MASTER

Modeling and forecasting office investment yields in Central and Eastern Europe

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Modeling and forecasting office investment yields in Central and Eastern Europe

Master Thesis

Eindhoven University of Technology
Department of Architecture, Building and Planning
Real Estate Management & Development Group

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May, 2007
Modeling and forecasting office investment yields in Central and Eastern Europe

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Preface

Property markets in Central and Eastern Europe experienced fascinating development processes since the collapse of the Soviet Union in 1989 and the ensuing abolition of communism in the Central and Eastern European region. Prague, Budapest, Warsaw and Bucharest transformed themselves into economically flourishing capital cities, disposing over high quality office schemes and state of the art shopping centers.

Within my research I attempted to more thoroughly examine these intriguing development processes in order to get a better understanding of the operation of property markets in general, and the developments in Central and Eastern Europe in particular. By translating my findings to the future, I provided an outlook for the future development of the office investment markets in these cities. Obviously, no one can indefectibly predict the future. Therefore, the findings presented in this thesis will deviate from the eventual development in the coming years. Nevertheless, the findings presented in this thesis, will be useful as they are helpful in understanding the (future) development of office investment markets in CEE.

I would like to express my gratefulness to a number of people, who supported me during my research over the past year. First of all, I would like to thank the members of my graduation committee: Mrs. Ingrid Janssen, Mr. Robert Weisz and Mr. Caspar Chorus of Eindhoven University of Technology and Mr. Gijs Klomp of ING Real Estate for their support, recommendations, brainstorming and feedback on the content and structure of my research. Additionally, I would like to thank Mr. Marcel Theebe for his feedback on the research structure and Mr. Karel Zeman for his support during my stay in Prague. Furthermore I am very grateful to Mr. Martin Sabelko, Mr. Jiri Lhotak, and Mr. Maarten van der Spek for enabling me to spend three months in ING Real Estate Investment Management’s regional office in Prague, which inevitably contributed to my understanding of the operation of the CEE property markets.

Last but not least, I want to thank Kim, my family, and friends for their support and during my research.

Martijn Hoefmans,
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Executive Summary

Introduction
This thesis studied the development of office investment markets in the capitals of the Czech Republic, Hungary, Poland, and Romania, in an effort to generate yield forecasts for office investments in the Central and Eastern European (CEE) region. In doing so, the following objective has been formulated:

Creating a model for the yield development of the office property investment markets in Central and Eastern Europe, based on the process of the emergence and development of property investment markets in Central Europe in order to offer property investors a better understanding of the future development of property investment markets in Central and Eastern Europe.

Based on this research objective, the thesis has been subdivided in the following three parts: introduction and theoretical framework, data collection and modeling, and forecasting and conclusions & recommendations.

Yields
Yields can be considered as a measure for property investment prices, since they reflect the price an investor is willing to pay for a property, based on the property's annual income (i.e. rent). Next to reflecting property pricing levels, yields are of importance to property investors, as they strongly influence the total return performances of property investments. According to literature, yields are composed of the following three components: risk free rate (RF), risk premium (RP) and expected rental growth (g). Accordingly, yields can be expressed as:

\[ Y = RF + RP - g \]

Thus, to understand the development of office investment yields in Central and Eastern Europe, and construct a yield forecasting model, one needs to examine these components and their relations to yields. In doing so, various drivers for these yield components will be selected and examined.

---

1 When speaking of Central Europe (CE) in this thesis, it includes the Czech Republic, Hungary and Poland, and when speaking of Central and Eastern Europe (CEE), it includes Romania as well.
Property investment market development process

Commercial property markets in the Central and Eastern European region have experienced turbulent development processes since the collapse of the Soviet Union in 1989, and the ensuing abolition of communism. Prior to 1989, conventional property markets could not exist in Prague, Budapest, Warsaw, and Bucharest, due to, among others, the absence of a free market economy and large amounts of properties being state-owned. However, as of 1990, commercial property markets rapidly developed themselves in Prague, Budapest and Warsaw, as their emergence was fuelled by Western companies who were in chase of new consumers in the formerly, isolated Central European region. Consequently, commercial property markets emerged as these new companies were all in chase of office and retail space, which was hardly available, and property market participants (e.g. brokers, consultants, developers and investors) entered the market. Meanwhile, commercial property markets in Bucharest did not yet develop themselves, mainly due to the country’s devastated economy which resulted from many years of autocratic rule by Ceaușescu.

To guide, examine, and relate the development processes in Central and Eastern Europe, the following figure has been used. Since the development and operation of property (investment) markets is closely related and influenced by economic development, and economic structures and characteristics, the model distinguishes both economic and property market development.

![Property market development model](image)

*Figure 1*  Property market development model [Klomp and Jansen, 2006]
Based on the development process, as outlined in figure 1, and a study of literature, characteristics per development phase (i.e. challenged, emerging and mature) have been collected and discussed. Consequently, these characteristics will be used as drivers to model the yield development.

Yield modeling
To examine the effects of the property markets' development processes on the office investment yields in CE, and the various, selected drivers, a yield model introduced by Teuben [2004] has been used. The model, which is illustrated in figure 2, splits the actual yield development in a trend and a cyclical element, at which the trend yield element reflects the development from a challenged starting point towards maturity. Consequently, the trend yield line is characterized by a steep decline in the first years, due to decreasing risk perceptions. Subsequently, the course of the trend yield will gradually flatten, as the market reaches maturity, and will increasingly be affected by cyclical patterns (i.e. cyclical yield element).

![Property investment yield development](image)

To model the development of office investment yields in Prague, Budapest and Warsaw, the various selected characteristics of the property market development process, which result from a literature study, and are related to the development process, have been categorized per yield component and element. Altogether, this results in the following schematic overview of the yield components and their selected trend and cyclical yield drivers, with the expected sign of the relation (either positive or negative) in brackets.
Overview selected yield component drivers

<table>
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<th>Risk free yield</th>
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</thead>
<tbody>
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<td>Trend</td>
<td>Trend</td>
</tr>
<tr>
<td>Service sector employment (-)</td>
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</tr>
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<td>Inflation rates (+)</td>
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<td></td>
</tr>
<tr>
<td>Growth of the office stock (+)</td>
<td>Liquidity (-)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3  Overview selected trend and cyclical yield elements per yield component

Data collection and actual yield modeling

In the following part, data has been collected for the various trend and cyclical yield drivers, as well as actual yield data, at which several sources have been exerted. As data in the period 1990-1992 is considered to unreliable, and moreover data for certain yield drivers is unavailable, data is only collected for the period 1993-2006. After having collected data, the data has been examined and related to the model by Klomp and Janssen, to ascertain whether the data displays the expected development pattern.

Subsequently, a correlation analysis has been conducted to examine whether the theoretically expected relations between the separate drivers and the trend or cyclical yield elements could statistically be demonstrated in the collected data sets. The correlation analyses indicated that all, but one (country risk rating), trend yield drivers disposed of the expected, significant relation with the trend yields. Conversely, in the case of the cyclical yields and their drivers, only a limited number of the expected relations were shown to be present and statistically significant. Consequently, based on these outcomes, a number of drivers have been eliminated.

To eventually construct yield models, which can be used to forecast office investment yields in Prague, Budapest and Warsaw, regression analyses have been conducted. While conducting these regressions, issues of autocorrelation and non-stationarity of times series were taken into account.

Constructing yield models

Based on the outcomes of the regression analyses, custom-made trend and cyclical yield models have been constructed for the office investment markets in Prague, Budapest and Warsaw. In all three cases, the actual inflation rates turned out to be the most useful driver for modeling the trend yield elements. In case of the cyclical yields, both the cyclical interest rates and the 1 year leading rental growth rates turned out to be useful drivers, although in the cases of Prague and Budapest only one of
these drivers is included in the cyclical yield model. For example, Budapest’s yields are modeled by using the following algebraical expression:

\[
\text{Yield}_{\text{Budapest},t} = 5.782 + 0.232 \cdot (\text{Actual inflation rate}_{\text{Hungary},t}) + 0.099 \cdot (\text{Cyclical interest rate}_{\text{Hungary},t})
\]

Using this formula to model yields leads to the following figure, in which the actual yields are plotted as well.

![Modeled and actual yields Budapest (1993-2006)](image)

When adding up the modeled trend and cyclical yield element, the modeled yields can be related to the actual yields, and the quality of the constructed yield model can be determined by using a goodness of fit measure. Altogether, in all three cases, the models’ goodness of fit measures are varying. Warsaw’s yield model has the best goodness of fit measure. The goodness of fit measures of both Prague’s and Budapest’s yield model are less favorable, which is mainly explained by the fact that these models have more difficulty to capture the yield compression, which resulted from the ‘wall of money’, which occurred since 2003 (see yield gap between in figure 4).

**Yield forecasting in Central Europe**

By using the constructed trend and cyclical yield models, and forecasts for the various drivers, forecasts can be made for the office investment yields in Prague, Budapest and Warsaw. Using these models implies that two assumptions are made, namely that the detected relations between the yield
elements and their drivers will persist in the future, and that the forecasts for the drivers are correct. In conclusion, the generated yield forecasts are quite deviating from more qualitatively generated forecasts by PMA and ING REIM. Relative to the forecasts by PMA and ING REIM, the generated yield forecasts are considerably higher. In both Prague and Budapest, these higher yield levels are explained by the models' incapacity to catch up with the earlier mentioned yield compression. In the case of Warsaw, the behavior of some of the model's drivers significantly influenced the generated yield forecasts.

Despite the generated yield forecasts being quite deviating from other yield forecasts, their outcomes do have some use, as the courses of the generated yield forecasts for Prague and Budapest are quite in line with PMA and ING REIM forecasts by forecasting a flattening yield course.

The case of Bucharest

Although the development of property markets in Central Europe already occurred with a rapid pace, the development pace of commercial property markets in Bucharest was even much faster. Fostered by Romania's prosperous economic development since 2000, the vast amounts of capital pouring into property investment markets, due to growing investor confidence in property investments, and Romania's forthcoming EU accession, Bucharest's office investment market developed itself with a tremendous pace as of 2003. This development is clearly reflected in the market's liquidity, which exploded since 2002, and is currently still very high, relative to neighboring markets in CEE. Consequently, office investment yields in Bucharest have rushed down with a staggering pace, rapidly narrowing the yield gap with CE, as figure 5 shows.
Constructing a custom-made yield model for Bucharest is unfortunately impossible, given the very small size of the available data sets. Alternatively, the CE yield models could be used to forecast Bucharest’s office investment yields, however, because of the turbulent development, translating CE yield models to Bucharest to model the city’s office investment yields, would not make sense. Therefore, a yield forecast for Bucharest is obtained by extending the city’s trend yield line, since Bucharest’s trend yield has predominantly driven yields since 2003, and this development is expected to continue in the coming years, due to the expected continuation of large amount of capital pouring into property investment markets. Nonetheless, as the market continues its development, it is expected to be increasingly affected by cyclical patterns. For example, the forecasted negative rental growth as of 2008, will likely have an upward effect on Bucharest’s office investment yields.

Conclusions

Unfortunately, the generated yield forecasts are quite deviating from other available yield forecasts, although the model does also forecast a flattening yield course in the coming years. Nevertheless, the outcomes of the conducted research are useful, as they provide a deeper insight in the development processes of the office investment markets in Central and Eastern Europe, and the findings can therefore be useful for understanding and examining development processes in other markets and/or sectors. Moreover, this study demonstrated the presence of significant relations between cyclical yields and leading rental growth rates and cyclical interest rates. These latter findings are valuable as they indicate that yields respond more directly to changing interest rates than is commonly believed. Additionally, these cyclical relations indicate that, relations which are considered to be characteristics of a mature market can also be traced in markets which are developing themselves into mature markets.

Although this study demonstrated the presence of property market fundamentals in the office investment markets in Prague, Budapest and Warsaw, it also illustrates that the office investment yields in these markets are influenced by irrational factors, such as the excessive amounts of capital pouring into the markets. Especially, in the case of Bucharest, irrational factors seem to have had a strong influence on the city’s office investment yields. Altogether, this raises the question whether the office investment markets in Central and Eastern Europe are overpriced.
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Introduction

1.1 Introduction

1.1.1 Globalization and an increasing interest in property investments

The ongoing globalization affects property markets and its actors and has its repercussion on real estate investment and development as financial markets are liberalized and deregulated. The removal of barriers to capital movement, liberalization of investment regimes, worldwide privatization processes, the lowering of national barriers and changes in legislative frameworks for (institutional) investment increases the opportunities for investors and developers to expand outside their domestic markets [Goldberg, 2004 and Hamilton, 1986]. Driven by diversification benefits arising from pursuing an international property investment strategy and the lowering of barriers, investors are more and more attracted and stimulated to invest on a cross-border basis.

Various studies examined cross-border property investment and development and report increasing levels of overseas property investments. A recent study by real estate advisor DTZ Zadelhoff [2006] reveals that there is an increasing interest for property investment; institutions have made a long term move into real estate as it is seen as a safer investment option compared to, for example, stocks, which have proven very volatile in their performances. Consequently most investors intend to increase their cross-border property holdings as yields in domestic markets like the UK are strongly compressed, which results in an increasing demand for cross-border property investments as higher returns can be obtained in foreign markets. Thus, as a result of the outcomes of their ‘Money into Property Europe 2006’ study, DTZ expects that the demand for European commercial real estate will remain strong and that the trend towards growth in cross-border investment will be a long-term phenomenon. Additionally, another trend can be observed over the past years as the classical property investment classes (office, retail, residential and industrial) are complemented by the appearance of new property investment classes such as hotels, infrastructure and hospitals.

Meanwhile, initial yields in Europe are declining as well. On the one hand, this is caused by favorable interest rates, healthy performances of property investments, and scarcity of investment supply, and
on the other hand, there is talk of a convergence of initial yields on a European level which results from increasingly interwoven property markets in Europe [PropertyNL newsletter, 2006]. These findings match the globalization issue, which forms the foundation for the increasing connectedness and interrelation of European property markets.

1.1.2 Increasing interest in the Central and Eastern European region

In this era of increasing interest in property investments and the resulting scarcity of investment objects in traditional property investment markets, investors in search of property investment opportunities expand into new markets. This explains the increasing interest in property investments in Central and Eastern European countries with their favorable economic prospects, increasing political stability and still immature property markets. In the recent past, the search for opportunities has drawn developers and investors to the former Soviet suppressed Central European nations of the Czech Republic, Hungary and Poland, which consequently led to the rapid development of property markets in these former communist countries. The currently ongoing mad stampede for investments in Central Europe converged yields in the Czech Republic, Hungary and Poland in line with European levels resulting in an overpriced property investment market according to PMA [2006] and EuroProperty [2006] and leading to a substantial discrepancy between demand and supply [de Groot, 2005]. Consequently, this contributed to the attention shift of investors and developers to behind lying countries such as Romania, Slovakia, Bulgaria, Ukraine, Turkey and Russia, many of which share similarities and a comparable background with the Czech Republic, Hungary and Poland in their early years of development.

Given this context (of 1: increasing (cross-border) property investments, 2: the emergence of property investment markets in Central and Eastern Europe, and 3: the similarities and comparable backgrounds between the more or less developed property investment markets in the capital cities of the Czech Republic, Hungary and Poland, and also the immature and underdeveloped character of markets in other Central and Eastern European countries) the question raises as to what can be learned from the development of property investment markets in the Czech Republic, Hungary and Poland for the future development of property investment markets in other Central and Eastern European countries.2

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2 When using the abbreviation CE in this thesis, it includes the Czech Republic, Hungary and Poland, when the abbreviation CEE is used it includes the three Central European countries and Romania.
1.2 Formulation of the problem:

As a result of the issues of globalization, the increasing interest in property investments, and the increasing interest in the Central and Eastern European region, the following problem definition arises.

