1 - 2 \cdot \lambda \cdot dt + \lambda^{2} \cdot dt^{2}) + (1 - \lambda \cdot dt)(\lambda^{2} \cdot dt^{2})]$$
$$= (\sigma^{2} + \gamma^{2} \cdot \lambda)dt$$

To determine the volatility of OPF *i*, we 1) estimate the variance based on the NAV returns during times where investors can redeem their shares, 2) add the estimated jump probability λ calculated as follows: number of trading days with a loss of more than one

percent divided by all trading days, 3) multiplied with γ as the average daily loss (for losses of more than one percent) and 4) take the square root and multiply with the square root of the number of trading days per year. Therefore, the volatility can be calculated as (see Table 4-A2 for the estimated parameters for every temporarily suspended OPF *i*):

Implied Volatility =
$$\sqrt{250} \cdot \sqrt{\sigma^2 + \gamma^2 \cdot \lambda}$$
. (4)

After having determined the implied volatility for every suspended OPF we calibrate the model for every temporarily suspended OPF by solving equation (3) numerically for the uncertain time of non-marketability \tilde{T} , as the discount is observable on the secondary market and the volatility by using its estimated implied volatility based on equation (4) since the issue date until the end of its suspension period. Whenever the resulting uncertain time of non-marketability \tilde{T} is smaller than two years we can interpret the whole discount as a pure premium for the compensation for an increase in *liquidity risk (impending NAV impairment* is equal to zero). In case of an uncertain time of non-marketability \tilde{T} larger than two years, the discount cannot be explained by *liquidity risk* only and a further force (*impending NAV impairment*) has to be at work. In this case, we calculate the *liquidity risk* for the temporarily suspended OPFs *i* at *t* for the time limit for the time of non-marketability \tilde{T} equal to two:

$$LR_t^{(i)} = \frac{F(V,\tilde{T}=2)_t^{(i)}}{V_t^{(i)}}.$$
(5)

In these cases, the reduction in value of the OPFs caused by the non-marketability is not sufficiently large to explain the observed discount and even if we suppose the upper bound of the Longstaff approach for the *liquidity risk*.

Capturing the *liquidity risk* for every temporarily suspended OPF with the Longstaff approach separately, we can determine the average *liquidity risk* as follows:

$$LR_{t} = \frac{1}{I} \sum_{i=1}^{I} \frac{F(V,\tilde{T})_{t}^{(i)}}{V_{t}^{(i)}} \forall t = t_{0} - \tau_{1}, \dots, t_{0} - \tau_{2},$$
(6)

where LR_t denotes the average non-marketability discount (*liquidity risk*) for all suspended traded OPFs (*I*) at time *t*. After the calculation of the upper bound for *liquidity risk*, we implicitly obtain the *impending NAV impairment* at time *t* formulas the residual component:

$$impendingNAV impairment_t = AD_t - LR_t \tag{7}$$

Figure 4-4 visualizes the *liquidity risk* and *impending NAV impairment* in relation to the average discount. As can be seen from the figure below the increase in *liquidity risk* (black dashed line) caused by the reduced liquidity due to the temporal suspensions of share redemptions basically corresponds to the entire average discount until 45 trading days after the beginning of the suspension of share redemptions (mechanism 2). Our explanation is that investors have no valid evidence in which way the values of the OPF NAVs are affected which can be regarded as a liquidity shock. Thereafter, when times passes between the trading days 45 to 135 *liquidity risk* is by far not able to explain the average discount. During this time period OPF management starts writing-off property values and market participants expect at least an *impending NAV impairment* of (black dotted line) about 4% (mechanism 1) and *liquidity risk* is not able to explain the increased discount any longer. This means that at the beginning of a suspension period, when investors take notice of the suspension, they price in the reduction of marketability but are not excessively concerned about potential write-offs of portfolio properties. Afterwards they start a reappraisal process (might driven or triggered by writing-offs of property values) of OPFs real estate portfolios and might be concerned about the NAV reflecting marketable prices. This behavior could be reflected in the rising impending NAV impairment. Subsequently to 135 days after the suspension the impending

NAV impairment is falling to zero again which seems puzzling at first glance. At this point in time three OPFs reopen again without significant depreciations and therefore we observe how capital markets incorporate the information contained in the reopening into stock prices.

