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List of Abbreviations

ADF	Augmented Dickey-Fuller Test
AIC	Akaike Information Criterion
ANN	Artificial Neural Network
ARMA	Autoregressive Moving Average
ASEAN	Association of Southeast Asian Nations
BR	Base Rate
COND	Consumer Discretionary Sector
CONS	Consumer Staples Sector
CPI	Consumer Price Index
CPIUSA	Consumer Price Index of the United States
CUSUM	Cumulative Sum (Sequential Analysis Technique)
CUSUMQ	Cumulative Sum based on Squared Residuals
DF	Dickey-Fuller
DJ	Dow Jones Index
ECB	European Central Bank
ECM	Error Correction Model
EGARCH	Exponential General Autoregressive Conditional Heteroskedastic
EM	Emerging Markets
EN	Energy Sector
ERM	Exchange Rate Mechanism
FED	Federal Funds Rate of the Federal Reserve Bank
FIN	Financials Sector
FTSE	Financial Times Stock Exchange
GAR	Generalised Autoregressive

GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GOV	Long-Term Government Bond (10 years)
GSCI	Goldman Sachs Commodity Index
HC	Health Care Sector
HQ	Hannan-Quinn Information Criterion
ICA	Independent Components Analysis
IMMEX	German Appraisal-Based Property Index
IND	Industrials Sector
INF	Information Technology Sector
IP	Industrial Production
IPD	Investment Property Database
IPUSA	Industrial Production Index of the United States
INTER	Interbank Rates
JB	Jarque-Bera
LI	Level of Integration
ln	Natural Logarithm
LR	Linear Restrictions
M1	Measure of the Money Supply
MAP	Multifactor Asset Pricing
MAT	Materials Sector
MSCI	Morgan Stanley Capital International
NAREIT	National Association of Real Estate Investment Trusts
NCREIF	National Council of Real Estate Investment Fiduciaries
NPI	Property Index of the National Council of Real Estate Investment Fiduciaries

OLS	Ordinary Least Squares
PP	Phillips-Perron
REIT	Real Estate Investment Trust
REEI	Financial Times Stock Exchange (FTSE) 350 Real Estate Index
SC	Schwartz Information Criterion
S&P	Standard & Poor´s
SP500	Standard & Poor´s 500 Stock Index
Std.Dev	Standard Deviation
SUR	Seemingly Unrelated Regression
TAR	Threshold Autoregressive
TEL	Telecommunication Sector
UK	United Kingdom
UR	Unemployment Rate
US	United States
USA	United States of America
USD	United States Dollar
UT	Utilities Sector
VAR	Vector Autoregressive
VEC	Vector Error Correction
VECM	Vector Error Correction Model
X12	Method for Seasonally Adjusting Data
ZERP	Centre of European Law and Politics

List of Symbols

α	Matrix indicating the Error Correction Term
ß	Matrix indicating the Cointegrating Vectors
c	Constant
Γ_i	Matrix representing the Short-Term Dynamics
€	Euro
$E(CF_t)$	Discounted Future Value of the Expected Cash Flow
ε_t	Error Term
H_0	Null hypothesis
H_A	Alternative Hypothesis
k	Order of Vector Autoregressive Process
k_t	Required Rate of Return
λ_{Trace}	Likelihood-Ratio Test Statistics of the Trace Test for Cointegration
λ_{Max}	Likelihood-Ratio Test Statistics of the Maximum Eigenvalue Test for Cointegration
n	Number of Vectors (contained in the respective Matrix)
μ	Vector of Constants
π	Cointegration Matrix including the Cointegrating Vectors and the Error Correction Term
P_0	Equity Price
£	British Pound
r	Number of Cointegrating Vectors
R^2	Goodness of Fit
Y_t	Vector Autoregressive Process
ΔY_t	Vector of the First Differences of Stochastic Variables Y

1 Introduction

Not just since the collapse of the US subprime market in summer 2007, much attention has given by policy-makers, scientists and the media to the linkage between financial markets and the real economy. In principle, the economic trend is an essential indicator for consumer confidence and growth prospects of companies, and in this way influences conditions and valuations on capital markets. In this function, the economic outlook particularly determines expectations with respect to operating profits and expansion measures of companies, costs of refinancing and ultimately to the required rate of return for potential investors.

Nevertheless, the huge dimension of the interdependency among economic forces is demonstrated by the current developments due to the worldwide financial crisis. Although this crisis derives its origin in a price collapse on US housing markets, its consequences affect both the world capital markets and the real economy. Via the channel of deteriorations of financial assets – particularly of stocks and asset backed securities (ABS) – the price collapse and a lack of transparency in the balances led to a loss of confidence within the banking sector. Due to a remarkable increase in the costs of refinancing on capital markets and the consequential tremendous liquidity problems across the worldwide banking sector, this progress caused tighter credit terms and higher refinancing costs even for the non-financial sectors. On the basis of a weakened order situation of the respective companies, the needs of labour forces considerably declined and required wide-ranging subsidy measures. In order to avoid an ongoing credit crunch and to prevent a collapse of constitutive parts of the financial system, both the international central banks and governments intervened in the financial markets by reducing key interest rates, injecting huge amounts of liquidity, providing guarantees and even executing partial nationalisations.

Apart from these crisis effects, current affairs signalise once again the complexity of economic interactions, which have been additionally enhanced by the ongoing globalisation on capital markets. Accordingly, demands on both scientists and implemented models tightened remarkably in order to gain reliable results and implications for decision makers. As a result, the conventional approach of using standardised models is no longer promising. On the basis of complex interdependencies and the well-known sensitivity of dynamic econometric models, it is necessary to employ a specified approach in order to be able to explain a small extract of economic interactions. For that reason, one main objective of this thesis is to use quantitative dynamic models which meet ambitious econometric requirements without neglecting the comparability of the respective countries or sectors under consideration. In the process, identical evaluation principles are chosen within each study in order to reduce possible deviations caused by divergent model specifications.

Objectives and Scientific Contributions

While much attention has focused on the modelling of the interdependencies between key aggregates and stock indices in industrialised countries, this thesis is focused on investments in emerging markets and real estate – two research branches that have up to now not been investigated to a comparable extent. The analysis of individual scientific issues therefore contributes to improving the understanding of conditions and essential interrelationships in these markets and sectors.

Within the scope of the present thesis, the empirical results are mainly based on the Johansen (1988) procedure. The use of vector error correction models (VECM) guarantees that the dynamic character among the selected determinants is taken into account and furthermore allows the evaluation of both the long-term equilibrium relationships and the channels during the adjustment process after deviations from the long-term trend. In addition, the empirical results are verified by employing further analyses in order to gain deeper insights into the respective scientific issue.

In Chapter 2 the study examines “Macroeconomic Effects on Emerging Market Sector Indices”. As emerging countries continue to gain in importance for the world economy, it is worthwhile extending research into regions that have up to now been comparatively neglected. To the best of my knowledge, the common element of all existing papers on the interrelationships between emerging market investments and economic development is that country-specific interdependencies are analysed. The present study on the other hand departs from this viewpoint, which is limited to separate countries, and instead conducts a supranational analysis of the emerging market sector indices. This examination is therefore based on the assumption that constituents of each sector index are more closely linked to each other than to companies of other sectors contained in conventional national indices. This particularly applies to national stock indices of emerging countries which are largely dependent on one individual sector, as can often be observed in oil-exporting countries. In contrast, following the approach of employing a supranational sector analysis avoids possible distortions resulting from the index composition and allows the identification of sector-specific sensibilities to international economic development.

The empirical results indicate that the observed sectors are stimulated by the US Industrial Production Index and the Dow Jones Index in the long run. Via the channel of reduced purchasing power and consequently lower demand for US imports, the cross-sectoral comparison furthermore reveals adverse effects of growing US inflation on emerging market sectors.

However, contrary to the a priori defined hypotheses, the majority of the examined sectors benefited from increasing commodity prices during the examination sample. As a result, this finding provides empirical evidence on the suspicion that the ongoing catching-up process and the consequential growth in affluence in the emerging countries is largely driven by growing commodity prices and exports. According to that, not only those sectors which are closely linked to commodity trade activities benefit from rising prices. Instead, via the

channels of increasing consumption rates and growing domestic purchasing power within the emerging economies, the remaining sectors also benefit from the increase in export earnings.

In contrast to Chapter 2, which conducts a cross-sectoral comparison, the following chapters are focused on the real estate sector in particular. The scientific approach of Chapter 3 is similar to the first one and is focused on “The Link between Property and the Economy” in the German and British real estate markets. Taking account of the wide-ranging differences between both property markets with respect to market structure, conditions and performance, the findings contribute to improving the evaluation of long-term and short-term effects in two different financial regimes.

On a long-term basis, the results of the implemented VEC models indicate remarkable similarities between both examined real estate markets. Accordingly, in spite of the outlined differences, the long-term equilibrium is determined by the same factors indicating the same signs and the same magnitude of coefficients. Consequently, the empirical results clarify that the fundamental role of property markets in an economy dominates country-specific characteristics in the long run. The distinctive features of the national property markets, however, are primarily relevant during the adjustment process after deviations from the long-term equilibrium. Despite the long-term similarities, the base rate in particular seems to be more important in the German than in the UK property market, where the financial system is known to be predominantly focused on funding by means of capital markets.

Although the economic environment is also considered in Chapter 4, this study is primarily aimed at the scientific issue of whether real estate stock indices in the United States and the United Kingdom are predominantly driven by the underlying property markets or by progress on general stock markets. Despite frequently mentioned benefits of real estate investments, such as high stability of value, comparatively low volatilities and opportunities to hedge against

inflation, investments in direct real estate nevertheless suffer from several disadvantages. Unlike stocks or bonds, neither the market volume nor the spectrum of the international real estate market has been developed to a sufficient extent up to now. In addition to issues of illiquidity, property investments are characterised by low information efficiency and insufficient market transparency. These drawbacks are noticeable in comparatively high information and transaction costs and therefore significantly reduce profit margins.

In the recent past, however, we have observed an ongoing expansion of securitised real estate. The listing on stock exchanges ensures that prices are calculated in real time and favours transparency on markets for real estate investments in this way. In addition, the division into shares reduces the minimum investment amounts and, by implication, the market entrance barriers for potential investors. A further consequence of listing on stock exchanges is that additional drivers – besides the development of the underlying properties – affect the performance and the risk/return structure of the listed asset to a significant extent. Consequently, the asset´s performance is dependent on current economic news, which implies that the company value is not spared from the general stock market risk, including incorrect analyst expectations and valuations. As the equity price is subject to supply and demand, it might therefore suffer from irrational behaviour on stock markets, for example due to exaggerations in phases of boom and bust, or caused by the well-known herding behaviour of investors.

For this reason, it is worthwhile considering whether real estate equities can still be characterised as real estate investments in their primary meaning and whether their distinctive features as an alternative investment still persist despite their listing on stock exchanges. For this purpose, an alternative approach is used. Instead of focussing only on the assets of real estate equities, direct real estate and stock indices – as was frequently done in previous studies – the macroeconomic environment is here explicitly taken into

account in each country. As real estate markets are known to be cyclical in nature (Lizieri et al., 1998), it is therefore supposed that the structure of market behaviour differs across phases of boom and bust. This might be recognisable by lower adjustment velocities after deviations from the equilibrium or by different volatilities of property values depending on the economic situation. For this reason, we presume a significant contribution of the macroeconomy to the explanation of developments on real estate markets in general and for analysing the features of real estate equities in particular.

On the basis of the outlined approach, the implemented methods indicate a significantly stronger linkage among the real estate assets compared to the equity assets in the long run. Therefore, this study clarifies that long-term investments in real estate equity indices still fulfil their function as an alternative investment in order to diversify an investor´s portfolio. This might be recognisable by low correlations to conventional assets and a more defensive risk/return structure compared to investments in general stocks.

2 Macroeconomic Effects on Emerging Market Sector Indices

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Abstract

This study supplies empirical evidence of the dynamic interactions between international macroeconomic determinants and ten emerging market sector indices. As so far empirical research follows the scientific approach of examining each country separately, this paper conducts a supranational sector analysis instead. Due to several economic and monetary crises we find structural breaks in nine of the ten sectors. Taking into account the consequential sub-periods, the sensibility of each sector index to macroeconomic influences is detected by the VECM findings which allows conclusions to be drawn about the sector-specific distinctions in the emerging markets. Contrary to theoretical expectations, the majority of the examined sectors benefited from increasing commodity prices during the examination sample. This finding therefore affirms that the ongoing catching-up process and the consequential growth in affluence in the emerging countries is largely driven by growing commodity prices and exports.

JEL Classification Code: G15

Key Words: Emerging markets, sector indices, macroeconomic variables, vector error correction models

2.1 Introduction

Particularly since the economic and monetary crises of the 1990s, emerging countries have continually been gaining importance for the world economy. In essence, this can primarily be recognised by intensified foreign trade relations with industrialised countries as well as by – particularly in recent times – growing trade activities among the emerging markets. This advancement is predominantly backed by huge commodity deposits which provide the basis for the occurred enlargement of export capacities. Consequently, increasing earnings due to these commodity trade activities lead to growing affluence, which in turn is recognisable by growing consumption rates and rising domestic purchasing power. This still ongoing catching-up process was additionally supported by increasing use of outsourcing measures by companies in industrialised countries. These companies have taken advantage of low wages, lower manufacturing costs and in the end higher profit margins. Furthermore, both the preparing and selling of commodities as well as the efficiency of the manufacturing process were additionally accelerated by the ongoing technological progress.

As companies in the emerging countries are likely to benefit in the course of the outlined catching-up process, international investors as well as scientific literature have focused on economic development and its impact on equity markets. To the best of our knowledge all existing studies concentrate on country-specific interdependencies between macroeconomic variables and the progress of the national stock market indices in the respective country. By using hitherto unconsidered data, this paper abandons the aforementioned scientific approach of examining each country separately and carries out a cross-national sector analysis instead.[1] Within the scope of this study we therefore supply empirical evidence of the dynamic relationships between ten emerging market

[1] As all examined sector indices and all macroeconomic factors are denominated in US dollars or refer to the US monetary zone, this examination is conducted from the viewpoint of a US investor.

sector indices and a set of international macroeconomic variables in the period from January 1995 to March 2007.

For this purpose, we examine whether cointegration exists in the VAR models. The use of the error correction approach makes it possible to evaluate the long-term relationships as well as the short run dynamics separately. In addition, we employ the impulse response analysis and the variance decomposition in order to gain further insights into the dynamic interactions between sector indices and economic progress. Due to the fact that several economic and monetary crises occurred within the examination period, it is necessary to verify the stability of the regression coefficients over time. The identification of structural breaks and the analysis of consequential sector-specific subsamples make it possible to minimize potential crisis effects and thus to enhance the validity of the test results.

Based on the implemented procedures we find strong evidence of significant interactions between the US economy and emerging market sector indices. Taking into account the distinctive features of each sector, the results are largely in line with the a priori defined hypotheses. However, as the vast majority benefited from increasing commodity prices during the examination sample, we conclude that the outlined catching-up process is predominantly backed by intensified commodity exports.

The remainder of this paper proceeds as follows. Section 2.2 reviews the related literature. Section 2.3 introduces the data and the model framework and hypothesises the theoretically expected relationships. Section 2.4 presents empirical evidence for the sector-specific subsamples after the occurred structural breaks. Section 2.5 concludes.

2.2 Review of Literature

Scientific literature has up to now concentrated on country-specific interdependencies. Numerous studies such as those by Fama (1981), Geske and Roll (1983) as well as Lee (1992) provide empirical evidence of significant influences of macroeconomic variables on the progress of stock markets. According to Chen et al. (1986) these macroeconomic factors become risk factors in equity markets via the channels of future corporate cash flow, required rate of return and future dividends.

As emerging economies are becoming increasingly important for the world economy, various researchers have directed their attention to them in the recent past. Naka et al. (1998) use the VECM according to Johansen (1988)[2] to examine the Indian stock exchange between 1960 and 1995. They conclude that the five examined variables are cointegrated, and that three long-term equilibrium relationships exist between the variables. The empirical results further indicate that industrial production represents the greatest positive and inflation the greatest negative determining factors that influence the Indian stock exchange. Wongbangpo and Sharma (2002) similarly provide evidence for the ASEAN-5 countries[3] of significant influences of the selected macroeconomic risk factors. While the effects of the variables gross national product (positive) and consumer price index (negative) are uniform for all five countries during the examined period between 1985 and 1996, the algebraic signs of the variables money supply, interest rate and exchange rate vary depending on the country.

In the framework of his analysis of macroeconomic interdependencies in 21 emerging capital markets, Al-Khazali (2003) determines a long-term equilibrium between stock prices, consumer price index, and the real economic activity by

[2] As several papers contribute to the development of the Johansen procedure as it is used within the scope of this study, the denoted year refers to the first paper of the VECM series by Johansen and Juselius.

[3] The ASEAN-5 countries (= Association of Southeast Asian Nations) include Indonesia, Malaysia, Philippines, Singapore and Thailand.

using cointegration tests. Furthermore, this study supplies empirical evidence of a negative relationship between stock returns and inflation in the short-run. In their study of interdependencies on the Indian market between 1994 and 2003, Ray and Vani (2003) draw on a VAR model and an artificial neural network (ANN). The results reveal that the variables interest rate, industrial production, money supply, inflation rate and exchange rate have a significant influence on equity prices, while no significance is discovered for the variables of fiscal deficit and foreign investment. Furthermore, some separately examined sub-periods are dominated by individual variables such as money supply or the inflation rate.

Using the Johansen procedure in his study of the Jordanian stock exchange between March 1980 and December 2003, Al-Sharkas (2004) discovers the existence of a long-term equilibrium between stock price development and four selected macroeconomic factors. While inflation and interest rate exert a significantly negative influence on the markets, the author discovers a positive relationship between market trends and industrial production as well as between market trends and money supply. Erdem et al. (2005) make use of an EGARCH model to examine the spillover effects on the Turkish stock market between 1991 and 2004. Here they discover major effects of the variables of inflation and interest rates on all examined equity indices. Based on the variables of money supply (M1) and exchange rate, spillover effects can be seen on individual Turkish sector indices, while the industrial production variable on the other hand has no influence on the indices examined.

The common element in all of these papers is that country-specific interdependencies between macroeconomic variables and national index progress are analysed. This study on the other hand departs from this viewpoint, which is limited to separate countries, and instead conducts a supranational analysis of the emerging market sector indices. Our examination is therefore based on the assumption that constituents of each sector index are more closely linked to each other than to companies of other sectors contained

in conventional national stock indices. This particularly applies to national stock indices which are largely driven by one individual sector. One example in this context is represented by the MSCI Russia stock index, as the companies of the energy sector aggregate 64.8% of the entire index.[4] Due to this index composition, effects of oil price variations would dominate effects in other sectors which implies that econometric analyses based on these indices would lead to unreliable economic implications. As a result, following the approach of employing a supranational sector analysis avoids these distortions and allows to identify the sector-specific sensibilities in the emerging countries to international economic development. In this way, we additionally gain findings whether these interdependencies correspond to those in industrialised countries.

2.3 Data Selection, Methodology and Hypotheses

2.3.1 Data

The econometric analysis is based on monthly data for the examination period between January 1995 and March 2007. The time series of the ten sector indices are provided by MSCI Barra, and the macroeconomic variables by Datastream.[5] These variables are represented by the Dow Jones Index, the Federal Funds Rate, the US Industrial Production Index, the US Consumer Price Index as well as the Goldman Sachs Commodity Index.

The selection of the macroeconomic risk factors is based on theoretical assumptions and propositions of comparable empirical examinations. The reason for the preponderance of chosen macroeconomic US variables lies on the one hand in the fact that many of the emerging countries are closely linked

[4] The denoted value refers to the morningstar database (as of December 2008).

[5] The considered time series are available since 1995. The fact that MSCI carried out a reclassification of individual sectors in April 2000 and therefore during the examination period does not falsify the empirical results. Each of the sector indices was retroactively calculated on the basis of the specifications of the new classification method and is uniformly presented for the examination period according to the new calculation principles.

to the United States. This is noticeable, among other factors, through the linking of national currencies to the US dollar or through intensive foreign trade activity with the United States. On the other hand, due to their major importance for the global capital market, US fundamental data can be interpreted as essential determinants for the investment climate in international stock markets.

As emerging countries benefit from a wide range of commodities we use the Goldman Sachs Commodity Index (GSCI) in order to model the influences of the commodity and energy markets. This index represents a basket of commodity futures. By its special weighting of individual commodities the major significance of energy commodities is taken into account without neglecting agricultural and industrial commodities as well as precious metals. In this way, we prefer to examine the impact of a wide range of commodities to the conventional use of oil price time series as a proxy for the progress of energy prices.

Table 2-1 outlines all time series used and presents the corresponding descriptive statistics for their first differences.[6] Accordingly, Figure 2-2 (in Section 2.6.1) reveals the progress of each sector index during the period between January 1995 and March 2007. All time series are presented uniformly in US dollars and are transformed into natural logarithms. Due to its interest character the FED variable represents the only exception in this context and is therefore used without any transformation. Furthermore, the time series of the macroeconomic variables US Industrial Production Index and US Consumer Price Index are seasonally adjusted with the additive variant of the X12 procedure.

[6] According to the definition of MSCI Barra, the following 27 countries are included in the emerging markets category: Korea, Taiwan, Brazil, South Africa, Russia, Mexico, China, India, Israel, Malaysia, Turkey, Thailand, Indonesia, Poland, Chile, Hungary, Czech Republic, Argentina, Egypt, Peru, Philippines, Colombia, Pakistan, Morocco, Jordan, Venezuela, Sri Lanka.

With the exception of the Federal Funds Rate, all variables display positive average growth rates during the examination period between January 1995 and March 2007. The results for the time series of all sector indices and for the macroeconomic variables US Consumer Price Index, Federal Funds Rate and Dow Jones Index uniformly display a bias to the left and leptocurtotic distributions. Furthermore, the Jarcque Bera test rejects the null hypothesis of normal distribution for these variables to the 99% level and for the sector index Health Care to the 95% level. The macroeconomic variables US Industrial Production Index and Goldman Sachs Commodity Index on the other hand are approximately normally distributed.

Table 2-1 Summary Statistics.

Panel A: MSCI Emerging Markets Sector Indices								
Variable	Symbol	Mean	Max	Min	Std.Dev.	Skewnes	Kurtosis	JB
Log of MSCI EM Energy	EN	0.013	0.216	-0.446	0.087	-1.147	7.694	166.025**
Log of MSCI EM Materials	MAT	0.009	0.182	-0.271	0.068	-0.779	4.677	31.887***
Log of MSCI EM Industrials	IND	0.002	0.133	-0.285	0.065	-1.130	5.616	72.708***
Log of MSCI EM Consumer Discretionary	COND	0.007	0.200	-0.328	0.074	-0.897	5.375	53.887***
Log of MSCI EM Consumer Staples	CONS	0.009	0.116	-0.269	0.051	-1.488	8.257	222.027***
Log of MSCI EM Health Care	HC	0.011	0.163	-0.170	0.057	-0.508	3.392	7.205**
Log of MSCI EM Financials	FIN	0.008	0.136	-0.351	0.069	-1.261	7.182	145.079***
Log of MSCI EM Information Technology	INF	0.008	0.298	-0.319	0.097	-0.307	4.355	13.462***
Log of MSCI EM Telecommunications	TEL	0.008	0.218	-0.398	0.079	-1.245	7.147	142.370***
Log of MSCI EM Utilities	UT	0.006	0.170	-0.488	0.081	-1.809	11.847	555.807***
Source: MSCI Barra, own calculations.								
Panel B: Macroeconomic Variables								
Variable	Symbol	Mean	Max	Min	Std.Dev.	Skewnes	Kurtosis	JB
Log of US Consumer Price Index	CPIUSA	0.002	0.012	-0.007	0.002	-0.067	6.320	67,146***
Log of US Industrial Production Index	IPUSA	0.003	0.054	-0.048	0.022	-0.001	3.210	0,268
Federal Funds Rate	FED	-0.002	0.500	-1.000	0.191	-1.376	8.701	243,840***
Log of Dow Jones	DJ	0.008	0.101	-0.164	0.043	-0.759	4.766	32,979***
Log of Commodity Index GSCI	GSCI	0.007	0.163	-0.182	0.059	-0.091	3.137	0,314
Source: Datastream, own calculations.								

Notes: ***, **, * denote significance at 1%, 5%, and 10% confidence level, respectively. JB = Jarque-Bera test on normality.

The evaluation of the standard deviations for the macroeconomic variables illustrates the exceptional position of the Federal Funds Rate, which is based on its function as an instrument of the Federal Reserve to intervene in the money market. Of all stock indices examined the time series of the Dow Jones displays the smallest standard deviation with a value of 0.043. In the sector comparison, the Consumer Staples (0.051) and Health Care (0.057) sectors have the lowest and the Information Technology (0.097) and Energy (0.087) sectors the highest values.

2.3.2 Cointegration and VECM

This paper is focused on the dynamic relationships between macroeconomic variables and sector indices of the emerging markets from the viewpoint of a US investor. For this purpose the cointegration concept is applied to vector autoregressive (VAR) models using the vector error correction framework (VECM) according to Johansen (1988).

