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Abstract

Purpose – The purpose of this paper is to evaluate how real estate returns behaved over the last two decades in relation to the other two asset types. This allows a direct evaluation of how investors make allocation choices and perceive risks and rewards offered by properties in the context of changing market conditions.
Design/methodology/approach – A de-smoothed MSCI index is used to reflect direct property returns and control for both income and capital returns within it. Indirect property returns are approximated by the RX Real Estate index. By supplementing this data with an analysis of trends in both space and capital markets it is possible to relate investor behavior to events affecting other assets.
Findings – It is possible to identify three distinctive periods characterized by different correlation of returns and behavior of investors: before the crisis of 2008, the crisis period between 2008 and 2012 and recovery afterwards. These appear to have corresponded to different stages of the economic cycle. Interestingly, performance of asset classes has also differed over that period suggesting that at different points in the cycle asset allocation decisions may have been made differently.
Practical implications – It appears that as investments over the last 15 years real assets in Germany behaved similarly to bonds. It is possible that this phenomenon was driven by an aversion to the stock market and its associated risk which became a concern after the financial crisis of 2008. Over the downturn that followed the market shock investors appear to have turned to assets with simpler risk profiles like direct real estate and government debt. On the other hand, the correlation between direct property investment index and stock returns has been found to be small but negative. This shows not only that the two asset classes were often driven by different factors but also suggests that diversification was, at least theoretically, possible.
Originality/value – Direct real estate investment returns have repeatedly been found to exhibit characteristics similar to those found in bond as well as equity markets (Eichholtz and Hartzell, 1996; Clayton and MacKinnon, 2003) but little research examines the correlation between returns offered by those asset classes in a mature financial and property market. In addition, the recent financial crisis provided a dynamically changing investment which is ideal for investigating structural relationships between assets.

Keywords Risk, Diversification, Asset allocation, Property investment, Portfolio optimization, Asset class correlations

Paper type Research paper

1. Introduction

The financial crisis of 2008 had a profound impact on all areas of finance. In fact, there have been suggestions that its influence on the market may have been so significant that many traditional investment strategies were altered which resulted in structural changes in how investments are made (Boz and Mendoza, 2014). Although it is too early to draw conclusions

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about lasting structural changes to investment patterns, there have been some trends that have emerged as financial markets recovered from the recession. One of such trends has been the rapid increase in direct property investment (Lange, 2016; Wieglemann and Szumilo, 2017). Germany has experienced this phenomenon in full strength with both domestic and international capital flows into this asset class climbing to record levels over recent years (Colliers, 2016). Given the political and economic uncertainty affecting the market over the last years it is difficult to attribute the growing interest in real assets directly to a structural shift in asset allocation strategies. It is, however, possible to investigate how property returns performed against other assets and compare their reactions to changing conditions.

Traditionally direct real estate investment returns have always been lower than those achieved in stock markets but higher than bond returns while offering a similar risk to return ratio. Critically, financial performance of real properties has also been thought to be determined by the same factors as the other two assets and offer limited diversification benefits. The logic of correlation to bond markets relies on the stability of lease contracts that generate cash flows which are contracted in advance. As for all fixed-income assets, their value is determined by interest rate risk and the default risk premium (Szumilo *et al.*, 2016). However, since these leases need to be renewed, property income is also exposed to the uncertainty of the space market. Given the high correlation between the space market and financial markets (Hoesli and Reka, 2015), there is a strong argument that over longer periods exposure of real assets to overall market risk increases.

Since the financial crisis direct real estate investment has increased very fast in Germany where the market has seen unprecedented level of activity from both domestic and foreign investors (Lange, 2016). Both bond and equity markets also experienced high volatility (Jung and Maderitsch, 2014) and, according to some academics, structural changes in pricing (Boz and Mendoza, 2014). Consequently, it appears possible that the financial crisis has, at least temporarily, altered the way in which investors allocate funds between the three assets.

This paper investigates the relationship between returns from different asset classes and examines their relationship in search for any structural changes over the last 15 years. It begins by analyzing German property investment markets over the last 15 years paying particularly close attention to financing sources and structures. In this context, it then presents a similar qualitative analysis of equity and bond markets. This is followed by a quantitative analysis of the relationship between equity and bond return indices and two indicators of property performance: the RX Real Estate Index and a de-smoothed MSCI index. Finally, both qualitative and quantitative results are discussed and conclusions drawn. The most significant findings are a negative correlation between equity and direct property returns and some evidence of structural changes in how investors perceived property investments over the last 15 years.