*How can the development of property investment markets in Central Europe be explained and what lessons can be learned from this for the further development of these property investment markets and the development of the property investment markets in Romania?*

1.3 Objective:

Based on the problem definition, as outlined in the previous paragraph, the following objective has been formulated:

*Creating a model for the yield development of the office property investment markets in Central and Eastern Europe, based on the process of the emergence and development of property investment markets in Central Europe, in order to offer property investors a better understanding of the future development of property investment markets in Central and Eastern Europe.*

A subdivision into a number of sub-questions, enumerated below, helps to achieve the objective.

- What parameters influence the development and operation of office property investment markets?
- How do these different parameters affect yields in office property investment markets?
- How can the development of office property investment markets in Central Europe be explained by using the distinguished parameters?
- What effects have the different parameters had on the development of yields on office property investments in Central Europe?
• Can there be found differences in the development of the individual office property investment markets in the Central European region?
• In what way can the different parameters be used to develop a yield forecasting model for the office property investment markets in the Czech Republic, Hungary and Poland?
• What parallels can be drawn between the development of the office property investment markets in Central Europe and the development of the office property investment market in Romania?
• In what way can the different parameters be used to develop a yield forecasting model for the office property investment market in Romania?

1.4 Research demarcation

Due to limitations in the availability of data, this research will focus on the office property investment markets in the capital cities of the Czech Republic, Hungary and Poland, as data on office investments are most widely available compared to other sectors (e.g. retail, industrial), and property investment markets in the countries still strongly concentrate in the capital cities of Prague, Budapest and Warsaw. Additionally, the development of the office property investment market of Romania’s capital Bucharest will be forecasted, as this market is particularly interesting for ING Real Estate Investment Management and the information regarding this market is more readily available.

1.5 Research and report structure

Several steps will need to be taken to develop a forecasting model for the development of the Central and Eastern Europe office investment markets, such as mentioned in the objective. Three major steps can hereby be described as is shown in the following overview of this thesis’s structure. The first part will consist of an introduction to the Central and Eastern European region and real estate as an investment class. Additionally, the development process of property markets will be examined, finally resulting in a theoretical yield model. Subsequently, in the following part, data will be collected and statistical analyses will be conducted to generate applicable yield models. In the final part of this thesis, yield forecasts will be generated for the office investment markets in Prague, Budapest, and Warsaw. Eventually, the findings derived from the development processes in these cities will be used to examine the development process of Bucharest's office investment market and generate yield forecasts.
The figure on the following page provides a schematic overview of the research approach, as well as this thesis's structure.

**Part I**  
**Introduction and theoretical framework**

- Chapter 1  Introduction
- Chapter 2  Introduction to the Central and Eastern European region
- Chapter 3  Real estate investment; the asset class and its characteristics
- Chapter 4  Modeling the development process of property markets

**Part II**  
**Data collection and modeling**

- Chapter 5  Data collection and discussion
- Chapter 6  Statistical yield modeling

**Part III**  
**Forecasting and conclusions & recommendations**

- Chapter 7  Forecasting the CE office investment market yields
- Chapter 8  The case of Bucharest
- Chapter 9  Conclusions and recommendations

*Figure 1.1  Schematic overview research and thesis structure*
A brief introduction to the Central and Eastern European countries

2.1 Introduction

The Czech Republic, Hungary, Poland and Romania are located in Central and Eastern Europe; a region in which Slovakia, Bulgaria and former Yugoslavia can be found as well (see figure 2.1). Before analyzing the four Central and Eastern European countries, their economies and property markets, a short introduction will be given on each of these four countries. Each of the markets will be described by its geographical location, population, history and politics to paint a picture of the context in which the studied property markets find themselves.

Figure 2.1 The Central and Eastern European region [World Factbook, 2006]
2.2 The Czech Republic

The Czech Republic is landlocked with Poland to the north, Germany to the northwest and west, Austria to the south and Slovakia to the east (see figure 2.2). The city of Prague is the nation’s capital, with other major cities being Brno, Ostrava and Plzen. [Czech Statistical Office, 2006]

In the 1990s, the Czech Republic had a stable population of well over 10 million inhabitants, but currently, the population is in decline as the result of an ageing population and a sharp drop in the birth rate in the early 1990s. This decline in births was caused by the general economic uncertainty at the start of the 1990s, lack of part-time/flexible jobs for women, a wider access to contraception and an increase of the average age of marrying couples. Compared to the other CEE countries, the Czech Republic is the 2nd smallest country in terms of population but it has the highest population density. The Czech gross domestic product (GDP) at power purchasing parity (PPP*) amounted to $18,341, ranking the Czech Republic on the 38th place on a global ranking according to IMF*[2006].

Quick Facts

- Population: 10.24 mln.
- GDP per capita by PPP in 2005: $18,351
- Area: 78,866 sq km
- Population density: 129.78 per sq km
- Ageing population
- Capital city Prague with 1.17 million inhabitants

[Czech Statistical Office, 2006]

Figure 2.2 Czech Republic. [World Factbook, 2006]

In 1918, after the First World War, the independent country of Czechoslovakia was created, a nation which was later torn in pieces before and during the Second World War. Czechoslovakia regained its taken lands after the Second World War, after which the reconstituted nation fell within the Soviet sphere of influence, resulting in a communist form of government. Despite efforts of the country’s leaders to liberalize the nation and create a more humane socialism (finding its climax in the Prague Spring Uprising in 1968), the Soviet suppression lasted until the ‘Velvet Revolution’ of 1989, after

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3 Appendix I provides definitions for abbreviations or concepts marked with a star (*)
which Czechoslovakia’s political independence was restored. This revolution formed the starting point for the transformation process, in which democracy replaced communism in Czechoslovakia.

In 1993, Czechoslovakia peacefully split itself into two independent countries: the Czech Republic and Slovakia. Thereupon, the Czech Republic continued its transformation course toward a modern democracy and economy, joining the NATO in 1999 and the European Union on May 1, 2004.

Furthermore, the government is continuously working on the stabilization and further development of the Czech economy, with the adoption of the Euro currency being one of the long-term objectives. However, political instability and uncertainty have a restraining effect on these processes [World Factbook and EUI Country Forecasts Czech Republic, 2006].

2.3 Hungary

Just like the Czech Republic, Hungary is a landlocked country in Central Europe, bordered by Austria, Slovakia, Ukraine, Romania, Serbia, Croatia and Slovenia and traversed by the rivers Danube and Tisza, as shown in figure 2.3. Budapest is the country’s capital, with other major cities being Debrecen, Miskolc, Szeged and Pécs. [Hungarian Central Statistical office, 2006]

![Figure 2.3 Hungary](image)

Since the 1980s, the Hungarian population has been declining, with birth rates showing the same strong decrease due to the same factors as in the Czech Republic. Consequently, the country is faced
with an ageing and declining population. In terms of population, Hungary is equal to the Czech Republic, but because of the country's greater surface area, the Hungarian population density is considerably lower. In comparison to the Czech Republic, Hungary's GDP per capita by PPP is also lower, by almost $1,000, ranking Hungary on the 40th position on the IMF global ranking.

Quick Facts
- Population: 10.08 mln.
- GDP per capita at PPP: $17,405
- Area: 93,030 sq km
- Population density: 108.35 per sq km
- Ageing population
- Capital city Budapest with 1.7 million inhabitants

[Hungarian Statistical Office, 2006]

Since 1867, Hungary was a part of the polyglot Austro-Hungarian Empire, which collapsed at the end of the First World War. After this war, in November 1918, the independent republic of Hungary was established, and only a few months later, with the proclamation of the Hungarian Soviet Republic, the first short period of communist rule became a fact.

In 1920 Hungary lost 71% of its territory as a result of new fixed borders and Horthy was elected as the new Regent. Despite alliances with Nazi Germany, Horthy lost his power when he was replaced by a Hungarian Nazi collaborator in 1944. After the collapse of the Nazi regime in 1945, Hungary experienced a short period of democracy before falling under Soviet influence once again with the establishment of a suppressing Stalinist rule in 1948. Several protests notwithstanding, the communist party exercised autocratic rule until the late 1980s, when Hungary shifted toward multiparty democracy and a market-oriented economy. These developments should be seen as the first steps in Hungary's transformation process from communism to democracy.

In October 1989, the Third Hungarian Republic was officially declared, resulting in the first free elections in 1990. Fostered by the collapse of the Soviet Union in 1991, the country developed closer ties with the West, joined NATO in 1999 and became a member of the European Union in 2004. Just like the Czech Republic, Hungary nowadays enjoys a stable democracy and a representative parliament, and the Republic has identified the adoption of the Euro currency as one of its long-term objectives. However, the recent political instability highlights the current instability of the country and high current account deficits are major obstacles. [EIU, Country Forecast Hungary and World Factbook, 2006]
2.4 Poland

Just like Hungary and Czech Republic, Poland is located in Central Europe, with Germany to the west, the Czech Republic and Slovakia to the south, Ukraine and Belarus to the east, and the Baltic Sea and Lithuania and the Russian enclave Kalingrad to the north, as can be glanced from figure 2.4. Warsaw is the Polish capital, other major cities are Łódź, Krakow and Gdansk [Polish central statistical office, 2006].

In line with Hungary and the Czech Republic, Poland’s ageing population is expected to decline in the (near) future, primarily as a result of a dramatic decrease in birth rates. Both in terms of population size and area, Poland is the largest country of the four CEE countries considered in this thesis, and the 2nd most densely populated after the Czech Republic. Additionally, in terms of the GDP per capita by PPP, Poland’s score is the second lowest in the CEE region, ranking Poland on the 51st position on a global scale.

![Poland Map](image)

**Quick Facts**

- Population: 38.54 mln.
- GDP per capita by PPP: $ 12,994
- Area: 312,685 sq km
- Population density: 123.25 per sq km
- Ageing population
- Capital city Warsaw with 1.70 million inhabitants

[Polish Statistical Office, 2006]

Shortly after World War I and several other conflicts, Poland regained its independence in 1918. However, in 1926, insurgent forces obtained power and ruled the nation until the start of World War II in 1939, when German and Soviet troops invaded Poland and divided the country in two zones. After World War II, the Soviet Union instituted a new communist government in Poland, analogous to many of the other countries in the Eastern Bloc, which brought Poland a new period of totalitarian Stalinist rule. Nevertheless, from 1956 onwards, the country took a more liberal approach, leading to a more modern economy and a government with credits. The formation of the trade union ‘Solidarity’ at around 1980 was a decisive development in Poland’s transformation, as it eroded the Communist
Party and won the parliamentary elections in 1989. The rise of the Solidarity movement was one of the key factors contributing to the collapse of communism all over Central and Eastern Europe. A shock therapy program and numerous legal reforms in the early 1990s transformed Poland's economy into the most robust in Central Europe in the mid 1990s. Just like Hungary and the Czech Republic, Poland joined NATO in 1999 and the European Union in 2004. Currently, Poland is a parliamentary representative democratic republic, and like the other two Central European countries, Poland is working on the introduction of the Euro, though this is a long term objective. [EIU, Country Forecasts Poland and World Factbook, 2006]

2.5 Romania

Geographically speaking, Romania is located in the South Eastern part of Europe. It borders Hungary and Serbia to the west, Ukraine and Moldova to the northeast, Bulgaria to the south and has a stretch of sea coast along the Black sea in the east (see figure 2.5). Bucharest, located in the South Eastern part of the country, is the nation's capital, with other major cities being Iași, Timișoara, Galați and Cluj-Napoca.

![Figure 2.5](image.png)

Quick Facts

- Population: 22.30 mlн.
- GDP per capita by PPP: $8,785
- Area: 237,500 sq km
- Population density: 93.90 per sq km
- Ageing population
- Capital city Bucharest with 1.93 million inhabitants

[Romanian Statistical Office, 2006]

As with the other CEE countries, Hungary's population is declining, primarily because of declining birth rates and emigration to Western Europe. Romania is the 2nd largest CEE country both in terms of population and area, and has the lowest population density. The north-northwestern part of the country is sparsely populated because of the inhospitable character of the Carpathian Alps. In terms of
the nation’s GDP per capita by PPP, Romania is ranked on the lowest position in the Central and Eastern European region. On a global scale, Romania is ranked on the 67th position in 2005 according to the IMF.

At the end of the 18th century, the Habsburg Monarchy incorporated the Transylvanian region into what successively became the Austro-Hungarian Empire. During this oppression, which lasted until 1918, the country suffered from the Magyarization policies of the Hungarian government. After the collapse of Austria-Hungary and the Russian Empire, the Kingdom of Romania was reestablished. Under the authoritarian King Carol II, Romania joined the Nazis during the beginning of the Second World War, but the Romanian support came to an end when the Soviet Union invaded a part of the country. After the war, the Soviets remained. Nonetheless, by the end of the 1960s and the early 1970s, the country experienced a ‘golden era’, during which the economy bloomed. Nicolae Ceauşescu’s successful grab for power and the installation of his autarchic regime unfortunately ended the prosperous era, and Romania suffered under his rule until he was overthrown during the Romanian Revolution in December 1989, and was executed with his wife shortly thereafter.

Following the collapse of the Soviet Union and the end of the Cold War, Romania started to develop closer ties with Western Europe and applied for EU membership in 1993. Reform processes and economic development in Romania fell short compared to the developments taking place in the Czech Republic, Hungary and Poland, but Romania eventually joined NATO in 2004 is an EU member since January 2007.
The environment of real estate as an asset class

3.1 Introduction

Before being able to proceed with the construction of a yield forecasting model as uttered in the objective, a wider understanding of the context in which property investment markets and property investments find themselves is imperative. Thus, in this chapter, an introduction will be given on real estate as an asset class and the global growing interest in property investments which announced itself over the past few years. Furthermore, this chapter will elaborate on the composition of yields and their central role in property investment markets.

3.2 Real estate as an asset class

As Wheaton and DiPascale [1992] and Corgel et al. [2000] have shown, real estate plays a dominant role in the world’s wealth, with real estate comprising 49% of the world’s wealth according to Corgel et al. and according to Wheaton and DiPascale, roughly 56% of the nation’s wealth in the U.S. in 1990. These figures clearly present real estate as the world’s largest asset class, thereby outpacing traditional asset classes such as stocks, bonds and derivates. The massive dimensions aside, property investments differ significantly from other investment classes in terms of the fixed locations, heterogeneity, high value per unit, illiquidity and the use of valuation to measure performances [Hoesli and MacGregor, 2000]. Property investment is defined by van Gool et al. [2001] as:

"Tying up capital in properties, either direct or indirect, with the intention of realizing prospective cash flows from exploitation and sale of the properties."