The concept of cointegration is traced back to Granger (1981, 1986) and Engle and Granger (1987). It combines time-series analytical procedures with the concept of economic equilibrium, and facilitates the analysis of long-term equilibrium relationships between non-stationary variables. The cointegration analysis is based on the observation that economic variables often display common trend behaviour. This implies that linear combinations of these variables converge towards a common equilibrium in the long term, even though individual time series fluctuate over time. According to Engle and Granger (1987), time series are cointegrated if they display the same degree of integration and a linear combination of these variables is stationary. Furthermore, the use of the time series in their levels guarantees that information losses due to the conventional use of first differences are avoided. According to the Granger representation theorem, the dynamic adjustment process of cointegrated variables towards the long-term equilibrium relationship can be represented by an error correction model (ECM). In this way, long-term equilibrium relationships are combined with short-term dynamics.

Modelling of the non-stationary variables as a vector autoregressive (VAR) process Y_t of finite order k forms the basis of the Johansen (1988) test procedure for cointegration. If at least two of the variables are cointegrated of the order of one, then the VAR(k) process can be reparametrised and written as a vector error correction model:

$$\Delta Y_t = \mu + \pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \tag{2-1}$$

ΔY_t is a (n x 1) vector of the first differences of stochastic variables Y_t, and μ is a (n x 1) vector of the constants. The lagged variables are contained in vector Y_{t-1}. The (n x n) matrices Γ_i represent the short-term dynamic. The coefficients of the cointegrating relationships (cointegration vectors) and of the error correction term are contained in the matrix π. In this way the long-term relationships between the variables are recorded (Nastansky, 2007).

π can be analysed as follows:

$$\pi = \alpha\beta' \tag{2-2}$$

ß represents a (n x r) matrix of the r cointegrating vectors. The (n x r) matrix α contains the so-called loading parameter, i.e. those coefficients that describe the contribution of the r long-term relationships in the individual equations. Here α and ß have full rank. It should be noted that the analysis of π is not definite. If in Equation (2-1) π is replaced by the Equation (2-2), then the error correction representation follows (vector error correction model, VECM).

$$\Delta Y_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \alpha\beta' Y_{t-1} + \varepsilon_t \tag{2-3}$$

2.3.3 Hypotheses

The expected equilibrium relations are formulated on the basis of the standard stock price valuation model:

$$P_0 = \sum \frac{\mathrm{E}(CF_t)}{(1+k_t)^t} \tag{2-4}$$

Here P_0 represents the equity price, $E(CF_t)$ the discounted future value of the expected cash flow, and k_t the required rate of return. In accordance with Naka et al. (1998), the required rate of return k_t consists of two fundamental components, namely the nominal, risk-free interest rate and the corresponding risk premium of each asset. According to Equation (2-4), macroeconomic developments have the effect of changing the expected cash flow and/or the required rate of return, and in this way influence equity prices.

Based on the standard valuation model, an increase in consumer prices implies an increase in nominal risk-free investment and in this way boosts the required rate of return k_t (Maysami and Koh, 2000). As a result, rising inflation implicates rising energy costs, increasing wage claims as well as growing nominal capital expenditure. Since companies cannot adapt their nominally higher costs immediately, cash flows do not rise without delay to the same extent as inflation (De Fina, 1991). In the expected case of not being able to compensate for these inflation effects by enhancing companies´ productivity immediately, this functional chain ends in negative effects on equity prices. Thus, we do not assume that common stocks are an effective hedge against growing inflation. Consequently, we expect a negative linkage between index performance and rising consumer prices.

Any type of output growth positively influences the expected future cash flow of companies (Naka et al., 1998). In a long-term view, economic growth implicates growing consumption rates and thus rising market potential. As a consequence

of this, the propensity to invest is increasing by implication. Finally, since US economic growth is an indicator of the global economy, the emerging markets are also likely to benefit from economic growth in the United States. In individual sectors, however, crowding-out effects by companies from industrialised countries could result. Assuming that companies expand their market share with increasing economic growth and by means of a decisive technological superiority at the expense of local companies, this can result in the opposite effect in emerging markets. Nevertheless, we assume that the first aspect prevails and therefore expect a positive linkage between growing industrial production in the United States and emerging market sector indices.

Evidence of the immense effect of changing the Federal Funds Rate on the global financial market is provided by Hamilton and Jordá (2002). Restrictive monetary measures by central banks burden the liquidity of market participants in the capital market. As increasing key interest rates implicate that credit terms tighten and thus negatively affect companies´ refinancing facilities, we expect negative effects of Federal Funds Rate hikes on equity prices.

As the Dow Jones Index is assumed to be the benchmark index of international stock markets we use this index within the scope of this paper as a determinant in the development of emerging market sector indices. According to the standard valuation model, the increase of the Dow Jones Index implicates rising cash flow expectations. Due to the evidence of existing contagion effects between international markets provided by King and Wadhwani (1990) it is therefore assumed that the performance of the emerging market sector indices is positively linked with the progress of the Dow Jones Index.

On the other hand, rising commodity prices put pressure on companies' expected cash flows through higher operating costs. It is assumed that passing the higher costs on to consumers only occurs with a delay. Consequently, a negative relationship is expected between GSCI and the progress of the sector indices in principle. In this context an exceptional position is occupied by

companies of the sectors Energy, Materials and Utilities. Due to their close linkage to commodity preparation and trading as well as in their capacity as energy suppliers, the companies of these sectors are particularly likely to be the first to profit from rising commodity prices. For that reason, we expect a positive linkage exclusively for constituents of the three mentioned sectors. Table 2-2 outlines the defined hypotheses.

Table 2-2 Hypotheses.

Hypothesis	Time-series	Variable	Expected Impact
Hypothesis CPI	US Consumer Price Index	CPIUSA	-
Hypothesis IP	US Industrial Production Index	IPUSA	+
Hypothesis RAT	Federal Funds Rate	FED	-
Hypothesis DJ	Dow Jones Index	DJ	+
Hypothesis COMM-1	Goldman Sachs Commodity Index (in general)	GSCI	-
Hypothesis COMM-2	Goldman Sachs Commodity Index: Sector Indices Energy (EN), Materials (MAT) and Utilities (UT)	GSCI	+

2.4 Empirical Results

2.4.1 Cointegration Analysis

2.4.1.1 Structural Change

Due to the fact that numerous economic and currency crises occurred in emerging markets in the 1990s it can be assumed that the effects of these crises will influence the time series to a significant extent. The so-called Mexican tequila crisis of 1995, the Asian currency crisis of 1997, the Russian crisis of 1998 and the Brazilian economic and currency crisis of 1998/99 fall within the examination period, and may therefore be responsible for distortions within the time series. As a result, the elimination of crisis effects is necessary in order to improve the validity of the test results. Furthermore, taking into account possible structural breaks is of particular importance when applying cointegration techniques. Ignoring the existence of structural breaks in the deterministic trend leads to unreliable unit root test decisions and ultimately to the risk of misspecified estimation models (Perron, 1989).

Consequently, prior to the econometrical analysis, we apply a two-stage test procedure in order to verify the stability of the regression coefficients over time and to ensure the identification of structural breaks. Firstly, the time series are checked for the existence of structural breaks by means of CUSUM and CUSUMQ tests. Secondly, the Chow test verifies the dates which are determined by these test procedures. For that reason the Chow test is ultimately crucial in terms of the exact determination of the sub-periods. Table 2-3 presents the resulting dates of structural breaks for each sector model as well as the corresponding test statistics and p-values of the Chow test.

As transnational indices are analysed for the purposes of this study, it is also necessary to preclude possible distortions due to cluster risks. Accordingly, the progress of a sector index could be dominated by developments in overrepresented countries. With regard to the examined MSCI Emerging Market Sector Indices, constituents are widely spread over countries. Due to heavy foreign trade activities, as expected, companies of South Korea, Taiwan and companies of the BRIC countries, namely Brazil, Russia, India and China, cover the largest part of the sectors' constituents. In this context, if anything, cluster risks could at most apply to the Energy and Health Care sectors, where Russian oil companies cover about 30% of the portfolio weighting and Israeli health care companies even more than 50% of the portfolio weighting. Nevertheless, results are consistent over all sectors. This applies to both the tests for structural breaks and the ultimate VECM results. Therefore, we conclude that the implemented country composition of the individual sector indices does not lead to significant distortions or losses of information.

The test procedures discover structural breaks during the examination period for nine of the ten sector indices. The Information Technologies sector is the only exception here. The identified dates lie within the short period between June 1998 and November 1999. Against the background of numerous economic and currency crises in the emerging markets in the 1990s it is

presumed that there is a close connection between the crisis effects and dates of the structural breaks. Consequently, although we assume that there are individual countries which where relatively unaffected by the crises mentioned above, ignoring the detected structural breaks would lead to instable results and thus to unreliable economic implications. Therefore, we apply the cointegration framework and the Johansen (1988) procedure while taking into account of the consequential sector-specific sub-periods.

Table 2-3 Results of the Chow Breakpoint Test.

Sector	Estimated breakpoint	Chow breakpoint test H_0: no structural break in t	
		F-Statistic	p-value
1 Energy	09/1998	3.288	0.004
2 Materials	06/1998	3.869	0.001
3 Industrials	06/1998	3.074	0.007
4 Consumer Discretionary	06/1998	3.517	0.002
5 Consumer Staples	07/1998	2.307	0.037
6 Health Care	06/1998	3.060	0.007
7 Financials	06/1998	2.256	0.041
8 Information Technologies	X	X	X
9 Telecommunication	11/1999	2.417	0.029
10 Utilities	09/1999	5.055	0.000

Notes: X denotes that the implemented tests identify no structural breaks during the examination period. CUSUM and CUSUMQ tests as well as the Chow test are carried out on the basis of the ordinary least squares (OLS) method.

2.4.1.2 Unit Root Tests

Unit root tests facilitate the determination of the stationary nature of time series. For the purposes of this examination the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981) and the Phillips-Perron (PP) test (Phillips, 1987, Phillips and Perron, 1988) are used. Here the null hypothesis of non-stationarity is tested against the alternative hypothesis of stationarity of the present time series.[7] Within the scope of this paper we prefer the results of the PP test in case of deviating results. By virtue of the correction procedure according to

[7] The test decisions are based on the critical values of MacKinnon (1991, 1996). The number of lags is determined in the framework of the ADF test with the aid of the Akaike information criterion (AIC), and the PP test is based on Newey-West (1994) bandwidth using Bartlett kernel.

Newey West (1994) as well as the Bartlett window, the PP test provides robust results both in the case of present autocorrelation and for time-independent heteroscedasticity (Perron, 1989).

By having regard to the sub-periods after the sector-specific structural breaks the ADF and PP tests come to the unanimous result that all time series are non-stationary in the levels and stationary in the first differences. All variables consequently display the same degree of integration.[8] In this way, the cointegration analysis can be conducted on the basis of consistent time-series.

2.4.1.3 Cointegration Tests

In order to detect the existence of cointegrating relationships we employ the trace test and the maximum eigenvalue test. Determination of rank and estimation of the coefficients are performed as a maximum likelihood estimation. The corresponding likelihood-ratio test statistics are:

$$\lambda_{Trace} = -T \sum_{r+1}^{k} \ln(1 - \lambda_i) \tag{2-5}$$

$$\lambda_{max} = -T \ln(1 - \lambda_i) \tag{2-6}$$

λ represents the estimated eigenvalues of the reduced rank of the matrix π. The sequential test strategy begins with r = 0 and is continued until the null hypothesis for a given significance level cannot be rejected for the first time. The related value of r ultimately corresponds to the cointegration rank. In this way there are (n-r) stochastic trends in the system. In this study the corresponding critical values are used in accordance with Osterwald-Lenum (1992). Analogous to Nastansky (2007), due to the precisely formulated

[8] The unit root test results of all examined sector models are available upon request.

alternative hypothesis, this examination prefers the results of the maximum eigenvalue test compared to those of the trace test.

Within the sector-specific examination periods at least one cointegrating relationship is detected by the applied cointegration tests.[9] The choice of the underlying VAR models is based in the first stage on the recommendations of the Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). The recommended VAR models are examined by means of further diagnostic tests. Should autocorrelation and/or heteroscedasticity occur in the consequential VEC models, then we choose the next highest order. In all models examined, the use of this approach avoids misinterpretation of the test results due to occurring heteroscedasticity at the tolerable expense of losing a few monitoring points.[10]

2.4.2 VECM Results

2.4.2.1 Evaluation Principles

Our main objective is to detect the interrelationships between international macroeconomic factors and the progress of the emerging market sector indices with respect to significance and signs of coefficients. For that reason, we choose equal evaluation principles in order to allow for comparisons between all sector models.

Due to this approach the normalisation of the ß vectors depends on which factors are identified as significant. The identification of those individual factors which significantly contribute to explaining the sector-specific equilibrium is based on the results of the tests for linear restrictions (LR tests). By employing

[9] To see the sector-specific results please refer to Chapter 2.6.2.

[10] However, prior to this decision, it is necessary to conduct further analyses in order to preclude the possibility that other reasons, such as high values of correlation among the selected variables, are responsible for the significant deviations from the null hypothesis of the White test.

LR tests we verify whether individual coefficients could be restricted to zero without accepting significant information losses. In case of being significant the sector indices are normalised to one in order to be able to evaluate the sector-specific nexus to the macroeconomic determinants in the long run. If this does not apply to individual vectors we restrict the respective sector index to zero. In this instance information is only provided via the coefficients related to the adjustment process.

The long-term equilibrium relationships for the sector-specific subsamples after the structural breaks are outlined in Table 2-4.[11] Coefficients within each vector are already converted so that relationships between the normalised variable and the risk factors can be identified directly as positive or negative.

As displayed, we take into account the case of multidimensional cointegrating relationships within the scope of our examination. The implemented restrictions are accepted by the LR tests indicating that these restrictions do not lead to significant losses of information. Furthermore, the p-values of the White tests consistently reveal that the risk of distorted VECM results due to heteroscedasticity is eliminated.[12]

[11] For reasons of clarity we do not report the corresponding constant c and the ε as a proxy for the error term.

[12] The estimated models are free of possible hazards caused by occuring autocorrelation occurring within the residuals, too, although this is not explicitly mentioned in Table 2-4.

Table 2-4 Long-term Equilibrium Relationships.

Sector	r	Index	CPIUSA	DJ	FED	IPUSA	GSCI	pWhite LR-Test	R^2
1 Energy (10/1998-03/2007)	2*	1.000	0	+0.844 [-4.439]	-0.097 [3.108]	+7.721 [-3.592]	+2.616 [-5.924]	0.255 0.582	0.347
		1.000	-54.157 [5.059]	0	0	0	+7.410 [-8.616]		
2 Materials (07/1998-03/2007)	2	1.000	0	0	0	+4.645 [-3.463]	+1.048 [-7.446]	0.609 0.103	0.323
		1.000	+3.575 [-8.179]	0	0	+7.249 [-7.788]	0		
3 Industrials (07/1998-03/2007)	2*	0	1.000	0	+0.017 [-9.532]	-1.421 [9.130]	0	0.249 0.350	0.321
		1.000	-86.895 [4.976]	0	0	+22.742 [-3.443]	+5.223 [-5.121]		
4 Consumer Discretionary (07/1998-03/2007)	2	1.000	0	+0.698 [-4.513]	-0.099 [7.907]	+14.996 [-9.417]	-0.644 [3.830]	0.227	0.250
		1.000	-6.610 [4.979]	0	-0.151 [-5.648]	+22.221 [-9.867]	0	0.935	
5 Consumer Staples (08/1998-03/2007)	2	1.000	-17.974 [6.245]	0	0	0	+4.896 [-8.488]	0.737	0.241
		1.000	0	0	0	+15.903 [-7.423]	-0.857 [3.332]	0.673	
6 Health Care (07/1998-03/2007)	1	1.000	-27.528 [4.777]	0	-0.174 [3.337]	0	+6.864 [-6.379]	0.262 0.744	0.256
7 Financials (07/1998-03/2007)	3*	1.000	0	+0.650 [-6.395]	+0.069 [-9.859]	+2.700 [-3.090]	0	0.217 0.552	0.274
		1.000	+4.512 [2.693]	0	0	+7.440 [-6.868]	+1.720 [-7.946]		
		0	1.000	-0.0482 [4.843]	0	0	+0.143 [-9.733]		
8 Information Technologies (01/1995-03/2007)	1	1.000	-10.424 [7.932]	0	0	+6.859 [-9.549]	+1.842 [-8.478]	0.684 0.119	0.264
9 Telecommunicat. (12/1999-03/2007)	3*	1.000	0	0	-0.072 [1.838]	+31.776 [-6.103]	0	0.484 0.221	0.366
		1.000	-21.433 [3.931]	0	0	+21.530 [-4.878]	+2.440 [-8.064]		
		1.000	0	+1.609 [-9.329]	0	0	+1.947 [-7.938]		
10 Utilities (10/1999-03/2007)	2*	1.000	0	+2.161 [-4.776]	-0.544 [5.089]	+19.842 [-1.969]	+9.441 [-14.406]	0.149 0.576	0.301
		0	+7.058 [-5.885]	0	0	+1.374 [-2.764]	1.000		

Notes: r denotes the number of cointegrating vectors. t-statistics are included in parentheses. * denotes that the VEC model includes a deterministic trend. CPIUSA = US Consumer Price Index; DJ = Dow Jones Index; FED = Federal Funds Rate; IPUSA = US Industrial Production Index; GSCI = Goldman Sachs Commodity Index. pWhite denotes the p-values of the White test for heteroscedasticity. LR-Test denotes the probabilities of the test for linear restrictions. R^2 denotes the goodness of fit.

Although scattered signs are contrary to the a priori defined hypotheses, the VECM results can be reasonably explained by the sector-specific distinctions. These findings are ensured by choosing alternative underlying VAR models. If normalised to the sector indices, the macroeconomic factors Dow Jones and the US Industrial Production Index consistently display positive signs in each ß-vector and thus affect each sector index in the same way.[13] Consequently, we are able to confirm the hypotheses related to the Dow Jones variable and the industrial production index without exception. This does not apply to the effects of the US Consumer Prices, the Federal Funds Rate and the Goldman Sachs Commodity Index, as their signs vary depending on the sectors´ distinctive features.

2.4.2.2 Consumer Prices

The majority of the examined sectors are negatively influenced by rising US consumer prices. In principle, higher rates of inflation implicate higher nominal wage demands and tightened conditions for raising capital. Furthermore, also the conditions for new investments tighten, because companies are faced with the problem of having less real investment capital at disposal. In this way, the financial scope for expansion measures is constricted, which in turn rules out companies being able to exhaust their efficiency limit. As companies are not able to balance these burdens immediately, growing inflation affects their cash flows negatively in this way. Accordingly, the decrease in real value of the US dollar due to growing US consumer prices burdens both the amount of US foreign investments and US imports. Furthermore, export companies of the emerging markets also suffer from a decreasing real value of their returns, because transcaction prices are set in US dollars.

[13] A different normalisation is chosen, for instance, in the first vector covering the Industrials sector in Table 2-4, as the sector index variable is not significant in that case. Due to the normalisation to the US Consumer Price Index (CPIUSA), we find a negative sign of the IPUSA variable indicating the adverse long-term relationship between growing inflation and industrial production.

In contrast, the results of the sectors Materials and Financials contradict the a priori defined hypothesis. The Materials sector primarily contains gold mining and aluminium processing companies. As prices of the related commodities rose remarkably during the examination period, cash flows of the sector´s constituents benefited from this development. Due to the inflation-hedging characteristics and the consequential additional demand for gold investments, we find a positive linkage between growing rates of inflation in the United States and the Materials sector, particularly as commodity prices are denominated in US dollars. Although the sectors Energy and Materials are likely to have similar conditions, we nevertheless find a distinction between these sectors. Due to the high ratio of gold mining companies, the inflation-hedging characteristic only applies to the Materials sector.

2.4.2.3 Federal Funds Rate

As expected, rate hikes of the Federal Reserve affect sector indices negatively, as they primarily lead to rising credit costs and therefore to rising costs of refinancing. Therefore, profit margins of US companies drop and lead to a decreasing readiness to invest. In this context, more severe credit standards cause a decrease in demand for foreign investments in the emerging markets, particularly as these investments usually require a high ratio of debt capital. The Financials sector represents the only exception in this context as the empirical results feature a positive linkage in that case. Compared to constituents of other sectors, financial companies have advantages in terms of shifting the higher credit costs on to customers. In consequence, due to their capacity as intermediaries, it is easier for constituents of the Financials sector to balance these additional burdens.

2.4.2.4 Commodity Prices

The vast majority of the examined sectors benefit from increasing commodity prices. This finding represents a considerable deviation from the a priori defined hypotheses. Due to their close linkage to commodity preparation and trading as well as in the capacity as energy suppliers, the companies of the sectors Energy, Materials and Utilities in particular are the first to profit from rising commodity prices.

As mentioned above, the ongoing catching-up process and by implication the growth in affluence in the emerging countries is largely caused by growing commodity exports. In short, huge commodity deposits, lower manufacturing costs and lower wages attract foreign companies to invest in the emerging markets. Due to the consequential rising demand for domestic workers, the unemployment rate drops which forms the basis for the growth in affluence, rising consumption rates and growing domestic purchasing power. Consequently, not only the sectors which are closely linked to commodities benefit from rising prices. Instead, via the channels of rising consumption rates and growing purchasing power, companies´ cash flows in several sectors are indirectly stimulated by increasing export earnings. As a result, the sectors Industrials, Health Care, Information Technologies and Telecommunciation also benefit from growing commodity exports and the consequential growth in affluence. Using our approach of employing a cross-national sector analysis, we therefore find no evidence of occuring effects caused by a Dutch disease.[14]

As the recorded catching-up process implicates that companies have to increase their demand for funding and insurance as well as real estate investments for the purpose of business expansion, this also applies to the

[14] The Dutch disease was detected in the Netherlands during the 1960s and is characterised as follows: A heavy orientation to commodity exports leads to a huge trade surplus and, by implication, to a revaluation of the domestic currency. Due to this process the manufactoring sector is burdened. In consequence, the downturn in the non-commodity sectors causes unemployment and decreasing consumption rates. In the end, this functional chain facilitates economic slowdown.

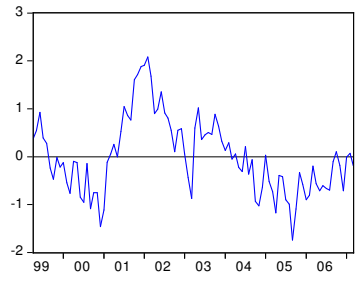
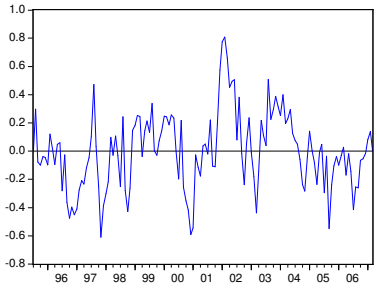
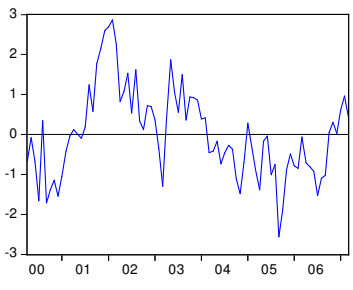
Financials sector. As a result, the sector´s constituents profit by lending money or by effecting insurances. The inconsistence of the GSCI´s signs in the Consumer Staples sector, however, can be accounted for by two opposed effects. On the one hand, this index contains companies which produce or sell articles of daily use, such as food, beverages and household or personal products. Therefore, in case of rising prices, the elasticity of demand is more inelastic compared to other sectors. On the other hand, rising prices nevertheless implicate higher costs of manufacturing and thus higher purchasing costs. As a consequence of this, cash flows of companies are burdened, albeit to a smaller extent compared to other sectors.

However, due to the comparatively high elasticity of demand for products in the segments leisure, media or automobiles, the Consumer Discretionary sector is the only one which is clearly negatively affected by rising commodity prices. The effects of growing commodity prices are noticeable by an increasing ratio of expenditures for products of daily needs relative to decreasing expenditures for products related to leisure, media or automobile. This process burdens the purchasing power and in this way reduces the sum of disposable income, which is ultimately decisive for the business of the Consumer Discretionary sector. For that reason, these developments result in depressed cash flows in the long run. As the same argumentation applies to the effects of growing rates of inflation, we find a negative linkage between the Consumer Discretionary sector and both rising commodity prices as well as growing rates of inflation.

2.4.2.5 Adjustment Process

The evaluation of the α-vectors allows to gain insights on the way how disequilibria in the sector models are linked with the economy. Real error correction terms are characterised by significant and negative alpha coefficients of the normalised variable in each vector. In this way, these mechanisms facilitate the return to the long-term equilibrium path.

Figure 2-1 Cointegration Graphs. [15]

Energy	Information Technology	Utilities
		

In case of disequilibria, the VECM results indicate a close linkage between the economy and the Energy sector. This is noticeable as deviations from the long-term equilibrium significantly affect consumer prices, the Dow Jones Index as well as the Federal Funds Rate. Besides this aspect, the close linkage is furthermore recognisable by high adjustment velocities.[16] The corresponding cointegration graphs are illustrated in Figure 2-1. As disequilibria affect several macroeconomic risk factors to a significant extent, we also find close linkages for the sectors Information Technologies and Utilities. However, the average adjustment period in the latter sector is not that short compared to the others.

Moreover, also the remaining sector models indicate close linkages to the US economy during the adjustment process, predominantly to US consumer prices (see Chapter 2.6.3). Consequently, the progress of each emerging market sector index has been significantly influenced by the US economy in both the long-term relationships and in the adjustment processes as well. As a result we

[15] In order to maintain the clarity we present only one cointegration graph for each sector model. The cointegration graphs of the remaining models are available upon request. All VEC models are additionally tested for stationary by the Dickey-Fuller (DF) test using the critical values according to Banerjee et al. (1993).