2. The German real estate market over the last 15 years

The German and European investment markets are booming and the trend is now in its seventh year. However, the factors that may drive the trend appear to be beyond the control of ordinary investors. Instead the interest in German real estate appears to be driven by changing economic and political paradigms. Real estate as an asset class is regarded by many investors as being safer than equity but still offers the upside growth potential unavailable from bond markets. This means allows it to offer a stream of cash flows that differs from other assets and react differently to structural changes in the market.

After the burst of the dot com bubble economic growth expectations were relatively unfavorable, which resulted in both rental and capital values in Germany being very low

(Lange, 2016). However, as economic growth accelerated real estate asset returns begun increasing. With increases in income returns, yields declined and capital values rose by around 60 percent between September 2003 and 2007 while investment volume tripled and reached EUR 255 billion in 2007 (JLL, 2016). The same period saw a reduction in the perceived investment risk and volatility (as measured by the CBOE Volatility Index). Although myopic in hindsight, the attitude was based on strong underlying trends prevailing at the time. Strong demand from tenants supported projections of high-income returns and their low volatility.

Investment demand was further increased by availability of cheap finance and structural changes in capital markets. Although risk may have been underestimated, its pricing has been made more difficult by intense competition among lenders driven at least partially by increasing internationalization of financial services. In a de-regulated environment, synthetic investment products gained more popularity and allowed very weak loan covenants. These included LTV ratios of over 90 percent, no repayment penalties and non-recourse collateral while lending rates were as low as 50-90 basis points above SWAP rates.

In 2007 the effect of the financial crisis on European properties transpired mainly through dramatically lower expectations of economic growth and higher unemployment leading to rental markets becoming much less promising. Until governments and central banks provided additional liquidity to financial markets in 2009 transaction volume reduced by 70 percent and returned to their levels from 2003 (Colliers, 2016). With unfavorable income expectations and low demand, yields increased, capital values collapsed. The trend to invest internationally observed before the crisis appeared to have reversed and investors started focusing on their domestic markets which lead to international purchases reducing by as much as 80 percent (JLL, 2016). Demand from debt-motivated investors also weakened considerably as loan covenants become much stricter. LTV ratios fell to as little as 50 percent and risk was priced much more conservatively (Lange, 2016). At the same time, many distressed assets offered attractive risk-adjusted returns for those who were able to arrange financing. Insurers, open-ended and closed-ended individual funds, special funds, pension funds and private equity funds begun investing in prime assets with good occupancy, high tenant credit ratings and long-term leases. This trend matured in 2011 when the number of such properties available for purchase decreased significantly. Since interest rates were still very low and the economic outlook uncertain, investors begun turning to marginally more risky real assets. The demand lead to the yields gradually decreasing and it appears that their highest values were recorded prior to 2010. Since then their downward trend has been relatively consistent and did not break despite increasing political uncertainty.

It appears that similar factors affected real estate assets worldwide. Low interest rates and increased uncertainty linked to mainstream asset returns appear to have created demand for prime real estate in most developed countries.

The real estate sector is still impacted by the consequences of the global financial crisis, specifically the subsequent fundamental change in monetary policies. Bienert *et al.* (2016) show that the historically low interest rates, credit demand as well as the lack of appropriate alternative investments and the comparably high liquidity in the market were key drivers of an unprecedented capital influx into property from domestic and cross-border investors alike. They also argue that the low interest rate environment in Germany has been a key driver of the real estate sector emerging from the global financial crisis with the reputation of a defensive asset class. In fact, after the crisis, Germany became one of Europe's most sought-after markets where property assets were in high demand from a wide variety of investors. This, in conjunction with low interest rates, significantly decreased investment yields.