When comparing performances of the various asset classes over the long term, it turns out that every asset class has its own specific risk/return profile. In general, stock (equity) investments are
characterized by relatively high returns which are however accompanied by high risks (i.e. high volatility of returns). Likewise, government bonds, with their lower return performances, entail lower risks. Consequently, a higher return corresponds to a higher risk and vice versa. This principle plays a dominant role in the Modern Portfolio Theory (MPT), originally published by Markowitz in 1952. In addition, property investment performances are generally seen as less risky compared to stocks and more risky compared to bonds. Traditionally, risk is hereby seen as the standard deviation of return, with a higher standard deviation (i.e. higher volatility) corresponding to a higher risk. The following figure, detailing the performances of stocks, bonds and real estate investments, clearly shows a high volatility (i.e. risk) on stock investments, whereas bonds show a gradual and stable performance with very little volatility, and the performance of property investments can be found in between stock and bond performances.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Annual Return</th>
<th>Equities (S&amp;P 500)</th>
<th>Real Estate (NCREIF)</th>
<th>Bonds (US Treasury)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>12%</td>
<td>16%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>15%</td>
<td>18%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>10%</td>
<td>12%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>13%</td>
<td>15%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>11%</td>
<td>13%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>12%</td>
<td>14%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>10%</td>
<td>12%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>11%</td>
<td>13%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>12%</td>
<td>14%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>10%</td>
<td>12%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>11%</td>
<td>13%</td>
<td>7%</td>
<td></td>
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<tr>
<td>2000</td>
<td>12%</td>
<td>14%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>10%</td>
<td>12%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>11%</td>
<td>13%</td>
<td>7%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.1 Performances of stocks, property investments and government bonds [Adapted from Standard & Poor's, 2006, NCREIF, 2006 and Yahoo Finance, 2006]

When calculating the standard deviations (SD) of the annual returns on the three different asset classes, considerable differences become apparent. Table 3.1 shows a very low standard deviation for returns on government bonds in the period 1970-2005, while the SD of real estate investments in the

---

To quantify the risk of a certain investment option, investors often calculate the standard deviation of the investment's return performances at which a higher standard deviation corresponds with a higher risk. The standard deviation measures the degree to which the return performances deviate from the average.
same period is more than twice as high, and the SD of equity returns is more than five times as high. Consequently, bonds have the lowest risk, whilst equities entail the highest risk. When interpreting figure 3.1 and table 3.1, it must be noted that both reflect performances of investments in the U.S. As different regions and countries experience different economic developments and cycles, a certain reticence is required when generalizing these performances. Furthermore, when comparing performances over time, disposing over the longest possible time series is essential as longer time series contribute to more underpinned statements.

<table>
<thead>
<tr>
<th>Standard deviation</th>
<th>14.92</th>
<th>6.37</th>
<th>2.76</th>
</tr>
</thead>
</table>

Table 3.1 Standard deviation of annual returns of equities, real estate investments and bonds [Adapted from Standard & Poor’s, NCREIF, and Yahoo Finance]

Generally, when composing an investment portfolio, an investor applies diversification strategies by allocating his investments over different assets to reduce risk. The foundation for diversification lies in the non-perfect correlation between the performances of different assets in a portfolio and forms the basis for the earlier mentioned MPT. Through diversification, an investor can reduce risk for the equivalent rate of return or increase return for the same level of risk by combining assets that are less than perfectly correlated. Using diversification strategies only makes sense when the performances of two different assets have a correlation of less than 1, meaning that they are not perfectly correlated. The principle of diversification is clearly explained in the following example.

A manufacturer of umbrellas will have strong sales in autumn, winter and the first part of the spring, whereas his sales will be marginal in the summer. By producing parasols as well, the manufacturer can solve his marginal sales in the second part of the spring and the summer by the sale of parasols in this period. Thus by diversifying his products which negatively correlate (i.e. when the sale of umbrellas will grow in autumn, the sale of parasols will decrease) the manufacturer benefits from his diversification as his sales will be more constant.

Consequently, efficient diversification involves combining investments to reduce risk without sacrificing the portfolio’s return, hence the occurrence of multi-asset portfolios characterized by a different weighting of stocks, bonds and real estate [McGreal et al., 2001]. Within each asset, further
Diversification may enhance performance. Real estate as an asset can be diversified by allocation across sectors (e.g., retail, office, residential, industrial) and regions (e.g., cities and countries).

3.3 The growing interest for property investment and global yield compression

Over the past years, an increasing interest in property investments announced itself due to several reasons. Figure 3.2 reflects this increasing interest by illustrating the growing levels of capital invested in real estate on a cross-border basis from 1998 to 2005. In the first place, the interest in real estate investments was stimulated by the performances of competitive assets. Whereas stock markets have shown very volatile and weak performances in the last years (e.g., collapse of the ICT bubble around the millennium and the East Asian financial crisis in the late 1990s), property investments have shown more stable and profitable performances in these years. Consequently, more and more (institutional) investors increased the property investment allocations in their investment portfolios, as they wanted to benefit from the stability of property investments and reduce the risks within their portfolios by decreasing their allocations to equities.
Secondly, institutional investors have structurally increased the percentage of property investment allocations within their investment portfolios because of the improved transparency of property investments. As a result of the availability of longer time series on property investment performances, which enables a decent risk/return analysis of the asset's performance and meaningful comparisons to other assets, growing familiarity with property investments as an asset class and increasing liquidity, ALM* studies attribute higher allocations to real estate [Urban Land Institute and PWC, 2006]. In addition, the Urban Land Institute (ULI) and PriceWaterhouseCoopers (PWC) quote:

"There is an increasing consensus that real estate has been repositioned as an asset class. This contention is supported by the continuing increase in strategic institutional target weightings in real estate. Private equity, venture capital and hedge funds that invest in real-estate related assets are all now the recipients of institutional allocations in addition to core investments".

A recent study by DTZ [2006] underlines this increasing interest of (institutional) investors in property investment and supports the findings of the ULI and PWC study by quoting:

"Institutions particularly in the UK have made a long term move into real estate in an attempt to boost portfolio growth and do not appear ready to rely once again on equities to provide this. Real estate is seen as a safer option. This will be a long-term factor influencing property markets for the next several years".

In addition, ING Real Estate Research in ING [2006] argues that real estate allocations within the institutional investment portfolios are growing as investors are shifting their strategies from simply chasing returns to an ALM based approach. This strategy shift which drives the real estate allocations in institutional investment portfolios is endorsed by Morgan Stanley in ING, where they state that institutional allocations to real estate investments will increase from 5-6% to 10-15% between 2005-2012, resulting in an estimated annual EUR 400bn inflow.

Finally, pension funds have shown a continuing appetite for property investments over the past years primarily because of demographic trends and changes. According to the ULI and PWC and CBRE [2005], pension funds have increased their weights on property investments as a result of the increasing transparency and the general ageing of the population in most European countries. The ageing population faces almost all European pension funds with funding shortfalls because of the generally applied Pay-As-You-Go (PAYG) standard. Currently pension funds struggle with the

*A system by which current pensions are paid for out of current contributions and no assets are put aside to meet future liabilities. This system relies on the principle that current tax payers pay for current pension payments in return for an understanding that future tax payers will pay for their pensions [CBRE, 2005].
consequences of this system as the number of pensioners increases, consequently intolerably burdening the current tax payers. Reforms such as the lengthening of working lives and increasing private/company pension provision can only partially solve the shortfall. Thus, to tackle this shortfall, the pension funds will have to invest the revenues from the reforms and additional increased taxes in long-term, low-volatility assets that generate reliable cash flows [ULI and PWC]. With real estate investment fulfilling these requirements, the increased transparency and the underweight of real estate in the pension funds’ portfolios, real estate investments are eagerly sought out by numerous hungry pension funds. In a presentation by ING, several parties underline the strengthening position of real estate in pension funds investment portfolios. In this presentation, ING Real Estate Research argues that investors need income generating properties to cope with the ageing population, which is in line with the outcome of a survey that revealed that over 50% of the surveyed pension funds plan to increase their real estate allocations, and that 30% seriously considers to allocate real estate investments for the first time. Moreover, according to figures provided by WM Company, DTZ and JP Morgan Fleming in CBRE [2005], pension funds are now increasing their property allocations which have been declining since the mid-1980s until the late 1990s. Furthermore, the typical allocations of pension funds vary from a marginal 1% in Austria to over 20% in Italy according to Mercer Investment Consulting and JP Morgan Fleming in CBRE.

Altogether, this rapidly growing interest in property investments had a significant influence on the pricing levels of property investments over the past years. The effects of this increasing interest are clearly reflected in the pricing of properties, as can be seen in figure 3.3. Yields have swiftly declined over the past years in various markets, causing property prices to increase.

![Office investment yields in European capital cities (1997 - 2006)](image)

*Figure 3.3 Office investment yields in various European capital markets (PMA, 2006a)*
Besides the rapidly growing interest of property investments contributing to this global yield compression, other reasons for the yield compression have been adduced. DTZ [2006] for example, argues that the application of more advanced finance methods, such as CMBS*, enable investors to make higher offers on properties. Furthermore, the persistently low interest rates over the past years are expected to have greatly contributed to the ongoing compression of property investment yields over the past years, according to, among others, JLL [2006] and CBRE in Vastgoedmarkt [2006].

3.4 Yields and returns on property investments

As stated earlier, an investor will require a certain rate of return when considering a property investment and will relate the asset class to other asset classes, such as equities and bonds. The required rate of return materializes in the property investment market from the interaction of the property investment market, the space market and the capital market. According to, among others, Hoesli and McGregor, yields on property investments are composed of the risk free rate, the risk premium and the expected rental growth. Algebraically, yields can therefore be expressed as:

\[ Y_t = RF_t + RP_t - g \]  
\[ Y_t = \text{net initial yield in period } t \]
\[ RF_t = \text{risk free rate in period } t \text{ (normally return on government bond)} \]
\[ RP_t = \text{risk premium in period } t \]
\[ g = \text{expected rental growth} \]

The formula implies that when returns on government bonds increase, yields will increase as well, that when risk premiums increase, yields will do the same, and, finally, that when the expected rental growth increases, yields will decrease. It must however be noted that yields may not always respond

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9 Both Archer and Ling [1997] and Geltner and Miller [2001] provide elegant models which link these three different markets.
8 When yields are discussed in this thesis, it refers to net initial yields (unless quoted else)
9 The following explanation of the composition of yields and their relation to return performances of property investments are partly derived from a study by Karakozova [2005].
as directly and clearly as suggested here. For example, yield levels may react to changing returns on government bonds with a certain time lag.\(^{10}\)

By using the following formula, yields can easily be calculated:

\[
Y_t = \frac{\text{NOI}_t}{\text{CV}_t} \times 100\% \tag{2}
\]

\(Y_t\) = the net initial property market yield at period \(t\)

\(\text{NOI}_t\) = the net operating income in period \(t\)

\(\text{CV}_t\) = the market value of the property in period \(t\)

When investing in real estate, the total annual return on the investment is bipartitely composed and consists of both income return and capital return. Algebraically, this results in the following formula [Hoesli and MacGregor]:

\[
\text{TR}_t = \text{IR}_t + \text{CR}_t \rightarrow \text{TR}_t = \frac{(\text{CV}_t - \text{CV}_{t-1}) + \text{NOI}_t}{\text{CV}_t} \tag{3}
\]

\(\text{TR}_t\) = total return in period \(t\)

\(\text{IR}_t\) = income return in period \(t\)

\(\text{CR}_t\) = capital return in period \(t\)

As follows from formula [2], the capital value of a property \((\text{CV}_t)\) can be found by simply capitalizing the income of the property \((\text{NOI}_t)\) at the property yield \((Y)\). Thus, equation [3] can be re-written as [Hoesli and MacGregor]:

\(^{10}\) Lagging implies that yields will, for example, respond to changing government bond yields with a certain time lag.
Formula [4] clearly shows the dependency of a property investment’s total return on the property yield and hereby underlines the importance of property yields when investing in real estate. Therefore having understanding of the realization of yields and the future expectations of yield levels is valuable information for investors.

3.5 Conclusion

As shown in this chapter, yields are composed of the following three major components: risk free rate, risk premium and the expected rental growth. Consequently, when constructing a yield modelling and forecasting model, one will have to take these components into account. Additionally, when modelling the yield development in the office investment markets of the capital cities of the Czech Republic, Hungary and Poland, one must take into account that these markets have, as briefly mentioned in the previous chapter, experienced a turbulent development over the past decade and are only recently regarded as more or less mature markets [Urban Land Institute and PWC, 2007]. Therefore, comprehending this development process and its drivers is essential for modelling and understanding the yield development in the CE region. Furthermore, the growing maturity and confidence in real estate as an asset class compared to more classical asset classes, has lowered the risk perceptions on property investments and resulted in a strongly growing demand for property investments by institutional investors, which consequently compressed yields. Additionally, the increasing application of advanced financing methods and persistently low interest rates over the past years contributed to the yield compression.

The following chapter will elaborate on the aforementioned issues by introducing a property market development model and an existing yield modelling model, which will eventually be used to create a yield modelling model for the Central European office property investment markets.
Modeling the development process of property markets

4.1 Introduction

Resulting from the findings in the previous chapter, this chapter will elaborate on the creation of a yield forecasting model. Understanding the development of the office property investment markets in the Central European region and the corresponding drivers is essential when modelling yields in these markets. Therefore, this chapter will initially discuss a property market development model and will thereupon use an existing yield modelling study to construct the forecasting model based on various selected drivers. The chapter will conclude by presenting the selected drivers for modelling office investment yields in the Central European region.

4.2 Property market development model

4.2.1 Introduction

According to various studies the development of property and investment markets follows a certain, specific process. This development process, which is discussed in this paragraph and visualized in figure 4.1, will be helpful in understanding the development of property markets and will moreover attribute to the selection of drivers for the yield forecasting model. When examining the development of property and investment markets, one must understand that, according to Geltner and Miller [2001], Van Gool et al. [2001] and Jones Lang Wootton [1992, in Adair et al., 1999], and others, urban dynamics and the development and operation of property markets are closely related and influenced by economic structures and characteristics. Consequently, the model by Klomp and Jansen [2006] distinguishes economic development as well as the development of property markets.

As can be seen in figure 4.1, the model by Klomp and Jansen plots the development of the economy and the property market over time. As time goes by, which is represented by movement over the horizontal axis, both the economy and the property (investment) markets develop themselves. The development of the economy and property markets is hereby represented by movement over the
vertical axis. The three development phases and their distinctive characteristics, which are distinguished in the model, will be discussed in the following pages, during which a distinction is made between the development of the economy and the property (investment) markets.

4.2.2 Economic development

When analyzing the economic growth pattern of a challenged economy into a mature economy, the development process can be divided in three different phases, as visualized by figure 4.1. Numerous sources in literature provide insight in the development process of economies and identify characteristics for distinguishing the different phases of economic development, of which the most relevant are presented in table 4.1.

Initially, during the challenged phase of the economy, the process is generally characterized by a phase of low economic growth, hyper inflation, and an industrially and agriculturally driven economy. Additionally, a challenged economy generally struggles with high unemployment rates, has a very small domestic commercial business sector, an underdeveloped service sector and is characterized by high interest rates and a large number of state-owned companies [Barry et al., 1996, WorldBank, 2006, Hartzell et al., 1993, Revenidis, 2002 and Teuben, 2004]. Countries, whose economies are qualified as challenged economies, are earmarked as high risk countries.
Inflation | Hyper-high | High-medium | Medium-low
GDP growth | Negative-low | High-medium | Medium-low
Unemployment | High | High-medium | Medium-low
Country risk | High | High-medium | Medium-low
Service sector employment | Medium | Medium-high | High
Commercial business sector | Limited | Rapidly growing | Established and modestly growing
Interest rates | High and volatile | High-medium and stabilizing to end | Medium-low and cyclical
Government bond yields | High | High-medium and stabilizing to end | Medium-low and cyclical
Privatization pace | Low | Medium-high | Medium-low

Table 4.1 Characteristics of economic development phases [Barry et al., WorldBank, Hartzell et al., Kevenidis, Teuben, Campos and Coricelli, 2002 and Kornai, 2006]

In the next phase, the economic growth rapidly accelerates over a number of years and strongly outpaces economic growth in developed and mature economies. An economy in this phase is qualified as an emerging economy (e.g. China is currently a typical emerging economy with double digits economic growth rates and a constant threat of economic overheating). Moreover, inflation rates, unemployment rates and interest rates more and more stabilize as the economy continues its growth towards maturity. Furthermore the development of the economy is reflected by a rapid expansion of the employment in the service sector and growing privatization of state owned assets. The continuing development of the economy altogether results in declining risk ratings.