[16] Within the scope of the adjustment processes the denoted α refers to the adjustment coefficient of the normalised variable of the respective vector. The estimated adjustment processes of all examined sector models are outlined in Chapter 2.6.3. For instance, it takes on average about 1/-α = 5 months to return to the long-term equilibrium after disequilibria in the Energy sector or on average about 1/-α = 1 month in the Financials sector. In contrast, the same instance would last about 1/-α = 12 years in the Health Care sector.

find no empirical evidence of possible decoupling effects of emerging economies from the US economy.

2.4.3 Impulse Response Analysis and Variance Decomposition

The results of the VECM analysis indicate that the examined emerging market sector indices are closely linked to developments of the US economy and that the effects can reasonably be explained by sector-specific distinctions. In order to gain further insights on the interactions between sector indices and macroeconomic determinants, all sector models are additionally analysed by means of impulse response analyses and variance decompositions. Impulse response analyses, allow to evaluate the reactions of the sector indices to a one-off shock of an independent variable. The variance decomposition, however, provides information on the relative significance of the individual variables in explaining index development.[17] To do this, the variance of the errors discovered ex post is allocated proportionately to the examined variables.

From a cross-sectoral point of view the largest negative effects predominantly result due to one-off shocks of the consumer prices, while the largest positive effects are caused by Dow Jones shocks (see Figure 2-3 in Chapter 2.6.4). Due to its capacity as a stock exchange index, the impulse response analysis and the variance decomposition unanimously discern a dominant influence of the Dow Jones variable on emerging market sector indices, especially in a short-term view. Here the results of the impulse response analyses demonstrate a

[17] By determining the Cholesky order a causal structure is implicitly assumed between the variables of the system in the case of both examination methods. This is expressed in the distribution of the common components of the interference terms in favour of the variables preceded in the Cholesky order. This fact has a major influence on the results especially in the case of a strong correlation between the original error values. Analogous to Nasseh and Strauss (2000), this study is therefore based on the assumption that exogenic shocks primarily influence production and thus, in accordance with the standard valuation model, the equity indices are influenced via expected future cash flows. The following Cholesky order results from this argument: US Industrial Production Index, Federal Fund Rate of the Federal Reserve, US Consumer Price Index, Goldman Sachs Commodity Index, Dow Jones Index as well as the respective sector indices.

uniform profile for all sectors. All sector indices react without delay to the Dow Jones shock and do not return to the starting point during the next twelve months. The uniformly instant shock effect can, among other causes, be accounted for by the contagion effects in international capital markets, which have been documented by King and Wadhwani (1990). The variance decomposition comes to the same conclusion, according to which a comparatively substantial contribution to variance of the sector indices is explained by the Dow Jones variable (see Table 2-7 in Chapter 2.6.5). Therefore both implemented methods indicate that variations on capital markets in the United States spill over to financial markets in the emerging countries immediately.

By contrast, the influence of the determinants representing the real economy is primarily relevant in a long-term point of view. In aggreement, the VECM results as well as the impulse response analyses detect a negative linkage between sector indices and US inflation. Moreover, also the results of the variance decompositions reveal an essential role of the US Consumer Price Index. Accordingly, a cross-sectoral comparison clarifies that the CPI variable explains a large fraction of the sector indices´ variance when considering longer time periods.

In this context, the significant role of the US consumer prices can reasonably be explained by the increased foreign trade activities of emerging countries, particularly with respect to commodity exports. As indicated by the VECM results, the examined emerging market sectors are closely linked with the US economy. For that reason, rising rates of US inflation reduces the purchasing power of US companies and finally results in decreasing demand for US imports. In consequence, this process burdens the earnings of export companies in the emerging markets. Although the examined sector indices contain 27 countries and consequently several different currencies, the implemented methods indicate negative influences of US consumer prices on emerging market sector indices. As the outlined functional chain can

furthermore reasonably be explained by economic theory, we assume that the aggregates of currency effects in each sector do not balance the adverse effects of rising US inflation.

2.5 Conclusion

This paper examines the equilibrium relationships between macroeconomic determinants and emerging market sector indices. Unlike previous studies, this paper departs from the viewpoint, which is limited to individual countries, and instead conducts a supranational analysis of sector indices. In order to consider the long-term relations as well as the adjustment process towards the long-term equilibrium we employ a vector error correction (VEC) framework according to Johansen (1988). The evaluation of the additionally conducted impulse response analyses and variance decompositions allows further insights concerning the dynamic interactions among variables. Using econometrical techniques, we therefore contribute to understanding the sector-specific distinctions and their interrelationships to the US economy.

Within the sample between January 1995 and March 2007 we find structural breaks for nine out of ten sector indices by using a two-stage testing procedure. The fact that the identified dates of the structural breaks lie within the short period between June 1998 and November 1999 suggests a close connection between the structural breaks and the numerous economic and monetary crises in the emerging markets in the 1990s.

Considering the consequential sub-periods, we find at least one cointegrating relationship in each sector model. With respect to significance and signs of coefficients, the VECM results can be reasonably explained by the sector-specific characteristics. According to that, we consistently detect stimulating effects of the US industrial production Index as well as of the Dow Jones in the respective sectors. Excepting the sectors Materials and Financials, we further on assume that sector indices are negatively influenced by rising US consumer

prices. This linkage can be accounted by remarkable export activities of emerging market companies and the consequential relevance of the US currency. Via the channel of reduced purchasing power and consequently lower demand for US imports, the cross-sectoral comparison reveals adverse effects of growing US inflation on emerging market sectors.

However, contrary to the a priori defined hypotheses, the majority of the examined sectors benefited from increasing commodity prices during the examination sample. As the elasticity of demand for products related to leisure, media or automobiles is relatively high, the Consumer Discretionary sector is the only one which is clearly negatively affected by rising commodity prices. As a result, this finding provides empirical evidence on the suspicion that the ongoing catching-up process and the consequential growth in affluence in the emerging countries is largely driven by growing commodity prices and exports. According to that, not only those sectors which are closely linked to commodity trade activities benefit from rising prices. Instead, via the channels of increasing consumption rates and growing domestic purchasing power within the emerging economies, also the remaining sectors participate in the increase of export earnings. For that reason, this result represents an essential deviation from economic theory related to industrialised economies, as these countries predominantly rely on importing commodities and in this way suffer from rising prices.

The implemented procedures clarify that the progress of the examined sector indices is closely linked with developments of the US economy. By following the scientific approach of employing a supranational sector analysis in the emerging markets, the findings reveal sector-specific distinctions which can be explained by convincing functional chains. Particularly with respect to the effects of commodity prices and US inflation, the results indicate an ongoing dependence on foreign trade activities during the examination sample. In that context, future progress of emerging market sectors will not only be dependent on commodities, but on foreign demand for products of emerging markets in

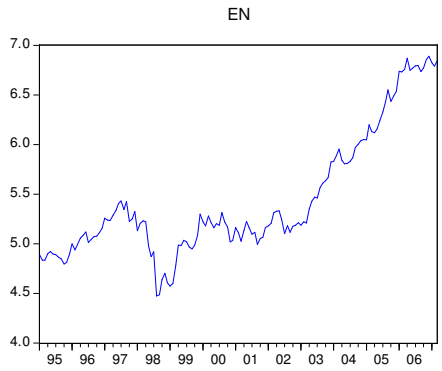
general. Nevertheless, based on the outlined growth in affluence and the consequential ongoing increase of domestic demand, the dependence on industrialised countries could be reduced to a significant extent in the near future. Until then, foreign economic growth, which is ultimately decisive for the resulting demand for products of emerging countries as well as currency effects will be of particular importance in order to stimulate companies´ cash flows. Exploring these interdependencies in the near future while considering the different developmental stages of each sector is an interesting avenue for further research.

2.6 Appendix

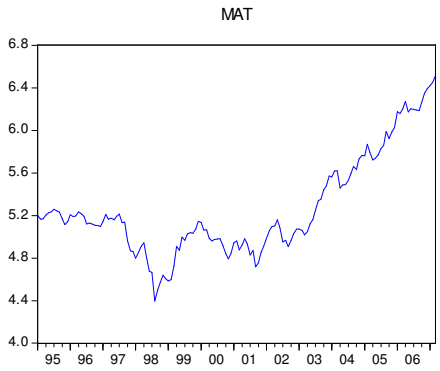
2.6.1 Sector Indices´ Progress (01/1995 – 03/2007)

Figure 2-2 Progress of the Sector Indices (in Logs).

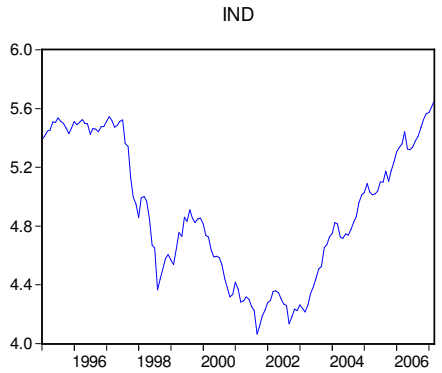
1 Energy



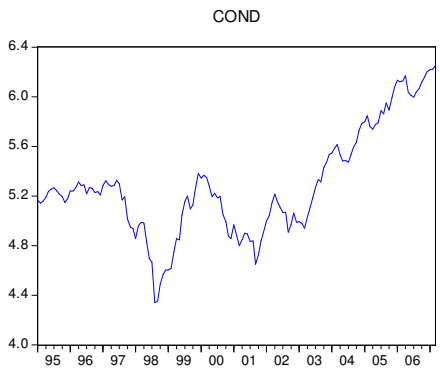
2 Materials



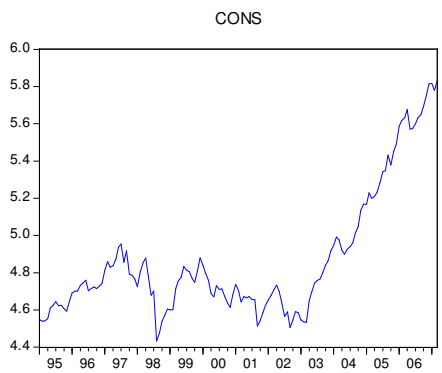
3 Industrials



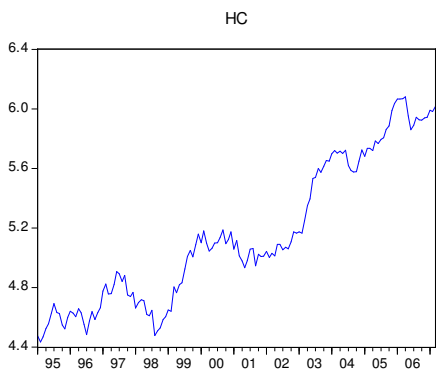
4 Consumer Discretionary

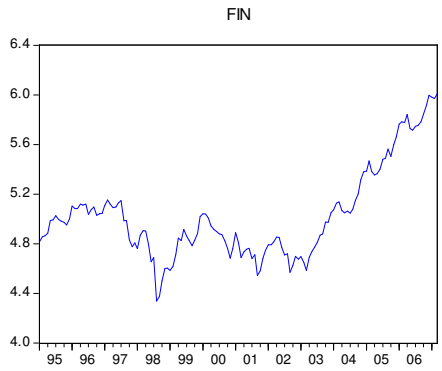
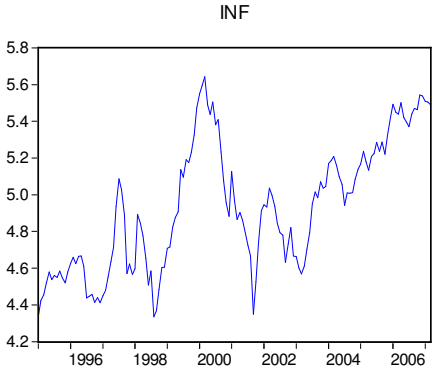
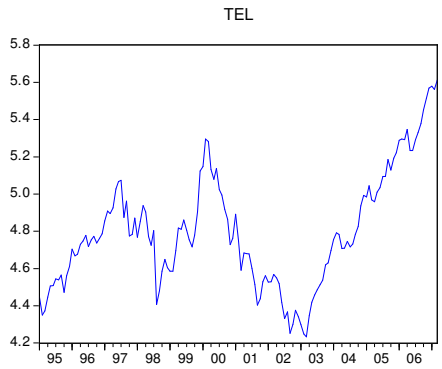
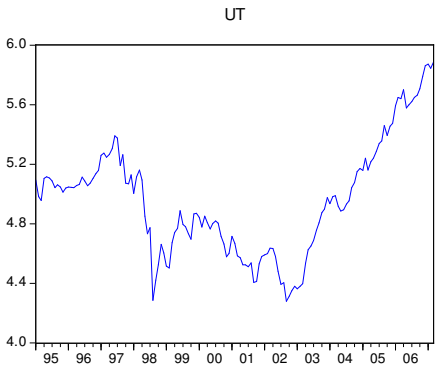


5 Consumer Staples



6 Health Care



7 Financials	8 Information Technology
	
9 Telecommunications	**10 Utilities**
	

2.6.2 Cointegration Tests

Table 2-5 Results of the Trace and Maximum Eigenvalue Tests.

1 Energy (EN)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	160.058 *	114.90	r = 0	r = 1	52.135 *	43.97
r ≤ 1	r > 1	107.922 *	87.31	r = 1	r = 2	39.985 *	37.52
r ≤ 2	r > 2	67.936 *	62.99	r = 2	r = 3	25.499	31.46
r ≤ 3	r > 3	42.437	42.44	r = 3	r = 4	18.917	25.54

2 Materials (MAT)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	145.052 *	114.90	r = 0	r = 1	46.416 *	43.97
r ≤ 1	r > 1	98.635 *	87.31	r = 1	r = 2	37.667 *	37.52
r ≤ 2	r > 2	60.968	62.99	r = 2	r = 3	23.914	31.46

3 Industrials (IND)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	166.514 *	114.90	r = 0	r = 1	60.417 *	43.97
r ≤ 1	r > 1	106.097 *	87.31	r = 1	r = 2	40.244 *	37.52
r ≤ 2	r > 2	65.852 *	62.99	r = 2	r = 3	25.178	31.46
r ≤ 3	r > 3	40.673	42.44	r = 3	r = 4	17.963	25.54

4 Consumer Discretionary (COND)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	120.317*	94.15	r = 0	r = 1	44.314 *	39.37
r ≤ 1	r > 1	76.002 *	68.52	r = 1	r = 2	38.867 *	33.46
r ≤ 2	r > 2	37.135	47.21	r = 2	r = 3	21.363	27.07

5 Consumer Staples (CONS)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	126.450 *	94.15	r = 0	r = 1	47.911 *	39.37
r ≤ 1	r > 1	78.538 *	68.52	r = 1	r = 2	39.271 *	33.46
r ≤ 2	r > 2	39.266	47.21	r = 2	r = 3	20.984	27.07

6 Health Care (HC)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	115.989 *	94.15	r = 0	r = 1	48.771 *	39.37
r ≤ 1	r > 1	67.217	68.52	r = 1	r = 2	32.058	33.46

7 Financials (FIN)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	155.949 *	114.90	r = 0	r = 1	51.325 *	43.97
r ≤ 1	r > 1	104.623 *	87.31	r = 1	r = 2	38.877 *	37.52
r ≤ 2	r > 2	65.746 *	62.99	r = 2	r = 3	31.798 *	31.46
r ≤ 3	r > 3	33.947	42.44	r = 3	r = 4	20.819	25.54

8 Information Technologies (IBF)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	112.320 *	94.15	r = 0	r = 1	45.816 *	39.37
r ≤ 1	r > 1	66.504	68.52	r = 1	r = 2	27.678	33.46

9 Telecommunications Services (TEL)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	173.189 *	114.90	r = 0	r = 1	49.752 *	43.97
r ≤ 1	r > 1	123.436 *	87.31	r = 1	r = 2	44.899 *	37.52
r ≤ 2	r > 2	78.537 *	62.99	r = 2	r = 3	35.622 *	31.46
r ≤ 3	r > 3	42.914 *	42.44	r = 3	r = 4	23.002	25.54
r ≤ 4	r > 4	19.911	25.32	r = 4	r = 5	13.366	18.96

10 Utilities (UT)							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical Value (95%)	H_0	H_A	λ_{Max}	Critical Value (95%)
r = 0	r > 0	160.058 *	114.90	r = 0	r = 1	52.135 *	43.97
r ≤ 1	r > 1	107.922 *	87.31	r = 1	r = 2	39.985 *	37.52
r ≤ 2	r > 2	67.936 *	62.99	r = 2	r = 3	25.499	31.46
r ≤ 3	r > 3	42.437	42.44	r = 3	r = 4	18.917	25.54

2.6.3 Adjustment Processes

Table 2-6 Adjustment Processes of the Sector Models.

Sector	Error Correction:	D(EN)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
1 EN (10/1998 - 03/2007)	CointEq1	**0.466**	**0.009**	**0.196**	**0.891**	**0.0597**	0.207
		[2.833]	[2.433]	[2.285]	[2.622]	[2.066]	[1.651]
	CointEq2	**-0.210**	**-0.005**	**-0.100**	**-0.355**	-0.010	-0.053
		[-2.661]	[-2.986]	[-2.423]	[-2.178]	[-0.787]	[-0.882]
Sector	Error Correction:	D(MAT)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
2 MAT (07/1998 – 03/2007)	CointEq1	0.207	**-0.017**	0.090	0.419	**0.131**	**0.447**
		[0.897]	[-2.876]	[0.621]	[0.803]	[2.871]	[2.328]
	CointEq2	-0.230	**0.021**	-0.123	0.260	-0.087	-0.343
		[-0.858]	[3.044]	[-0.732]	[0.431]	[-1.649]	[-1.540]
Sector	Error Correction:	D(IND)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
3 IND (07/1998 – 03/2007)	CointEq1	**-2.383**	**-0.140**	-0.941	0.251	-0.394	-0.617
		[-3.067]	[-6.098]	[-1.536]	[0.102]	[-1.933]	[-0.678]
	CointEq2	-0.020	**-0.003**	-0.020	0.045	0.002	0.004
		[-1.325]	[-6.510]	[-1.654]	[0.913]	[0.636]	[0.256]
Sector	Error Correction:	D(COND)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
4 COND (07/1998 – 03/2007)	CointEq1	-0.1140	**0.010**	0.101	**0.579**	-0.008	-0.107
		[-0.921]	[3.261]	[1.386]	[2.061]	[-0.381]	[-0.979]
	CointEq2	0.105	**-0.004**	-0.074	-0.128	**0.049**	0.106
		[1.314]	[-2.020]	[-1.561]	[-0.704]	[3.347]	[1.505]
Sector	Error Correction:	D(CONS)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
5 CONS (08/1998 – 03/2007)	CointEq1	-0.0213	**-0.001**	0.010	0.015	0.007	**0.086**
		[-0.893]	[-2.012]	[0.493]	[0.198]	[1.292]	[3.091]
	CointEq2	0.0442	0.0016	-0.0231	**0.389**	**0.037**	-0.073
		[0.815]	[0.871]	[-0.494]	[2.262]	[2.660]	[-1.159]

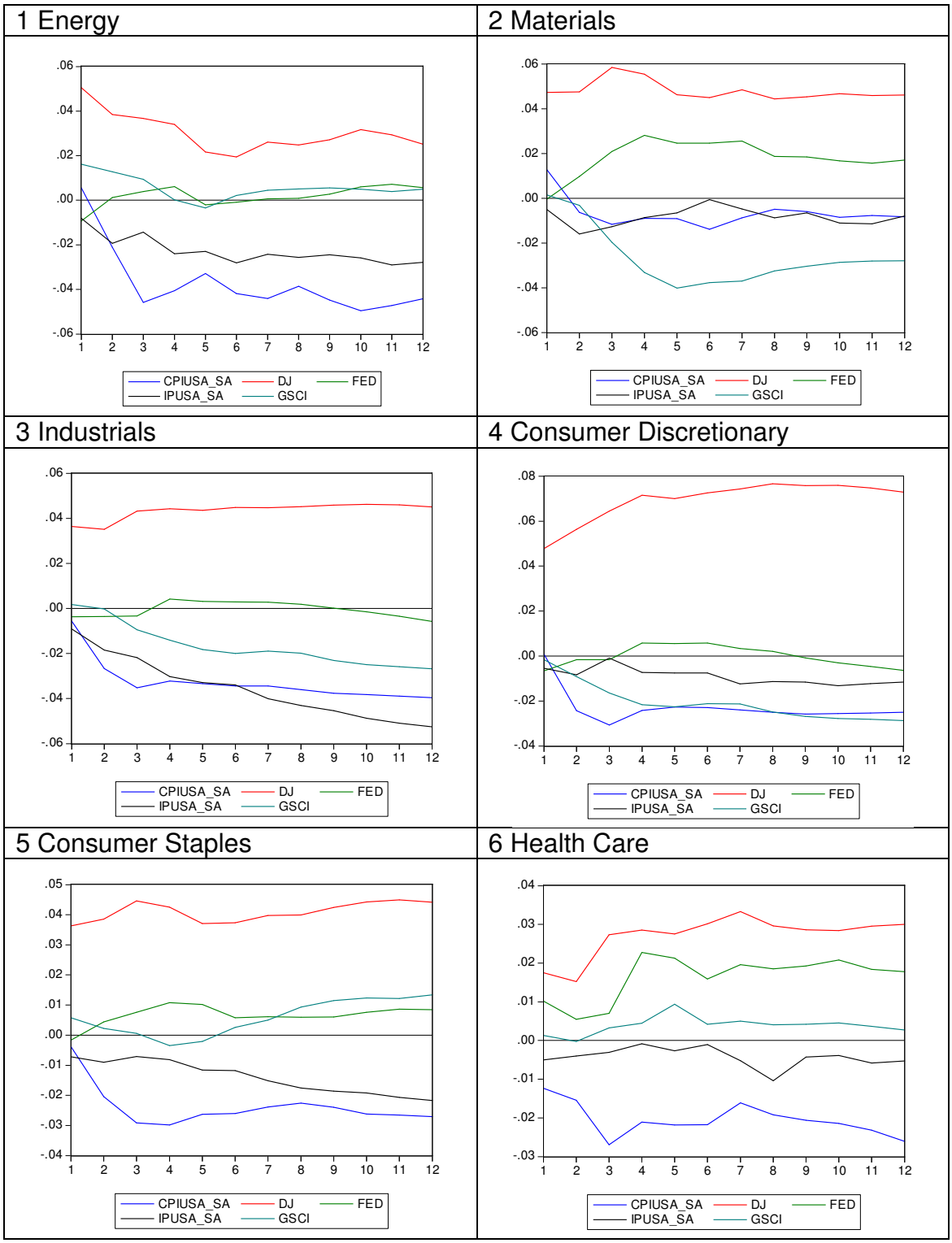
Notes: Bold type denotes significant results. t-statistics are included in parentheses. All values are first differences. For reasons of clarity we omit the corresponding constant c and the error term ε. CPIUSA = US Consumer Price Index; DJ = Dow Jones Index; FED = Federal Funds Rate; IPUSA = US Industrial Production Index; GSCI = Goldman Sachs Commodity Index.

Sector	Error Correction:	D(HC)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
6 HC (07/1998 – 03/ 2007)	CointEq1	-0.007	-0.001	-0.001	0.090	**0.019**	**0.072**
		[-0.343]	[-1.707]	[-0.031]	[1.493]	[3.869]	[3.459]
Sector	Error Correction:	D(FIN)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
7 FIN (07/1998 – 03/2007)	CointEq1	**-0.935**	**-0.035**	-0.203	**3.650**	-0.066	-0.029
		[-2.374]	[-3.386]	[-0.764]	[3.910]	[-0.790]	[-0.078]
	CointEq2	**0.705**	**0.030**	0.222	**-1.860**	0.095	0.086
		[2.428]	[3.936]	[1.135]	[-2.705]	[1.539]	[0.313]
	CointEq3	**-9.163**	**-0.468**	-3.922	**18.484**	-0.982	0.121
		[-2.404]	[-4.565]	[-1.524]	[2.047]	[-1.202]	[0.033]
Sector	Error Correction:	D(INF)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
8 INF (01/1995 – 03/2007)	CointEq1	**-0.151**	-0.001	**-0.083**	0.105	**0.023**	**0.122**
		[-2.444]	[-0.876]	[-3.043]	[1.135]	[2.283]	[3.557]
Sector	Error Correction:	D(TEL)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
9 TEL (12/1999 – 03/2007)	CointEq1	0.084	**0.012**	0.185	**1.126**	0.001	0.163
		[0.478]	[2.701]	[1.729]	[2.867]	[0.034]	[1.031]
	CointEq2	-0.065	**-0.013**	-0.202	**-1.059**	0.011	-0.142
		[-0.349]	[-2.648]	[-1.777]	[-2.534]	[0.291]	[-0.847]
	CointEq3	-0.071	0.007	0.131	**1.041**	0.034	0.272
		[-0.434]	[1.635]	[1.311]	[2.829]	[1.032]	[1.838]
Sector	Error Correction:	D(UT)	D(CPIUSA)	D(DJ)	D(FED)	D(IPUSA)	D(GSCI)
10 UT (10/1999 – 03/2007)	CointEq1	-0.069	**0.006**	-0.025	0.208	**0.029**	**0.127**
		[-1.203]	[4.618]	[-0.746]	[1.360]	[2.384]	[2.338]
	CointEq2	-0.509	**0.088**	-0.103	2.249	0.206	1.111
		[-0.761]	[5.155]	[-0.262]	[1.265]	[1.427]	[1.764]

Notes: Bold type denotes significant results. t-statistics are included in parentheses. All values are first differences. For reasons of clarity we omit the corresponding constant c and the error term ε. CPIUSA = US Consumer Price Index; DJ = Dow Jones Index; FED = Federal Funds Rate; IPUSA = US Industrial Production Index; GSCI = Goldman Sachs Commodity Index.