As key insight from the calibration exercise we learn that both mechanisms of contagion can be observed. As a result of fund suspensions, investors are concerned about the reduction in marketability and the entire discount of about 5% can be explained by *liquidity risk* (mechanism 2). Once the danger of *impending NAV impairments* becomes severe, the discount can substantially increase due to the anticipation of future write-offs and/or the possibility that OPF management is not able to recover the required liquidity within the two year time limit again to avoid a controlled liquidation (mechanism 1). Hence, liquidity aspects play major role and potential impairments do only matter in extremely unfavorable market situations by the occurrence of relevant information that cause a revaluation.

The presented results should not be interpreted the way that investors only fear a reduction in marketability and are not concerned about an *impending NAV impairment*. Especially when OPFs approach the end of the time-limit of two years and a controlled liquidation becomes more probable the *impending NAV impairment* is expected to be the dominant factor. In case the OPF management is not able to achieve a reopening again the properties are valued in liquidation values instead of going concern values.

In order to check our results for robustness we could also think about calculating the upper liquidity bound in a portfolio context by considering effects from portfolio reallocation (see Longstaff (2001)) and even more sophisticated by additionally accounting for changes in volatility over time (see Hou and Howell (2011)). Both effects separately as well as the combination of both have an impact on the upper bound. Admittedly, we do not want to show

liquidity effects in a portfolio context. Instead we focus on the implied volatility as the main driver for our results and use 1) the volatility – based on share prices – during the suspension period as an upper estimator for liquidity risk, and 2) the volatility of listed OPFs in Switzerland in the next two sub-sections.

Figure 4-4: Average Discount, *Liquidity Risk*, and *Impending NAV Impairment* of Temporarily Suspended OPFs – Jump Diffusion Model

This figure shows the average discount of suspended OPFs for both the 2005/2006 and 2008/2010 crisis periods[as calculated in Equation (1)], the *liquidity risk* [as calculated in Equation (6)], and the *impending NAV impairment*[as calculated in Equation (7)], relative to the suspension date t0 – used volatility is calculated with the jump diffusion model (see equation (4)). See Table 4-A1 for detailed listing of temporal suspended OPFs.



For the first robustness check we use the volatility based on share price returns within the period of temporal share redemption suspensions for every OPF separately – ex post consideration. This period can be regarded as the period of the highest risk for OPFs and therefore the calculated volatility is higher compared to the implied volatility based on the jump diffusion model above. Therefore the resulting *liquidity risk* within this robustness check is clearly an upper estimator for its magnitude. By comparing Figure 4-4 and 4-5 we can see that the *impending NAV impairment* is still present, but the value is roughly halved. This means that even when taking the highest justifiable volatility as input parameter for the

model calibration the *liquidity risk* is not the only driver for the discount and market participants are concerned about funds' NAVs.

Figure 4-5: Average Discount, *Liquidity Risk*, and *Impending NAV Impairment* of Temporarily Suspended OPFs – Share Price Volatility during Suspension Periods

This figure shows the average discount of suspended OPFs for both the 2005/2006 and 2008/2010 crisis periods [as calculated in Equation (1)], the *liquidity risk* [as calculated in Equation (6)], and the *impending NAV impairment* [as calculated in Equation (7)], relative to the suspension date t0 – used volatility is calculated with the volatility based on the share price returns during the suspension period. See Table 4-A1 for detailed listing of temporal suspended OPFs.



The second robustness check is taking advantage from the fact that OPFs issued in Switzerland have to be listed and buying and selling of OPF shares has to take place at a stock exchange as the secondary market, which is restricted by law. There are only two exemptions from this regulation: 1) investors can redeem one year in advance (reserve redemption notification) and 2) investors can buy shares directly from fund management when OPF management intends to buy new properties. This institutional setup is ideal for estimating OPF volatility directly and not via a jump diffusion model, but the drawback is that the real estate portfolio structure has not to be coinciding with the German. In detail we estimate the volatility for all OPFs in Switzerland over the last 10 years and take the average volatility (equally weighted) as the input factor for the model calibration, which is 6.77% (see Table 4-A3 for a summarization of all OPFs in Switzerland). By comparing Figure 4-4, 4-5 and 4-6 we can see that both robustness checks show comparable results meaning that the *impending NAV impairment* is still present. Therefore *liquidity risk* is not solely able to explain the observed discounts.