After this turbulent phase of growth, the economic growth starts to smoothen out and settles at a more or less moderate pace, which is in line with the growth in mature economies, as the economy has reached a mature status. This mature status is furthermore characterized by medium-low values for unemployment, inflation and interest rates and a dominant position of the service sector within the country's employment structure. Finally, as the economy has reached maturity, its performances will start to show more clear cyclical patterns, which are commonly referred to as the 'business cycle'.

The process of economic development is obviously accompanied by several shocks, and alternates moments of disappointments with euphoria. Hyperinflation, high interest rates, and temporary recessions are examples of the harmful and painful side effects of the prosperous economic development [Campos and Coricelli, and Kornai].
4.2.3 Development of commercial space and investment markets

As shown in figure 4.1, the development of property markets can be divided in three phases as well, based on different characteristics of the markets in the distinguished phases. These different characteristics are summarized in tables 4.2 and 4.3, and will be explored in more detail on the following pages.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of class A office stock</td>
<td>None-very low</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
<tr>
<td>Rents</td>
<td>Low but accelerating by the end</td>
<td>Initially shortage, later declining and stabilizing</td>
<td>Cyclical</td>
</tr>
<tr>
<td>Number of lease transactions</td>
<td>Low</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
<tr>
<td>Transparency</td>
<td>Opaque-low</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
<tr>
<td>Interaction and flexibility of demand and supply</td>
<td>High</td>
<td>High-medium</td>
<td>Medium-low</td>
</tr>
<tr>
<td>Owner occupation</td>
<td>High</td>
<td>High-medium</td>
<td>Medium-low</td>
</tr>
<tr>
<td>Office locations</td>
<td>City centre</td>
<td>Shift to newly developed locations</td>
<td>Various locations with their own characteristics</td>
</tr>
<tr>
<td>Sophisticatedness property profession</td>
<td>None</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Property rights and market practice</td>
<td>None</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

Table 4.2 Characteristics of the development of the office space market [Keogh and D'Arcy, Wegener in Adair et al., Klomp and Jansen, Klomp and Jones Lang Lasalle, 2006]

In the wake of the economic development, property markets starts to develop themselves as well. In the challenged phase of the economy, the commercial business sector is small and underdeveloped, consequently commercial property markets are characterized by incidents and there is no property investment market, meaning that the liquidity in the office investment market is virtually absent [Klomp and Jansen]. The very few active investors, most of whom invest in property developments, are driven by opportunity and speculation. Additionally, a very low share of class A office stock, generally concentrated in the city centre, intransparency, a low number of lease transactions, and high yields in the property investment market [Klomp, 2002] characterize this phase in the development of property
markets. Furthermore, the operation and development of property markets is hindered by uncertain property rights, the lack of a sophisticated property profession [Keogh and D'Arcy, 1994] and inflexible decision making processes [Wegener, 1995 in Adair et al.]. Finally, the intransparency at first sight seems to be inconsistent with the high flexibility and strong interaction between demand and supply, as expressed in table 4.2. However, property markets in this phase are very small in size, planning procedures and permits can be easily acquired and only a few parties are active in the market. Consequently, the few well-informed parties are able to respond quickly to changing levels of demand. Therefore, demand and supply flexibility is regarded to be high in this phase while transparency is very low, since only a few parties are well-informed. As property markets are still in their infancy, the property market is very volatile and irregular in its performances, as is reflected by the bumpy orange line in figure 4.1.

As the economy starts to accelerate in the next phase and experiences turbulent growth, the business sector will rapidly grow, consequently resulting in a fast growing demand for space to accommodate their extending businesses. Meanwhile, as a country experiences economic growth, the real disposable income of its inhabitants will grow, which will likely result in increasing expenditures and the expansion of the retail sector. With the rapidly increasing levels of demand, the available supply of suitable commercial space is exceeded, resulting in shortage rents in the early stage of this phase. As stock and supply start to increase and the market continues its development, rents will settle at more sustainable levels in later stages. In addition, this turbulent phase (i.e. emerging phase) is characterized by a growing transparency, the continuous entrance of professional parties, a diminishing flexibility, declining yield levels, the appearance of an investment market and a growing standardization of property rights and market practice [Keogh and D'Arcy, Klomp and Klomp and Jansen]. Whereas a limited number of parties were involved in the challenged phase of the market, more and more parties enter the market, causing transparency to increase. Because of strengthening regulation and growing market practices, supply is increasingly unable to respond directly to changing levels of demand, resulting in declining flexibility and interaction between demand and supply. Meanwhile the investment markets gradually develop themselves. Initially, they are characterized by non-core strategy investments, which will in a later stage be replaced as new parties (i.e. institutional investors) enter the markets. In sum, growing stability characterizes the performances and operation of property markets in this development phase, whilst the investment markets appear and gather strength.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>High</th>
<th>High-medium</th>
<th>Medium-low with cyclical course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yields</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Investor character</strong></td>
<td>Speculative and opportunity investors</td>
<td>Speculative-Non-speculative, institutional investors by the end</td>
<td>(Non)speculative, institutional, opportunity and private investors</td>
</tr>
<tr>
<td><strong>Liquidity</strong></td>
<td>None</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
<tr>
<td><strong>Transparency</strong></td>
<td>Low-medium</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
<tr>
<td><strong>Sophisticatedness property sector</strong></td>
<td>None</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Property rights and market practice</strong></td>
<td>None</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Importance of the performance of other assets</strong></td>
<td>None</td>
<td>Low-medium</td>
<td>Medium-high</td>
</tr>
</tbody>
</table>

Table 4.3 Characteristics of the property investment market development [Keogh and D'Arcy, Teuben, Klomp, Klomp and Jansen and Jones Lang Lasalle]

With the economy reaching the level of maturity in the third phase, property markets will achieve maturity in this phase as well\(^\text{11}\) (see figure 4.1). In this phase, the property market starts to develop the typical cyclical pattern of rent levels (i.e. the real estate cycle) that characterizes a mature property market. At the same time, property investment yields will gradually show a similar cyclical course as well. These cyclical patterns are related to the earlier mentioned business cycle and the retarding relations between demand and supply interactions. Mueller [1995] studied this phenomenon, which is also known as the pork cycle\(^\text{12}\), and provides a more comprehensive curriculum. A professionalized property profession, a market which disposes over a medium-low grade of flexibility and interaction between demand and supply, declining yield levels, increasing transparency, a growing number of

\(^{11}\) It must however be noted that economies with similar GDP performances do not necessarily have equally developed property markets [Keogh and D'Arcy].

\(^{12}\) The pork cycle refers to the delayed interaction between demand and supply on the commercial space market; as demand increases, property developers will start to develop commercial space. However because of planning procedures, construction time etc. it will take some time for the space to be delivered to the market, meanwhile prices will increase because of scarcity. Once the newly developed space is delivered, most of the demand has already been absorbed by the market and there will be an oversupply of space, consequently resulting in decreasing prices.
investment deals (i.e. liquidity), the ongoing entry of institutional investors, and a widening spectrum of active investor types all contribute to the development of property and investment markets into maturity, characterized by the distinctive cyclical patterns\(^1\). These cyclical patterns are typical results of the aforementioned business cycle and the related pork cycle. The more mature a market is, the higher fluctuations in rental growth will be. This is clearly illustrated when the rental growth rates of the London office market, a market which is considered to be a perfect example of a mature market, and rental growth rates of a less perfectly mature market are examined. Figure 4.5, which plots the annual rental growth rates of London City and Amsterdam, clearly displays more extreme rental growth rates in London than in Amsterdam.

![Rental growth in London City and Amsterdam (1981-2006)](image)

\[\text{Figure 4.5} \quad \text{Annual rental growth rates in London City and Amsterdam [PMA, 2006]}\]

### 4.3 Yield model by Teuben

Whereas the model by Klomp and Jansen has a qualitative character and mainly visualizes the development process of a property market from its challenged starting point to maturity, Teuben [2004], in his study on forecasting total returns on European high street retail properties, produced a

\(^1\) Keogh and D'Arcy argue that there is no evolutionary path to be followed by all property markets and moreover every market requires a specific examination and interpretation. Nonetheless, in general property markets undergo the same development process in broad outlines.
quantitative model for modelling and forecasting the development of property markets. Unlike Klomp and Jansen, Teuben did not make a distinction into different phases of development. By using past developments, Teuben constructed both a rent forecasting model and a yield forecasting model, of which the latter one will be discussed hereafter. Although Teuben used his model to model and forecast returns on the high street segment in the retail sector, Teuben reports that the model should be applicable for modelling and forecasting in other real estate sectors as well.

The yield development model of Teuben, in which the development (i.e. growing maturity) of a property investment market is reflected, splits the actual development of the yields (represented by the dotted orange line in figure 4.2) in a trend development (dark blue line) and a cyclical development (represented by the pale blue line, see figure 4.6). Hereby, the trend development is represented by the logarithmic trend-line calculated from the actual yields. Additionally, the cyclical yield is calculated by subtracting the actual yields from the calculated logarithmic yield trend-line.

![Property investment yield development](image)

**Figure 4.6  Yield model adapted from Teuben [2004]**

The trend hereby represents the structural development of the market and the corresponding yield levels, which are high in the early years of the development of a property investment market, but which will decline as the market continues its development and disposes over a growing maturity. As the market finally reaches maturity, the trend course will flatten out, as yield levels will stabilize within a certain range, and the trend line will become horizontal from a certain point in time. Thus, as
Teuben argues and reflects in his model, the maturing process of a property market is the major reason for the trend development.

Whereas the trend component of the yields is fuelled by structural changes due to the development and growth of the property investment market towards maturity, the **cyclical** yield component is driven by cyclical changes and the supply and demand for property investments. These cyclical drivers are often related to the cyclical pattern of the earlier mentioned business cycle. As they affect the demand and supply of property investments, factors which contain cyclical elements, such as interest rates, yields on government bonds, rental growth expectations, and performances of other assets (e.g. equities) all contribute to a greater or lesser extent to the cyclical pattern of yields.

The model in figure 4.6 suggests that the cyclical element displays a perfect cyclical course from the starting point onwards. This assumption is, however, inconsistent with the earlier discussed property market development process. Among others, Mueller [1995] and Klomp and Jansen argue that a property market will only gradually start to show a cyclical pattern once the market approaches maturity. Consequently, it is not very surprising that Teuben hardly found any clear cyclical patterns in the 42 cities he studied, as quite a number of the studied markets only recently could be regarded as mature markets. Nonetheless, the model’s appropriateness and underlying principles are justified by the model’s “goodness-of-fit” outcomes, as reported by Teuben. In sum, the pale blue line in figure 4.6 will generally show a rather fluctuating course in the early periods, instead of a cyclical course as suggested by the pale blue line, but will gradually exhibit a more recognizable cyclical pattern as the market experiences the development process.

In the following paragraph, drivers will be selected for modelling the trend and cyclical yield elements in the office investments markets in Central Europe.

### 4.4 Selection of drivers;

#### 4.4.1 Introduction

Based on literature on modelling yields and returns on property investments (the development process of property markets, as discussed earlier in this chapter), drivers will be selected for both the trend and cyclical yield elements of the yields on office property investments in the Central European region. As earlier shown in paragraph 3.4, yields are composed of the following three components: risk free rate, risk premium and the expected rental growth. Therefore, the various selected drives will be classified based both on this component breakdown as well as on the anatomized yield element.
4.4.2 Risk free rate

As already briefly mentioned in paragraph 3.4, the yield on long term government bonds is generally used as a proxy for the risk free rate. Consequently, yield and return modelling studies by among others Sivitanides [1998], McGough and Tsolaces [2001], Ling and Naranjo [2002] and Teuben [2004] used yields on long-term government bonds to model yields and returns. Another measure for representing the risk free rate are interest rates, as they are closely related to government bonds. In modelling yields and returns on the Finish office property market, Karakozova [2005] successfully used long-term interest rates as a proxy for the risk free rate. In sum, literature clearly pushes government bond yields and interest rates forward as representatives for the risk free rate. Thus, according to literature, yields on 10 year government bonds or long-term interest rates would be the best measure for the risk free rate.

However, collecting historical time series on government bond yields and long term interest rates is likely to be problematical in the Central European region, as the desired time series are probably unavailable due to a lack of data. According to the Czech National Bank [2006], the first Czech 10 year government bonds were only issued in 2000. Consequently, the likely lack of suitable time series on the initial drivers for the risk free rate will have to be tackled by selecting a second driver for the risk free rate. Therefore, another interest type will be selected in chapter 5, based on the availability of the required time series.

As earlier noted in paragraph 4.2, yields on government bonds and interest rates are closely related to the development of a nation's economy, with yields and interest rates initially being high, but declining and developing into a cyclical pattern as the economy matures. Therefore, both interest rates and government bond yields can be regarded as trend drivers, as well as, cyclical drivers. Consequently, these drivers will be anatomized in a trend element, reflecting the structural development of the economy, and a cyclical element affecting the cyclical yield. The relations of the interest rate as well as the government bond yields with the trend and cyclical yield elements are expected to be positive, meaning that the yield elements will increase when the interest rate elements will show a positive growth.

Additionally, when examining relations between long term government bonds, interest rates, and yields, one must keep in mind that these relations can be lagged by nature. Various studies have shown that property investment yields show a lagged reaction to changing government bond yields or interest rates. Hence, this learning will be taken into account when examining these relations.

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**4 The IMF in Teuben [2004] mentioned using the 10 year government bond as a representative for the risk-free rate as this is regarded to be a representative investment horizon for real estate.**
Selected drivers for risk free rate and their expected relation:

- Government bond yield (+)
- Interest rate (+)

4.4.3 Risk premium

When investing capital in an asset class, an investor will require certain compensation for doing so. This compensation relates to the perceived risk of the respective investment option: the higher the perceived risk on this option, the higher the required risk premium, and vice versa. Determining the required risk premium on any investment is difficult. There is no unambiguous method, since many factors are involved, furthermore, different investors can have different perceptions of risk.

Whereas there is a wide agreement on the determinants and composition of the risk free rate, little agreement and concord is found in literature on the composition of risks associated with property investment and the determination of risk premiums. Numerous studies elaborated on the risks associated with property investments, all providing different classifications for risks and infinite numbers of risks. As a result of their survey on the assessment and management of risk in the property investment industry, the Investment Property Databank (IPD) [2000] mapped the most frequently mentioned risk factors out of a total of over 1,600 different sorts of risk. Given this large number of risks, several classifications have been introduced to create some order in the chaos.

The selected drivers for the risk premium in this paragraph will be classified based on their operational level: macro, meso and micro. However, no drivers will be selected on the micro level as this study focuses on office investments at a market level, consequently micro level risks (i.e. risks at object level) will not be considered, as these can be diversified away[^15].