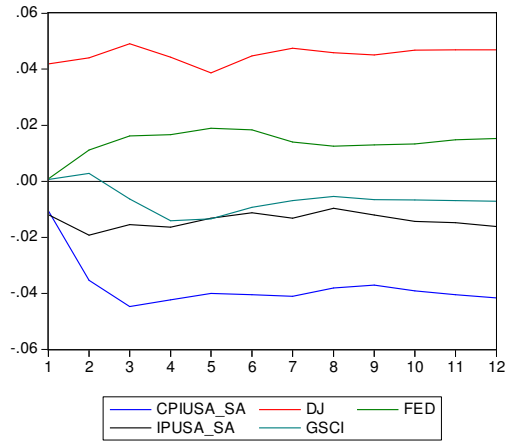
2.6.4 Impulse Response Analyses

Figure 2-3 Results of the Impulse Response Analyses.

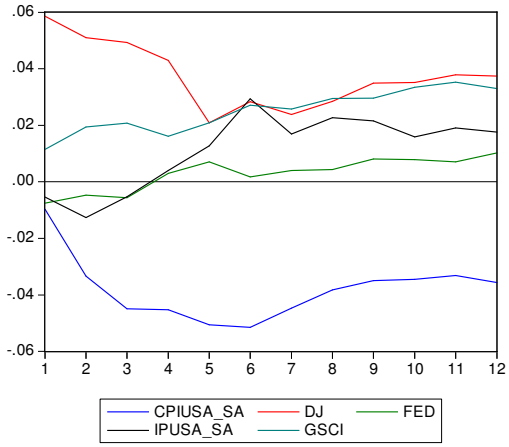


Notes: In this figure only the responses of the respective sector indices are presented. CPIUSA = US Consumer Price Index; DJ = Dow Jones Index; FED = Federal Funds Rate; IPUSA = US Industrial Production Index; GSCI = Goldman Sachs Commodity Index.

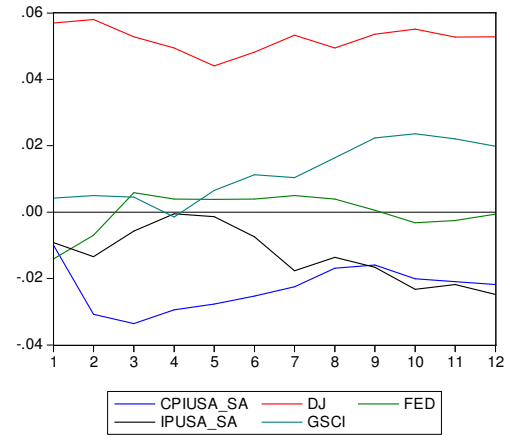
7 Financials



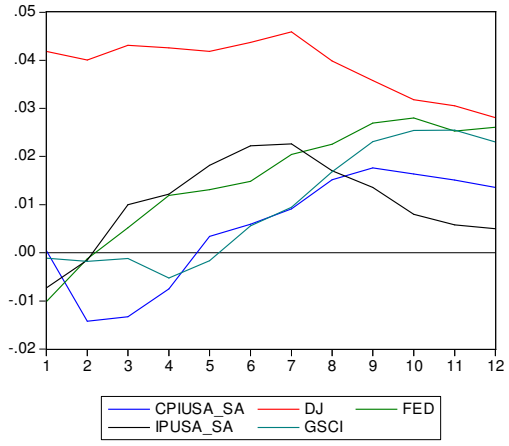
8 Information Technologies



9 Telecommunications



10 Utilities



Notes: In this figure only the responses of the respective sector indices are presented. CPIUSA = US Consumer Price Index; DJ = Dow Jones Index; FED = Federal Funds Rate; IPUSA = US Industrial Production Index; GSCI = Goldman Sachs Commodity Index.

2.6.5 Variance Decompositions

Table 2-7 Results of the Variance Decompositions.

Sector	Period	EN	CPIUSA	DJ	FED	IPUSA	GSCI
1 EN	1	43.722	4.978	48.176	0.061	0.006	3.054
	6	46.181	2.292	37.957	8.511	3.403	1.651
	12	48.979	1.342	32.136	12.217	4.402	0.921
	18	49.876	0.940	29.262	14.509	4.801	0.608

Sector	Period	MAT	CPIUSA	DJ	FED	IPUSA	GSCI
2 MAT	1	99.466	0.000	0.000	0.003	0.530	0.000
	6	72.911	6.873	0.273	6.245	1.3735	12.322
	12	71.130	6.668	0.223	6.057	1.309	14.610
	18	72.759	6.405	0.175	5.944	1.322	13.392

Sector	Period	IND	CPIUSA	DJ	FED	IPUSA	GSCI
3 IND	1	46.221	1.148	48.941	0.504	3.069	0.114
	6	30.383	17.856	34.481	0.242	13.596	3.439
	12	28.366	16.934	27.939	0.160	21.284	5.313
	18	27.477	16.350	23.339	0.848	25.419	6.565

Sector	Period	COND	CPIUSA	DJ	FED	IPUSA	GSCI
4 COND	1	49.598	0.013	48.740	0.955	0.637	0.054
	6	36.625	6.635	52.124	0.310	0.563	3.740
	12	30.980	6.581	55.491	0.222	1.085	5.637
	18	28.101	6.667	56.009	0.693	1.113	7.414

Sector	Period	CONS	CPIUSA	DJ	FED	IPUSA	GSCI
5 CONS	1	41.722	0.6052	54.077	0.110	2.138	1.346
	6	29.969	17.920	47.454	1.691	2.652	0.311
	12	33.762	15.289	42.362	1.352	5.591	1.642
	18	35.841	13.739	38.526	1.486	7.201	3.203

Notes: EN = Energy, MAT = Materials, IND = Industrials, COND = Consumer Discretionary, CONS = Consumer Staples, HC = Health Care, FIN = Financials, INF = Information Technologies, TEL = Telecommunications Services, UT = Utilities. CPIUSA = US Consumer Price Index, DJ = Dow Jones Index, FED = Federal Funds Rate, IPUSA = US Industrial Production Index, GSCI = Goldman Sachs Commodity Index.

Sector	Period	HC	CPIUSA	DJ	FED	IPUSA	GSCI
6 HC	1	81.722	4.699	9.534	3.213	0.778	0.050
	6	68.879	9.911	14.876	5.555	0.233	0.544
	12	70.923	8.224	14.377	5.645	0.453	0.375
	18	73.575	8.313	13.100	4.255	0.448	0.305

Sector	Period	FIN	CPIUSA	DJ	FED	IPUSA	GSCI
7 FIN	1	47.421	2.923	45.904	0.022	3.714	0.013
	6	27.79	26.162	36.102	4.248	4.103	1.591
	12	27.828	26.707	36.904	3.780	3.619	1.160
	18	28.844	26.968	35.607	3.670	3.834	1.073

Sector	Period	INF	CPIUSA	DJ	FED	IPUSA	GSCI
8 INF	1	59.223	1.016	37.376	0.625	0.317	1.440
	6	68.162	12.920	14.230	0.215	1.548	2.922
	12	68.414	12.041	11.715	0.315	2.219	5.293
	18	68.750	11.527	11.054	0.604	2.262	5.800

Sector	Period	TEL	CPIUSA	DJ	FED	IPUSA	GSCI
9 TEL	1	18.912	2.187	72.254	4.379	1.872	0.393
	6	17.130	17.151	62.178	1.256	1.369	0.912
	12	13.436	12.990	62.714	0.7311	5.256	4.871
	18	11.586	11.518	60.578	0.453	8.300	7.561

Sector	Period	UT	CPIUSA	DJ	FED	IPUSA	GSCI
10 UT	1	50.892	0.005	45.050	2.650	1.369	0.031
	6	64.188	1.327	29.368	1.826	3.102	0.186
	12	66.228	2.039	20.948	5.043	2.551	3.188
	18	67.750	1.743	17.452	7.391	1.887	3.774

Notes: EN = Energy, MAT = Materials, IND = Industrials, COND = Consumer Discretionary, CONS = Consumer Staples, HC = Health Care, FIN = Financials, INF = Information Technologies, TEL = Telecommunications Services, UT = Utilities. CPIUSA = US Consumer Price Index, DJ = Dow Jones Index, FED = Federal Funds Rate, IPUSA = US Industrial Production Index, GSCI = Goldman Sachs Commodity Index.

3 The Link between Property and the Economy

This paper is the result of a joint project with Steffen Sebastian.

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Abstract

This study supplies empirical evidence on the dynamic interactions between the property markets in Germany and the United Kingdom and their country-specific macroeconomic environment. Using a VECM framework, the findings contribute to improving the evaluation of the properties' behaviour by considering a wide range of macroeconomic risk factors. On a long-term basis, we find remarkable similarities between both examined real estate markets with respect to significance, signs and magnitude of coefficients, despite essential differences in terms of market structure, conditions and performance. This suggests that the fundamental role of property markets in an economy dominates the country-specific characteristics in the long run. However, the distinctive features of the national property markets, including differences with respect to the financial systems, are primarily relevant during the short-term adjustment process back to the long-term equilibrium.

JEL Classification Codes: E22, E44

Key words: property markets, macroeconomics, cointegration, vector error correction model

3.1 Introduction

The real estate sector is an essential part of a nation's economy and represents the most important component of a nation's fixed capital stock. Nevertheless, theoretical and empirical work linking the macroeconomy to real estate returns is still very limited and focuses primarily on the housing sector and its contemporaneous interaction with the economy. In contrast, this paper supplies empirical evidence on the dynamic interactions between property markets and their country-specific macroeconomic environment. In this context we analyse the real estate markets in Germany and the United Kingdom, two of the most important ones in Europe.[18]

A comparison between these two property markets reveals remarkable differences with regard to the market structure and market conditions. While the UK investment market is dominated by the property market of Greater London, the German real estate sector is dominated by several sub-markets, such as Berlin, Frankfurt or Munich. Furthermore, the UK real estate sector is known to be one of the most professional markets and is characterised by a high transparency and comparatively low transaction costs compared to other property markets of industrialised countries. In contrast, the German market shows significantly higher transaction costs and is frequently criticised for its lack of available data, among other failings. Moreover, during the examination period from July 1995 to July 2007, the UK IPD All Property Index reveals that the property held within institutional portfolios generated a return of more than three times the return earned by comparable German property. An empirical investigation of commercial property returns in these two markets might provide insights into similarities and deviations due to the general nature of property markets on the one hand, and national distinctions on the other.

[18] With a turnover of approximately €577.6 million, the British market was the largest European market in 2005. Germany was fourth after France and Italy with €136.9 million; see ZERP (2007).

Deviating from the majority of academic literature, this study is focused on appraisal-based property indices. The UK real estate market is represented by the well-known and widely-used property index of the Investment Property Database (IPD). The UK IPD is calculated on a monthly basis and measures returns to direct investment in commercial property. For the German market we use the IMMEX, an index based on the return series of German open end funds. Our work is similar to Hoesli et al. (2008) who are – to the best of our knowledge – the first to apply the use of the cointegration framework in the context of appraisal-based real estate indices. The authors focus on inflation hedge characteristics with a wide set of macroeconomic data as control variables. Against this backdrop, our study examines the development of real estate prices while considering the influences of a wide range of macroeconomic risk factors including inflation. As a result, our study is focused on the properties' behaviour with regard to the complete business environment in the selected economies. This wider angle allows a differentiated approach, which in turn allows differentiated interpretations. Furthermore, we think that some methodological aspects of the evaluation of the vector error correction model (VECM) are, in that context, worth examining and reporting.

Despite the differences between the property markets in Germany and the UK mentioned above, our estimation results for the long-term equilibria finally show comparable results in terms of significance, order of magnitude and sign. We find a negative linkage between the property indices and the unemployment rates, while both property markets are positively affected by the respective consumer price index and government bond yields. According to this, the results apply to economic theory and affirm the a priori defined hypotheses without exception. However, deviations are found in the estimations for the short-term dynamics indicating a different mode of adjustment after deviations from the long-term equilibrium. In this context, the base rate in particular seems to be more important in the German than in the UK property market, where the financial system is known to be predominantly focused on funding by means of capital markets.

The remainder of this paper proceeds as follows. Section 3.2 reviews the related literature. Section 3.3 introduces the selected data, the model framework and the progress of the macroeconomic environment during the examination period. Section 3.4 provides empirical evidence. The conclusions are presented in Section 3.5.

3.2 Review of Literature: Real Estate and Macroeconomics

In the context of real estate research, the academic studies primarily focus on the link between the housing sector and its economy. For instance, Baffoe-Bonnie (1998) uses a vector autoregressive (VAR) model to explain the relationship between house prices and macroeconomic key aggregates in US subregions. He detects that the influence of the variables differs strongly across these subregions. However, from a cross-regional point of view, employment and mortgage rates strongly affect house prices. Case (2000) discusses global macroeconomic effects on US house prices. He notes that the impact of fundamentals depends on the openness of the different states. By applying the VECM approach, Kasparova and White (2001) examine the housing markets in selected European countries, including Germany and the UK. Granger tests reveal that the effect of house prices on GDP is significantly greater than the effect of GDP on house prices. Tsatsaronis and Zhu (2004) use a structured vector autoregressive (VAR) model to measure the impact of economic indicators such as GDP, the interest rate and inflation on house prices. They find that the inflation hedge characteristic of residential real estate is the main contributor to house price movements, although the interest rate has increased in importance over the past decade.

Using the Johansen (1988) procedure, Wilson and Zurbruegg (2008) examine whether house price movements in Australia can be determined by a single, national housing market model. By implementing restrictions of single factors in both the long-term relationship and the adjustment process, the authors

uncover substantial differences between Australian state cities in long-term driving factors for house prices. In line with Cho (1996), they therefore conclude that modelling results are highly sensitive and largely depend on the selected sample, data and model specifications.

The recent studies by Fraser et al. (2008) and Miles (2008) are focused on the boom-bust cycles of housing markets. Fraser et al. (2008) analyse New Zealand's real house prices relative to fundamental real house values for the sample from 1970 to 2005 in order to ascertain whether increases in house prices are justified by changes in expectations about fundamentals. Using a time-varying present value model, the authors detect disparities between actual and fundamental house prices. Accordingly, a significant proportion of the overvaluation results from price dynamics rather than from fundamentals. In contrast, Miles (2008) examines the forecasting qualities of non-linear models in phases of boom and bust. For this purpose, the author analyses the housing markets of five US states and uses quarterly data from 1979 to 2001. In the process, the study identifies the generalised autoregressive (GAR) model as the superior model compared to the Markov-switching model or ARMA and GARCH models.

Apart from the research on the housing sector, a few studies have been conducted in order to analyse the dynamic interactions between property markets and their country-specific macroeconomic environment. Early studies, such as those by Hartzell et al. (1987) and Gyourko and Linneman (1988) have focused on real estate investments as inflation hedges. The former find that commercial real estate portfolios hedge against both expected as well as unexpected inflation. The latter distinguish between direct investments in non-residential property and REIT investments. While non-residential property investments are mostly positively correlated with inflation, REIT investments are similar to conventional equity or bond investments, and thus strongly negatively correlated with inflation.

Another branch of empirical studies mainly concentrates on explaining REIT returns in the United States, e.g. Liu and Mei (1992), Karolyi and Sanders (1998), Ling and Naranjo (1999) and Ling et al. (2000). Using a VAR model, McCue and Kling (1994) examine the relationship between US REIT returns and a set of macroeconomic variables. The resulting variance decompositions indicate that nearly 60% of the variation in real estate prices is explained by the macroeconomy, thereby it is the nominal short-term interest rate variable that explains the majority of the real estate price movement. The study by Liang and McIntosh (1998) is focused on the relationship between employment growth in metropolitan areas and their property market performance, as well as the volatility of the index over the sample period from 1983 to 1997. The authors find empirical evidence of a positive linkage between the employment betas and the return betas as well as between the according volatilities. Admittedly, these findings are only relevant in a short-term view.

Ling and Naranjo (1999) apply multifactor asset pricing (MAP) models in order to analyse whether commercial real estate markets are integrated with equity markets. The study finds that the risk premium of the market for exchange-traded real estate companies corresponds to that of the equity market. Therefore, the authors conclude that the two markets are integrated and that the degree of integration significantly increased during the 1990s. In contrast, the integration hypothesis does not apply to real estate portfolios that are based on appraisal-based investments.

Using MAP models as well, Sing (2004) examines the effects of systematic market risk factors and common risk factors on the variations in excess returns of securitized and direct real estate investments. For this purpose, the author uses the SUR estimation technique and the standard Fama and MacBeth (1973) two-pass regression technique to estimate the risk premia in the proposed MAP models. The evaluation of the test results shows that macroeconomic risk factors are priced notably differently in securitized and

direct real estate markets. Hoskins et al. (2004) use correlation models and survey the influence of selected macroeconomic risk factors on the commercial property markets in Australia, Canada, the UK and the US. In the process, the variables gross domestic product, unemployment and inflation are identified as major determinants. In this context, the authors find divergences in relation to the validity of the test results as well as in terms of explanatory power across the examined markets.

In order to examine the response of REIT returns to unexpected changes in fundamental macroeconomic variables, Ewing and Payne (2005) use the generalised impulse response analysis based on unrestricted VAR models. The results reveal a negative linkage between the expected REIT returns and shocks to monetary policy, economic growth as well as to inflation shocks, but a positive effect on the NAREIT due to an unexpected one-off shock to the default risk premium. By means of a multivariate approach to unsmoothing appraisal-based real estate indices, Wang (2006) uses the functional relationships between real estate returns and economic activities in the UK to infer the extent to which an appraisal-based index is smoothed. This method enables the correction of appraisal-smoothing and the detection of the true market volatility information.

In contrast, Bredin et al. (2007) focus on the impact of unanticipated changes in US monetary policy on returns and the volatility of equity REITs. Based on the implemented GARCH models, the results indicate significant responses in both returns and volatility to unanticipated variations, although the volatility pattern remains unchanged. The significance of monetary policy for issues of REIT returns is also the subject of the study by Simpson et al. (2008). The results show a strong asymmetry in the response of equity returns to inflation and highlight a dependence on the prevailing monetary policy environment. Accordingly, during expansionary periods, equity REITs are stimulated by both increasing and decreasing inflation.

While Lizieri et al. (2007) conduct an independent components analysis (ICA), which embodies an alternative approach to examining the relationship between macroeconmic ascendancies and REIT returns, Hoesli et al. (2008) apply the vector error correction (VEC) approach to examine the interactions between the economy and stock indices as well as public and private real estate indices in the 1977–2003 period. In the process, this paper focuses primarily on the inflation-hedging characteristics of real estate investments in the United States and the United Kingdom. Considering the impact of real and monetary variables, they find a positive long-run linkage between commercial real estate returns and anticipated inflation for both examined countries, while the converse holds for inflation shocks. Moreover, the cutback of a potential disequilibrium due to changes in inflation is characterised by a long-term and gradual adjustment process.

In his study on Australian central business district office markets, De Francesco (2008) finds equilibrium relationships between the vacancy rate and rent as well as between demand and employment. By employing an error correction model (ECM) framework, the author distinguishes between permanent and temporary effects and supplies empirical evidence of a significant linkage with macroeconomic variables. Plazzi et al. (2008), examine cross-sectional dispersions of return and growth in rents for commercial real estate in US metropolitan areas and find that time series fluctuations can be significantly explained by the term and credit spreads, inflation and the short rate of interest.

Bisping and Patron (2008) study the impact of residential and non-residential investment on US economic growth, including the external sector. The results of generalised impulse response analyses indicate that shocks to residential investments have a larger impact on GDP than shocks to non-residential investments. Consequently, this result confirms the finding of Coulson and Kim (2000) who used a closed-economy approach.

3.3 Data Selection and Methodology

3.3.1 Real Estate Data

Unlike other assets on financial markets, appraisal-based real estate indices are not calculated on the basis of supply and demand. Instead, properties are subject to valuations of appraisers. Accordingly, aggregation of individual properties to indices, low frequency of the occurring appraisals and several smoothing phenomena – such as appraiser bias - might cause smoothing effects in the index series. However, despite considerable research, there is still no undisputed evidence on how to unsmooth real estate data.[19] In line with Hoesli et al. (2008), we therefore decided to use the original time series for the purposes of our examination. One effect of this could have been that smoothing effects lead to significant autocorrelation parameters in our models. Nevertheless, despite using the original time series, the consequential VECM results are free from possible distortions due to occurring autocorrelation, which ultimately indicates that following this approach is eligible.

In our study the UK real estate market is represented by the monthly UK IPD All Property Index, which has been released by the Investment Property Database (IPD) since December 1986. This index is based on valuations of the underlying properties and is widely used in empirical research. Unfortunately, no index of comparable quality and with sufficient history exists for the German property market. We therefore use the IMMEX, which is based on the return series of German open end funds and corrected for returns resulting from investments in liquid assets. [20] The IMMEX has been calculated on a monthly basis since 1980 and, like the well-known US NCREIF Property Index (NPI), is essentially based on annual appraisals that might occur at any time of the year. While within the NPI most appraisals take place in the fourth quarter, appraisals incorporated in the German index are distributed over the whole year.

[19] For a discussion see Bond and Hwang (2007).

[20] For further details see Maurer et al. (2004).

3.3.2 Macroeconomic Data

The macroeconomic determinants cover a broad range of possible macroeconomic influences. The selection is based on theoretical assumptions and propositions of comparable empirical examinations. Some cointegration studies differentiate variables in the event stationarity in order to obtain a large dataset which can then technically be used in the VECM. This approach helps to ensure that the data universe matches to the a priori defined theoretical assumption. However, we have decided against using first differences. Using first differences may lead to a loss of information and to distortions of the results. As VEC models are rather sensitive models we propose using a dataset which is as consistent as possible. In doing so, we prefer to include only variables that exhibit the same degree of integration.

Macroeconomic influences are represented by the consumer price index as a proxy for inflation, the industrial production index serves as a proxy for the economic growth, the rate of unemployment, [21] the long-term government bond yields (10 years) as well as the base rate, which represents the key interest rate of the corresponding central bank.[22] Due to the third stage of the European Monetary Union in 1999, we use the main refinancing rate of the German Central Bank as a proxy for the German base rate during the examination period prior to the introduction of the common European currency, and the main refinancing rate of the European Central Bank (ECB) for the period after the monetary union.

The consumer price index and industrial production index variables are seasonally adjusted and transformed into their natural logarithms.[23] These time series are denominated in local currencies. Despite the fact that the cointegration concept is designed for analysing long-term relationships, we

[21] We use the time series released by the Deutsche Bundesbank for the German model, while the UK counterpart covers unemployed people over the age of 16.

[22] All macroeconomic time series are taken from the Datastream database.

[23] The industrial production indices for both countries and the consumer price index of Germany are available as seasonally adjusted time series. The UK consumer price index has been seasonally adjusted using the additive variant of the X12 procedure.

have nonetheless decided to use monthly data, since these are better suited to detecting structural breaks than to data with annual or quarterly frequency.

3.3.3 Hypotheses

The scope of this investigation incorporates the key interest rates of the corresponding central banks as an indicator for the standards on credit markets. In this context, increases in the base rate primarily implicate tightening credit terms. Growing credit costs cause a decrease in demand for property investments, particularly as property investments usually require a high ratio of debt capital. Therefore, we expect a negative linkage between base rate increases and property prices. While funding for property investments in Germany is primarily through bank loans, in the UK there is a wider range of sources for raising money to fund property investments. For that reason, we assume a closer linkage between property prices and the base rate in the German bank-based financial system.

As has been frequently verified in real estate research, we expect positive long-term effects on properties with ongoing economic growth. This applies to both property prices and rents. Economic growth stimulates the demand for real estate investments and in this way boosts property prices. In addition, higher cash flow expectations ensure easier credit standards and facilitate the increase in profit margins of real estate companies.

Corresponding to the results of former scientific studies, such as Hartzell et al. (1987), Gyourko and Linneman (1988) or Hoesli et al. (2008), we assume that property indices benefit from rising domestic consumer prices in the long run. Particularly with respect to commercial properties, rental contracts contain inflation-subscripted rental payments or, in the UK, provide rent reviews on a frequent basis. In this way, the adverse effects of increasing inflation can be compensated to a significant extent. Thanks to these aspects, we can take property investments as an appropriate tool to hedge against inflation and

therefore assume a positive relationship between the examined property indices and consumer prices.

Deviating from the investigation by Hoesli et al. (2008), labour market effects are taken into account in our study. Above all, increasing unemployment negatively affects purchasing power and the consumption behaviour within an economy and therefore represents a reliable indicator for the domestic economic outlook. Particularly in times of recession, the process of economic recovery is burdened by delayed effects of unemployment. Concerning property investments, low employment rates should result in low demand for office space and thus depress rent levels. In accordance with the results of Liang and McIntosh (1998) and Hoskins et al. (2004), we therefore expect a negative linkage between the unemployment rate and property prices.