However, as yields on prime properties contracted investors were forced to find alternatives. While some turned to riskier buildings and speculative development schemes, others started to look for opportunities in foreign destinations. As risk remained the main concern the strongest performing economies with the most transparent real estate markets attracted the most international capital (JLL, 2016). With Germany ranking amongst the top 10 destination for international real estate capital flow destinations, cross-border investments appear to continue to put downward pressure on yields. In 2016 average net initial yields in the office segment across the "Big Seven" have slid to below the 4 percent mark for the first time in history. The current (Q4 2016) average is 3.93 percent, marking a decrease of 20 basis points from the first quarter of the year and, at the same time, the most pronounced yield compression within a single quarter since 2000. This puts the price structure for office properties increasingly close to that of the typical high street property with retail use in prime urban locations. The average prime yield across the "Big Seven" stands at 3.70 percent by Q4 2016, and also experienced a further decline in yield over 2016 (albeit of just five basis points). The same holds true for other retail products: shopping centers and specialized retail centers both saw yields declines of 15 basis points to 4.1 and 5.10 percent, respectively (Colliers, 2016). While real estate in Germany has historically been shaped and dominated by domestic investors (open-ended real estate funds, insurers, pension funds), the share of commercial real estate transactions involving foreign capital has now risen to about 50 percent (Colliers, 2016). International investors also appear to be willing to accept higher risks than their domestic rivals (e.g. secondary locations, "B" cities, properties with vacancies) in their transactions.

3. German bonds and equity markets

The Frankfurt Stock Exchange has the third largest total market capitalization in Europe. At the same time, German bonds are considered to be one of the safest fixed-income securities while the equity market as developed and well-diversified (Arajärvi, 2009). In addition, Milonas and Rompotis (2015) show that when market capitalization and assets held are used as an indicator, German financial markets are significant both in Europe and globally. In this context, it appears interesting to compare how in a mature investment environment returns from the main two asset classes reacted to the financial crisis in comparison to real assets.

The equity market (represented by price levels of DAX) experienced a steady period of growth since 2003 until the financial crisis of 2008 when it appears to have structurally changed (Koziol and Vogt, 2016). After the crisis it saw a reduction in transaction volumes and liquidity. At the same time, the foreign ownership of domestic stock has decreased. According to the Bundesbank (2014), the share of equity in listed German companies held by foreign investors changed from 58.8 percent in 2007 to 51.6 percent in 2008. While liquidity has decreased, volatility appears to have been limited by quantitative easing strategies adopted by most major central banks. The large amount of new money flowing into markets allowed investors to reduce their exposure to the stock market without withdrawing capital. At the same time safer companies, especially ones paying regular dividends, performed better than risky ones (Fuller and Goldstein, 2011). This appears to suggest that income generation has been an attractive feature of investment vehicles after the financial crisis.

Debt markets appear to have experienced an opposite trend. The long-term cost of funding measured by the ten-year German Government yield was at 5.3 percent in 2002 but deceased only to 4.6 percent in June 2008. This shows that even during a period of growth interest rates remained relatively stable. The situation has changed considerably after the crisis and the dramatic reduction to 1.5 percent in 2013 and into negative territories in 2016 appears to have been fueled not only by growing domestic but also international demand.

Short-term rates have followed the same pattern of a small reduction before the crisis and a dramatic decrease afterwards (Koziol and Vogt, 2016). If income generation was indeed attracting investors, it may not be surprising that fixed-income securities became very popular vehicles for protecting capital.

4. Data

The research uses two data sets with different frequency and timespan span of the collected data. In order to investigate the relationship between direct property, equity and bond investment returns, annual data from 1998 to 2015 were used while indirect property returns were investigated on a daily basis in years 2007-2016. This approach was necessary due to data limitations common for real estate markets, Direct property returns were approximated using the MSCI total property return index. Different approaches to dealing with valuation-based indices were considered but following recommendations of Lizieri *et al.*, a de-smoothing approach was adopted with the smoothing parameter equal to 0.8. It needs to be noted that valuations derived using international methods (DCF or investment method) may reflect market volatilities more accurately than real estate valuations using German regulated methods (ImmoWertV, market value according to \$194 Federal building act). Ultimately, the decision on how to adjust for changes in value rests with the valuer who has to apply certain standards. In theory, all approaches should lead to same result (market value). However, German methods have been shown to be mathematically prone to smoothing biases (Schnaidt and Sebastian, 2012). While changes in value in international methods are typically significantly driven by actual market rents and investment yields, the regulated German valuation system has four key value drivers: rents, yields (Liegenschaftszins), remaining useful lifetime of the building and finally the value of the land. Consequently, changes of market rents and yields have a comparably lower impact on the calculated market value. By its nature, the remaining useful lifetime of a building is independent from market volatility. The "land value" also tends to be more stable since changes in values of land often have a significant time lag to market movements and are driven by changes in the real estate sector.