Macro level

Macro-level risks operate at an (inter)national level and cannot be influenced by the individual investor. Based on a literature review, the following risk factors have been selected on the macro level:

- the contribution of the service sector to the Gross Domestic Product (GDP)
- inflation rates
- unemployment rates
- GDP growth rate
- the performances of equities
- country risk rating

[^15]: According to the Capital Asset Pricing Model (CAPM) theory, risks can be divided into two components: specific and systematic risk. According to this theory, specific risk can be diversified away by diversifying investments over a significant number of assets. Meanwhile the systematic risk cannot be diversified away as it incorporates the risk of the economy and market in general.
According to among others, Teuben [2004] the employment in the service sector is a useful factor as it relates to the development status of an economy and is moreover directly related to the office market. As earlier shown in table 4.2, a more developed economy generally disposes over a stronger service sector (i.e. higher ratio of employment in the service sector). Consequently, as this factor reflects the development process from the challenged phase to maturity, it will be used as a driver for the yield trend. Hereby the relation between the employment in the service sector and the trend yield element is expected to be negative, since a growing employment in the service sector reflects a growing maturity (i.e. declining trend yield).

Like with the contribution of the service sector to the GDP, and as shown in table 4.2, inflation rates are strongly related to the development stage of an economy. Ling and Naranjo [2002], Sivitanides [1998] and De Wit and van Dijk [2003] have all shown the influence of inflation rates on property returns and yields. Unlike the interest rates, the inflation rates will not be split into a trend and cyclical element, since the inflation rates show a much less volatile course as an economy continues its development in comparison to the interest rates and government bonds. The inclination to treat the inflation rates as a mere trend driver may best be illustrated and supported by inflation policies which are often applied by central banks. The European Central Bank (ECB), for example, pursues an active EURIBOR interest rate management to control and maintain price stability which is one of the key matters of its policy. Thus, since the interest rates are used for keeping the inflation rates within a certain range (2 percent in the Euro zone), the interest rates will be much more volatile than the inflation rates. The relations between the cyclical and trend element of yields and the inflation rates are expected to be positive, growing inflation rates are associated with higher perceptions of risk, consequently resulting in increased yield levels.

The GDP growth rate represents the economic growth of a country and is, just like the inflation rate and the strength of the service sector, related to the economic development status of a country (see table 4.2 once again). Projections of future GDP growth rates are particularly interesting for investors, as they give a clue to the prosperity and potential of a country's economic future. Consequently, one would therefore expect property investment yields to be related to GDP growth rates projections (i.e. leading relation).

Logically, the risk of investing in a country with stable and moderate GDP growth projections is considered to be lower compared to investing in a country with projections of volatile economic

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16 "EURIBOR (Euro InterBank Offered Rate) is the benchmark rate of the large Euro money market that has emerged since 1999 and is the rate at which Euro interbank term deposits are offered by one prime bank to another prime bank and is published at 11.00 a.m. CET" [Euribor, 2006]
growth. Both de Wit van Dijk and Karakozova demonstrated the relations between the GDP growth rate and office property investment returns. Additionally, Karazokova found the GDP growth rate to be the strongest explanatory variable on office property investment returns. Thus, the GDP growth rate will be selected as a driver for the cyclical yield due to its cyclical character, at which both leading and non-leading relations will be examined. GDP growth rates are expected to have a negative relation with the cyclical yield element, as a growing GDP growth rate points to strengthening economic conditions, which subsequently justify lower yield levels.

As shown earlier in table 4.2, unemployment rates are, just like the inflation rates and the contribution of the service sector to the GDP, related to the development stage of an economy. Both de Wit and van Dijk and Teuben have shown the relations between unemployment rates and property returns and yields on respectively office investments and retail investments. Although unemployment rates are related to the development stage of an economy, the unemployment rates will not be split in a trend and a cyclical element, as unemployment rates in the former communist CE region do not reflect the 'standard' development pattern, indicated in table 4.2. Consequently, the unemployment rates will be used as a driver for the cyclical yield at which their relation is expected to be positive by nature. Additionally, just like in the case of GDP growth rates, property investment yields are expected to be related to leading unemployment rates. This is expected as unemployment projections, just like GDP growth rates, give a clue on the expected development of the market, which is of a particular concern to investors. Thus, property investment yields will therefore be related to unemployment projections in the ensuing chapters.

Within the investment portfolio, property investments compete with other asset classes such as government bonds and equities. Consequently, an investor will compare the different asset classes in terms of risks and return performances when composing an investment portfolio and allocating capital over the various asset classes in an effort to take optimal benefit of diversification strategies. McGough and Tsolaces, Teuben and Karakozova demonstrated the (lagged) relation between equity performances and property investment returns and yields. As the different nationalities of the investors in the Central European region are wide-ranging, and property investments within their

17 According to Kornai [1992] in Campos and Coricelli [2002], socialist economies like in the CE region were characterized by an excessive demand for labor. Consequently, unemployment rates were artificially low when communism collapsed, but rapidly increased after the collapse of a state controlled economy and the introduction of a market economy.
portfolios compete with other asset classes on a pan-European level, the cyclical yield will be related to a composed pan-European equity return performance index.

When using performances of equities as a driver for property yields, one must understand that return performances of equities are, just like property investment returns, bipartitely composed. On the one hand, by the dividend return, and on the other hand, by the capital growth of the equity. The course of the latter one is generally characterized by cyclical pattern, as a consequence of the business cycle, and, moreover has the strongest impact on the return performance of equities, due to its much stronger volatility. Therefore, the capital growth performance of equities will be used as a driver for the cyclical yield. The relation between the return performances of equities and the cyclical yield is expected to be positive, whether time-lagged or not.

The final driver on macro level is the country risk rating, which reflects the risk attributed to investing in a specific country. As already shown in table 4.2, the country risk rating strongly relates to the development stage of a country and its economy. A country risk rating is composed of different risk factors, for example, political, economical, demographic and financial risk ratings: factors which reflect the structural development of a country [Kevenidis]. Therefore, the country risk rating can serve as a suitable driver for the trend yield. In his study, Teuben successfully used a country risk rating to model his trend yield elements.

The relation between the trend yield element and the country risk rating depends on the construction of the country risk rating index. If a declining country risk corresponds to a lower score on the country risk index, the relation to the trend yield element is expected to be positive. Conversely, the relation is expected to be negative by nature if a declining risk corresponds to a higher score on the country risk rating index.

Meso level

Meso level risks operate at the property market level and are therefore related to the operation of all market parties. Consequently, an individual investor cannot influence the risk factors as these are determined by the operation of the market as a whole. The extent of the office stock and the liquidity of the investment market will be used as risk drivers on the meso level.

The extent of the class A office stock does relate to the development stage of a property market (see table 4.3) and can therefore be used as a driver for the trend yield. Although de Wit and van Dijk [2003] found no significant relation between the extent of the office stock and the returns on office property investments, the extent of the class A office stock will be used in this study, as de Wit and van Dijk studied mature markets. Whilst in mature markets, the class A office stock will generally show
growth as well, this growth will be less 'spectacular' compared to the growth in a market developing from a challenged into a mature one. In such a market, the growth of the office stock will be turbulent and high in the early years and will gradually level off as the market continues its development. Thus, both the extent of the class A office stock and the growth of the class A office stock will be used as a driver for the yield trend element. Hereby, the relation between the trend yield element and the extent of the class A office stock is expected to be negative, and the relation between the growth of the office stock and the trend yield element is expected to be positive by nature. Additionally, one must understand and that the extent of the class A office stock is most likely to be strongly related to the earlier discussed FTE employment in the service sector, since increasing employment in the service sector leads to an augmenting demand for office space and a consequent increase of the office space stock.

A frequently mentioned source of risk on the meso level is the investment market liquidity, with more liquid markets having a lower risk profile as investors will experience fewer difficulties when selling or buying properties. With liquidity being the result of the interaction between demand and supply on the investment market, it consequently constitutes as a valuable driver for the risk premium perceived by investors, since it is related to investors' demands. Like some other risk premium drivers, the liquidity of the investment market is related to the development stage of the market as shown in table 4.4. Due to this relation to the development status of the property market, the office investment market liquidity will be used as a driver for the trend yield element. The investment market liquidity is expected to be negatively related to the trend yield element, meaning that trend yield levels are expected to decline when liquidity increases.

Selected drivers for risk premium and their expected relations:

- Contribution of the service sector to the GDP (-)
- Inflation rates (-)
- GDP growth (-)
- Unemployment rates (+)
- Equity performances (+)
- Country risk rating (+/-)
- Class A office stock (-)
- Growth of the class A office stock (+)
- Liquidity of the office investment market (-)
4.4.4 Expected rental growth

The final component of the yield on property investments is the expected rental growth. Unlike the risk free rate and the risk premium component, yield levels are negatively affected by an increase of the rental growth component. Logically, an investor is willing to pay a lower yield if he expects a future rental growth, as this will have a positive effect on his investment returns. The most obvious driver is selected for the expected rental growth, namely (projections of) rental growth rates.

The importance of rental growth rates on property yields have been demonstrated by Sivitanides, McGough and Tsolaces and Teuben, among others, and can, moreover, theoretically be argued and supported as well. As rental growth rates show a cyclical pattern, which is commonly referred to as the real estate cycle, rental growth rates will be used as the cyclical driver for the expected rental growth. Rental growth rates are expected to be negatively correlated to the cyclical yield element, as an expected rental growth in the future will result in a higher net operating income (NOI) for an investor. Because of the prospect of a growing rental income in the future, investors shall therefore be willing to pay a higher price (i.e. lower yield) and vice versa. Logically, in examining the relations between the cyclical yield elements and rental growth rates, rental growth projections will be used, as the relation is evidently expected to be leading by nature.

Selected driver for the rental growth and its expected relation:

- Rental growth rates (-)

4.5 The trend and cyclical yield models

As shown, the development of property markets is closely related to a country's (macro) economical development process. This process can be divided in three different phases: challenged, emerging and mature, which all have their own characteristics in terms of economical performances and office space and investment market characteristics. Together with findings from earlier studies, characteristics have been selected from this development process to serve as drivers for modeling yields on the office investment markets in Central and Eastern Europe. The yield model as introduced by Teuben, which divides yields in a trend and cyclical element, will be used for the yield modeling and forecasting. The various selected drivers have been classified as a trend driver, consequently representing the structural development of the market from a challenged starting point to maturity, or as a cyclical driver, which reflects the cyclical character of the market. As some of the selected drivers both entail
cyclical and trend elements, these drivers will be split in a cyclical and a trend element. In sum this results in the following expressions of the trend and cyclical yield element and their drivers.

\[
\text{Trend yield}_{c,t} = f \left( \begin{array}{c} (-) \text{ FTE employment in the service sector}_{n,t}, (+) \text{ Inflation rates}_{n,t}, (+/-) \text{ Country risk}_{n,t}, (-) \text{ Office stock}_{c,t}, (+) \text{ Growth of the class A office stock}_{c,t}, (-) \text{ Liquidity}_{c,t}, (+) \text{ Government bond yield}_{n,t}, (+) \text{ Interest rates}_{n,t} \end{array} \right)
\]

\[
\text{Cyclical yield}_{c,t} = f \left( \begin{array}{c} (-) \text{ GDP growth}_{n,t}, (+) \text{ Unemployment}_{n,t}, (+) \text{ Equity performance}_{se,t}, (-) \text{ Rental growth}_{c,t}, (+) \text{ Government bond yield}_{n,t}, (+) \text{ Interest rates}_{n,t} \end{array} \right)
\]

Subscripts:
- \(c\) city
- \(t\) time
- \(n\) national
- \(e\) European

The following figure provides an overview of the selected drivers per yield component (i.e. risk premium, rental growth and risk free rate) and element (i.e. trend and cyclical), with the expected relations in brackets.

*Figure 4.7 Yield components and their cyclical and trend drivers*
Part II: Data collection and modeling

Chapter 5: Data collection and analyses
Chapter 6: Statistical analyses and modeling
Data collection and analysis

5.1 Introduction

In the previous chapters, the trend and cyclical yield element have been introduced and accompanying drivers for both elements have been selected. Subsequently, this chapter discusses the collection of data for each of the different drivers, as well as, the selected data source for the office property investment yields themselves. Additionally, the selection for the individual drivers will be justified by demonstrating either the trend or cyclical character of the various drivers, and data characteristics will, if possible, be related to the earlier discussed property market development process characteristics.

5.2 Availability, reliability and uniformity

When collecting data for any research, the availability, reliability and uniformity of data are of a major importance since the quality of data can have a significant influence on the research results [De Heus et al., 2003]. Especially in the formerly communist nations of the Czech Republic, Hungary and Poland the availability, reliability and uniformity of data can be problematical and are therefore a point of particular attention according to among others Adair et al. [2004].

The availability of historical data can be a considerable obstacle when gathering data for the Czech Republic, Hungary and Poland especially when it concerns historical data prior to the communism collapse in the early 1990s. Historical macro economical data prior to 1990 is, for example, not available as this data was closely guarded by the communist governments, who considered the data to be strictly confidential. Furthermore, should there be any data available prior to 1990, the reliability of this data is seriously to be questioned as communist governments did not have a strong reputation on taking the provision of national statistics serious. Additionally, as for the property market data, availability is an issue as well, as conventional commercial property markets did not exist prior to the
communism collapse. Consequently, because of the radical changes in economic structures and market principles and operations in the early 1990s, the availability and reliability of data in the early 1990s is doubtful. Finally, the uniformity of data is a point of interest as outcomes can be affected when data from different sources with different definitions is used.

Because of the reliability and limitations in the availability of data in the early 1990s, data since 1993 will be used for the distinguished drivers. Furthermore, the lack of data uniformity will be tackled by using data from one single source per driver for each of the individual countries.

5.3 Trend and cyclical yield elements

5.3.1 Introduction

According to Teuben's methodology, as introduced and discussed in the previous chapter, the actual, historical office investment yields of Prague's, Budapest's and Warsaw's office investment market will have to be anatomized and analyzed in this paragraph.

5.3.2 Yield data source

Various sources could be selected for the historical, actual yields in the office investment markets of Prague, Budapest and Warsaw. Real estate advisors and brokers such as Cushman & Wakefield, CBRE, Jones Lang Lasalle, DTZ and Colliers have been active in the CE property markets since their emergence in the early 1990s and provide data on office investment yields. However, not all parties have been active in the market since the early 1990s, consequently there is no single party that covers all markets (i.e. Prague, Budapest and Warsaw) in the required period. Moreover, different parties may use different definitions and standards for determining and reporting office investment yields. To circumvent the problems of the required time series length and data uniformity, data provided by the Property Market Analysis (PMA) Office Investment Forecast database will be used for determining the trend and cyclical yield elements, as PMA databases provide the required time series for the three CE property investment markets on a uniform base.

5.3.3 Trend and cyclical yield elements in Prague, Budapest and Warsaw

As earlier discussed in the previous chapter, the trend yield element is represented by the logarithmic trend line of the actual yields, at which the residual forms the cyclical yield element. In the following

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18 PMA databases are composed by combining data and information as provided by market parties (e.g. brokers and consultants) at which the data is purified and made uniform.
figures, the actual yields and the trend and cyclical yield elements of Prague, Budapest and Warsaw respectively are presented.