We assume however a positive linkage between long-term government bond returns and real estate indices. As mentioned above, decreasing market interest rates encourage more bank lending, which in turn facilitates the financing of property investments. As a result, the demand for real estate investments ought to be stimulated. Another effect of a decrease in the market interest rates is that bond investments become more attractive, which in turn leads to higher bond prices and consequently lower bond yields. However, from an investor's perspective, investments in long-term government bonds and property investments can be considered as substitutes. This particularly applies to property investments of comparable quality with regard to term and solvency. Therefore, the returns in both markets should be interrelated in the long run. As a result, we expect a positive linkage between the government bond variable and the examined property indices.

3.3.4 Preliminary Tests

We examined the data from January 1980 to July 2007 for the German model and from December 1986 to July 2007 for the British model for structural breaks. Taking into account structural breaks is particularly important when applying cointegration techniques. The omission of structural breaks leads to unreliable unit root test decisions and consequently to the risk of misspecified estimation models (Perron, 1989). For that reason, we prefer analysing the sample after the identified structural breaks rather than analysing a larger examination period in order to avoid the risk of misspecified vector error correction models including unreliable economic implications.

Time series are checked with CUSUM and CUSUMQ tests. Based on these results we additionally verify the identified points by applying the Chow test, which is ultimately decisive for the detection of the examination period. We identify a structural break in January 1995 for the UK. Thus, the investigation period is set from June 1995 to July 2007 (146 observations) for Germany and the UK in order to allow comparisons of the results between both national datasets.

3.3.5 Descriptive Statistics

Table 3-1 outlines all time series and presents the corresponding descriptive statistics. As revealed, algebraic signs of the means are equal in both countries. Due to their nature as interest rates, we observe that key interest rates and government bonds show comparatively high standard deviations. The highest correlation coefficients are displayed for the base rate and the rate of unemployment in both countries, as well as for the base rate and IPD in the UK. Nevertheless, the correlation matrix does not reveal any critical multi-correlation.

Table 3-1 Summary Statistics (1995:07 – 2007:07).

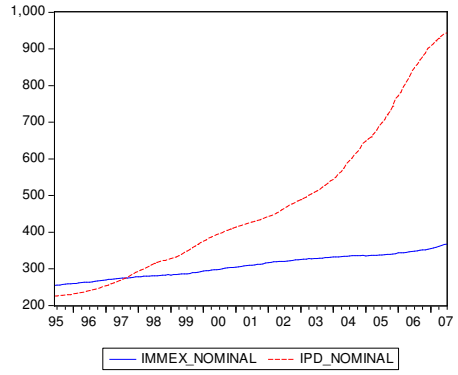
Panel A: Germany					correlation coefficients				
	Mean	Max.	Min.	Std.Dev	RE	BR	CPI	GOV	IP
RE	0.003	0.015	-0.005	0.003					
BR	-0.026	0.540	-0.640	0.164	-0.007				
CPI	0.001	0.006	-0.006	0.002	0.201	-0.069			
GOV	-0.014	0.420	-0.370	0.174	0.129	0.178	0.074		
IP	0.002	0.042	-0.039	0.012	0.005	0.044	0.005	0.037	
UR	-0.001	0.713	-0.284	0.136	-0.164	-0.296	-0.037	-0.143	-0.098
Panel B: United Kingdom									
	Mean	Max.	Min.	Std.Dev	RE	BR	CPI	GOV	IP
RE	0.010	0.027	-0.000	0.004					
BR	-0.007	0.250	-0.500	0.152	0.275				
CPI	0.001	0.005	-0.003	0.001	0.036	-0.067			
GOV	-0.019	0.470	-0.550	0.188	-0.012	0.057	0.009		
IP	0.000	0.024	-0.054	0.008	0.054	0.077	0.063	-0.099	
UR	-0.023	0.200	-0.300	0.083	0.142	-0.219	-0.028	0.116	-0.009

Notes: All data are first differences. Macroeconomic data derives from Datastream. Std.Dev = standard deviation. RE represents the log return of the respective national property index, BR = base rate of the corresponding central bank, CPI = log return of consumer price index, GOV = long-term government bonds yields (10 years), IP = log return of industrial production index, UR = unemployment rate.

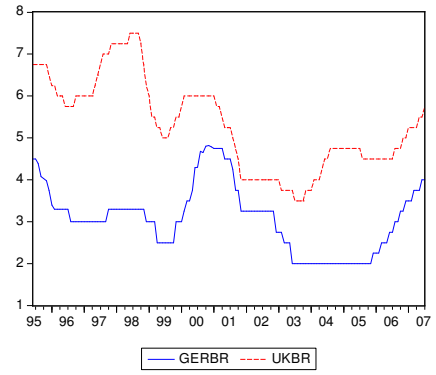
The evaluation of the economic environment of both countries during the examination period identifies essential differences. As indicated in Figure 3-1, the German economy shows a continued upward trend after the collapse of the New Economy bubble and the uncertainty after the “9/11” terrorist attacks. In contrast, the UK Industrial Production Index reaches its peak in 2001, after which it is characterised by a slight downturn. Furthermore, although the progress of the consumer price index in both countries is almost coincident, we find higher UK interest rates for both the long-term government bond yields and the base rate. Particularly with respect to property investments, the combination of these two aspects ought to reveal a major advantage for the German real estate market, as both aspects stimulate the demand for property investments to a larger extent than is the case in the UK. Nevertheless, although both property indices display positive rates of return, the British IPD clearly outperforms the German IMMEX during the examination period.

Figure 3-1 Macroeconomic Environment in Germany and the UK.

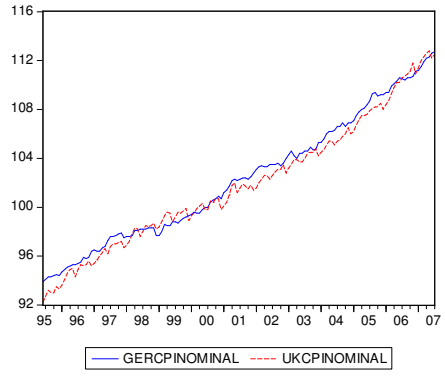
German IMMEX vs. UK IPD



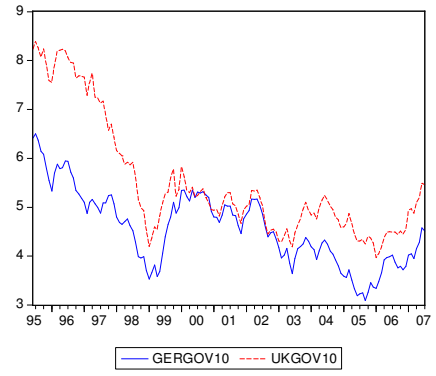
Base rates



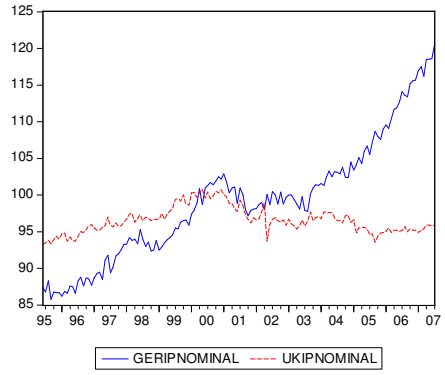
Consumer price index



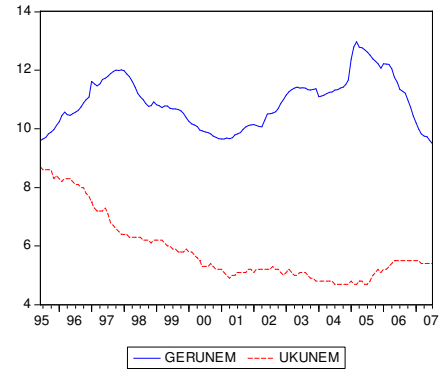
Government bond yields (10 years)



Industrial production index



Unemployment (%)



As highlighted in Figure 3-1, in the course of 2003 the growth rate of the IPD started to increase even further. While Germany's unemployment remained at a higher level than the UK's during the whole examination period, the unemployment rate in the United Kingdom is characterised by a remarkable decline between 1995 and 2000 and remained at this comparatively low level until the end of the sample period.

3.3.6 Methodology

In order to analyse the dynamic interactions between the selected macroeconomic variables and the property indices in Germany and the UK, this study applies the cointegration concept to vector autoregressive (VAR) models using the vector error correction (VEC) framework according to Johansen (1988).

The concept of cointegration is traced back to Granger (1981, 1986) and Engle and Granger (1987). It combines time series analytical procedures with the concept of economic equilibrium, and facilitates the analysis of long-term equilibrium relationships between non-stationary variables. The cointegration analysis is based on the observation that economic variables often display common trend behaviour. This implies that linear combinations of these variables converge towards a common equilibrium in the long run, even though individual time series fluctuate over time. According to Engle and Granger (1987), time series are cointegrated if they display the same degree of integration and a linear combination of these variables is stationary. Furthermore, the use of the time series in their level specification guarantees that information losses due to the conventional use of first differences are avoided. According to the Granger representation theorem, the dynamic adjustment process of cointegrated variables towards the long-term equilibrium path can be represented by an error correction model. In this way, long-term equilibrium relationships are combined with short-term dynamics.

Modelling of the non-stationary variables as a vector autoregressive (VAR) process Y_t of finite order k forms the basis of the Johansen (1988) test procedure for cointegration. If at least two of the variables are cointegrated of the order of one, then the VAR(k) process can be reparametrised and written as a vector error correction model:

$$\Delta Y_t = \mu + \pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \tag{3-1}$$

ΔY_t is a (n x 1) vector of the first differences of stochastic variables Y_t, and μ is a (n x 1) vector of the constants. The lagged variables are contained in vector Y_{t-1}. The (n x n) matrices Γ_i represent the short-term dynamic. The coefficients of the cointegrating relationships (cointegration vectors) and of the error correction term are contained in the matrix π.

π can be decomposed as follows:

$$\pi = \alpha\beta' \tag{3-2}$$

ß represents a (n x r) matrix of the r cointegrating vectors. The (n x r) matrix α contains the so-called loading parameter, i.e. those coefficients that describe the contribution of the r long-term relationships in the individual equations. Here α and ß have full rank. It should be noted that the analysis of π is not definite. If in Equation (3-1) π is replaced by the Equation (3-2), then the error correction representation follows (vector error correction model, VECM).

$$\Delta Y_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \alpha\beta' Y_{t-1} + \varepsilon_t \tag{3-3}$$

3.4 Empirical Results

3.4.1 Cointegration Analysis

Unit root tests facilitate the determination of the stationary nature of time series. For the purposes of this examination, the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981) and the Phillips-Perron (PP) test (Phillips, 1987, Phillips and Perron, 1988) are used. Here the null hypothesis of non-stationarity is tested against the alternative hypothesis of stationarity of the present time series.[24] Within the scope of this paper we prefer the results of the PP test in the event of deviating results. By virtue of the correction procedure according to Newey and West (1994) as well as the Bartlett window, the PP test provides robust results in the case of autocorrelation and for time-independent heteroscedasticity (Perron, 1989). As reliable unit root test results require correctly specified trend behaviour, we additionally apply CUSUM and CUCUMQ tests as well as Chow breakpoint tests in order to preclude misinterpretation due to structural breaks in the deterministic trend.

All examined time series are non-stationary in levels but stationary in first differences (see Section 3.6). Consequently, all variables display the same degree of integration. So the vector error correction model can be conducted on the basis of a consistent dataset.

In order to detect the existence of cointegrating relationships we employ the trace test and the maximum eigenvalue test. Determination of rank and estimation of the coefficients are performed as a maximum likelihood estimation. The corresponding likelihood-ratio test statistics are:

[24] The test decisions are based on the critical values of MacKinnon (1991, 1996). The number of lags is determined in the framework of the ADF test with the aid of the Akaike information criterion (AIC), and the PP test is based on Newey-West (1994) bandwidth using Bartlett kernel.

$$\lambda_{Trace} = -T \sum_{r+1}^{k} \ln(1 - \lambda_i) \tag{3-4}$$

$$\lambda_{max} = -T \ln(1 - \lambda_i) \tag{3-5}$$

λ represents the estimated eigenvalues of the reduced rank of the matrix π. The sequential test strategy begins with r = 0 and is continued until the null hypothesis for a given significance level cannot be rejected for the first time. The related value of r ultimately corresponds to the cointegration rank. In this way there are (n-r) stochastic trends in the system. In this study the corresponding critical values are used in accordance with Osterwald-Lenum (1992).

The applied cointegration tests display the existence of at least one cointegrating relationship in each VAR model. The choice of the underlying lag structure of the VAR models is based in the first stage on the information criteria of Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ). We further test the models for heteroscedasticity and autocorrelation. Should both or either occur in the consequential VEC models we choose the next highest order. In all models examined the use of this approach enables the avoidance of misinterpretation of the test results at the tolerable expense of losing a few degrees of freedom.[25]

[25] Prior to this decision, it was necessary to conduct further analyses in order to preclude the possibility, that other reasons, such as, for instance, high values of correlation among the selected variables, were responsible for the significant deviations from the null hypothesis of the White test.

Table 3-2 Results of the Trace and Maximum Eigenvalue Tests.

Germany							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical value (95%)	H_0	H_A	λ_{Max}	Critical value (95%)
r = 0	r > 0	151.539 *	114.90	r = 0	r = 1	64.116 *	43.97
r ≤ 1	r > 1	87.423 *	87.31	r = 1	r = 2	39.127 *	37.52
r ≤ 2	r > 2	48.296	62.99	r = 2	r = 3	24.636	31.46

United Kingdom							
λ_{Trace} Test				λ_{Max} Test			
H_0	H_A	λ_{Trace}	Critical value (95%)	H_0	H_A	λ_{Max}	Critical value (95%)
r = 0	r > 0	138.986 *	94.15	r = 0	r = 1	57.093 *	39.37
r ≤ 1	r > 1	81.893 *	68.52	r = 1	r = 2	28.472	33.46
r ≤ 2	r > 2	53.420 *	47.21	r = 2	r = 3	25.435	27.07
r ≤ 3	r > 3	27.986	29.68	r = 3	r = 4	16.390	20.97

Notes: * denotes the null hypothesis is rejected at the 95% level.

Table 3-2 outlines the results of the cointegration tests. Due to the precisely formulated alternative hypothesis, this examination prefers the results of the maximum eigenvalue test to those of the trace test. These test results indicate the existence of two cointegrating relationships in the German and one in the UK economy.

3.4.2 Evaluation Principles

In many empirical studies, the methodological approach is not, or only incompletely, reported, leaving the reader without information as to how the results have been achieved. As the results depend strongly on chosen restrictions, it is worthwhile to report and justify at least the essential details of our applications.

The VECM results for the examination period between June 1995 and July 2007 are summarised in Tables 3-3 and 3-4. We chose equal evaluation principles in order to allow for comparisons between both countries. The case of multidimensional cointegrating relationships is explicitly taken into account within the scope of this examination. For this purpose we apply hypotheses tests in order to verify whether individual coefficients can be restricted to zero without accepting significant losses of information. In so doing, only a single regressor is eliminated in each step. The identification of those individual

factors which significantly contribute to explaining the country-specific equilibrium is based on the results of the tests for linear restrictions (LR tests).

Due to this approach, the normalisation of the ß-vectors depends on which factors are identified as significant. In the case of significance, the property indices are normalised to one in order to evaluate the long-term relationships between property and economy. If this does not apply to individual vectors, we restrict the respective property index to zero. In this case information is only provided via the coefficients related to the adjustment process.

As outlined in Table 3-3, the implemented restrictions are accepted by the LR tests. Furthermore, the p-values of the White tests consistently indicate that the risk of heteroscedasticity is eliminated.[26] Due to the decomposition of the π matrix, the use of the error correction approach allows for the separate evaluation of the long-run relationships and the adjustment mechanism separately (see Equation 3-2). The corresponding vectors for each country are shown in Tables 3-3 and 3-4.

3.4.3 VECM Results

The evaluation of the long-term relationships in both economies reveals remarkable similarities with respect to significance, signs and magnitude of coefficients. Consequently, despite the outlined differences in the examined real estate markets, the long-term equilibrium is specified by the same macroeconomic determinants, indicating consistent interdependencies between property and economy in the long run. According to that, if the β-vectors are normalised to property indices (Table 3-3, rows 1 and 3), the long-term equilibrium relationships are determined by the property index, consumer price index, long-term government bonds and unemployment rate in each case. These macroeconomic determinants consistently display the same signs in

[26] The estimated models are free of possible hazards caused by autocorrelation occurring within the residuals, too, although this is not explicitly mentioned in Table 3-3.

each β-vector and thus affect each property index in the same direction. The estimations reveal positive effects on property indices by the consumer price index and the long-term government bonds, while negative effects are detected for the unemployment rate. Therefore, these results confirm without exception the a priori defined hypotheses in these cases for both countries.

Table 3-3 Long-Term Equilibrium Relationships (β-vectors)

Country	r	RE	BR	CPI	GOV	IP	UR	pWhite prob LR-Test
Germany	2*	**1.000**	0	**4.913** [3.354]	**0.063** [-2.589]	0	**-0.533** [3.947]	0.209 0.978
		0	**1.000**	0	**1.260** [-6.523]	**41.656** [-12.910]	0	
United Kingdom	1	**1.000**	0	**4.8764** [-8.755]	**0.107** [-4.065]	0	**-0.791** [6.886]	0.462 0.054

Notes: Bold type denotes significant results on a 5% level (t-statistics in parentheses). Coefficients are converted so that relationships between the normalised variable and the risk factors can be identified directly as positive or negative. For reasons of clarity we do not report the corresponding constant c and the ε as a proxy for the error term. *T*-statistics are included in parentheses, r = number of cointegrating vectors. * denotes that the VEC model includes a deterministic trend. RE represents the national property index, BR = base rate of the corresponding country-specific central bank, CPI = consumer price index, GOV = long-term government bonds (10 years), IP = industrial production, UR = unemployment rate. pWhite denotes the p-values of the White test for heteroscedasticity, LR-test the probabilities of the test for linear restrictions.

Table 3-4 Adjustment Processes (α-vectors).

Country	Error Correction	D(RE)	D(BR)	D(CPI)	D(GOV)	D(IP)	D(UR)
Germany	CointEq1	**-0.011** [-3.07]	**1.167** [5.194]	0.002 [0.657]	0.389 [1.402]	0.008 [0.457]	**-0.056** [-3.312]
	CointEq2	0.000 [-0.149]	**-0.153** [-7.212]	-0.000 [1.061]	0.028 [1.061]	0.001 [0.701]	**0.005** [3.300]
United Kingdom	CointEq1	**-0.011** [-2.348]	-0.005 [-0.024]	**0.005** [2.068]	**0.996** [3.509]	**0.040** [3.124]	**-0.056** [-2.493]

Notes: Bold type denotes significant results on a 5% level (t-statistics in parentheses). RE represents the national property index, BR = base rate of the corresponding country-specific central bank, CPI = consumer price index, GOV = long-term government bonds (10 years), IP = industrial production, UR = unemployment rate. All values are first differences. For reasons of clarity we do not report the corresponding constant c and the error term ε.

In this context, the positive relationship between properties and consumer prices is of particular interest as this result reveals that direct property investments provide opportunities to hedge against inflation in the long run. Furthermore, the model estimations indicate high t-values and comparatively large coefficients for the CPI variables in each economy.

However, the linkage of the property market and the macroeconomy cannot be evaluated without taking into account the results of the adjustment process, as displayed in Table 3-4. The α-vectors describe the adjustment process when the linear combinations deviate from the long-term equilibrium path. In this case the α-vectors highlight in which way this disequilibrium affects the remaining macroeconomic risk factors. We observe a real adjustment mechanism in each vector, as the α-coefficients of the normalised variable are significantly negative. This implies that the linear combinations return to the long-term equilibrium in each case.

Furthermore, the coefficient estimates for the property markets are identical for Germany and the UK, indicating with α = -0.011 a quite small value in each case. Therefore, it takes on average about $\frac{1}{-\alpha} = 7.5$ years for the linear combinations of the variables to return to their common long-term equilibrium path. This quite long period of adjustment illustrates that the real estate sector is characterised by a comparatively high level of slackness, which is even more obvious when applying appraisal-based real estate indices. In comparison, the adjustment process is already completed after an average of 6.5 months within the second cointegrating relationship of the German model, which is normalised to the base rate variable. Figures 3-2 and 3-3 illustrate the adjustment processes for the observed paths. The zero line represents the long-term equilibrium, and the curve represents the deviations.

Figure 3-2 Cointegration Graphs (Germany).[27]

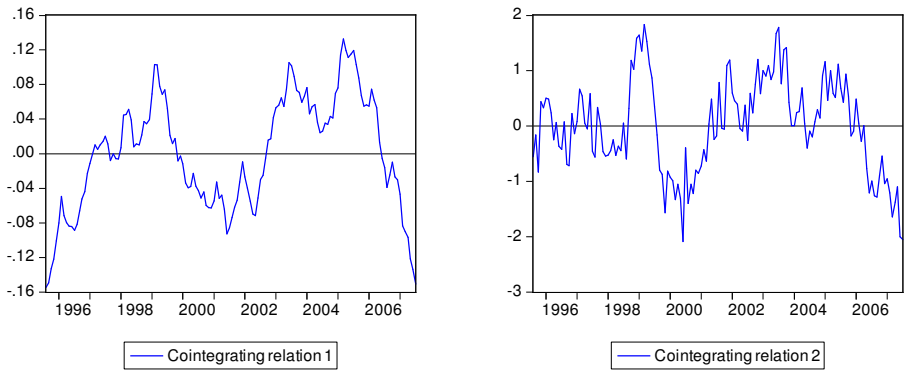
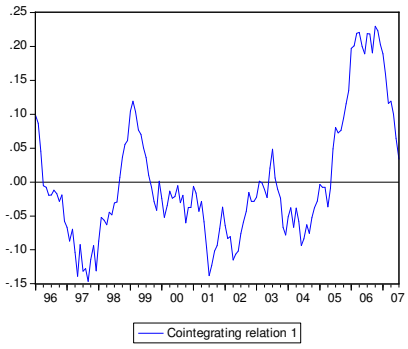


Figure 3-3 Cointegration Graphs (United Kingdom).



Although we find equal adjustment velocities, the mode how disequilibria affect the respective economy is remarkably different in both real estate markets. In this context, a disequilibrium is defined by an observed property index that lies above its long-term equilibrium level. In the case of the UK, all variables apart from the base rate are significantly affected in case of deviations from the long-term path. According to the UK model, this would result in an increase in consumer prices, long-term government bond yields and industrial production, and in a decline of the unemployment rate. In Germany, however, the same scenario would only lead to a higher base rate and a lower unemployment rate.

[27] Both VEC models are additionally tested for stationarity by the Dickey-Fuller (DF) test using the critical values according to Banerjee et al. (1993).

Evaluating the observed cointegrating relationships in their entirety furthermore reveals a considerable difference concerning the contribution of the base rate variable to the cointegrating relationships. Although the base rate is not significant in the long-term equilibrium of the first cointegrating relationship in the German model, it shows a significant coefficient within the α-vector with comparatively high *t*-values. As a consequence of this, the German base rate variable contributes to the explanation of the cointegrating relationship via the channel of the adjustment process. In contrast, the UK base rate is neither significant in the long-term equilibrium nor in the adjustment process. With respect to the cointegrating relationship (i.e. the combination of α- and ß-vectors), the link between the property market and the UK economy can therefore be explained without the impulse of the credit market.[28]

The results of the German model additionally reveal the existence of a second cointegrating relationship, indicating a long-term equilibrium between the base rate, government bonds and industrial production. While the property market does not have any impact on the cointegrating relationship in this scenario, the base rate is once more of particular importance as this variable reveals significant coefficients in both vectors of the second cointegrating relationship, and in this way indicates its essential relevance for the German economy.

In this context we assume a close connection between the role of the base rate variable and the distinctions of the financial systems in both economies. This applies to both the relevance in explaining property indices and in terms of the significance of this variable within the VEC models in their entirety. The German regime is still mainly bank-based, implying that companies generally prefer bank loans to funding on capital markets. Therefore, as the base rate is one of the main factors for the level of bank credits, the base rate variable plays a significant role within the German bank-based financial system. In contrast, the

[28] As the base rate variable displays significant coefficients within the short-term matrix $\sum \Gamma_i \Delta Y_{t-i}$ of the VECM equation (see Equation 3-3), omitting the base rate variable does not improve the validity of the results in the case of the UK, even though we cannot detect a significant contribution within the cointegrating relationship $\pi = \alpha \beta'$.

reverse applies in the UK. The base rate has no significant impact on the adjustment process, which can be explained by the stronger orientation of the British financial system towards capital markets.

Moreover, our results clarify that the unemployment variable is worth considering in scientific studies with regards to on the link between direct property and its economic environment. From a macroeconomic point of view, employment represents a major source of the aggregate wealth of a nation's economy and in this way determines purchasing power as well as consumer behaviour. With respect to the real estate sector, the situation on the labour markets represents an indicator for the demand side for properties, which implies that declining unemployment rates result in rental growth and increasing property prices. According to this, we consistently find significant coefficients in both the long-term relationships and during the adjustment process in both examined economies. This result deviates from the finding of Liang and McIntosh (1998), who detect effects resulting from employment growth in the short-term only.

3.5 Conclusion

While property markets are an important part of a national economy, there is very little empirical evidence regarding their interaction with the markets for money, credit, employment and other macroeconomics. This paper examines Germany and the UK, two of the most important European property markets. Using appraisal-based indices, our study examines the development of property prices while considering the influences of a wide range of macroeconomic risk factors. We apply a cointegration framework and find two cointegrating relationships for Germany and one for the UK. The use of the consequential vector error correction models (VECM) supplies empirical evidence for the long-term linkage of direct real estate investments to macroeconomic influences, as well as the mutual dependencies during the short-term adjustment process.