In contrast to the de-smoothed annual direct returns, indirect property returns were based on a logarithmic approximation of daily RX Real Estate Index returns without adjusting for gearing. RX index contains up to 30 real estate companies (including REITs) from the Prime Standard. The companies included in the index have to generate a minimum daily trading volume of €1 million. Using the starkly different measures of real estate returns allowed comparing different strategies of property investment.

Equity and government bond markets were approximated by logarithmic returns of the DAX and REX Gesamt Kursindex indices. The latter of the two contains 30 national bonds with integer time to maturity periods, while the former is a general stock market index. Descriptive statistics are available in Table I.

Table I. Descriptive statistics and correlations for high-frequency index returns

	Index		
	RX	REX	DAX
Descriptive statistics			
Mean (%)	−0.002	0.009	0.017
SD	0.001	0.002	0.015
Correlation matrix			
RX	1	−0.063	0.028
REX	−0.063	1	−0.120
DAX	0.028	−0.120	1

Differences in data frequency and the resulting characteristics determined quantitative methods applied in this research. A DCC-GARCH model was used to examine indirect and direct property returns while an autoregressive distributed lag (ARDL) model was applied to the analysis of direct investments.

5. Methods

This research uses two basic models used in time series analysis in financial markets: a multivariate GARCH (Fabozzi *et al.*, 2006) and ARDL (Veiga, 2014).

DCC-GARCH models are ideal for high-frequency financial time series analysis as they allow controlling for their characteristic statistical features such as fat tails of distributions or serial autocorrelation which have been identified by other researchers (Gyourko and Keim, 1992). Given the high frequency of index return data collected for this study, this model appears suitable for examining the relationship of bond and equity markets.

On the other hand, ARDL models are used to analyze data with lower frequency (annual or quarterly) to test for short- as well as long-term relationships as it allows for the effect of the repressor to be distributed over time. This approach has been applied to examine interactions of equity, bond and direct property returns.

5.1 DCC-GARCH models (indirect real estate returns)

Estimating DCC-GARCH model parameters allows determining correlation coefficients which indicate how strongly returns from different assets are related. In such model, the conditional variance equation is determined by lagged values of conditional variances and conditional mean values of squared returns. At the same time, conditional correlation equation is determined by standardized residuals from the variance equation and lagged conditional correlations (see Engle, 2002, 2009).

DCC-GARCH models were used to measure interdependence of high-frequency returns and its development over time. AR(p) models for those indices indicated the maximum value of autoregression to be 1, while GARCH(p, q) models indicated the best fit for GARCH(1,1). The initial results of time series analysis allowed adopting a DCC-GARCH specification following equations presented in Appendix 1.

The models were estimated using a two-step maximum likelihood method with conditional student t distribution. In the first step, parameters for conditional expected values and conditional variance equations were estimated, while in the second for the conditional correlation equation (Engle, 2002, 2009).

5.2 ARDL models (direct real estate returns)

The ARDL model suggested by Pesaran and Shin (1998) was used to determine the relationship between direct property and other asset returns. In this model, the value of the dependent variable is determined by its past values as well as current and past values of exogenous variables. The ARDL(1,1) model parameters were estimated separately for the relationship of DAX and REX indices due to the high correlation between annual returns of stock and bond markets. The following equations were estimated:

$$\mathrm{MSCI}_t = \alpha_0 + \rho \mathrm{MSCI}_{t-1} + \beta_1 \mathrm{DAX}_t + \beta_2 \mathrm{DAX}_{t-1} + \varepsilon_t, \tag{1}$$

$$\mathrm{MSCI}_t = \alpha_0 + \rho \mathrm{MSCI}_{t-1} + \beta_1 \mathrm{REX}_t + \beta_2 \mathrm{REX}_{t-1} + \varepsilon_t, \tag{2}$$

where MSCI_t is the de-smoothed MSCI index; DAX_t the index DAX (stock market); REX_t the index REX (bond market); ρ the autoregression parameter; β_1,β_2 the exogenous variables parameters; and ε_t the random error.