Figure 4-6: Average Discount, *Liquidity Risk*, and *Impending NAV Impairment* of Temporarily Suspended OPFs – Average OPF Volatility listed in Switzerland

This figure shows the average discount of suspended OPFs for both the 2005/2006 and 2008/2010 crisis periods [as calculated in Equation (1)], the *liquidity risk* [as calculated in Equation (6)], and the *impending NAV impairment* [as calculated in Equation (7)], relative to the suspension date t0 – used volatility the average volatility (equal weighting) of all OPFs listed in Switzerland. See Table 4-A3 for a detailed listing all OPFs listed in Switzerland.



4.4.3 Forecast-Ability of the Initial Discount to Temporal

Suspension of Share Redemptions

The major finding from the previous subsection is that the *liquidity risk* is inadequate in fully explaining the average discount for suspended OPFs. Instead *impending NAV impairment* is also able to grasp investors' judgment regarding the revaluation of OPFs share price in the secondary market. For this reason, we want to find out whether the initial discount

in response to the change in marketability when OPFs stop providing liquidity has forecastability. In detail, we aim to analyze in a first step whether the initial discount can give an indication whether the OPF management depreciates (writes-off) property value during the suspension period or not using a logit-model (see Table 4-3). In the second step, we consider the accumulated depreciations⁴³ of the OPF management during the suspension in order to find out whether these depreciations are driven by the initial discount using standard ordinary least square regressions (see Table 4-4).

The logit-model documents that the magnitude of the initial discount can explain whether OPF management will conduct depreciations within the suspension period or not (see Table 4-3).⁴⁴ This finding confirms our notion that initial discount can be regarded as a proxy for investors' perception of the future depreciation potential. The controlling variables size and the period dummy are not statistically significant. Remarkably, the size of the OPF is no major driver for the depreciation probability. One could argue that bigger OPF have aggressively wrote up portfolio properties in the past and therefore showed above average returns which attracted substantial new fund inflows and have for that reason a higher write-off potential. Admittedly, we cannot show such a relation. Furthermore, the indication whether the suspension was during the first or second crisis does not significantly affect the depreciation probability also.

 ⁴³ We have calculated the accumulated depreciations by checking press releases, semi-annual report, and annual reports of the OPFs. When no or insufficient information was provided we asked the public relations department of the OPF directly and cross checked the material with their press releases, semi-annual report, annual reports and newspaper articles found in Lexis Nexis and Factiva. See Figure A1 for a visualization of two exemplary OPFs.
 ⁴⁴ As a robustness check we calculated the average initial discount and for the first 5 and 30 days after the

⁴⁴ As a robustness check we calculated the average initial discount and for the first 5 and 30 days after the announcement of temporal suspension of share redemption and find that the results stay qualitatively stable. Tables and figures available up on request from the authors.

When focusing on explaining accumulated depreciation, we find a slightly different picture (see Table 4-4). The initial discount⁴⁵ is still able to explain the depreciation behavior meaning that a higher initial discount results in higher depreciations during the suspension period. Interestingly, the period dummy is statistically significant with a negative sign which means that the depreciation potential during the first crisis in the OPF market in 2005/2006 was lower in contrast to the current crisis.

Summarizing both analyses, we find that (1) market prices have a high explanatory power to forecast which OPF management has to depreciate its property values during the time span of the temporal suspension, (2) investors have a good assessment towards the depreciation potential during the suspension period where they are restricted from redeeming their shares, and (3) therefore, the observed discount that could account for *impending NAV impairment* reasonably reflects the future prospects of the fund's underlying property values.