Despite essential differences in terms of market structure, conditions and performance, we find remarkable similarities between both examined real estate markets with respect to significance, signs and orders of magnitude in the long run. Accordingly, the long-term equilibrium in the real estate sectors of both economies is determined by exactly the same macroeconomic factors, namely consumer prices, government bonds and the unemployment rate. Here we find a positive linkage between the property markets and consumer prices as well as the government bonds, while the property markets are negatively affected by the respective unemployment rates. These results apply to economic theory and therefore confirm without exception the a priori defined hypotheses.

Besides the confirmation of inflation-hedging characteristics of direct property investments, we also detect a significant role of the labour market in both economies. Unlike the vast majority of the related literature, we consider the unemployment rate for the purposes of our examination and find a substantial influence within both the long-term relationships and during the adjustment processes in both examined countries. Therefore, we conclude that taking into account the effects on labour markets is worthwhile with regard to prospective studies on this issue.

When the economy deviates from the long-term equilibrium path, a further similarity can be detected in terms of the adjustment velocity. For both economies it takes on average about 7.5 years to return to the long-term equilibrium. However, the structure of the adjustment processes is considerably different between both economies. In Germany, only the base rate and the unemployment rate are significantly affected in case of a disequilibrium in the property market. In contrast to this, all examined macroeconomic determinants react to a deviation in the UK property market from the equilibrium level, with the ecxeption of the base rate.

With respect to the relevance of the base rate in the examined economies, we therefore find a remarkable deviation between Germany and the UK. While this variable plays no role in the UK model – neither in the long-term nor during the adjustment process – the base rate significantly contributes to the explanation of the cointegrating relationships in the case of Germany. In this context we assume that this distinction is caused by the differences in the financial systems and the consequential deviations in terms of the funding behaviour in both economies. The base rate variable plays a significant role in the German model due to the bank-based orientation of the economy. In contrast, this does not apply to the UK markets, as the financial system is predominantly focused on funding by means of capital markets.

Our results clarify that real estate markets in Germany and the UK show remarkable similarities in the long run, despite the structural differences and their divergent developments in the recent decades. This implies that over longer time periods the fundamental role of the property markets in an economy dominates country-specific characteristics. The distinctive features of the national property markets, however, seem to affect primarily the short-term adjustment processes.

3.6 Appendix

Table 3-5 Unit Root Tests (1995:07 – 2007:07).

Panel A: Germany								
Factor	**Variable**	**ADF-Test (AIC)** AIC, maximum lags: 13			**PP-Test** Newey-West bandwidth using Bartlett			**LI**
		ADF (none)	**ADF (intercept)**	**ADF (trend + intercept)**	**PP (none)**	**PP (intercept)**	**PP (trend+ intercept)**	
IMMEX	ln IMMEX			-2.822 (9)			1.680 (7)	I(1)
	Δ ln IMMEX		**-3.468 (3)**			**-11.390 (7)**		
ECB Base Rate	BR		-2.586 (4)			-2.141 (8)		I(1)
	Δ BR	**-3.140 (3)**			**-11.531 (8)**			
Consumer Price Index	ln CPI			-1.733 (0)			-1.480 (7)	I(1)
	Δ ln CPI		**-11.848 (0)**			**-12.126 (11)**		
Long-Term Government Bonds	GOV		-2.813 (1)			-2.554 (5)		I(1)
	Δ GOV	**-8.937 (0)**			**-8.929 (4)**			
Industrial Production Index	ln IP		1.080 (3)			0.799 (3)		I(1)
	Δ ln IP	**-3.477 (4)**			**-15.795 (8)**			
Unemployment Rate	UR		-2.205 (4)			-1.801 (8)		I(1)
	Δ UR	**-5.868 (0)**			**-5.905 (5)**			
Panel B: United Kingdom								
Factor	**Variable**	**ADF-Test (AIC)** AIC, maximum lags: 13			**PP-Test** Newey-West bandwidth using Bartlett			**LI**
		ADF (none)	**ADF (intercept)**	**ADF (trend + intercept)**	**PP (none)**	**PP (intercept)**	**PP (trend+ intercept)**	
Index of the Investment Property Database	ln IPD			-2.541 (7)			-1.260 (9)	I(1)
	Δ ln IPD		**-2.585 (12)**			**-5.042 (5)**		
Base Rate of the Bank of England	BR		-2.071 (6)			-1.761 (8)		I(1)
	Δ BR	**-4.581 (1)**			**-8.465*** (6)**			
Consumer Price Index	ln CPI			-1.048 (0)			-1.096 (3)	I(1)
	Δ ln CPI		**-11.678 (0)**			**-11.678 (2)**		
Long-Term Government Bonds	GOV		-1.962 (7)			-2.262 (5)		I(1)
	Δ GOV	**-3.892 (6)**			**-9.887 (6)**			
Industrial Production Index	ln IP		-2.0201 (9)			-2.711 (3)		I(1)
	Δ ln IP	**-2.930 (8)**			**-18.174 (12)**			
Unemployment Rate	UR			-2.051 (9)			-0.981 (8)	I(1)
	Δ UR		**-2.643 (8)**			**-12.899 (9)**		

Notes: Printed in bold type = statistical significance at 95% level. ADF = Augmented Dickey Fuller test for stationarity. AIC = Akaike information criterion, PP = Phillips-Perron test for stationarity, LI = level of integration. The number of lags and the bandwidths are given in parentheses.

4 Real Estate Equities – Real Estate or Equities?

This paper is the result of a joint project with Steffen Sebastian.

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We gratefully acknowledge the various suggestions offered by the participants of the Joint Conference of the Deutsche Bundesbank and the Centre of European Economic Research (ZEW) in Mannheim, 20–21 October, 2008, the participants of the 16th European Real Estate Society (ERES) Conference in Stockholm, Sweden, 24–27 June, 2009, and the participants of the 2009 Joint International Real Estate Conference of the Asian Real Estate Society (AsRES) and the American Real Estate and Urban Economics Association (AREUEA) in Los Angeles, USA, 11–14 July, 2009, which resulted in a substantially improved paper.

Abstract

This study examines whether real estate stock indices in the United States and the United Kingdom are predominantly driven by the underlying property markets or by progress on general stock markets. In the process, we abandon the conventional approach of focussing on only the three assets, namely real estate equities, direct real estate and stock indices. Instead, we conduct an analysis which explicitly takes into account the macroeconomic environment in each country. Based on vector error correction models (VECM) and variance decompositions, we detect a significantly stronger linkage among the real estate assets compared to the equity assets in the long run. However, despite these long-term similarities, we also identify differences concerning the linkage to the respective economic environment. Accordingly, we find a close nexus of the US real estate market with the real economy, while the financial market indices in the UK are predominantly focused on each other.

JEL Classification Codes: C32, G11, L85

Key words: real estate investments, cointegration, vector error correction model (VECM), macroeconomics

4.1 Introduction

Real estate as an asset class describes a considerable investment vehicle for private, commercial and institutional investors. Primarily thanks to their nature as a real asset, investments in properties reveal different features compared to conventional assets like stocks and bonds. In particular, this applies to long-term investment horizons and is recognisable by low correlations and a distinctive risk/return structure, which in turn is accountable for being classified as an alternative asset. With respect to issues of asset allocation, investments in real estate therefore provide remarkable potential for diversifying an investor's portfolio. Earlier studies measuring the diversification benefits, such as Eichholtz (1996), Eichholtz et al. (1998), Liu and Mei (1998) or Liu et al. (1997), find favourable characteristics of real estate investments, including high stability of value, comparatively low volatilities and opportunities to hedge against inflation.

Investments in direct real estate nevertheless suffer from several disadvantages. Unlike stocks or bonds, neither the market volume nor the spectrum of the international real estate market has been developed to a sufficient extent up to now. In addition to issues of illiquidity, property investments are characterised by low information efficiency and insufficient market transparency. These drawbacks are noticeable in comparatively high information costs and thus increasing transaction costs, which in turn significantly reduce profit margins.

In the recent past, however, we have observed an ongoing expansion of securitised real estate.[29] Investors are nowadays faced with a wide range of products related to real estate investments. Besides the conventional investment in direct real estate (residential or rental properties), investors also have opportunities to invest in several forms of securitised real estate, such as

[29] According to Brounen et al. (2006) the market capitalisation for securitised real estate rose to USD 800 billion as of the end of 2005.

closed and open-end funds, listed real estate companies, REITs or real estate private equity. In this context, listed real estate in particular provides opportunities to adjust the disadvantages outlined above. Accordingly, the listing on stock exchanges ensures that prices are calculated in real time and favours transparency on markets for real estate investments in this way. In addition, the division into shares reduces the minimum investment amounts and, by implication, the market entrance barriers for potential investors. As a result, listed real estate provides an easier way for investors – in particular for private investors – to participate in the progress of the real estate sector.

A further consequence of listing on stock exchanges is that additional drivers – besides the development of the underlying properties – affect the performance and the risk/return structure of the listed asset to a significant extent. Consequently, the asset's performance is dependent on current economic news, which implies that the company value is not spared from the general stock market risk, including incorrect analyst expectations and valuations. As the equity price is subject to supply and demand, it might therefore suffer from irrational behaviour on stock markets, for example due to exaggerations in phases of boom and bust, or caused by the well-known herding behaviour of investors.[30] As a result, listed companies are faced with the risk that market values are predominantly driven by developments on general stock markets, although the main business of real estate companies remains unchanged and is still focused on trading and renting real estate.

For this reason, it is worthwhile analysing whether real estate equities can still be characterised as real estate investments in their primary meaning and

[30] In this context, several irrationalities on capital markets were detected by different studies within the research branch of behavioural finance. For example, the findings of Kahneman and Tversky (1979) contradict the basic tenets of utility theory. The authors detected a value function that is normally concave for gains, but commonly convex and generally steeper for losses. Furthermore, Shiller (1981) discussed the stock market's efficiency and found that volatility of stock prices is much higher than fundamentally justified. For an overview concerning further possible irrationalities and their distinctions from current economic theory, please refer to Andrikopoulos (2007).

whether their distinctive features as an alternative investment still persist despite listing on stock exchanges.[31] Previous studies, such as Liu and Mei (1992), Li and Wang (1995), Karolyi and Sanders (1998), Pagliari et al. (2005) and Hoesli and Serrano (2007), among others, examined this question and reached inconsistent results which are largely dependent on the selected method or the sample under consideration. Therefore, despite considerable research, there is still no incontrovertible evidence on this issue.

4.1.1 Macroeconomic System

Using a different approach, our study is focused exactly on this issue and examines whether real estate stock indices in the United States and the United Kingdom are primarily driven by the progress on property markets or by developments on general stock markets. Deviating from the conventional procedure of only focussing on the three financial market indices, namely real estate equities, direct real estate and general stocks, we conduct an analysis which explicitly takes into account the macroeconomic environment in each country. Following this approach allows us to consider the effects resulting from interdependencies between the macroeconomy and the three asset classes mentioned above.

According to Lizieri et al. (1998), real estate markets are generally considered to be cyclical in nature. Therefore, it is possible that the structure of market behaviour differs across phases of boom and bust. This might be recognisable by lower adjustment velocities after deviations from the equilibrium or by different volatilities of property values depending on the economic situation.[32] For this reason, we presume a significant contribution of the macroeconomy to

[31] Generally, the term “property” is used in British English and “real estate“ in American English, respectively. For the purposes of our examination, however, we use the term “property“ in order to denote direct real estate investments, while the term “real estate“ denotes real estate as an asset class in general, including securitised real estate.

[32] With regard to general stock markets, this issue was analysed by Black (1976), who found that falling prices are more volatile than rising prices.

the explanation of developments on real estate markets in general and for analysing the features of real estate equities in particular.

4.1.2 Cointegration and VECM

For the purposes of this examination we conduct a cointegration framework and the Johansen (1988) procedure.[33] The use of this method facilitates the consideration of the dynamic character among the selected risk factors. Moreover, the use of an appropriate lag structure within the implemented VEC models takes into account the possibility that macroeconomic variations might affect assets – especially appraisal-based indices – predominantly with a delay.

Deviating from the existing studies concerning the features of securitised real estate, we additionally take into account the case of multi-dimensional cointegrating relationships. Consequently, the evaluation of the implemented VEC models is not limited to the long-term relationships in the β-vectors. Instead, the adjustment process (α-vectors) and cross-vectoral effects are also considered. This procedure ensures that the relevance of real estate equities is assessed by evaluating the VEC models in their entirety. Moreover, by following the approach of taking into account the economic environment within the scope of vector error correction models, it is possible to examine the relevant channels which are responsible for the adjustment process after deviations from the long-term equilibrium. In this context, the results detect remarkable deviations between the economies in the US and the UK. Accordingly, we find a strong orientation towards the macroeconomy in the United States, where disequilibria affect neither the real estate assets nor the general stock market. In contrast, the financial market indices in the United Kingdom, namely the real estate equity index, the general stock market and the direct property index, are predominantly focused on each other.

[33] As several papers contribute to the development of the Johansen procedure as it is used within the scope of this study, the denoted year refers to the first paper of the VECM series by Johansen and Juselius.

In order to achieve convincing results we conduct further analyses in order to gain more detailed insights into whether real estate equities are predominantly driven by properties or equities. For this reason, we additionally employ variance decompositions and verify our VECM results in this way. Nevertheless, both implemented procedures indicate that real estate equities are primarily driven by their underlying property markets in the long run, rather than by the progress of general stock markets.

The remainder of this paper proceeds as follows. Section 4.2 reviews the related literature. Section 4.3 introduces the selected data and outlines the progress of the macroeconomic environment during the examination period. Section 4.4 presents the model framework. Section 4.5 provides empirical evidence and Section 4.6 concludes.

4.2 Literature Review

The scope of this examination covers a wide range of research branches. Besides the analysis of the distinctive features of real estate assets, it is also necessary to consider the literature on the impact of the macroeconomy on the real estate sector.

4.2.1 Nature of Real Estate Assets

The benefits of both direct and listed real estate with respect to diversification in a multi-asset portfolio have been discussed in various studies. Several authors certify favourable features of real estate investments in terms of geographical diversification in particular. In this context, real estate provides even more attractive advantages than international diversification through stocks and bonds. For example, Eichholtz (1996) detects significantly lower correlations between national real estate returns compared to common stocks or bond returns and therefore concludes that international diversification reduces the risks of a real estate portfolio to a larger extent than conventional asset portfolios. Case et al. (1997) find that geographical diversification within

different types of commercial real estate, namely industrial, office and retail, is profitable. Furthermore, the study of Eichholtz et al. (1998) examines the impact of continental factors on real estate returns and verifies the existence of attractive international diversification potential for European and US investors. These favourable features of international real estate diversification are additionally confirmed by the studies by Newell and Webb (1996) and, with respect to industrial real estate, by Goetzmann and Wachter (2001).

Concerning the issue of whether real estate equities are dominated by properties or general stocks, previous studies reach inconsistent results which are largely dependent on the selected method, market or sample. In this context, related literature on integration characteristics of listed real estate is primarily focused on US markets using REIT data (see e.g. Liu and Mei, 1992, Karolyi and Sanders, 1998, and Ling et al., 2000). In the process, several studies detect high correlations of securitised real estate to common stocks. For instance, Li and Wang (1995) conduct a multifactor asset pricing (MAP) model and find that the US REIT market is integrated with the general stock market. Oppenheimer and Grissom (1998) use frequency space correlations and come to the same conclusion, according to which US REITs show significant co-movement with stock market indices. Moreover, by using regressions Quan and Titman (1999) detect significant relations between stock returns and changes in property values and rents in 17 different countries. This finding is additionally confirmed by the analysis of Ling and Naranjo (1999), who also examine whether commercial real estate markets are integrated with equity markets. Using multifactor asset pricing (MAP) models, the study finds that the risk premium of the market for exchange-traded real estate companies is integrated with the equity market. The authors additionally note that the degree of integration has significantly increased during the 1990s. In contrast, the integration hypothesis does not apply to real estate portfolios which are based on appraisal-based investments.

Another cluster of studies find that correlations between direct real estate and securitised real estate have increased over time (see e.g. Gosh et al. (1996) for the US market). Clayton and MacKinnon (2001) examine the sample between 1978 and 1998 for the US market by the use of a multi-factor approach. Although direct real estate does not contribute to the explanation of REIT returns over the entire sample, the study shows time-varying results concerning the link between REITs, direct real estate and financial assets. Nevertheless, they also find increasing correlations among direct and indirect real estate. Time-varying correlations are also detected by Hoesli and Serrano (2007), who analyse the relationships between securitised real estate, stocks, bonds and direct real estate in 16 economies. The international analysis reveals decreasing regression betas over time, indicating that the influence of the financial assets on securitised real estate has become less important in recent years. Nevertheless, the general stock market and bonds still explain a significant fraction of the variance of securitised real estate. As this does not apply to direct real estate, the results suggest that securitised real estate is driven by stocks and bonds rather than by their underlying property markets.

A third cluster of more recent studies, however, contradicts the results of the earlier studies outlined above and indicates that real estate securities behave more like properties than like general stocks in the long run (see e.g. Pagliari et al., 2005, Westerheide, 2006, Tsai et al., 2007, or Morawski et al., 2008). These findings point to opportunities for investors to combine the advantages of listed real estate with those of direct property investments and would have remarkable implications with respect to asset allocation in a multi-asset portfolio. As there is still no undisputed evidence concerning this question, neither provided by studies that address the pre-modern REIT era before the early 1990s nor by those that address the modern REIT era, we contribute to the literature by analysing this issue through a different approach. Accordingly, we assume that strict observation of econometric requirements as well as the consideration of the macroeconomic environment ensures reliable results.

4.2.2 Real Estate and Macroeconomics

Real estate research linking the real estate sector with its economic environment has up to now primarily focused on the existence of inflation-hedging characteristics of real estate assets. In this context, Hartzell et al. (1987) find that portfolios of commercial real estate hedge against both expected as well as unexpected inflation. Gyourko and Linneman (1988), however, distinguish between direct investments in non-residential property and REIT investments. While non-residential property investments are mostly positively correlated with inflation, REIT investments are similar to conventional equity or bond investments and thus strongly negatively correlated with inflation. Using regressions, limited opportunities were also detected by Liu et al. (1997) for the sample between 1980 and 1991. They found that real estate securities do not represent a better hedge against inflation than common stocks in the five examined countries.

In contrast, Quan and Titman (1999) and Hoesli et al. (2008) detect favourable features of real estate investments to hedge against inflation. Quan and Titman (1999) use regressions and attest that real estate is positively driven by inflation as well as by the GDP. By employing a vector error correction (VEC) approach, Hoesli et al. (2008) examine the interactions between the economy, stock indices and public and private real estate between 1977 and 2003. Considering the impact of real and monetary variables, the authors find a positive long-run linkage between commercial real estate returns and anticipated inflation in the United States and the United Kingdom, while the converse holds for inflation shocks.

Further empirical studies have been conducted in order to identify the most important macroeconomic determinants for the progress of real estate indices. In this context, McCue and Kling (1994) use VAR models and find significant influences of the factors of inflation and three-month treasury bills on US REIT returns. Ensuing variance decompositions indicate that nearly 60% of the variation in real estate prices is explained by the macroeconomy and that it is

the nominal short-term interest rate that explains the majority of the variation in real estate series. Other studies, such as those by Liang et al. (1995) or Mueller and Pauley (1995), focus on the linkage between real estate prices and interest rates by assuming that this linkage is time-varying and differs depending on periods of high and low interest rates. Using a threshold autoregressive (TAR) model for the real estate markets in the United States and the United Kingdom, Lizieri et al. (1998) distinguish between two interest rate regimes. In general, their results clarify that decreases in real estate prices are more extreme in a high real interest environment than the increases associated with lower real rates.

In their study on the risk/return structure of publicly-traded real estate companies, Bond et al. (2003) find that the consideration of country-specific market and value risk factors in particular provide additional explanatory power, although this finding is not universally valid over all 14 countries under consideration. Therefore, the authors conclude that the potential of international diversification with real estate companies cannot reliably be assessed without having regard to the standards for regulation and disclosure as well as governance standards of the related companies. According to Bond et al. (2003), the results of Hamelink and Hoesli (2004) point to a dominance of the country factor over property-type factors. A further highly significant role is also detected for the value/growth factor, which is characterised by substantial levels of volatility.

Using multifactor asset pricing (MAP) models, Sing (2004) examines the effects of systematic market risk factors and common risk factors on the variations in excess returns of securitised and direct real estate investments. For this purpose, the author uses the SUR estimation technique and the standard Fama and MacBeth (1973) two-pass regression technique to estimate the risk premiums in the proposed MAP models. The evaluation of the test results shows that macroeconomic risk factors are priced notably differently in securitised and direct real estate markets. In contrast, Wang (2006) follows another approach, whereby he uses the functional relationships between real

estate returns and economic activities in the UK to infer the extent to which an appraisal-based index is smoothed. Using this method enables the correction of appraisal-smoothing and the detection of the true market volatility information.

4.3 Data Selection

4.3.1 Real Estate and Stock Market Data

With respect to regulation, disclosure and accounting standards, we still find remarkable differences across international real estate markets.[34] As these country-specific distinctions significantly influence results, reduce comparability and therefore affect inferences, using a reliable and consistent data set is particularly important for the purposes of our examination.

Real estate markets in the United States and the United Kingdom are characterised by high transparency and low transaction costs compared to other real estate markets in industrialised countries. Furthermore, the market for US and UK property companies is much more actively traded than other national real estate markets, and in this way highlights the higher level of development and liquidity. As a consequence of this, real estate markets in the US and the UK supply reliable data and representative indices for both direct as well as indirect real estate investments, which is vital to our approach of analysing the features of real estate equities. Admittedly, this does not apply to further national real estate markets, as the according direct property indices in particular are not comparable to the well-known and widely-used US NCREIF and the UK IPD or do not cover the required period. The NCREIF Property Index (NPI), provided by the National Council of Real Estate Investment Fiduciaries, has been published since 1978 and currently covers 5.976 US properties – including all types of real estate – and presents a market value of USD 328 billion (as of 2008:q1). The UK counterpart is represented by the property index of the Investment Property Database (IPD), which incorporates

[34] For a discussion see Bond et al. (2003).

monthly adjustments or appraisals of the underlying properties and contains 3.695 properties with a market value of £40.8 billion as of August 2008 (Investment Property Database (IPD), 2008).

In the US model we also use the FTSE NAREIT Equity REIT Index of the National Association of Real Estate Investment Trusts (NAREIT) as a proxy for the American real estate stock market. This index is a sub-index of the FTSE NAREIT US Real Estate Index series and only includes companies which own or operate income-producing real estate, such as apartments, shopping centres, offices, hotels and warehouses. Currently, this index contains 110 constituents with a net market capitalisation of USD 276.638 million (as of January 2008). In the UK model we use the capitalisation-weighted UK FTSE 350 Real Estate Index to cover the British real estate sector.

In order to cover the influences of the general stock market, we use the respective benchmark indices for the US and UK equity markets. As frequently done in previous studies, the general stock market is represented by the FTSE 100 Index in the UK model, while the S&P 500 Composite Index is used to cover the general stock market in the United States. Due to the fact that US REITs are largely contained in the S&P Small Cap 600 Index, another possibility could be to use this subindex for the purposes of this examination.[35] However, following this approach does not improve validity, because the index history is not as long as that of the S&P 500 Composite Index and, due to a correlation coefficient in the amount of 0.86, using the S&P Small Cap 600 Index does not provide additional findings.

[35] As of June 2009, the portfolio weighting of US REITs only amounts to 5.8% of the S&P Small Cap 600 Index. Source: Morningstar Database.

4.3.2 Macroeconomic Data

The selection of the macroeconomic factors is based on theoretical assumptions and represents a good compromise between covering the most important influences resulting from the economic environment without over-parametrising the models. The determinants are represented by the consumer price index (CPI) as a proxy for inflation, the real gross domestic product (GDP) as a proxy for economic growth and the interbank rates (three months) for considering the influences of the money market. Interbank rates represent a major indicator for the resulting credit costs and in this way primarily cover aspects of bank lending. As interbank rates can furthermore be taken as an indicator for the aggregate investment climate of an economy, we prefer the use of this time series to long-term interest or mortgage rates.

The implemented approach allows the analysis of possible inflation-hedging characteristics of investments in real estate. According to economic theory, real estate is largely classified as a hedging instrument against inflation, because owners benefit from increasing nominal income and capital growth, while the real value of their debt is eroded (Lizieri et al., 1998). Furthermore, due to the characteristic as a real asset, the net asset value of the related property is not subject to depreciation of money to such an extent as conventional assets like equities or bonds. Furthermore, particularly with respect to commercial properties, rental contracts largely contain inflation subscripted rental payments. In this way, the adverse effects of rising inflation can be compensated to a significant extent. Nevertheless, our results clarify that passing a blanket judgement is pointless in this context. Instead, considering the complete business environment and its interrelationship to the real estate sector is indispensable for each country under consideration.

4.3.3 Different Nature of Selected Time Series

Within the scope of our examination, one main issue is to reduce the risk of possible distortions which could be caused by the different natures of the selected time series. Indices representing the general stock markets and the real estate equities are calculated in realtime, while the macroeconomic data is only released on a monthly or – in the case of the gross domestic product – on a quarterly basis. Moreover, it is normal that macroeconomic releases are subsequently revised. The appraisal-based direct property indices represent an exception in this context, as their valuation is executed by an appraiser. Due to the low-frequency appraisals, variations or economic development affecting real estate prices are only considered with a delay. This issue highlights the necessity of using low-frequency data for the purposes of our examination. For this reason, we use quarterly data to examine real estate assets. Furthermore, we conduct vector error correction models (VECM), which are said to provide more reliable results if covering a longer time horizon compared to a shorter sample with a huge number of high frequency data points.