Selection of optimal lag parameter was guided by the General-to-specific procedure (Campos and Ericsson, 2005) and resulted in a conclusion that a one period lag (of both dependent and independent variables) was the most adequate.

6. Empirical results

6.1 Indirect property returns

Table II presents results for DCC-GARCH model parameters for RX, REX and DAX indices. The estimated values of conditional expected values and variances for each equation are insignificant at 5 percent confidence level only for the DAX index. Combined α_1 and β_1 parameters in the conditional variance equation are less than 1. Values obtained in the second estimation step are also significant, as are all parameters v of the student t distribution degrees of freedom estimated in both steps. Their values in the range from 5.060 to 8.101 indicate fat tails in distributions of residuals.

The DCC-GARCH model allows measuring the strength of interdependence of the examined indices, as well as their behavior over time, using conditional correlation. Its values for each of pair the analyzed indices are presented in Figure 1.

Conditional expected value and variance equations

Parameter (index)	Estimate	*p*-value	Parameter (index)	Estimate	*p*-value
$\gamma_{1,0}$ (RX)	0.001	0,007	$\gamma_{3,0}$ (DAX)	0.084	~0.000
$\gamma_{1,1}$ (RX)	0.064	0,003	$\gamma_{3,1}$ (DAX)	0.002	0.934
$\omega_{1,1}$ (RX)	0.000	0,001	$\omega_{3,1}$ (DAX)	0.024	0.012
$\alpha_{1,1}$ (RX)	0.187	~0,0000	$\alpha_{3,1}$ (DAX)	0.092	~0.000
$\beta_{1,1}$ (RX)	0.785	~0,000	$\beta_{3,1}$ (DAX)	0.901	~0.000
$\gamma_{2,0}$ (REX)	0.010	0,003	v_1	5.060	~0.000
$\gamma_{2,1}$ (REX)	−0.069	0,002	v_2	5.967	~0.000
ω_{21} (REX)	0.000	0,026	v_3	6.772	~0.000
$\alpha_{2,1}$ (REX)	0.046	~0,000	v	7.101	~0.000
$\beta_{2,1}$ (REX)	0.950	~0,000	–	–	–
Log-likelihood	2,895.461	Akaike	−2.470	Bayes	−2.411

Conditional correlation equation

Parameter	Estimate	*p*-value	Parameter	Estimate	*p*-value
a	0.021	~0.000	b	0.955	~0.000

Table II.
Estimation results for DCC-GARCH models

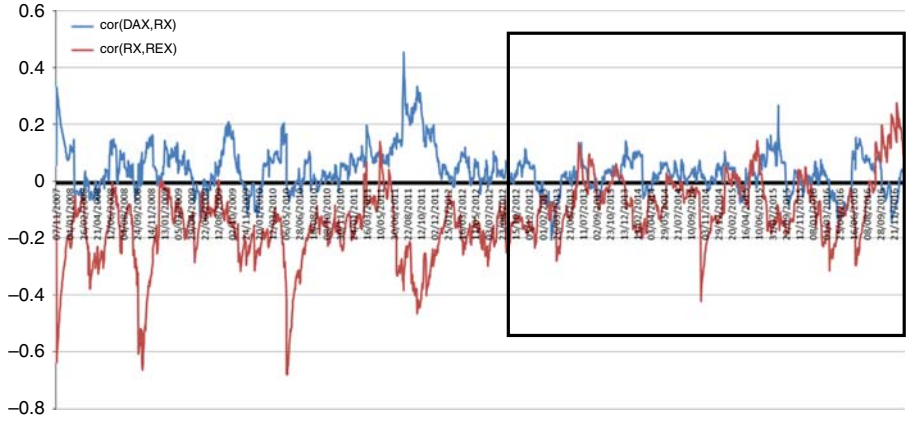

Figure 1.
Dynamic conditional correlations

Temporal changes in dynamic conditional correlations indicate two distinct periods within the analyzed time series. The first, between 2007 and 2012, shows much larger differences between the two measured values. In addition, correlation of DAX and RX is positive and much higher than in subsequent years. The second period, since 2013 onwards, presents much lower correlation of indirect property investments against both stock and bond returns.