⁴⁵ As a robustness check we calculated the average initial discount for the first 5 and 30 days after the announcement of temporal suspension of share redemption and find that the results stay qualitatively stable. Tables and figures available up on request from the authors.

Table 4-3: Logit Model Predicting Depreciation of Property Portfolio Value within the Period of Temporal Share Redemption Suspension

The Logit regressions were run so that the dependent variable equals 1 if the OPF depreciated the value of its portfolio properties within the period of temporal share redemption suspensions (and 0no depreciation take place). The exogenous variables is the Initial Discount as calculated in equation (1) after the announcement of the suspension of temporal share redemption (first ten day average), 3) Ln(Size) is calculated as the logarithm of OPFs' assets under management, and 4) a Period Dummy variable indicating that the event is during the first crisis for OPFs (2005/2006). We included all OPFs that have already reopened again or are suspended for time period larger than 6 month. See Table 4-A1 for detailed listing of considered temporal suspended OPFs. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Coefficient	t-statistic	
Constant	14.1130	0.3365	
Initial Discount	0.9523^{*}	1.8257	
Ln(Size)	-1.1061	-1.1639	
Period Dummy	-3.3685	-1.6665	
McFadden R ²	36.30%		
LR-Ratio	7.6854		
Number of Observations	17		

Table 4-4: Ordinary Least Square Regression Explaining the Depreciation of OPFs Portfolio Property Value

For estimation, we use the depreciation in absolute terms during the suspension period as a dependent variable in both regressions. The exogenous variables is the Initial Discount as calculated in equation (1) after the announcement of the suspension of temporal share redemption (first ten day average), 3) Ln(Size) is calculated as the logarithm of OPFs' assets under management, and 4) a Period Dummy variable indicating that the event is during the first crisis for OPFs (2005/2006). We included all OPFs that have already reopened again or are suspended for time period larger than 6 month. See Table 4-A1 for detailed listing of considered temporal suspended OPFs.***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Coefficient	t-statistic	
Constant	2.4073	1.3090	
Initial Discount	0.1770^{**}	2.1814	
Ln(Size)	-0.1602	-1.3011	
Period Dummy	-0.1602*	-1.9257	
\mathbb{R}^2	42.64%		
Number of Observations	17		

4.5 Conclusion

As a consequence of a severe crisis in one market segment, other markets can also be impacted by two possible mechanisms of contagion. First, the trading possibilities (for given underlying values) worsen and second the prospects of the underlying values worsen. The OPF market is especially suited for the analysis of these two forms of contagion. Once the fund cannot provide liquidity and is under suspension, the price of the OPF in the secondary market is supposed to be strongly below the potential redemption value due to restricted trading possibilities (*liquidity risk*) and the increased danger of future write-offs (*impending NAV impairment*).

In this paper, we analyze financial contagion mechanisms by disentangling OPF discounts into the liquidity risk component and the NAV component. We find that at the beginning of a suspension period investors are only concerned about the reduction in marketability (mechanism 2). However, with the appearance of uncertainty about the properness of the reported portfolio property values (NAVs) the NAV component gains in importance (mechanism 2). Hence, liquidity aspects play major role within the first 180 suspension days and potential impairments gain in importance by the occurrence of relevant information that cause a revaluation.

The OPF market is especially well-suited for computing the liquidity risk discount according to the Longstaff approach as the maximum length of the non-trading period is two years at most. Apparently, the relation between the discount from liquidity risk and uncertainty about the underlying fundamental value may be different for other markets but still the values estimated for OPFs especially the liquidity discount are a first meaningful starting point.

A relevant challenge for further research is to apply the decomposition of observed discounts into a liquidity component and a component for uncertainty about the fundamental underlying value as carried out for OPFs in this paper to other markets.

4.6 References

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4.7 Appendix

Table 4-A1: Summarization of Suspension Dates of Temporal Share Redemption and the Related OPF Names

This table shows for every event of a temporal suspension of share redemptions the suspension date and the reopening date (if possible) and the funds' name.