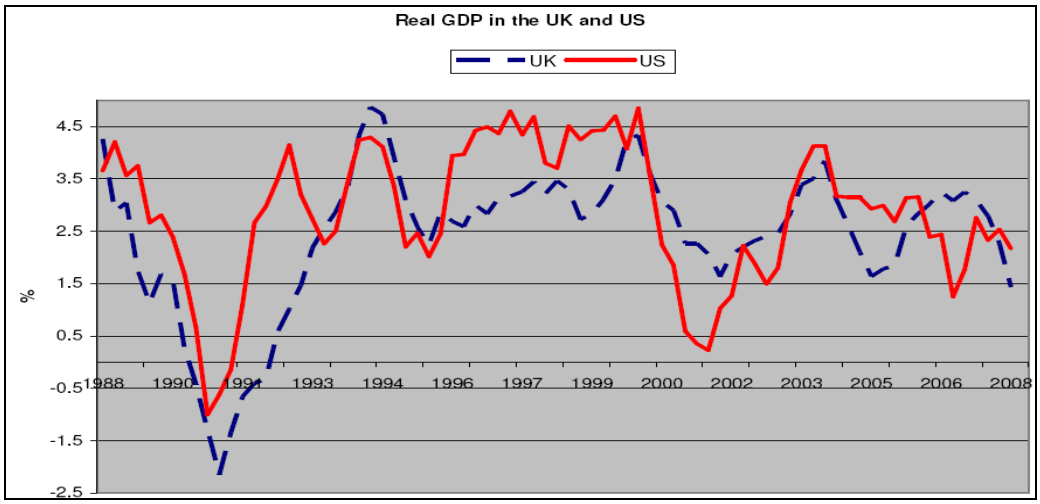
All time series are denominated in local currencies and are transformed into natural logarithms. Due to their interest character, interbank rates represent the only exception in this context and are therefore used without any transformation. Furthermore, the consumer price index and the real gross domestic product time series as well as the direct property indices are seasonally adjusted. Time series based on appraisals are known to be subject to artificial smoothing. However, as there is currently still no incontrovertible evidence on how to unsmooth real estate data, we use the original time series in order not to bias our results.[36]

[36] For a discussion see Bond and Hwang (2007).

4.3.4 Testing for Structural Breaks

In order to preclude misinterpretation and consequently incorrect economic implications due to instability in the deterministic trend, we examine the dataset for structural breaks. Taking into account structural breaks is particularly important when applying cointegration techniques. Ignoring the existence of structural breaks leads to unreliable unit root test decisions and consequently to the risk of misspecified estimation models (Perron, 1989). As illustrated in Figure 4-1, the periods at the beginning of the 1990s, after the collapse of the New Economy in 2000 and around "9/11" in 2001 are particularly worth testing, because the recessions and their consequences for credit markets ought to be closely linked to our real estate-related macroeconomic model.

Figure 4-1 Real GDP in the UK and the US.



Source: Datastream.

We prefer to apply stability tests on the basis of dynamic multivariate models if employing cointegration techniques. In so doing, we abandon the approach of the related studies, which primarily use CUSUM and CUSUMQ tests or Chow tests on the basis of OLS regressions. As the stability hypothesis is rejected far too often for multivariate dynamic models with many parameters relative to the number of available observations, we use the bootstrap versions of the Chow

test according to Candelon and Lütkepohl (2001).[37] We examined the data from 1978:q1 to 2008:q2 for the US model and from 1988:q1 to 2008:q2 for the UK model for structural breaks. The splitting sample Chow tests are applied on the basis of VEC models.[38]

In both economies, the results of the tests for structural breaks divide the sample in 1992:q1 (see Figures 4-4 and 4-5, Section 4.7.1). As a result, the examination period is set from 1992:q1 to 2008:q2 for both economies and therefore allows for comparisons of the results between both national datasets. Although data is available from 1978:q1 to 2008:q2 for the US model and from 1988:q1 to 2008:q2 for the UK model, we prefer to examine the sample after the detected structural breaks, because the estimation results for the whole sample are not sufficiently robust compared starting the analysis as of 1992. This lack of robustness is recognisable by the fact that significance and signs of coefficients vary depending on our manual specifications, namely the selection of the model order or the implemented restrictions within the cointegrating vectors. In this context, neither recursive estimations nor moving windows provide evidence of robust results. In short, covering the whole sample would lead to instable results and most likely to unreliable economic implications. For that reason, we choose not to artificially extend the sample by applying techniques to repair the structural breaks.

Covering the sample after the detected structural breaks, however, ensures robust results even if individual model specifications are changed.[39] Accordingly, even though we accept to cover, at least approximately, one real estate cycle, following this approach ensures econometrically correct results

[37] For further details see Candelon and Lütkepohl (2001).

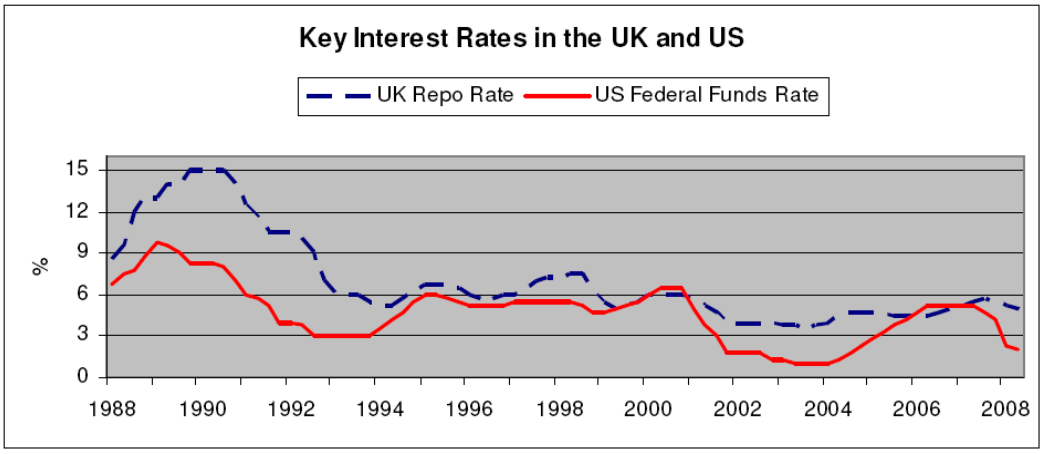
[38] The date for the structural break is verified using different VECM orders in order to minimise the impact of individual model specifications. Nevertheless, these alternative specifications are in line with the evaluation principles as outlined below. As all test orders indicate structural breaks at the end of 1991 or at the beginning of 1992, we start our sample in 1992:q1.

[39] Where alternative model specifications are chosen only the magnitude of coefficients vary, whereas significance and signs of coefficients remain largely unchanged.

and allows reliable economic implications. Moreover, the identified date of the structural breaks can reasonably be explained by the recessions that occurred at that time and their tremendous consequences for credit markets. Subsequent to the saving and loan crisis during the late 1980s, the US recession began in July 1990 and was worsened by a credit crunch in the US financial sector. In addition, modifications in tax legislation led to remarkable changes in the structure of US real estate markets (Glascock et al., 2000). Accordingly, the anticipation of the consequences due to the Omnibus Budget Reconciliation Act in 1993 resulted in a remarkable increase in the underlying equity capital of REITs and thus in a historical shift in US real estate investment markets.

In the UK, however, a boom in the housing market during the 1980s and the consequential increases in house prices stimulated consumer spending, which in turn resulted in remarkable increases in the rate of inflation. Consequently, the Bank of England increased interest rates to as high as 15% in 1989:q4 in order to protect the value of the British pound (see Figure 4-2). The costs of mortgage payments increased and led to a rising number of home repossessions and falling house prices. As a consequence of this, consumer spending decreased and caused an economic slowdown which ultimately resulted in the 1991 UK recession.

Figure 4-2 Key Interest Rates in the US and the UK.



Source: Datastream.

Nevertheless, the recovery in both countries was supported by a remarkable decrease in the key interest rates of the corresponding central banks (see Figure 4-2). While the US federal funds rate amounted to 9.75% in 1989:q1, the ongoing expansive monetary policy ended at the 3% level at the end of 1993. The same applies to the monetary policy of the Bank of England. The reduction of interest rates began at the 15% level at the end of 1990 and ended at 5.25% at the beginning of 1994. [40]

4.3.5 Descriptive Statistics

Table 4-1 outlines all time series used and presents the corresponding descriptive statistics for their first differences. A comparison between both economies reveals several similarities and we therefore assume a comparable economic environment during the examination period in the two economies under consideration.

Table 4-1 Descriptive Statistics (1992:q1 to 2008:q2).

United States	NCREIF	NAREIT	CPI	INTER	GDP	SP500
Mean	0.023980	0.030561	0.006693	-0.027538	0.007535	0.019328
Median	0.025793	0.033473	0.007194	-0.010000	0.007327	0.023570
Maximum	0.050291	0.195899	0.015374	0.990000	0.018049	0.174682
Minimum	-0.015398	-0.135524	-0.003782	-1.770000	-0.003519	-0.166637
Std. Dev.	0.014615	0.069323	0.003130	0.497905	0.004762	0.061566
United Kingdom	IPD	REEI	CPI	INTER	GDP	FTSE
Mean	0.023745	0.021959	0.004837	-0.070909	0.006795	0.013089
Median	0.025312	0.045027	0.004672	-0.010000	0.006741	0.017144
Maximum	0.077325	0.248814	0.019581	0.700000	0.014147	0.119784
Minimum	-0.090169	-0.227301	-0.005356	-2.650000	-0.002439	-0.195991
Std. Dev.	0.023908	0.103840	0.005566	0.501597	0.003059	0.064034

Notes: NCREIF = direct property index in the United States , NAREIT = real estate equity index in the United States , IPD = direct property index in the United Kingdom, REEI = FTSE 350 Real Estate Index as a proxy for the real estate equity market in the United Kingdom, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, SP500 = Standard & Poor's 500 Stock Index, representing the general stock market in the US, FTSE = FTSE 100 Index, representing the general stock market in the UK.

[40] In addition, immense currency speculation imposed pressure upon the British pound during that time. In particular, this applies to September 16, 1992, the date which came to be known as the "Black Wednesday". Despite considerable intervention measures by the Bank of England (BoE), the deterioration of the UK currency could not be stopped and ultimately resulted in the UK opting out of the European Exchange Rate Mechanism (ERM).

Due to their nature as interest rates we observe that the interbank rates show comparatively high standard deviations. In addition to equal algebraic signs of the means, the CPI, the GDP and the general stock market display comparable values in both economies. As the investigation period after the recessions is congruent with a long-term upward trend in the real estate sector, we furthermore find comparatively high mean values of the direct and indirect real estate indices in each country.

4.4 Methodology

In order to analyse the dynamic interactions between the selected macroeconomic variables and direct as well as indirect real estate indices in the United States and the United Kingdom, this study applies the cointegration concept to vector autoregressive (VAR) models using the vector error correction (VEC) framework according to Johansen (1988).

The concept of cointegration is traced back to Granger (1981, 1986) and Engle and Granger (1987). It combines time series analytical procedures with the concept of economic equilibrium, and facilitates the analysis of long-term equilibrium relationships between non-stationary variables. The cointegration analysis is based on the observation that economic variables often display common trend behaviour. This implies that linear combinations of these variables converge towards a common equilibrium in the long term, even though individual time series fluctuate over time. According to Engle and Granger (1987), time series are cointegrated if they display the same degree of integration and a linear combination of these variables is stationary. Furthermore, the use of the time series in their levels guarantees that information losses due to the conventional use of first differences are avoided. According to the Granger representation theorem, the dynamic adjustment process of cointegrated variables towards the long-term equilibrium path can be represented by an error correction model (ECM). In this way, long-term equilibrium relationships are combined with short-term dynamics.

4.4.1 Cointegration Analysis

Unit root tests facilitate the determination of the stationary nature of time series. Here, the null hypothesis of non-stationarity is tested against the alternative hypothesis of stationarity of the present time series. Within the scope of this paper we prefer the results of the Phillips-Perron (PP) test (Phillips, 1987, and Phillips and Perron, 1988) to those of the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981) in case of deviating results.[41] By virtue of the correction procedure according to Newey West (1994) as well as the Bartlett window, the PP test provides robust results both in the case of present autocorrelation and for time-independent heteroscedasticity (Perron, 1989).

By considering the periods after the structural breaks, the PP tests indicate that the examined time series are non-stationary in their level specification and stationary in the first differences (see Table 4-4 and 4-5 in Section 4.7.2). Consequently, all variables display the same degree of integration. The cointegration analysis can therefore be conducted on the basis of a consistent dataset.

In order to detect the existence of cointegrating relationships, we employ the trace test and the maximum eigenvalue test. Determination of rank and estimation of the coefficients are performed as a maximum likelihood estimation. The corresponding likelihood-ratio test statistics are:

$$\lambda_{Trace} = -T \sum_{r+1}^{k} \ln(1 - \lambda_i) \tag{4-1}$$

$$\lambda_{max} = -T \ln(1 - \lambda_i) \tag{4-2}$$

λ represents the estimated eigenvalues of the reduced rank of the matrix π. In the process, the sequential test strategy begins with r = 0 and is continued until

[41] The test decisions are based on the critical values of MacKinnon (1991, 1996).

the null hypothesis for the 5% significance level cannot be rejected for the first time. The related value of r ultimately corresponds to the cointegration rank. In this way there are (n-r) stochastic trends in the system.

In this study the corresponding critical values are used in accordance with Osterwald-Lenum (1992).[42] The applied cointegration tests display the existence of three cointegrating relationships within the VAR model for the US economy and two for the UK counterpart.

Modelling of the non-stationary variables as a vector autoregressive (VAR) process Y_t of finite order k forms the basis of the Johansen (1988) procedure. If at least two of the variables are cointegrated of the order of one, then the VAR(k) process can be reparametrised and written as a vector error correction model:

$$\Delta Y_t = \mu + \pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (4\text{-}3)$$

ΔY_t is a (n x 1) vector of the first differences of stochastic variables Y_t, and μ is a (n x 1) vector of the constants. The lagged variables are contained in vector Y_{t-1}. The (n x n) matrices Γ_i represent the short-term dynamic. The coefficients of the cointegrating relationships (cointegration vectors) and of the error correction term are contained in the matrix π.

π can be decomposed as follows:

[42] The choice of the underlying lag structure of the VAR models is based in the first stage on the information criteria of Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ). We furthermore test the models for heteroscedasticity and autocorrelation. Should both or either occur in the consequential VEC models we choose the next highest order. In all models examined the use of this approach enables misinterpretation of the test results to be avoided at the tolerable expense of losing a few degrees of freedom. Prior to this decision, it was necessary to conduct further analyses in order to preclude the possibility, that other reasons such as high values of correlation among the selected variables, are responsible for the significant deviations from the null hypothesis of the White (1980) test.

$$\pi = \alpha\beta' \tag{4-4}$$

ß represents a (n x r) matrix of the r cointegrating vectors. The (n x r) matrix α contains the so-called loading parameter, i.e. those coefficients that describe the contribution of the r long-term relationships in the individual equations. Here α and ß have full rank. It should be noted that the analysis of π is not definite. If in Equation (4-3) π is replaced by the Equation (4-4), then the error correction representation follows (vector error correction model, VECM):

$$\Delta Y_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \alpha\beta' Y_{t-1} + \varepsilon_t \tag{4-5}$$

4.4.2 Evaluation Principles

Within the scope of this examination we choose equal evaluation principles in order to allow for comparisons between both countries. The approach of evaluating the VEC models in their entirety allows us to gain deeper insights into the intensity of linkages among variables as well as into the relevant channels which are responsible for the adjustment process after deviations from the long-term equilibrium. In the process, the case of multidimensional cointegrating relationships is explicitly taken into account. For this purpose, we apply hypotheses tests in order to verify whether individual coefficients can be restricted to zero without accepting significant losses of information. In so doing, only a single regressor is eliminated in each step. The identification of those individual factors which significantly contribute to explaining the country-specific equilibrium is based on the results of the tests for linear restrictions (LR tests). If individual variables do not significantly contribute to the detected equilibrium, these factors are restricted to zero within the corresponding vector. In this case information is only provided via the coefficients related to the adjustment process.

4.4.3 Variance Decomposition

Employing variance decompositions provide further information on the relative significance of the individual variables in explaining index development. To do this, the variance of the errors discovered ex post is allocated proportionately to the examined variables. As this method is also conducted on the basis of vector error correction models, we once more take into account the dynamic character of the interrelations among the considered variables. By determining the Cholesky order, a causal structure is implicitly assumed among the variables of the system. This is expressed in the distribution of the common components of the interference terms in favour of the variables preceded in the Cholesky order. This fact could have a major influence on the results, especially in the case of a strong correlation between the original error values. As a consequence of this, we verify the results of the variance decompositions as outlined in Section 4.7.4 (Figure 4-6 and 4-7) by choosing alternative Cholesky orders. However, the results are robust – although the absolute values fluctuate slightly, the rank order among variables remains unchanged.

4.5 Empirical Results

Prior to the analysis of the features of real estate equities, we evaluate the implemented model framework with respect to econometric requirements and economic plausibility. Despite the well-known disadvantage of vector error correction models, namely their sensitivity, both implemented models meet the econometric requirements which have been defined prior to the estimation. In addition, the signs of the macroeconomic factors can reasonably be explained by economic theory. As a result, this VECM framework, including the implemented model specifications, is adapted for examining and evaluating the features of real estate equities.

4.5.1 VECM Results – Technical Evaluation

The VECM results for the examination period between March 1992 and June 2008 are summarised in Tables 4-2 and 4-3. Based on the cointegration test results we find three cointegrating relationships in the US and two cointegrating relationships in the UK model. In each model, the first and second β-vectors are normalised to the direct and securitised real estate index, respectively, while the third one in the US model is normalised to the CPI index.[43]

The implemented restrictions are accepted by the LR tests. Furthermore, the p-values of the White tests consistently indicate that the risk of heteroscedasticity is eliminated.[44] Both VEC models are additionally tested for stationarity by the Dickey-Fuller (DF) test using the critical values according to Banerjee et al. (1993). Although not significant in every case, the adjustment coefficients for the error correction terms display negative signs, indicating a return to the long-term equilibrium path. Due to the decomposition of the π matrix, the use of the error correction approach allows the evaluation of long-run relationships as well as the adjustment mechanism separately (see Equation 4.4). Accordingly, the vectors for the long-term relationships are outlined in Table 4-2 and the vectors with reference to the adjustment processes are displayed in Table 4-3.

[43] The outlined evaluation principles require that the normalised variable significantly contributes to the long-term equilibrium in the respective vector.

[44] The estimated models are free of possible hazards caused by autocorrelation occuring within the residuals, too, although this is not explicitly mentioned in Table 4-2.

Table 4-2 Long-Term Equilibrium Relationships (β-vectors).

Economy	r	NCREIF	NAREIT	CPI	INTER	GDP	SP500	pWhite prob LR-Test
United States	3*	1.000	+0.544 [-12.294]	0	0	0	+0.281 [-11.682]	0.342 0.053
		+1.281 [17.985]	1.000	+19.435 [-20.444]	-0.075 [10.619]	0	0	
		0	+0.011 [-3.589]	1.000	+0.003 [-11.768]	-0.253 [10.912]	0	

Economy	r	IPD	REEI	CPI	INTER	GDP	FTSE	pWhite prob LR-Test
United Kingdom	2	1.000	+0.989 [-18.465]	0	-0.181 [8.989]	0	0	0.208 0.055
		+0.632 [-10.043]	1.000	0	0	0	+0.497 [-5.470]	

Notes: Coefficients are converted so that relationships between the normalised variable and the risk factors can be directly identified as positive or negative. For reasons of clarity we do not report the corresponding constant c and the ε as a proxy for the error term. *T*-statistics are included in parentheses, r = number of cointegrating vectors. * denotes that the VEC model includes a deterministic trend which displays significant coefficients in all three vectors. NCREIF = direct property index in the US , NAREIT = real estate equity index in the US, IPD = direct property index in the UK, REEI = FTSE 350 Real Estate Index as a proxy for the real estate equity market in the UK, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, SP500 = Standard & Poor's 500 Stock Index, representing the general stock market in the US, FTSE = FTSE 100 Index, representing the general stock market in the UK. pWhite denotes the p-values of the White test for heteroscedasticity, LR-Test denotes the probabilities of the tests for linear restrictions.

4.5.2 VECM Framework: Significance and Signs

We find consistent signs of the macroeconomic variables in both examined economies which also apply to economic theory. As expected, the real estate assets are positively affected by the general stock markets, while negative effects are detected due to an increase in the interbank rates in each economy.

For the purposes of our examination, the interbank rates are used as an indicator for the interest rate levels, which are ultimately decisive for the resulting credit costs. Referred to individual projects, returns on properties and developments suffer from increasing interest rates and the resulting adverse effects on project-specific debt financing. As investments in properties in particular are known to require a high ratio of debt capital, the increase in the interbank rates leads to a further decreased demand for property investments, which in turn results in decreasing property prices. However, the positive sign of

the interbank rates (in the third vector of the US model) also applies to economic theory, as in that case the vector is normalised to the consumer price index. In this context, our results confirm the findings of Geltner et al. (2007), who classify the money market as the best hedge against inflation on the condition that the investor reinvests in the money market. Moreover, our results indicate a negative relationship between the CPI and the GDP, which once more clarifies the adverse long-term effect of rising inflation on domestic economic growth.

Nevertheless, the inter-country comparison reveals a difference in terms of possible inflation-hedging characteristics of real estate assets. According to the US model, a positive relationship is detected between the consumer price index and the NAREIT (vector 2 and 3), indicating that investments in real estate equities benefited from rising inflation during the examination period. In contrast, this does not apply to real estate investments in the UK, as the estimations do not indicate significant coefficients – neither positive nor negative – of the CPI variable in either vector. These distinctions are in line with the inconsistent findings of the related studies outlined above. Therefore, our results affirm that conclusions on the issue of whether real estate represents an appropriate tool to hedge against inflation cannot reliably be drawn without considering the complete business environment and its interrelationship to the relevant real estate sector.

4.5.3 Linkage to the Macroeconomy

With regard to the cointegrating relationships in their entirety, our results consistently feature distinctions between the markets in the United States and the United Kingdom. While we find a stronger linkage to the macroeconomic environment in the United States, the financial market indices in the United Kingdom are predominantly focused on each other. This distinction is recognisable by both the long-term relations and the observed adjustment processes.

In the US model, the macroeconomic determinants CPI and GDP significantly contribute to the explanation of the long-term equilibrium in the US model (see Table 4-2). Furthermore, the third vector is primarily focused on the real economy, indicating that the long-term equilibrium is determined by the CPI, the GDP, the interbank rates and the real estate equity index. In contrast, neither of these aspects applies to the UK model, where the real economy – represented by the GDP and the CPI – does not significantly contribute to the long-term equilibria.

Table 4-3 Adjustment Processes (α-vectors).

Economy	Error Correction:	D(NCREIF)	D(NAREIT)	D(CPI)	D(INTER)	D(GDP)	D(SP500)
United States	CointEq1	-0.099	0.191	-0.054	**-12.418**	**-0.223**	-0.597
		[-1.596]	[0.194]	[-1.317]	**[-2.420]**	**[-5.780]**	[-0.739]
	CointEq2	-0.0390	-0.504	**-0.068**	-7.555	**-0.189**	-0.549
		[-0.752]	[-0.612]	**[-1.978]**	[-1.762]	**[-5.857]**	[-0.812]
	CointEq3	-0.981	2.894	**-1.530**	**-192.998**	**-3.253**	-19.978
		[-0.942]	[0.175]	**[-2.215]**	**[-2.241]**	**[-5.026]**	[-1.473]
Economy	Error Correction:	D(IPD)	D(REEI)	D(CPI)	D(INTER)	D(GDP)	D(FTSE)
United Kingdom	CointEq1	-0.007	0.163	0.000	**-1.683**	-0.004	**0.178**
		[-0.498]	[1.768]	[0.080]	**[5.506]**	[-1.707]	**[2.977]**
	CointEq2	**-0.040**	-0.052	**0.013**	-0.639	**-0.007**	**0.151**
		[-2.170]	[-0.453]	**[2.311]**	[-1.677]	**[-2.470]**	**[2.033]**

Notes: Bold type denotes significant results based on t-statistics (in parentheses). All values are first differences. For reasons of clarity we omit the corresponding constant c and the error term ε. NCREIF = direct property index in the US , NAREIT = real estate equity index in the US , IPD = direct property index in the UK, REEI = FTSE 350 Real Estate Index as a proxy for the real estate equity market in the UK, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, SP500 = Standard & Poor´s 500 Stock Index, representing the general stock market in the US, FTSE = FTSE 100 Index, representing the general stock market in the UK.

In addition to the long-term relations (β-vectors), we take into account the results of the adjustment processes (α-vectors) and the corresponding cointegration graphs. The α-vectors describe the adjustment process when the linear combinations deviate from the long-term equilibrium path. In that case, the α-vectors indicate in which way this disequilibrium affects the remaining model variables (see Table 4-3). The corresponding cointegration graphs for the observed paths are illustrated in Figure 4-6 (Section 4.7.3).