Prague

Combining the actual yields in Prague's office investment markets with its anatomized yield elements (i.e. trend and cyclical yield element) results in the following figure. When interpreting this figure, one must keep in mind that the drawn lines are interpolated lines. Since annual yield data is used, the intervening values are obtained by simply connecting the values two successive years. Consequently, the plotted lines don’t necessarily reflect the actual course.\(^{19}\)

![Prague office yields and yield elements (1993 - 2006)](image)

The trend yield element for Prague obviously shows a similar course compared to the trend yield line as introduced in the yield model by Teuben, with a strong declining course in the first years and a flattening course as the market continues its development. The plotted formula in figure 5.1 describes the calculated logarithmic trend yield line at which the coefficient \((-2.25)\) is related to the steepness of the line, i.e. the higher the coefficient, the steeper the trend line will be. In addition, the annual value of the trend yield can be obtained by calculating the natural logarithm of the annual \(x\)-value (for example, 1993 = 1, 1994 = 2 etc.), multiplying this outcome by \(-2.25\) and adding 12.75.

\(^{19}\)The issue of interpolation also applies for any other graphs as discussed in this thesis.
The course of the cyclical yield element is not as evident as in the model, and it is hard to discover a clear cyclical pattern in the pale blue line. Though, the strong downward move since 2003 has the appearance of a cyclical course and might be the starting point of a coming cyclical pattern, indicating a growing maturity. The absence of a clear cyclical pattern is not surprising, as it is in line with the findings by Teuben, who found only a few clear cyclical patterns in the 42 cities which he studied.

Budapest

The following figures plots the actual, historical office investment yields in Budapest, as well as, the calculated trend and cyclical yield elements.

Budapest office yields and yield elements (1993 - 2006)

Like in Prague, the trend yield element in Budapest clearly corresponds with the yield element by the model. Compared to Prague, Budapest's trend yield element has a stronger declining course, which may indicate a more rapid market development in Budapest. The stronger declining course of the trend line course is reflected in a higher absolute value of the trend line's coefficient.

It must however be noted that one must pay circumspection when comparing the different trend yield lines as yield levels in the early years of the market development were either theoretically argued or based on only very few known transactions and may therefore lead to a distorted view.
Additionally, in line with Teuben's findings, the cyclical yield does not have the clear cyclical character. Furthermore, just like in Prague, a more distinct cyclical character appears to emerge around 2003 when a strong downward move of the cyclical yield is perceptible.

**Warsaw**

Figure 5.3 plots both the historical actual yields in Warsaw's office investment market since 1993 and its anatomized yield elements.

![Warsaw office yields and trend and cyclical yield elements](image)

Once again the course of the trend yield element corresponds to the model, hereby underlining the development of the market towards maturity. Of all three cities, Warsaw has the strongest declining trend yield line (i.e. highest coefficient value), which may indicate a more rapid development in comparison to the other cities. Though, the earlier made annotations must be kept in mind.

Furthermore, the cyclical yield element once again does not show the perfect cyclical development as in Teuben's theoretical model. Nonetheless, some cyclical movement can be detected, and like in Prague and Budapest, a downward move in the cyclical yield over the past few years may indicate the origin of a cyclical pattern and a corresponding growing maturity.
5.4 Trend yield drivers

5.4.1 Introduction
In the previous chapter, eight drivers have been selected as drivers for the trend yield element. Successively, the selected data sources and the character of these drivers, by means of a visual expression, will be discussed hereafter. Furthermore, the drivers will be related to the property market model by Klomp and Jansen.

5.4.2 Selected trend yield drivers
The following eight drivers will be discussed in this paragraph: government bond yields, interest rates, FTE employment in the service sector, actual inflation rates, country risk rating, class A office stock, growth of the class A office stock, and the office investment market liquidity. The following table provides an overview of the used data sources for the eight selected trend yield drivers.

<table>
<thead>
<tr>
<th>Trend yield drivers</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government bond yields</td>
<td>Not available</td>
</tr>
<tr>
<td>Interest rates (trend element)</td>
<td>OECD Database (adapted from)</td>
</tr>
<tr>
<td>FTE employment in the service sector</td>
<td>Experian Regional Database</td>
</tr>
<tr>
<td>Actual inflation rates</td>
<td>PMA Office Occupier Forecast Database</td>
</tr>
<tr>
<td>Country risk rating</td>
<td>Economist Intelligence Unit</td>
</tr>
<tr>
<td>Extent of the class A office stock</td>
<td>PMA Office Occupier Forecast Database</td>
</tr>
<tr>
<td>Growth of the class A office stock</td>
<td>PMA Office Occupier Forecast Database</td>
</tr>
<tr>
<td>Office investment market liquidity</td>
<td>ING REIM CEE Investor Database</td>
</tr>
</tbody>
</table>

Table 5.1 Selected trend yield drivers and data sources

Government bond yields
The earlier expressed fear concerning the lack of useful time series on government bond yields turned out to be correct, since the available time series on government bond yields are too short to be taken into account in this study. Even in the most extensive financial databases, such as Bloomberg and Reuters, the longest available time series on Central European government bond yields only go back to 1999. Consequently, the government bond yield will not be used as a trend, nor as a cyclical driver within this study.
Interest rates

The actual 3-months short term interest rates, subtracted from the Organization for Economic Co-operation and Development (OECD) database are used for computing the trend lines of the interest rates.

Trendlines ST interest rates and actual (A) rates (1993 - 2006)

As can be seen in figure 5.4, the actual short term interest rates in the Central European countries (dotted lines) do dispose of the expected pattern, and, consequently do their calculated trend yield lines dispose of this pattern as well. Whereas extremely high interest rates (for example 39.5 percent in Poland in 1993 and 32.04 percent in Hungary in 1995) were recorded in the challenged phase of the economies, less volatile and much lower interest rates were recorded by the end of the millennium as the Central European economies continued their development towards maturity.

When comparing the interest rates between the individual countries, it must be noted that the Czech interest rates have constantly been lower than their Hungarian and Polish counterparts, thereby indicating that the Czech economy is more robust and less volatile in its performances in comparison to the Hungarian and Polish economies. However, like the other economies, the Czech economy experienced a recession as well, which is clearly reflected in the interest rates in 1997 and 1998. In sum, the selection of the short term interest rates as a trend yield driver seems to be supported by the actual short term interest rates and their corresponding trend lines.
**FTE employment in the service sector**

Experian's^{21} Regional database is used for collecting data on the full time equivalent (FTE) employment in the service sector.

![FTE employment in the service sector (1993 - 2006)](image)

Figure 5.5 reflects the structural development of the CE economies with strengthening positions of the service sector, which is in line with the characteristics as uttered in table 4.2. Furthermore, the persistently, non-cyclical upward trend of all three lines justifies the selection to use the unemployment rate in the service sector as a trend driver. Albeit, all three countries experience the same development, significant differences can be seen in figure 5.5. The traditionally, industrial and agricultural orientation of the Czech Republic's and Poland's economies, results in lower employment rates in the service sector compared to the traditionally more service orientated Hungarian economy.

Although the CE countries have made considerable progress in transforming their economies, there is still quite a long way to go to attain the 75-80 percent employment rates in the service sector that can be found in Western European countries such as The Netherlands and the UK.

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^{21} Experian is a global provider of information databases including for example macroeconomic, business, life style and credit rating information.
**Actual inflation rates**

The PMA Office Occupier Forecast database [2006b] is used for collecting data on the inflation rates in the Central European countries.

![Actual inflation rates (1993-2006)](image)

**Figure 5.6 Actual inflation rates of the Czech Republic, Hungary and Poland [PMA, 2006b]**

The actual inflation rates, as expressed in figure 5.6, do reflect the structural economic development from a challenged starting point towards maturity, with the characteristic very high inflation rates in the early 1990s and decreasing inflation rates as time goes by and the economies continue their development. Based on the characteristics per development stage and the actual inflation rates, a broad division of the three phases of economic development is represented by the dotted circles in figure 5.6. When comparing the courses of the plotted inflation lines in figure 5.6 to the courses of the interest rate lines in figure 5.4, both drivers turn out to have a very similar course. This course is explainable since both drivers are generally very closely related, as earlier noted in paragraph 4.4. Although, all three countries experience the same development of the inflation rates, differences are found among the CE countries. At first, the steepness of the individual lines significantly differs and moreover the lines of the Hungarian and Polish inflation rates are much steeper than their trend yield lines. Furthermore, whereas the inflation rates in the Czech Republic and Poland have been very similar over the past five years, the inflation rates in Hungary have been structurally higher in this period as they were generally twice as high. These structurally higher inflation rates indicate that the Hungarian economy is weaker and less robust than its Czech and Polish counterparts.
Country risk rating

The country risk rating provided by the Economist Intelligence Unit\(^{22}\) (EIU) has been selected as the data source for this trend driver at which a lower rating corresponds with a lower perception of risk.

EIU country risk ratings (1993 - 2006)

![EIU country risk ratings graph](image)

Figure 5.7  Country risk ratings for the Czech Republic, Hungary and Poland [EIU, 2006]

Unfortunately, the time series only start in 1996. Consequently, no data is available for the period 1993-1995. According to the findings in the previous chapter, perceptions of risk will gradually lower as a country and its economy experience progressive development. As can be seen in figure 5.7, it is hard to discern structural downward developments in the country risk ratings. When the individual countries are compared, differences can be found. Whereas the Hungarian country risk rating displays the strongest downward development, Poland’s risk rating is more or less constant within a certain range. Overall, the Czech Republic has the best score, apart from the rapid deterioration in 1996-1997 as a result of a temporary economic recession. In sum it is hard to detect a general development which squares with the theoretically assumed development pattern.

Extent of the class A office stock

Data provided by the PMA Office Occupier Forecast database is used for the collection of data on the extent of the class A office stock in the Central European capital cities. Like with the yield data, broker

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\(^{22}\) The Economist Intelligence Unit is a research and advisory company providing country, industry and management analysis on a worldwide basis.
information could be used for this driver. However, because of the earlier argued motives, the PMA Office Occupier Forecast database is selected.

![Extent of the class A office stock (1993 - 2006)](image)

Figure 5.8 The extent of the class A office stock in Prague, Budapest and Warsaw [PMA, 2006b]

As expected, and in line with the property market development process, the cities' office stocks have exploded since 1993. The total class combined A office stock in Prague, Budapest and Warsaw grew from an estimated 358,000 square meters in 1993 to 6,039,000 square meter by the end of 2006. This structural development underlines the trend character of this driver and thereby supports the selection to look upon this driver as a trend driver.

When the office stock rates of the individual cities are compared, the different course of the Warsaw office stock attracts attention due to its different pattern compared to the similar growth pattern of Prague and Budapest. Whereas Prague and Budapest show a more or less linear growth pattern, Warsaw's office stock growth is almost flat until 1998 and than rapidly accelerates and overtakes Prague and Budapest. Logically, because of the much bigger size of Poland, and its capital Warsaw, in terms of population, the extent of the office stock is much higher than in Prague and Budapest, which are virtually equal in size. However when the number of square meters office space per inhabitant of the individual cities is calculated, Prague's and Warsaw's figures are similar (1.48 sq meter per inhabitant), while Budapest records 1.05 sq meter per inhabitant, indicating a trailing development in the Hungarian capital. In a wider perspective, all three CE cities have a considerable arrear as Western European cities like Amsterdam and Vienna record 7.75 and 5.70 sq meter per inhabitant respectively, as of year end 2006.
Growth rates of the class A office stock

The relative growth of the class A office stocks in Prague, Budapest and Warsaw has been calculated based on the office stock data provided by the PMA Office Occupier database.

![Growth rates of the class A office stock (1993 - 2006)](image)

Figure 5.9  Growth rates of the extent of the class A office stock [PMA, 2006b]

As can be seen in figure 5.9, the expected declining course of the growth rates is clearly present in the case of Prague with a rapidly declining growth as the office market experiences its development towards maturity. Whereas the expected pattern is clearly recognizable in Prague, it is less apparent in both Budapest and Warsaw. To gain a better image of the growth patterns in Budapest and Warsaw, an additional figure is created, dropping Prague's excessive growth in 1993.
Figure 5.10 provides a better insight in the growth of the office stocks in both Budapest and Warsaw. While the expected growth pattern is more or less present in Budapest, Warsaw's growth rate pattern is substantially different and does not really match the expected growth pattern. All in all, the graphical expressions of the growth rates suggest that the growth rates of the class A office stock may be a useful driver, though the statistical analyses in the following chapter will give a decisive answer.

Office investment market liquidity

Data extracted from the ING Real Estate Investment Management CEE Investor database\(^2\) is used as the data source for measuring the liquidity of the office investment markets in Prague, Budapest and Warsaw.

\(^2\) The ING REIM CEE Investors database covers all known and retrieved property investment transactions and related information (buyer, seller, size, yield, main tenant(s), location etc.) in the Central and Eastern European region.
Office investment market liquidity (1993 - 2006)

The investment market liquidity is measured by the annual percentage of traded office stock in square meters. As the Central European region experienced a strong yield compression in the studied period, the annual volumes of traded square meters are used as a measure instead of the more commonly used capital flow measure, as the latter one is more sensitive for yield compression. Furthermore, by relating the annual liquidity to the extent of the office stock, possible side effects of the rapidly growing office stocks are tackled.

According to the findings of chapter 4, liquidity increases as markets develop themselves from a challenged starting point towards maturity. Consequently, one would expect an upward tendency in the liquidity of the office investment markets of the CE capital cities. As can be seen in figure 5.11, the liquidity of Warsaw’s and Prague’s markets dispose over the expected development pattern, whilst the expected pattern is hardly recognizable Budapest’s market. Additionally, the figures refute an earlier expressed fear by Adair et al. (1999), who concluded their study by expressing their fear for lack of large scale investments in the Central European region, which they considered to be essential for further development. Since the cumulative liquidity of the three individual markets clearly displays an upward course this fear is evidently rejected.

When taking a narrower look on figure 5.11, Budapest’s high liquidity during 1999-2001 and extremely low liquidity in 2002 as well as the rapid growth of the liquidity since 2004 is striking. A more profound examination of the database reveals that the 1999-2001 liquidity rates were distorted by some voluminous portfolio deals. The rapid growth since 2004 is explained by the 2004 EU entries.

Prior to the Czech Republic’s, Hungary’s and Poland’s 2004 EU accession, many (institutional)
investors were unable to invest in the Central European region due to restrictive conditions in their statutes, which prohibited property investments in non-EU member countries. Consequently, as a result of these 2004 entries many new investors, driven by a chase for property investments entered the market, subsequently boosting liquidity and contributing to the ongoing development.

5.5 Cyclical yield drivers

5.5.1 Introduction
Like for the trend yield element drivers, the selected cyclical yield element drivers will be discussed in this paragraph, at which their data source, their cyclical character, as well as, the relation with the property market development model and its characteristics will be discussed.

5.5.2 Selected cyclical yield drivers
The following cyclical yield drivers will be discussed in this paragraph: GDP growth, unemployment, equity performances, rental growth rates, and the cyclical element of the short term interest rates. Table 5.2 provides an overview of the selected data sources of the various cyclical yield drivers.

<table>
<thead>
<tr>
<th>GDP growth rates</th>
<th>Experian Regional Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rates</td>
<td>Experian Regional Database</td>
</tr>
<tr>
<td>Equity performances</td>
<td>Various</td>
</tr>
<tr>
<td>Rental growth rates</td>
<td>PMA Office Occupier Forecast Database</td>
</tr>
<tr>
<td>Cyclical element of interest rates</td>
<td>OECD Database (adapted from)</td>
</tr>
</tbody>
</table>

Table 5.2 Selected trend yield drivers and data sources

GDP growth
Data subtracted from the previously quoted Experian Regional Database will be used for this cyclical yield driver.
As can be seen in figure 5.12, the courses of the GDP growth rates in the Czech Republic, Hungary and Poland display a volatile and cyclical course over the period 1993-2006, thereby supporting the selection of this driver as a cyclical driver.