During the analyzed period, the relationship between DAX and RX was generally positive. This signals that public investing in real assets and in other sectors was considered as substitutes driven largely by similar factors and offering no diversification benefits. In general, the market priced the risk of the two sectors similarly especially during the period of high volatility (2007-2012). This is consistent with the findings of other studies as using similar methods (GARCH models). Asteriou and Begiazi (2013) determined that US REITs were highly dependent on the stock market returns and offered no diversification benefits against those in those assets.

Since 2013 correlation between DAX and RX decreased to less than 0.2 indicating a period when the general stock market had much less influence on real estate equities and returns from property companies are driven by different factors than the rest of the market. Critically, it appears that since 2013 the two vehicles were increasingly driven by different factors as correlation of their returns decreased.

Interestingly, the structural transformation that occurred in 2012 did not change the relationship between bond and indirect property markets. They reminded negatively correlated throughout the sample period and negative conditional correlation values signal that debt was a viable investment alternative to public real estate. This was not only especially noticeable between 2007 and 2012 but also true afterwards.

6.2 Direct property returns

Table III presents the results of ARDL(1,1) model estimation which show the relationship of returns from bonds and stocks to direct property returns. The estimated parameters indicate that the two main asset classes were correlated and possibly influenced unlisted real asset performance over the examined period. Current and lagged values of the DAX index appear to had a negative impact on the MSCI index suggesting that poor performance of the stock market was correlated to higher returns generated from the property market. The reverse is observed for the REX index as its current and lagged values are positively related to the MSCI index. For both models there appear to be a temporal autocorrelation effect in direct property returns despite the fact that the data have been de-smoothed.

The obtained results appear to suggest that there was a close relationship between equity, bond and direct property results in Germany over the analyzed time period. The positive relationship between bond and real estate returns suggests that investment in the two assets was driven by similar factors. This resulted in their high correlation and no

Model	Parameter	Coef.	SE[a]	*p*-value
Equation (1) (DAX)	α_0	4.270	0.574	0.000
	ρ	0.645	0.193	0.001
	β_1	−0.026	0.009	0.004
	β_2	−0.017	0.007	0.014
Equation (2) (REX)	α_0	3.463	0.609	0.000
	ρ	0.664	0.133	0.000
	β_1	0.271	0.079	0.001
	β_2	0.148	0.069	0.032

Notes: $n = 18$. [a]Semirobust standard errors

Table III.
Estimation results for ARDL(1,1) models

diversification opportunities between the two asset classes. On the other hand, the negative relationship with the stock market suggests that equity returns reacted to the same market conditions with changes in opposite directions. However, although estimated coefficients indicate that the correlation was negative and statistically significant, it was not very strong. Consequently, diversification benefits were on average very low. However, it needs to be noted that the MSCI index is not investable and individual assets may have offered those benefits. On average investing into a real estate market prolife did not offer significant diversification effects to investors.

Similar statistical results have been presented by Kainulainen (2015) for the Finnish real estate market. Their conclusion was that property markets were not mature enough to be treated as unrepentant asset class. Although high correlation with bond markets appears to suggest a similar conclusion for the German market, the association is not perfect. In addition, the stock market is negatively correlated with direct property returns, which appears to suggest not only that diversification benefits exist but also that the property investment market in Germany is relatively mature.

In order to investigate the finding of the high-frequency estimation analysis that structural changes in market behavior occurred in different sub-periods, ARDL(1,1) models were also estimated for periods 1999-2008 and 2009-2015. This allowed examining the market over different stages of the real estate cycle. Since the sample is relatively short, it was not appropriate to include controls for these periods within the previous model. Results are presented in Table IV.

In general, signs of the estimated coefficients are consistent for both equity and bond markets over each of the estimated sub-periods and are similar to those presented in Table III. An increase in equity returns is associated with a fall in the MSCI index, while the opposite is true for its relation with bond yields. The key difference between sub-period results is the temporal distribution of the relationship of the MSCI index with DAX and REX. Before the financial crisis, the correlation was much quicker and stronger than during the recession and recovery. This is evident from higher absolute ratios of β_1-β_2 parameters in years 1999-2008 and a reversal of that trend afterwards. It can be interpreted as a tendency of markets to attribute more weight to historical information and is consistent with the claim that investment patters have changed after the crisis.