		Suspension Date of	
No.	OPF Name	Temporal Share	Date of Reopening
		Redemption	
1	Grundbesitz-Invest	December 13, 2005	March 3, 2006
2	KanAm US-grundinvest Fonds	January 17, 2006	March 31, 2006
3	KanAmgrundinvest Fonds	January 19, 2006	April 13, 2006
4	AXA Immoselect	October 28, 2008	August 28, 2009
5	CS EUROREAL	October 29, 2008	June 30, 2009
6	DEGI EUROPA	October 30, 2008	-
7	DEGI INTERNATIONAL	October 30, 2008	January 30, 2009
8	Focus Nordic Cities	October 28, 2008	January 28, 2009
9	KanAm US-grundinvest Fonds	October 27, 2008	-
10	KanAmgrundinvest Fonds	October 28, 2008	July 8, 2009
11	Morgan Stanley P2 Value	October 30, 2008	-
12	SEB Immoinvest	October 29, 2008	May 29, 2009
13	TMW Immobilien Weltfonds	October 28, 2008	December 11, 2009
	UBS (D) 3 KontinenteImmobilien		
14	[renamed to UBS (D) 3 Sector	October 30, 2008	October 27, 2009
	Real Estate Europe]		
	UBS (D) EuroinvestImmobilien		
15	[investable for institutional	October 30, 2008	August 6, 2009
	investors only]		
16	DEGI INTERNATIONAL	November 16, 2009	-
17	AXA Immoselect	November 17, 2009	-

Table 4-A2: Parameters of the Jump Diffusion Model

This table shows for every suspended OPF the jump-probability λ , jump-size γ and the resulting implied volatility of the jump diffusion model. If an OPF had to be suspended several times we indicate the corresponding period in parentheses.

OPF Name	Jump-Probability λ	Jump-Size γ	Implied Volatility
Grundbesitz-Invest	0,18%	1,19%	1,30%
KanAm US-grundinvest Fonds (2006)	1,83%	3,25%	7,30%
KanAmgrundinvest Fonds (2006)	0,56%	1,82%	5,71%
AXA Immoselect (2008)	0,44%	1,73%	5,33%
CS EUROREAL	0,20%	1,50%	3,80%
DEGI EUROPA	0,22%	1,43%	2,12%
DEGI INTERNATIONAL (2008)	2,48%	1,87%	6,81%
Focus Nordic Cities	1,70%	3,18%	4,58%
KanAm US-grundinvest Fonds (2008)	0,43%	2,03%	5,33%
KanAmgrundinvest Fonds (2008)	2,67%	1,76%	10,16%
Morgan Stanley P2 Value	0,13%	1,37%	2,78%
SEB Immoinvest	5,28%	1,59%	8,96%
TMW Immobilien Weltfonds	8,47%	2,23%	5,95%
UBS (D) 3 KontinenteImmobilien [renamed to UBS (D) 3 Sector Real Estate Europe]	1,44%	1,55%	5,05%
UBS (D) EuroinvestImmobilien [investable for institutional investors only]	0,30%	1,69%	4,16%
DEGI INTERNATIONAL (2009)	1,49%	1,40%	5,53%
AXA Immoselect (2009)	1,32%	1,88%	5,65%
Table 4-A3: Summarization of all OPFs in Switzerland

This table shows the name for every OPF included in the calculation of the Swiss OPF volatility.

No. **OPF** Name 1 AXA ImmovationInstitutional 2 BONHÔTE - IMMOBILIER 3 **CENTRALFONDS** Zentralschweizerischer Immobilienfonds 4 Credit Suisse 1a Immo PK 5 Credit Suisse Real Estate Fund Interswiss 6 Credit Suisse Real Estate Fund Siat 7 Immo Helvetic 8 Immobilier-CH pour Institutionnels 56j 9 IMMOFONDS Schweizerischer Immobilien-Anlagefonds 10 LA FONCIERE 11 Patrimonium Real Estate Funds - Patrimonium Swiss Real Estate Fund 12 Polymen Fonds Immobilier 13 Procimmo Swiss Commercial Fund 14 Realstone Swiss Property 15 Schroder ImmoPLUS SOLVALOR 61 Fonds de placement immobilier 16 17 Streetbox Real Estate Fund 18 SWISSCANTO (CH) REAL ESTATE FUND IFCA 19 Swissinvest Real Estate Investment Fund 20 Swissinvest Real Estate Investment Fund UBS (CH) Property Fund - Direct Residential Plus 21 UBS (CH) Property Fund - Léman Residential "Foncipars" 22 UBS (CH) Property Fund - Swiss Commercial "Swissreal" 23 UBS (CH) Property Fund - Swiss Residential "Anfos"