The turbulent economic development which the Central European region experienced since the 1990 Soviet and communism collapse, and the subsequent economic and political transformations is reflected by the high growth rates in Poland in the mid 1990s and the Czech recession during 1997-1998. Meanwhile the Hungarian economy recorded a more stable and constant growth, albeit the economic scandal which leaked out in September 2006 raises questions on the reliability and credibility of these growth figures. As of 2000, the individual Central European GDP growth rates exhibit more and more coherence, and seem to develop a more regular pattern as the economies are strengthening their maturity and will increasingly be affected by the business cycle phenomenon.

For additional understanding, studies by Campos and Coricelli [2002] and Kornai [2006] hand more profound insight into the economic and political transition processes in the Central and Eastern European region.

In a leaked recording of an MSZP meeting, Hungary's Prime minister Gyurcsány admitted that he had been lying about the country's economical conditions in an effort to win the April 2006 elections. It turned out that the country's economic conditions is much worse than expected which lead to a strong devaluation of the Hungarian forint (HUF) and riots. In an effort to recover and reinforce the Hungarian economy, taxes were raised by the government.
Even though, the CE economies can be considered as mature economies, their GDP growth rates (projections) are still considerably higher than GDP growth rates (projections) in fellow EU members. Consequently, the Central European region disposes of a more prosperous economic growth potential in comparison to for example the UK, Germany, France and The Netherlands and will therefore remain an attractive investment region.

**Unemployment**

Once again the Experian database is used for subtracting data for a cyclical driver. Whilst other cyclical drivers, such as the GDP growth rate and the cyclical element of the inflation rates display quite a clear cyclical pattern, cyclicality is less apparent in the unemployment rates, as can be seen in figure 5.13. In comparison to the other cyclical drivers, the courses of the unemployment rates are less volatile, though some upward and downward movement is present.

![Unemployment rates](image)

*Figure 5.13 Unemployment rates in the Czech Republic, Hungary and Poland [Experian, 2006]*

As figure 5.13 reveals, significant differences can be found when the individual countries are compared. In comparison to its Czech and Hungarian counterparts, the Polish unemployment rates are extremely high and almost twice as high as the unemployment rates in the Czech Republic and Hungary over the past six years. Except for Hungary, the unemployment rates do not display the development pattern as introduced in table 4.2, with declining unemployment rates as the economy continues its development. These irregular patterns of the unemployment rates may be related to the earlier made annotation concerning the influence of the socialist employment structures (see
paragraph 4.4.2). Despite these objections regarding the usefulness of this driver, the driver will be used at which the statistical analysis will give a decisive answer on the usefulness of this specific driver.

**Equity performances**

Based on capital growth performances of a number of European stock markets, an index reflecting the capital growth performances of equity investment on a pan-European level has been composed and will be used as a cyclical driver.

![Capital growth of equities (1993 = 0)](image)

**Figure 5.14**  *Capital growth performances of equities on a pan-European level* [Adapted from Yahoo Finance, 2006]

The performances of six European stock markets (United Kingdom, France, Germany, The Netherlands, Belgium and Austria) have been used to create a weighted pan-European index, at which the weights are related to the population size of these countries. For additional understanding, Appendix II provides an overview of the performances of these various stock markets. As can be seen in figure 5.14, the course of this driver is clearly cyclical, consequently supporting the selection of this driver as a cyclical driver.

**Rental growth rates**

Annual rental growth rates extracted from the PMA Office Occupier Forecast [2006b] database are used for this driver. As can be seen in figure 5.15, rental growth rates have continuously been either
negative or zero in the period 1993-2004 and have only recently shown a development towards positive growth, thereby indicating the development from scarcity and high flexibility driven rents to more pork-cycle (i.e. less flexibility and interaction) driven and cyclical rents. Albeit, positive rental growth is virtually absent, cyclical patterns can very well be described, thereby supporting the selection of this driver as a cyclical driver.

![Annual prime rental growth rates (1993 - 2006)](image)

The figures clearly indicate that the 1990s rental levels had been unnaturally high, and rapidly declined as supply could rapidly respond to growing demand due to a large pipeline stock and a lack of planning procedures, spatial restrictions etc. Despite rental growth being negative as of 2001, rental growth figures stabilized and hardly suffered from the economic recession which affected Western European economies in the early years of the second millennium. Meanwhile governments strengthened their planning procedures and building permit regulations, causing flexibility and interaction to moderate. As a result of the growing regulation, rents started to be more and more affected by the pork-cycle phenomenon and are starting to show positive growth.

Albeit the rental growth shows an upward development with positive rental growth, market parties generally assume that the fluctuations in the Central European rental growth rates will be rather moderate, as the markets still dispose of a rather strong, but declining, flexibility. The Prague office
market for example, disposes over a large pipeline stock\textsuperscript{26} of office space (completed with building permits) waiting for demand and pre-leases. As planning procedures and building periods in the Czech Republic are rather short in comparison to mature markets, supply and demand are very elastic. This elasticity enables property developers to react rapidly to increasing demand levels in the Prague office market by building their pipeline stock premises in a short period, as a result of which rental growth rates will be rather flat.

When comparing the individual cities, Budapest's office property market displays the lowest volatility in rental growth rates and lowest decline in rents in comparison to Prague and Warsaw. Whereas Budapest's class A office rents fell by 5.0 percent in 1999, their Prague and Warsaw counterparts fell by 11.1 and 13.9 percent respectively.

**Cyclical element of the short term interest rates**

Like with the cyclical inflation figures, the plotted cyclical elements of the interest rates are calculated by subtracting the actual interest rates from the calculated trend lines. The resulting cyclical residual disposes over a cyclical course, although the courses are not equally evident for all three countries. Furthermore, as can be seen in the figure, the volatility of the cyclical interest rates flattened out as the economies continued their development and sowed their wild oats.

![Cyclical short term interest rates (1993 - 2006)](image)

*Figure 5.16  Cyclical short term interest rates in the Czech Republic, Hungary and Poland [OECD, 2006]*

\textsuperscript{26} According to among others PMA [2006] the current pipeline stock in Prague is significant, and within this pipeline stock the level of speculative developments has declined over the past years.
When comparing the courses of the individual cyclical interest rates, differences can be found among the three countries. Whereas, for example, the cyclical interest rates in the Czech Republic rapidly grew since 1994 as the country fell into a brief recession, the cyclical interest rates in Hungary displayed a declining course as the country recovered from its early 1990s recession. Since 2002 the courses of the cyclical interest rates have shown a more similar a less volatile course, thereby underlining their growing maturity.

### 5.6 Conclusions

This chapter discussed data related to yields on office investments in Prague, Budapest and Warsaw, their dissected elements (i.e. trend and cyclical yields) and, the earlier introduced trend and cyclical yield drivers as well as their relations to the property market development models which were introduced in the previous chapter.

For each of the individual cities it is hard to descry a cyclical pattern in the calculated cyclical yields, which is, however, in line with earlier findings of Teuben. Nonetheless, based on the earlier handed characteristics of the various selected drivers per development phase, a broad division in the different phases could be made. Furthermore, all three cities dispose of the expected course of the trend yield line, although differences are found in the individual trend yield lines, at which Budapest's and Warsaw's cyclical trend yield lines are steeper than their Prague counterpart. One must, however, be careful in addressing any hasty conclusions to these findings because of the data reliability in the early years of the time series. Albeit most of the selected drivers do dispose of the expected development pattern, thereby supporting the selection of the driver as either a trend or cyclical driver, some of the selected drivers lack the expected characteristics.

In the following chapter, statistical analyses will be carried out to determine whether the assumed relations between the trend and cyclical yield and their respective drivers can be traced in the collected and just discussed data.
6.1 Introduction

Contiguous to the theoretical explanation and construction of the yield model, the selection of suitable drivers in chapter four, and the data collection and discussion in the previous chapter, this chapter examines the statistical analysis of the collected data and expected relations. By means of statistical analyses the existence of the expected relations, as well as, the usefulness of the various selected trend and cyclical drivers will be examined. The chapter will conclude by answering the question to what extent the yield developments in the Central European countries can be modeled by using the selected drivers, and will instigate to a forecast of the office investment yields in Prague, Budapest and Warsaw.

6.2 Steps to be taken

To meet this study's objective and finally construct a yield forecasting model for the individual office property investment markets in Prague, Budapest and Warsaw, based on the previously selected drivers, a number of steps will have to be taken and several statistical analyses will have to be conducted.

The first step of the statistical analysis consists of calculating correlations between the different yield elements and the various selected drivers. Contiguously, the second step will be the interpretation of these correlations in order to determine the usefulness of the selected drivers. Subsequently, based on the outcomes of the correlation analysis, a number of drivers will be selected for modeling the trend and cyclical yield element by using regression techniques. Based on the outcomes of these regression analyses the definite drivers for modeling the trend and cyclical yield elements of the individual cities will be selected. Consequently, for each of the individual office investment markets a yield model can be composed by combining the trend and cyclical yield models.
For determining the accuracy of the composed yield models, a goodness of fit measure relating the yields calculated by the yield model and the actual yields will be calculated. Finally, by using the composed yield models and the collected datasets for the various drivers, forecasts for the yield levels in the office investment markets of Prague, Budapest and Warsaw can be made in the ensuing chapter.

### 6.3 Parametric and non parametric statistics

When conducting statistical analyses one must understand that statistical techniques can be divided into two branches, namely parametric and non parametric statistics. Whether to apply parametrical or non parametrical techniques when conducting a statistical analysis on a data set depends on the distribution of the various variables and the number of observations.

Non parametric statistics differ from parametric statistics as parametric statistics assumes that the distributions of the variables being assessed are characterized as probability distributions whereas non parametric statistics makes no specific assumptions about the distribution of the variables being assessed [Slotboom, 2001]. For example, the Pearson product-moment correlation coefficient, being a parametric statistical test, assumes that the variables are normally distributed. Consequently, non parametric tests have less power and are less robust\(^2\) in comparison to parametric statistical tests. As non parametric statistics is less powerful and robust, using parametric statistics will generally be preferred. However, applying parametric statistics in case of small data sets can be questioned as the reliability of the statistical tests is negatively affected by the small size of the data sets.

The general criterion for applying parametric statistics is that for applying parametric statistics, the variables should be normally distributed or the number of observations per variable needs to be 30 or higher. Hence, these conditions will have to be taken into account in the following sections.

### 6.4 Correlation analysis

#### 6.4.1 Introduction

To determine whether the presumed relations between the trend and cyclical yield elements and their respective drivers, as uttered in the previous chapter, can be found in the Central European office investment markets, a correlation is conducted. These analyses will be discussed in this paragraph.

\(^2\) Many of the traditional parametric tests are rather robust, meaning that the tests are impervious for departures from the underlying assumptions [Slotboom]
6.4.2 Correlation

Because of the available time series being rather short, a non parametric statistical test has been selected to find out whether the theoretically expected relations as expressed in the chapter four can be retrieved in the collected data sets. To examine the presence of these theoretically expected relations, Spearman's rank correlation coefficients\(^28\) will be calculated and interpreted. Accordingly, the outcomes will be used to determine whether a specific trend or cyclical yield driver will be used in the further statistical analyses.

By using SPSS\(^29\), correlations between two variables can be calculated at which the absolute value of the correlation coefficient is related to the strength of the relation and the sign of the coefficient (i.e. a positive or negative value) is related to the direction of the computed relation. A positive relation between two variables implies that once the rank of variable \(x\) increases, the rank of \(y\) will increase as well and vice versa. Conversely, a negative relation implies that once the rank of variable \(x\) increases, the rank of variable \(y\) will decrease and vice versa. Additionally, the higher the absolute value of the correlation coefficient, the more closely two variables will be related (i.e. keep up with one another). On the contrary, the more the correlation coefficient approaches zero, the weaker the relation will be.

Next to the (absolute) value, the significance of a retrieved relation is of a major importance as it indicates whether the relation found in the observed sample has occurred by chance or not. To determine whether a relation has occurred by mere chance or not, a statistical hypothesis test is performed, at which the null hypothesis assumes that there is no relation. Significance is represented by the so-called p-value. Subsequently, this p-value will have to be compared to the specified significance level (alpha; \(\alpha\)). Within real estate studies, popular levels of significance are 0.1 (10%), 0.05 (5%) and 0.01 (1%). When conducting statistical analyses, different significance levels can be chosen, at which a lower pre-specified level of significance corresponds to more stern conditions\(^30\). Within this study, the 5% significance level will be applied.

To determine whether the null hypothesis is rejected or not, the correlation’s p-value will be related to the specified \(\alpha\)-value. If the significance test results in a lower p-value than the \(\alpha\)-value, the null hypothesis is rejected, meaning that the results are statistically significant given the pre-specified level of significance, and no result of mere chance. Consequently, in the case of a correlation analysis, the

\(^{28}\) In contrast to the frequently used parametric Pearson's correlation coefficient test, which assumes that relations between the variables being examined are linear and normally distributed, the non parametric Spearman's rank correlation coefficient test does not require linearity or a normal distribution.

\(^{29}\) SPSS is a software application for statistical data analysis.

\(^{30}\) Roughly speaking, a 10% significance level implies that there is a 10% chance that the relation occurred as a result of mere chance; likewise a 5% level implies that there is a 5% chance that the relation occurred as a result of sheer chance.
rejection of the null hypothesis means that the relation between two different variables is significant and thus no result of sheer chance. As noted earlier, the smaller the p-value and used significance level, the more significant the result is said to be. By way of illustration, the following table provides some examples of fictitious (in)significant relations based on pre-specified α-levels at which the significant correlations are printed bold.

<table>
<thead>
<tr>
<th></th>
<th>x,y</th>
<th>0.1</th>
<th>0.751</th>
<th>0.036</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x,z</td>
<td>0.1</td>
<td>0.306</td>
<td>0.268</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>y,z</td>
<td>0.05</td>
<td>0.015</td>
<td>0.711</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>y,v</td>
<td>0.05</td>
<td>0.895</td>
<td>0.018</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>y,v</td>
<td>0.01</td>
<td>0.895</td>
<td>0.018</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>x,v</td>
<td>0.01</td>
<td>0.976</td>
<td>0.007</td>
<td>Y</td>
</tr>
</tbody>
</table>

Table 6.1 Examples of (in) significant correlations

Finally, one must understand that the presence of a significant correlation between two variables only means that there is a statistical relation between these two variables, and that it does not necessarily imply that it is a matter of causality.31

6.4.3 Correlations of the trend drivers and the trend yield

The collected data sets for the different trend drivers have been assembled in three separate SPSS data files containing all drivers, as well as, the calculated trend yield data for each of the individual markets. Subsequently, a correlation analysis has been conducted, of which the correlation coefficients and the corresponding significance levels are plotted in table 6.2.

Since a correlation analysis is meant for expressing relations between two series of data, it is not usable for analyzing relations between mathematically generated trend lines. As trend lines values are formed by a mathematical equation, a correlation analysis would relate two mathematical equations, which is senseless and the outcome would not have any meaning. Consequently, no correlations have been computed between the trend elements of the interest rates and the trend yield elements. Despite the interest rates not being taken into account on the correlation analysis, they will further on be used in the regression analyses.