Model	Period of time	Parameter	Coef.	SE[a]	*p*-value
Equation (1) (DAX)	1999-2008	α_0	3.790	0.609	0.000
		ρ	0.497	0.312	0.111
		β_1	−0.027	0.012	0.024
		β_2	−0.017	0.008	0.034
	2009-2015	α_0	4.297	1.482	0.004
		ρ	0.891	0.115	0.000
		β_1	−0.008	0.016	0.609
		β_2	−0.024	0.006	0.000
Equation (2) (REX)	1999-2008	α_0	3.583	1.034	0.001
		ρ	0.797	0.113	0.000
		β_1	0.374	0.073	0.000
		β_2	0.162	0.041	0.000
	2009-2015	α_0	3.188	1.287	0.013
		ρ	0.857	0.143	0.000
		β_1	0.151	0.090	0.092
		β_2	0.224	0.081	0.006

Note: [a]Semirobust standard errors

Table IV.
Estimation results for ARDL(1,1) models for sub-periods (1999-2008 and 2009-2015)

7. Empirical results in context of the market

It appears that structural changes in how the three asset classes were perceived in relation to each other have occurred over the investigated period. The variations are especially noticeable when the distinction between direct and indirect real estate investment is made. As indicated by both qualitative and quantitative evaluations, it is possible to identify three distinctive periods characterized by different correlation of returns and behavior of investors: before the crisis of 2008, the crisis period between 2008 and 2012 and recovery afterwards. These appear to have corresponded to different stages of the economic cycle. Interestingly, performance of asset classes has also differed over that period suggesting that at different points in the cycle asset allocation decisions may have been made differently.

It appears that returns on bonds and property were driven by the same factors. This was particularly noticeable after the financial crisis materialized. It is possible that the primary driver of asset allocation at that time was driven by risk perception and low interest rates. The analysis is consistent with the claim that investors faced with high risk in equity markets turned to safer alternatives but the low interest rates discouraged them from relying solely on debt investments.

When all equities performed poorly, property companies appeared to have followed this trend. The fact that the assets that should have driven their performance performed relatively well appear to have not provided protection against poor stock performance. Even over longer horizons listed real estate was highly correlated with the stock market. On the other hand, direct property investments were closely related to bond market returns. This could be driven by aversion to high gearing adopted by many property companies which increases their risk. Another possible explanation of this finding is the preference to focus on investing in improving performance of specific assets rather than relying on portfolio selection skills of property companies. The findings are consistent with the literature on the topic which suggests that direct and indirect properties generate returns driven by different factors (Oikarinen *et al.*, 2011).

Although its effect is small, there appear to be a statistically significant diversification benefit between direct real estate assets and stocks. It is unlikely to offer any real advantage to investors not only because its magnitude but also due to the fact that the MSCI index is not investable. Nevertheless, the finding itself is important as it signals that it was possible to select real assets which improved portfolio performance. On the other hand, direct property investment offered no diversification against debt returns.

8. Conclusions

Structural changes in relative asset performance presented in this study have interesting implications for investors as they show that diversification benefits were not constant over time and varied with stages of the business cycle. It appears that as investments over the last 15 years real assets in Germany behaved similarly to bonds. It is possible that this phenomenon was driven by an aversion to the stock market and its associated risk which became a concern after the financial crisis of 2008. Over the downturn that followed the market shock investors appear to have turned to assets with simpler risk profiles like direct real estate and government debt. This is supported by the fact that the correlation of real asset returns to stock indices was marginally negative. Given the fact that short-term investment risk of the two asset classes is based mainly on counterparty risk, they offered an alternative to capital withdrawn from equity markets. In fact, their returns remained highly positively correlated throughout the downturn and recovery periods. On the other hand, the correlation between direct property investment index and stock returns has been found to be small but negative. This shows not only that the two asset classes were often driven by different factors but also suggests that diversification was, at least theoretically, possible. However, gaining a systematic advantage by exploiting this feature alone appears

unlikely. The MSCI index return cannot be purchased and is impossible to replicate. Consequently, obtaining the advantage of using its statistical properties to optimize portfolio performance is not a viable strategy. However, the findings show that investors who diversified into real estate over the last 15 years have, on average, benefited from doing so. While it is likely that individual assets over or underperformed the index, it appears that, on average, including real assets into a portfolio improved its overall risk-adjusted performance. More research is needed to determine the spatial and temporal distribution of the returns which offered diversification as it is possible that some portfolios offered very different returns than others and that investors observed different performance depending on the time of their entry into the market. Nevertheless, given the findings of this research it appears logical that real properties have become very popular during the economic downturn and early stages of recovery.