The evaluation of the α-vectors affirms the outlined differences concerning the long-term relationships (β-vectors) in both examined economies. As a consequence, the mode of the adjustment process back to the long-term equilibrium is remarkably different in the US economy compared to the UK. Accordingly, deviations from the long-term equilibrium affect neither the real estate assets nor the general stock market in the US model. Instead, these disequilibria significantly affect the GDP, the consumer prices and the interbank rates. This mode of adjustment can therefore be interpreted as a remarkable orientation towards the US macroeconomy. In contrast, this does not apply to the UK model, where disequilibria affect the general stock index (in both vectors) and the property index (in vector 2) very significantly and therefore indicate a remarkable orientation towards the financial market indices.

The reason for these outlined distinctions between both economies can reasonably be explained by the interdependency among economic growth, credits and inflation. In principle, the sample from 1992:q1 to 2008:q2 is characterised by increasing demand for properties and increasing property prices in both real estate markets. Contemporaneously, this progress was enhanced by comparatively high GDP rates relative to low interbank rates. During that period of time, the GDP rates only revealed one remarkable decline due to the aftermath of the “9/11” terrorist attacks in 2001, even though still indicating positive rates of economic growth. Despite the comparatively resistant economic growth, the interbank rates in both economies even feature negative mean values over the examination sample, and in this way additionally stimulated loan-financed investments.[45] As a consequence, this instance particularly facilitates investments in properties which largely rely on a high ratio of debt capital and therefore benefit from decreasing credit costs by nature.

[45] Compared to the key interest rates of the corresponding central banks, the interbank rates reveal a spread as a risk premium for lending money to competitors. Nevertheless, the interbank rates are known to be largely influenced by these key interest rates. For this reason, the outlined effects are closely linked with the expansive monetary policy of the US Federal Reserve during the examination sample. However, examining the effects of monetary policy and the strategies on how to intervene in the money market is not the subject of the current paper, but of another one.

As this ratio has been even more extreme in the US economy over the whole sample period, this instance results on the one hand in additional demand for loan-financed investments in the United States. On the other hand, in accordance with economic theory, the functional chain of economic growth, low levels of interest and increasing property prices imply rising rates of inflation. This fact can easily be identified by the significant contribution of the CPI variable within the US VEC model (see Tables 4-2 and 4-3). Moreover, this finding is additionally affirmed by larger US CPI mean values over the examination sample compared to the UK counterpart (see Table 4-1). As in this context inflationary expectations also increase by implication, loan-financed investments are also stimulated in terms of inflation, because real indebtedness decreases over time on the basis of rising inflation.

As a result, via the channel of a more extreme ratio of high GDP rates relative to low interest rates and its consequential stimulating effects on real estate and inflation, this process results in self-intensifying effects and in this way affects the real economy and real estate markets as well. For this reason, the US economy is ultimately closer linked with its real estate sector than the economy in the UK, where this ratio has been slightly more moderate and in the end did not trigger self-intensifying effects.

4.5.4 Features of Real Estate Equities

As mentioned above, due to the fact that both implemented models meet the econometric requirements and the macroeconomic influences can furthermore be reasonably explained by economic theory, we use the outlined VECM framework in order to analyse the features of real estate equities.

The real estate equity indices in both economies are significantly influenced by the progress on the underlying property markets. The model estimations show a strong linkage between the real estate equity indices and the direct properties,

indicating that both real estate assets affect each other positively in the long run. This strong linkage is recognisable by their unalterable contribution to the long-term equilibrium (in vectors one and two in each model) with comparably high t-values. Restrictions of one of these two real estate assets are rejected by the LR test and would lead to significant losses of information within both VEC models. Moreover, this finding is robust if choosing alternative VEC specifications.[46]

In each economy, one cointegrating vector is determined by the examined financial market indices (vector 1 in the US model and vector 2 in the UK model). Independent of the implemented normalisation, the corresponding direct property index, the real estate equity index and the general stock market significantly contribute to the long-term equilibrium in these vectors, indicating equal signs in both countries. Therefore, both the property index and the general stock index significantly determine the progress of the real estate equity index.

In order to analyse whether real estate equities primarily reflect real estate or equities, some studies take the comparison of the corresponding coefficients as a basis for their decision. The fact that the general stock market is only included in one vector in each model, while both real estate assets significantly contribute to the long-term equilibrium in at least two vectors, describes a further widely-used but not quite reliable criterion in this context. With respect to the outlined VECM results, both aspects would suggest a closer linkage between the real estate assets compared to the equity assets and would therefore indicate that the distinctive features of real estate investments still persist despite the listing on stock exchanges. Nevertheless, we prefer to employ further analyses and therefore conduct additional variance decompositions in order to verify the VECM results and to gain further insights into this issue.

[46] Although choosing alternative VEC specifications, we nevertheless keep the evaluation principles as outlined above.

4.5.5 Variance Decomposition

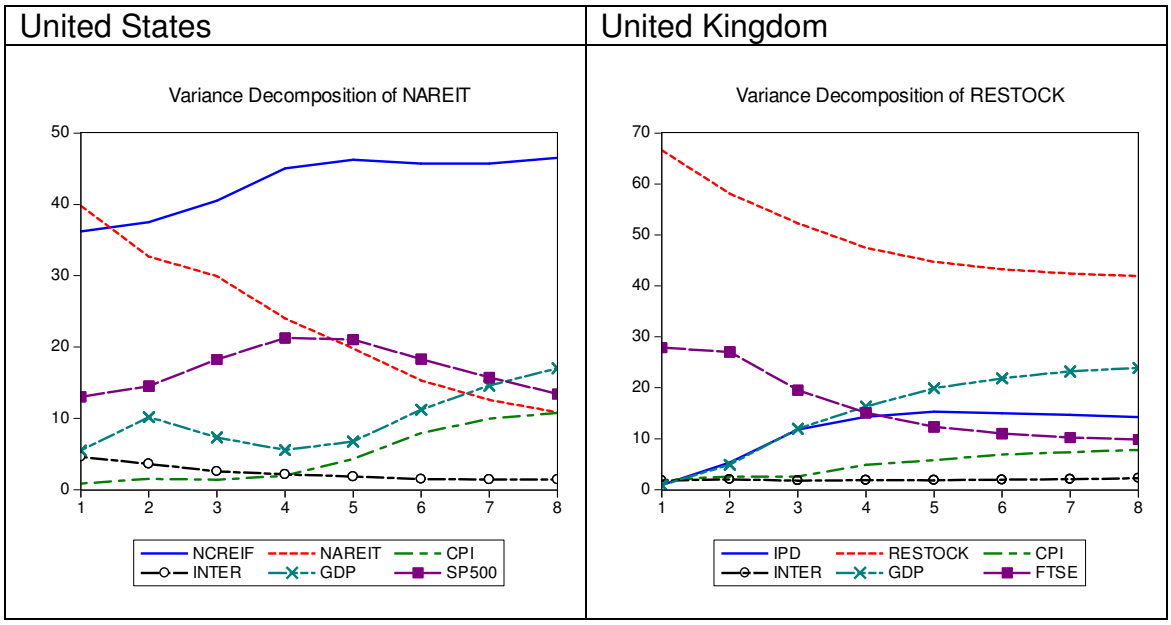
As indicated in Figure 4-3, a comparatively substantial contribution to the variance of the US NAREIT is explained by the NCREIF (46.53%), while the S&P 500 only explains a significantly smaller fraction (13.43%).[47] This implies that the real estate equity index in the US is driven more by its underlying property market than by the general stock market. For this reason, we can take this result as a stronger linkage among the real estate assets than the equity assets.

Although not indicating comparable values, the same applies to the UK. The real estate equity index is primarily influenced by the GDP (23.88%), while the IPD and the FTSE Composite Index explain 14.25% and 9.85%, respectively. In addition, we find in both economies a remarkable growth in influence of the property indices when considering longer periods. In contrast, the reverse applies to the impact of the general stock markets, as its measured contribution is characterised by a tendency to decline over time.

For this reason, the results of the implemented variance decompositions consistently indicate a closer linkage among the real estate assets compared to the equity assets in both economies. The long-term synchronicity between listed and direct real estate consequently implies that the distinctive features of real estate investments in their primary meaning still persist despite the influences of the general stock market.

[47] The denoted values refer to the numerical output in Section 4.7.4.

Figure 4-3 Variance Decompositions.



Notes: NCREIF = direct property index in the United States , NAREIT = real estate equity index in the United States , IPD = direct property index in the United Kingdom, REEI = FTSE 350 Real Estate Index as a proxy for the real estate equity market in the United Kingdom, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, SP500 = Standard & Poor's 500 Stock Index, representing the general stock market in the US, FTSE = FTSE 100 Index, representing the general stock market in the UK.

Accordingly, in spite of being subject to supply and demand, the developments of the underlying real estate properties remained the key driver of the performance of listed real estate during the examined sample. As a result, besides benefits in terms of liquidity, transparency and management, long-term investments in listed real estate offer opportunities to combine advantages of both direct and listed real estate, and therefore also provide remarkable potential for diversifying the investor's portfolio.

4.6 Conclusion

Investments in listed real estate imply that the progress on the underlying property markets no longer represents the only driver of the performance and risk/return structure of this asset. Instead, listed companies are faced with the risk that market values are predominantly driven by developments on general stock markets, although the main business of the constituents remains unchanged and is still focused on trading and renting real estate properties. For that reason, it is worthwhile considering to what extent developments on general stock markets influence the progress of listed real estate. Answering this question is of particular importance with respect to issues of asset allocation in a multi-asset portfolio. If predominantly driven by progress on general stock markets, the benefits of listed real estate in terms of portfolio diversification would be considerably limited. By implication, the intended risk/return structure of an investor's portfolio would be significantly distorted, because the consideration of listed real estate would involuntarily increase the proportion of investments that are subject to general stock market risk. Consequently, this scenario would ultimately result in a portfolio allocation which is riskier than requested.

For that reason, our study is focused on the issue of whether real estate stock indices are primarily driven by the progress of property markets or by developments on general stock markets. For the purposes of this examination, we analyse the real estate markets in the United States and the United Kingdom in the period since 1992. Deviating from the conventional procedure of exclusively focusing on the three financial market indices, namely real estate equities, direct real estate and general stocks, we follow the approach of taking into account the macroeconomic environment in each country. As real estate markets are considered to be cyclical in nature, the consideration of the macroeconomy avoids the ignoring of information resulting from the business environment and thus the impact of the cyclical trend.

Using a vector error correction framework and variance decompositions, in both economies we consistently find a significantly stronger linkage among real estate assets compared to the linkage among the examined equity assets. The real estate equity markets are therefore predominantly driven by the progress of the underlying properties, which can therefore still be interpreted as the key driver of listed real estate in the long run. Long-term investments in listed real estate therefore not only provide opportunities for portfolio diversification, but additionally allow the combination of advantages of both real estate assets, including benefits in terms of liquidity, transparency and management. As a result, investments in real estate equities can still be classified as an alternative investment and therefore still represent a favourable tool in terms of asset allocation.

In addition to examining the features of real estate equities, the approach of taking into account the economic environment for the purposes of this study allows comparisons with respect to the relevance of the real economy in the examined real estate markets. In this context, the inter-country comparison reveals one striking distinction according to which the progress of the real estate sector in the United States is more closely linked to the macroeconomy than is the case in the United Kingdom. This distinction is recognisable by both the determination of the long-term relationships and during the observed adjustment process in case of disequilibria. In contrast, we do not detect comparable linkages in the British economy, where the financial market indices predominantly stimulate each other.

In this context, we identify the ratio of GDP and interest rates as the principal reason for the closer linkage to the macroeconomy in the United States. Throughout the whole examination sample, we find higher GDP rates relative to lower interest rate levels in the US economy, which was responsible for additional demand for loan-financed investments and in this way further increased property prices. Accordingly, via this channel and its consequential stimulating effects on inflation, the economic environment in the United States

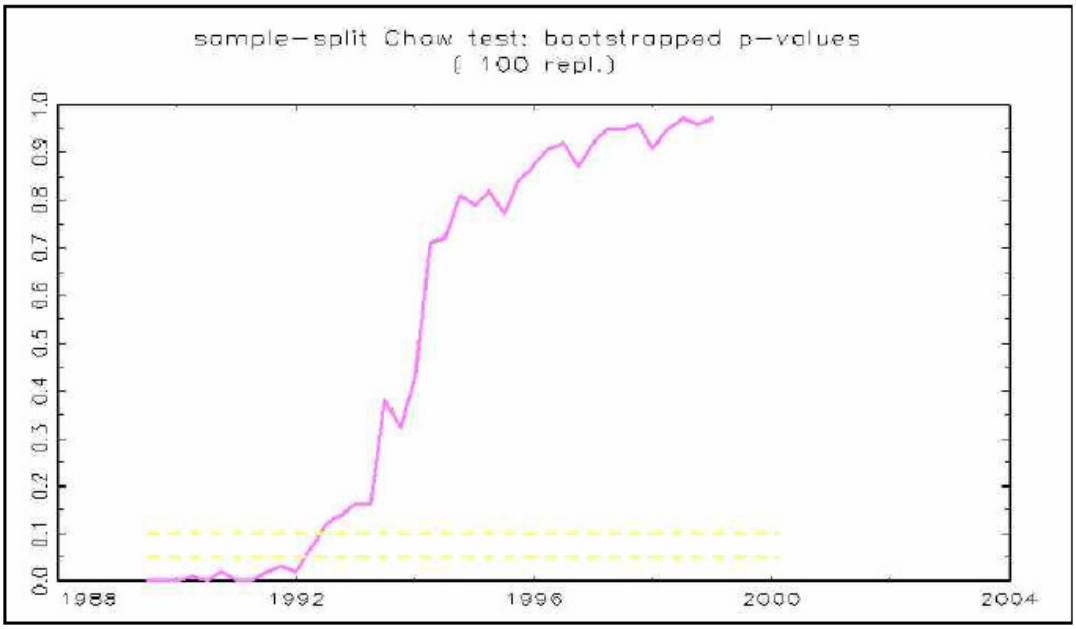
is more severely affected by these developments, which ultimately results in the closer nexus with its real estate sector.

This study clarifies that long-term investments in real estate equity indices still fulfil their function as an alternative investment in order to diversify an investor's portfolio. For that reason, we further on assume lower correlations to conventional assets and a more defensive risk/return structure compared to investments in general stocks. Nevertheless, if considering shorter investment horizons, passing a blanket judgement is pointless in this context, despite the consistent long-term results. Instead, considering the distinctive features of the respective real estate sector and its linkage to the complete business environment is indispensable in order to be able to assess influences on real estate equity indices in the right way.

4.7 Appendix

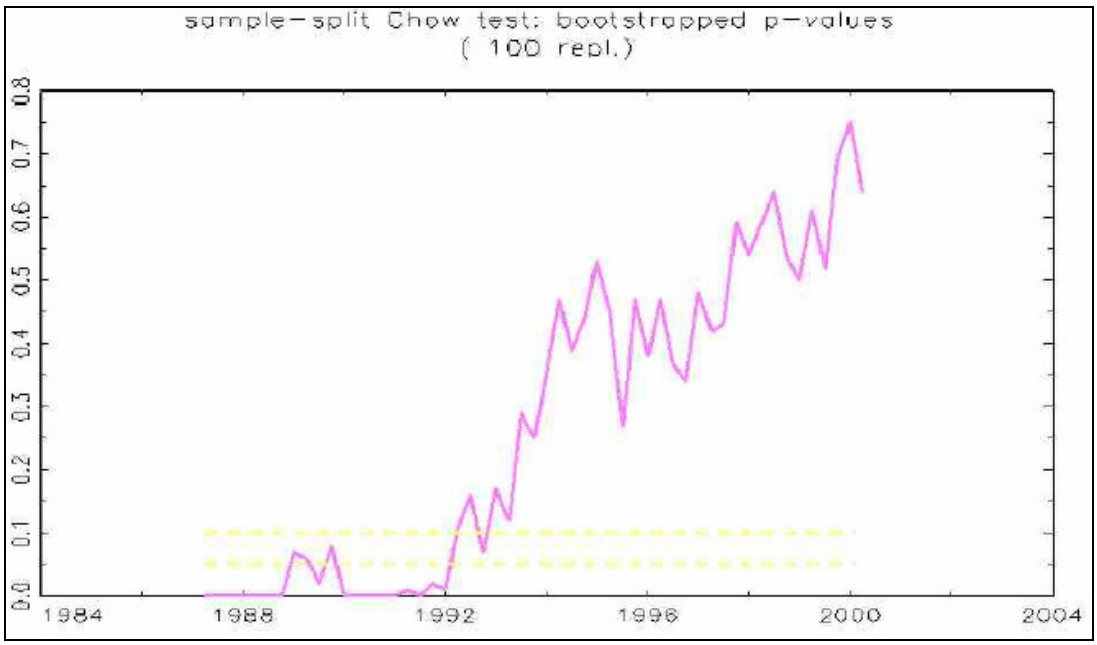
4.7.1 Testing for Structural Breaks

Figure 4-4 Sample Split Chow Test for the United States (1978:q1 – 2008:q2).[48]



[48] The structural breaks are computed with the JMulti software. The output table is available on request.

Figure 4-5 Sample split Chow Test for the United Kingdom (1988:q1 - 2008:q2).



4.7.2 Unit Root Tests

Table 4-4 United States: Unit Root Tests (1992:q1 - 2008:q2).

United States	**Variable**	**PP-Test** Newey-West bandwidth using Bartlett kernel			**LI**
		PP (none)	**PP (intercept)**	**PP (trend + intercept)**	
Direct Property Index	ln NCREIF			-2.328 (4)	I(1)
	Δ ln NCREIF	-1.769* (1)			
Real Estate Stock Index	ln NAREIT		-2.010 (0)	-2.521 (2)	I(1)
	Δ ln NAREIT	-5.575*** (0)	-5.777*** (2)		
Stock Index	ln SP500		-1.709 (3)		I(1)
	Δ ln SP500	-7.278*** (0)			
Gross Domestic Product	ln GDP			-1.314 (3)	I(1)
	Δ ln GDP		-5.597*** (0)		
Consumer Price Index	ln CPI			-2.562 (13)	I(1)
	Δ ln CPI		-13.110*** (1)		
3 Month Interbank Rate	INTER		-3.473 (3)		I(1)
	Δ INTER		-4.776*** (3)		

Notes: ***, ** and * denotes statistical significance at 99%, 95% and 90% level, respectively. PP= Phillips-Perron test for stationarity, LI = level of integration. The bandwidths are given in parentheses.

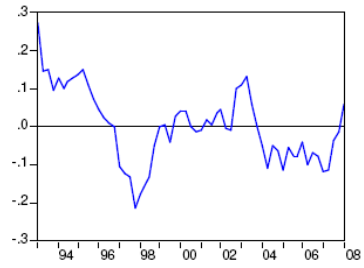
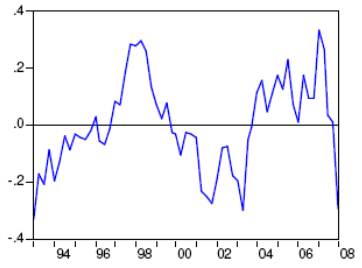
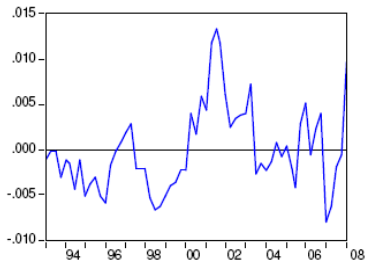
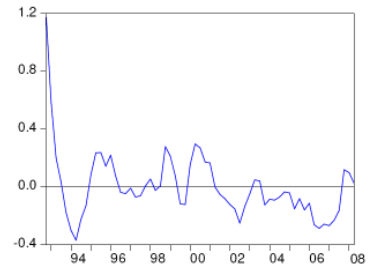
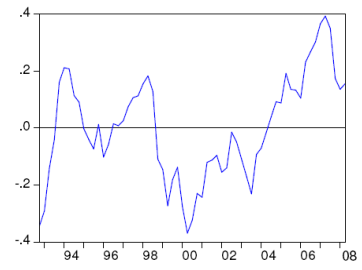
Table 4-5 United Kingdom: Unit Root Tests (1992:q1 to 2008:q2).

United Kingdom	**Variable**	**PP-Test** Newey-West bandwidth using Bartlett kernel			**LI**
		PP (none)	**PP (intercept)**	**PP (trend + intercept)**	
Direct Property Index	ln IPD			-3.299 (5)	I(1)
	Δ ln IPD		-2.586* (3)		
Real Estate Stock Index	ln REEI		-0.676 (3)	-2.206 (4)	I(1)
	Δ ln REEI	-7.190*** (4)	-8.175*** (3)		
Stock Index	ln FTSE		-1.569 (5)		I(1)
	Δ ln FTSE	-7.111*** (5)	-7.468*** (5)		
Gross Domestic Product	ln GDP			-1.027 (3)	I(1)
	Δ ln GDP		-6.812*** (2)		
Consumer Price Index	ln CPI			-0.809 (4)	I(1)
	Δ ln CPI		-6.971* (4)		
3 Month Interbank Rate	INTER		-1.823 (5)		I(1)
	Δ INTER	-4.008*** (2)			

Notes: ***, ** and * denotes statistical significance at 99%, 95% and 90% level, respectively. PP= Phillips-Perron test for stationarity, LI = level of integration. The bandwidths are given in parentheses.

4.7.3 Cointegration Graphs

Figure 4-6 Cointegration Graphs for the US and the UK Models (1992:q1 – 2008:q2).

United States		
Cointegration Equ. 1	Cointegration Equ. 2	Cointegration Equ. 3
		
United Kingdom		
Cointegration Equ. 1	Cointegration Equ. 2	
		

Notes: Here, the zero line represents the long-term equilibrium and the curve shows the deviations. In principle, the evaluation of the cointegration graphs reveals similarities between both real estate markets. According to the graphs, deviations from the long-term equilibrium range between a comparable order of magnitude in the cointegrating relations 1 and 2. Limited to the period between 1992 and 1993, relation 1 of the UK model displays the only exception in this context. The main distinction, however, is represented by the existence of a third cointegrating relationship within the US model which is furthermore primarily focused on the real economy. As indicated by the low scale values of this cointegrating relationship, deviations are kept within bounds and were quickly absorbed by the macroeconomy during the examination sample.

4.7.4 Variance Decomposition

Table 4-6 Variance Decompositions (United States).

Period	NCREIF	**NAREIT**	CPI	INTER	GDP	SP500
1	36.212	**39.788**	0.870	4.592	5.520	13.017
2	37.500	**32.652**	1.528	3.623	10.170	14.524
3	40.508	**29.925**	1.395	2.576	7.328	18.265
4	45.046	**23.991**	1.978	2.154	5.553	21.275
5	46.256	**19.802**	4.321	1.834	6.754	21.031
6	45.730	**15.303**	7.940	1.485	11.228	18.311
7	45.714	**12.582**	9.936	1.425	14.606	15.734
8	46.524	**10.837**	10.759	1.427	17.024	13.426

Notes: This analysis is based on vector error correction models. NCREIF = direct property index in the US , NAREIT = real estate equity index in the US, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, SP500 = S&P 500 Stock Index, representing the general stock market in the US.

Table 4-7 Variance Decompositions (United Kingdom).

Period	IPD	**REEI**	CPI	INTER	GDP	FTSE
1	0.950	**66.611**	1.872	1.796	0.898	27.870
2	5.3511	**58.049**	2.601	2.033	4.935	27.029
3	11.851	**52.274**	2.600	1.775	11.9721	19.525
4	14.315	**47.462**	4.904	1.879	16.339	15.098
5	15.351	**44.721**	5.821	1.847	19.904	12.353
6	15.048	**43.250**	6.888	1.948	21.839	11.024
7	14.695	**42.399**	7.385	2.048	23.219	10.252
8	14.249	**41.921**	7.832	2.261	23.881	9.852

Notes: This analysis is based on vector error correction models. IPD = direct property index in the UK, REEI = FTSE 350 Real Estate Index as a proxy for the real estate equity market in the UK, CPI = domestic consumer price index, INTER = interbank rates (3 months), GDP = real gross domestic product, FTSE = FTSE 100 Stock Index, representing the general stock market in the UK.

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Ich habe die vorgelegte Dissertation selbst verfasst und dabei nur die von mir angegebenen Quellen und Hilfsmittel benutzt. Alle Textstellen, die wörtlich oder sinngemäß aus veröffentlichten oder nicht veröffentlichten Schriften entnommen sind sowie alle Angaben, die auf mündlichen Auskünften beruhen, sind als solche kenntlich gemacht.

Regensburg, 15. Juli 2009

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(Alexander Schätz)

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Die Reihe „Schriften zu Immobilienökonomie" wurde 1994 von Karl-Werner Schulte begründet. Ab Band 29 war Stephan Bone-Winkel, ab Band 57 Wolfgang Schäfers Mitherausgeber. 2014 (ab Band 67) wurde die Reihe mit den seit 2008 von Jürgen Kühling herausgegeben „Schriften zum Öffentlichem Immobilienrecht und Infrastrukturrecht" fusioniert und wird seitdem gemeinsam von den Professoren der IREBS International Real Estate Business School als „Schriften zu Immobilienökonomie und Immobilienrecht" herausgegeben. Anlässlich der Zusammenlegung der Schriftenreihen wurden auch frühere Arbeiten an der IREBS, die bisher in den Schriftenreihen noch nicht veröffentlicht wurden, neu herausgegeben.

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