Figure 4-A1: Appreciation and Depreciations for two exemplary OPFs

This figure shows all appreciations and depreciations of portfolio properties, the secondary market price, and the NAV for the Morgan Stanley P2 Value and the SEB Immoinvest OPF. Price data was available from Thomson Financial Datastream and information about appreciations and depreciations are obtained by checking press releases, semi-annual report, and annual reports of the OPFs and newspaper articles found in Lexis Nexis and Factiva.



a) Morgan Stanley P2 Value





5 Conclusion

Overall, we have shown that Open-ended Property Funds can add significant value to investor portfolios that other real investment vehicles, e.g. REITs, cannot provide. This result is robust to various holding periods, errors in mean and standard deviation and single fund investment. Therefore, OPFs are a valuable asset class that private and institutional investors should include in their asset allocation decisions. However, we have also shown that OPFs bear substantial liquidity risks. Suspension of share redemption freezes investments for up to two years. Furthermore, the reduction in liquidity and the possibility of fund liquidation results in an initial discount of about 6%, which can widen significantly when the liquidation and "fire sales" become likely.

In awareness of these risks, the German Ministry of Finance has proposed additional regulations for OPFs in 2010 (see BMF (2010)). They propose to introduce a minimum holding of two years and minimum notice periods between 6 and 24 months for all OPFs. Also, share redemption should be only possible in half-year intervals. Share redemption in other periods should be made possible by share listing of OPFs. Finally, it is proposed that a new liquidation law should allow funds to sell properties below net asset values during periods of suspension of share redemption to lower the risk of "fire sales". However, it can be assumed that these additional rules reduce the liquidity risk (lower probability of suspension of share redemption), but could also affect the risk-return profile in a way that at least parts of the value added by this asset class is destroyed.

As our analysis has shown about one third of all OPFs had to suspend share redemption. Therefore it seems important to further study the determinants of liquidity shortages. Even during the crisis, the majority of OPFs redeemed shares, so it seems unnecessary to introduce minimum holding periods and minimum notice periods for all OPFs. In contrast, further research should study how probabilities of suspension of share redemption could be determined by fund characteristics. Therein the detailed liquidity positions of OPFs should be included, as funds have an incentive to hold lower liquid securities with higher returns (a similar problem arises for ETFs, which use less liquid swaps than their underlyings). These probabilities could be used to introduce a more precise regulation without harming a valuable asset class. Additionally, regulation should be more aligned to investor types. As we have seen, OPFs add value to portfolios of both private and institutional investors. However, OPFs with relatively high investments by institutional investors were more affected by suspension of share redemption than other OPFs. Therefore, regulation should distinguish between investor types as OPFs are attractive for both private and institutional investors. Private investors are less sophisticated in their financial decisions compared to institutional investors. Hence, the regulation should also protect private investors from disadvantageous actions by institutional investors. Especially establishing minimum holding periods seems promising as the typical private investor holds OPFs in average for seven to eight years.

Furthermore, our analysis shows that liquidity risks must be included in the asset allocation as it can be potentially harmful to investors. Although much recent research in real estate finance has focused on liquidity, it only focuses on direct real estate investments. It shows that liquidity potentially limits the diversification benefits of real estate and leads to lower allocations to real estate. However, as we have shown, OPF liquidity risk is different than for other real estate investments. This line of research should therefore be extended to include the special liquidity risk inherent in OPFs, to study if OPFs still can add significant value when liquidity risk is explicitly considered in the asset allocation model. This is especially important when considering lifecycle asset allocation models, as investors depend crucially on the possibility to liquidate their investments during retirement. Hence these models should be altered to cope for this additional risk, in order to give reliable results (see also Maurer et al. (2012)).

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