However, the prominent place of real assets in diversified portfolios may not be a permanent shift. It appears that the high demand may have generated some structural changes in the property industry and their impact is difficult to predict form historical data. After yields on prime assets compacted, investors were forced to shift to purchasing more and more risky properties.

This process may offer higher returns but at the same time changes the risk profile of an average property investment and it is unclear if those transactions will offer the same benefits. While more research is needed to determine the future place of real assets in diversified portfolios, it appears that when the market was looking for safer alternatives to equity investments German direct properties were an attractive alternative to government bonds.

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Appendix 1

Specification of the DCC-GARCH model used in the examination of direct real estate investment:

$$\mathbf{Y}_t = \boldsymbol{\mu}_t + \boldsymbol{\eta}_t, \quad \boldsymbol{\eta}_t | \mathbf{F}_{t-1} \tilde{} t(0, \mathbf{D}_t \mathbf{R}_t \mathbf{D}_t, v) \tag{A1}$$

$$\mathbf{Y}_t = [\mathrm{RX}_t, \ \mathrm{REX}_t, \ \mathrm{DAX}_t], \tag{A2}$$

$$\mu_t = \left[\mu_{\mathrm{RX},t}, \ \mu_{\mathrm{REX},t}, \ \mu_{\mathrm{DAX},t}\right], \tag{A3}$$

$$\mu_{\mathrm{RX},t} = \gamma_{1,0} + \gamma_{1,1}\,\mathrm{RX}_{t-1}, \tag{A4}$$

$$\mu_{\mathrm{REX},t} = \gamma_{2,0} + \gamma_{2,1}\,\mathrm{REX}_{t-1}, \tag{A5}$$

$$\mu_{\mathrm{DAX},t} = \gamma_{2,0} + \gamma_{2,1}\,\mathrm{DAX}_{t-1}, \tag{A6}$$

$$\mathbf{D}_t^2 = \mathrm{diag}\{\mathbf{H}_t\},\ \ \mathbf{H}_t = \mathbf{V}_{t-1}(\boldsymbol{\eta}_t), \tag{A7}$$

$$H_t = \left[H_{\mathrm{RX},t},\ H_{\mathrm{REX},t},\ H_{\mathrm{DAX},t}\right], \tag{A8}$$

$$H_{\mathrm{RX},t} = \omega_{1,1} + \alpha_{1,1}\eta_{t-1}^2 + \beta_{1,1}H_{\mathrm{RX},t-1}, \tag{A9}$$

$$H_{\mathrm{REX},t} = \omega_{2,1} + \alpha_{2,1}\eta_{t-1}^2 + \beta_{2,1}H_{\mathrm{REX},t-1}, \tag{A10}$$

$$H_{\mathrm{DAX},t} = \omega_{3,1} + \alpha_{3,1}\eta_{t-1}^2 + \beta_{3,1}H_{\mathrm{DAX},t-1}, \tag{A11}$$

$$\boldsymbol{\varepsilon}_t = \mathbf{D}_t^{-1}\boldsymbol{\eta}_t, \tag{A12}$$

$$\mathbf{R}_t = \mathrm{diag}\{\mathbf{Q}_t\}^{-0.5}\mathbf{Q}_t\mathrm{diag}\{\mathbf{Q}_t\}^{-0.5}, \tag{A13}$$

$$\mathbf{Q}_t = \overline{R}(1-a-b) + a\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}' + b\mathbf{Q}_{t-1}, \tag{A14}$$

where $\mathbf{Y}_t$ is the vector of returns; $\mu_{i,t}$ the vector of expected value equations; $\gamma_{i,0}$, $\gamma_{i,1}$ the parameters of the ith expected value equation; $H_{i,t}$ the vector of expected variance equation; $\omega_{i,1}$, $\alpha_{i,1}$, $\beta_{i,1}$ the parameters of the ith expected variance equation; v_1, v_2, v_3 the degrees of freedom in the student t distribution for selected indices in the first step of estimation; v the degrees of freedom in the student t distribution for selected indices in the second step of estimation; ε_t the matrix of standardized residuals; $\mathbf{R}_t$ the matrix of conditional correlations; and a, b the parameters of conditional correlation.

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