31 Causality means that there is a relation between a cause and a resulting effect. To determine whether a relation is causal, conducting a regression analysis can be useful.
Finally, when interpreting the correlation coefficients, one must be a little distant, since the value of the correlation coefficients can be distorted as the time series of the selected drivers may be non-stationary by nature. Non-stationary series may result in misleading and overestimated outcomes of statistical analyses [Verbeek, 2004]. Consequently, the phenomenon of non-stationary series will have to be taken into consideration by the continuation of the statistical analyses in this study and will therefore be discussed more deeply in paragraph 6.6.

<table>
<thead>
<tr>
<th>Country risk</th>
<th>0.382</th>
<th>0.247</th>
<th>0.596</th>
<th>0.053</th>
<th>-0.085</th>
<th>0.873</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service sector employment</td>
<td>-0.920</td>
<td>0.000**</td>
<td>-0.934</td>
<td>0.000**</td>
<td>-0.996</td>
<td>0.000**</td>
</tr>
<tr>
<td>Class A office stock</td>
<td>-0.946</td>
<td>0.000**</td>
<td>-1.000</td>
<td>0.000**</td>
<td>-1.000</td>
<td>0.000**</td>
</tr>
<tr>
<td>Class A office stock growth</td>
<td>0.881</td>
<td>0.000**</td>
<td>0.784</td>
<td>0.001**</td>
<td>0.604</td>
<td>0.022*</td>
</tr>
<tr>
<td>Investment market liquidity</td>
<td>-0.969</td>
<td>0.000**</td>
<td>-0.842</td>
<td>0.000**</td>
<td>-0.949</td>
<td>0.000**</td>
</tr>
<tr>
<td>Actual inflation rates</td>
<td>0.825</td>
<td>0.000**</td>
<td>0.952</td>
<td>0.000**</td>
<td>0.947</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

Significant at 5% (*)
1% (**)  

Table 6.2 Spearman’s rank correlation coefficients and p-values (significance) between trend yield drivers and calculated trend yields  

As can be seen in table 6.2, the expected positive correlation between the calculated trend yield elements and the country risk rating occurs in both Prague and Budapest. Nonetheless, both relations are insignificant, although the level of insignificance strongly differs. Whilst the expected positive relations are traced in both Prague and Budapest, a very weak negative and highly insignificant relation is found between Warsaw’s cyclical yield and Poland’s country risk rating. Altogether, the varying outcomes of the correlation analysis are in line with the earlier made annotations in paragraph 5.4 at the analysis of the country risk rates. Since the outcomes of the correlation analysis are not univocal, as different relations were found for the individual cities and the available time series lack the period 1993-1996, the usefulness of this trend driver is to be questioned. Consequently, this driver will not be used in the continuation of this study.

As the FTE employment in the service sector in all three countries dispose of the expected development pattern by displaying an upward progress (recall figure 5.4), it is not very surprising that all hypothesized relations can be traced in the datasets. As table 6.2 shows, the correlation coefficients are very high in all three cases and, moreover, the relations are all highly significant. Based on the outcomes of the correlation analyses, the service sector employment rates are clearly pushed forward as a suitable driver. One must, however, be a little distant in attributing too much importance to the very high correlations coefficients, as the time series can be non-stationary by nature.
Like the FTE employment in the service sector, the extent of the class A office stock disposes of the expected course, consequently resulting in very strong and highly significant relations, as can be seen in table 6.2. In the cases of Budapest and Warsaw, the correlation coefficients even amount to a perfect correlation of -1.000, thereby indicating a 100 percent negative relation between the extent of the class A office stock in these cities and their trend yield elements. As already notified in chapter 4, the earlier discussed driver FTE employment in the service sector is most likely to be strongly related to the extent of the class A office stock. Consequently, the mutual relation between these two trend yield drivers will have to be taken into account on the further statistical analysis, should both drivers be included in a single trend yield model.

In all three cases, the expected positive relation between the growth rates of the class A office stock and the trend yield element is traced, as can be seen in table 6.2. In all three cases, the relations turn out to be strong and significant, although the relation in the case of Warsaw is less strong in comparison to Prague and Budapest. All in all, the outcomes support the theoretical assumptions as expressed in chapter 4 and 5. Therefore, the growth rates of the class A office stock will be used in the continuation of this study.

As expected, the upward development of the office investment market liquidity, which has earlier been discussed in paragraph 5.4, is negatively related to the trend yield elements of all three Central European capital cities. The possible usefulness of this trend driver is furthermore supported by the comparability of the correlation coefficients and p-values (see table 6.2). In sum, the strong and highly significant relations in Prague, Budapest and Warsaw inevitably push the office investment market liquidity forward as a possibly suitable and valuable driver for modeling the trend yield element.

Finally, as already expected based on the actual inflation rates plotted in figure 5.6, the expected positive relations between the actual inflation rates and the trend yield elements are supported by the outcomes of the correlation analysis. In all three cases, strong and highly significant correlations are found between the actual inflation rates and the trend yield elements. Thus, like almost every other selected trend yield driver, the actual inflation rates will also be taken into account on the further statistical analysis and modeling of the trend yield elements.

### 6.4.4 Correlations of cyclical drivers and the cyclical yield

Just like the correlations of the trend yield elements and their selected drivers, correlations between the cyclical yield element and the various selected cyclical drivers have been determined by conducting a Spearman correlation analyses. The outcomes of these correlation analyses are summarized in table 6.3, at which the possible presence of non stationary series should once again be

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32 Such issues are more commonly known as multicollinearity
kept in mind when interpreting the correlation coefficients. Since some relations between the selected drivers and the cyclical yield elements can be expected to be time lagged or leading (see paragraph 4.4) by nature, several time lagged or leading relations have been analyzed between some cyclical yield drivers and the cyclical yields. An example of a possible time lagged driver which will be analyzed are the cyclical short term interest rates, since earlier studies have shown that the relation between yields and interest rates can be time lagged.

<table>
<thead>
<tr>
<th>Time Lag</th>
<th>Stock Market Performances</th>
<th>Cyclical Short Term Interest Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 year time lag</td>
<td>0.174</td>
<td>0.553</td>
</tr>
<tr>
<td></td>
<td>0.176</td>
<td>0.547</td>
</tr>
<tr>
<td></td>
<td>0.020</td>
<td>0.946</td>
</tr>
<tr>
<td>1 year time lag</td>
<td>0.152</td>
<td>0.605</td>
</tr>
<tr>
<td></td>
<td>0.022</td>
<td>0.940</td>
</tr>
<tr>
<td></td>
<td>0.064</td>
<td>0.829</td>
</tr>
<tr>
<td>No time lag</td>
<td>-0.090</td>
<td>0.759</td>
</tr>
<tr>
<td></td>
<td>-0.165</td>
<td>0.573</td>
</tr>
<tr>
<td></td>
<td>0.033</td>
<td>0.911</td>
</tr>
<tr>
<td>1 year time lead</td>
<td>-0.349</td>
<td>0.221</td>
</tr>
<tr>
<td></td>
<td>0.231</td>
<td>0.426</td>
</tr>
<tr>
<td></td>
<td>-0.033</td>
<td>0.911</td>
</tr>
<tr>
<td>2 year time lead</td>
<td>-0.389</td>
<td>0.169</td>
</tr>
<tr>
<td></td>
<td>0.537</td>
<td>0.047**</td>
</tr>
<tr>
<td></td>
<td>-0.218</td>
<td>0.455</td>
</tr>
</tbody>
</table>

Table 6.3 Spearman’s rank correlation coefficients and p-values (significance) between cyclical yield drivers and the cyclical yields

Only one significant relation between the GDP growth rates and the cyclical yield elements was found for any of the individual countries during the period 1993-2006, as can be seen in table 6.2. One must, however, not attribute too much value to this relation, since it negative value is inconsistent with the theoretical expectations as expressed in chapter 4. Whereas the expected negative relations were retrieved in the Czech Republic and Poland, Hungary’s relations are deviating because of their positive nature. In sum, the selection of the GDP growth rates as a cyclical driver is rejected because of
insignificant relations in the cases of Prague and Warsaw and the deviating positive relations that were found in the case of Budapest.

No significant relations were found between the (leading) unemployment rates and the cyclical yield element, as most relations are highly insignificant. Moreover, whereas quite some uniformity was found in the relations of the GDP growth rates and the retrieved relations were in line with the expectations, the expected positive relations between the cyclical yield and the unemployment rates are only found in the Czech Republic. All in all, the outcomes of the conducted correlation analysis indicate that the unemployment rates are of no use for modeling the cyclical yield element, due to the insignificance of the retrieved relations. The outcomes thereby seem to confirm the earlier expressed objections related to the deviating development pattern of the unemployment rates in the former communist economies (recall paragraph 4.4 and 5.5).

According to the theoretical argumentation in chapter 4, the (non)lagged return performances of equities are expected to be positively related to the cyclical yield element. Albeit this supposition is supported by the correlation analysis' outcomes of the one and two year lagged return performances of equities, the traced relations are rather weak, as well as, highly insignificant. Furthermore, differences are found between the individual cities, although one must not attach too much value to these differences as the retrieved relations are all highly insignificant (i.e. likely to be a result of sheer chance). Altogether, the outcomes of the conducted correlation analysis indicate that the (non) lagged return performances of equities are unusable for modeling the cyclical yield element, and will therefore not be used for modeling the cyclical yield elements.

Whilst none of the recently discussed cyclical drivers disposed of the expected significant relation to the cyclical yield element, significant relations occurred between the rental growth rates and the cyclical yields. In all three cases, the theoretically expected negative relation between the cyclical yield and the leading rental growth rates could be retrieved in the collected datasets, as can be seen in table 6.3. However, whilst the negative relations in the cases of Prague and Warsaw turned out to be significant, the retrieved negative relation in the case of Budapest turned out to be insignificant. Despite the lack of significant negative relations in the case of Budapest, the one and two year leading rental growth rates will be used in the continuation of the statistical analyses, since the relations in the cases of Prague and Warsaw are quite promising.

As can be seen in table 6.2, the expected positive correlations between the cyclical short term interest rates and the cyclical yield element can be traced in the collected datasets, thereby supporting the selection of the short term interest rates as a cyclical driver. Although eight out of nine relations have the expected positive correlation coefficient, only three relations turn out to be significant and no significant relation could be found in Prague. Furthermore, it must be noted that using lagged time series seems to be rejected by the outcomes of the correlation analysis as stronger
relations are found when no time lag is applied. In sum, the outcomes suggest to use the non lagged Hungarian and Polish cyclical interest rates when modeling Budapest’s and Warsaw’s cyclical yield elements.

6.5 Selection of usable drivers per yield element (based on the correlation analysis)

6.5.1 Introduction
Based on the outcomes of the conducted correlation analyses in the previous paragraph, a selection of the most suitable drivers per yield element can be made. For both the trend and cyclical yield, a number of drivers have been selected to be used in the further construction and development of the trend and cyclical yield models. Further on, these various drivers will be put through some more statistical examinations to finally come to underpinned yield models for each of the individual office investment markets.

6.5.2 The trend yield element
According to the theoretical explanation provided in chapter four, the trend yield element can be modeled by using a number of drivers, resulting in the following expression:

\[
\text{Trend yield}_{c,t} = f \left( (+) \text{ Country risk}_{n,t}, (-) \text{ FTE employment in the service sector}_{n,t}, (-) \text{ Office stock}_{c,t}, (+) \text{ Office stock growth}_{c,t}, (-) \text{ Liquidity}_{c,t}, (+) \text{ Inflation rates}_{n,t}, (+) \text{ Interest rates}_{n,t} \right)
\]

Based on the outcomes of the statistical analysis conducted in the previous paragraph, not all of the selected drivers are significantly correlated to the trend yield element as table 6.1 shows. Consequently, the following drivers will be taken into account on the further modeling of the trend yield:
FTE employment in the service sector  [Prague, Budapest and Warsaw]  
Extent of the class A office stock  [Prague, Budapest and Warsaw]  
Growth of the class A office stock  [Prague, Budapest and Warsaw]  
Investment market liquidity  [Prague, Budapest and Warsaw]  
Actual inflation rates  [Prague, Budapest and Warsaw]  
Trend line of the interest rates  [Prague, Budapest and Warsaw]

As earlier noted, despite the trend lines of the interest rates not being taken into account in the correlation analyses, they will be used on the further statistical analyses and yield modeling. From a uniformity point of view, every effort will be made to construct trend yield models using the same driver(s) for each of the individual markets. Additionally, using the same trend drivers per city will make the models and the final forecasting more convincing and credible. Furthermore, the construction and use of uniformed models can be contributive to the construction of a yield model for Bucharest's office investment market further on in chapter 8.

6.5.3 The cyclical yield element

Next to an expression for modeling the trend yield element, chapter four also provided an expression for the cyclical yield element based on the theoretically expected relations with a number of cyclical drivers:

\[ \text{Cyclical yield}_{c,t} = f((-) \text{GDP growth}_{n,t} (+) \text{Unemployment}_{n,t} (+) \text{Equity performance}_{e,t} (-) \text{Rental growth}_{c,t} (+) \text{Interest rates}_{n,t}) \]

Based on the findings of the correlation analysis, quite a number of the selected drivers dropped out as their relations were either insignificant or inconsistent with the hypothesized relations. Consequently, the following drivers have been selected for modeling the cyclical yield element:

- Cyclical interest rate (not lagged)  [Budapest and Warsaw]  
- 1 year leading rental growth  [Prague and Warsaw]  
- 2 year leading rental growth  [Prague and Warsaw]
Like with modeling the trend yield elements, model uniformity considerations will play an important role in constructing the cyclical yield models as well, due to the earlier expounded reasons.

6.6 Modeling the trend and cyclical yield; statistical implications and preconditions

6.6.1 Introduction
Modeling and forecasting time series, such as return performances and yields, is still a rather underexposed activity in the real estate sector. Whereas other assets classes, like bonds and equities have a long and nearly inexhaustible track record and tradition on modeling performances, only a limited number of studies focused on modeling real estate time series. Studies by Karakozova [2005], McGough et al. [2005], McGough and Tsolaces [2001], and Sivitanides [1998], for example, elaborated on modeling and forecasting real estate time series. In order to take benefit of existing studies, and generate well-considered models, having understanding of modeling and forecasting of and the applied techniques will be very valuable. Consequently, this paragraph discusses various elements related to time series analysis and modeling.

6.6.2 Econometrics
Time series analysis and modeling is an element of the econometric discipline within the economic science, which examines the relations and effects of changing economic variables over time. Economic science generally has a theoretically driven orientation, meaning that economists use theories as a starting point and examine whether these theoretical expectations can be supported by datasets. In doing so, an economist will attempt to mathematically model the real world, at which this modeling is driven by a theoretical orientation. Conversely, econometric science has a different approach since it is data orientated. Consequently, an econometricist's approach is characterized by an inverse approach, at which statistical analyses are conducted to find out whether datasets support theoretical assumptions. Therefore, econometrics is generally used for supporting economical theories based on a quantitative approach, at which (advanced) regression techniques are frequently used. For example, econometric techniques can indisputably prove that a higher price results in a declining demand as is hypothesized by economical theory. Next to supporting or rejecting economic hypotheses, econometrics enables the attribution of numerical values to demand curves for example [Verbeek, 2004].

Despite econometrics still being a rather young discipline within the economic science, the discipline experienced a turbulent development over the past decades, and already greatly contributed to the development of economic science. Various highly advanced statistical techniques and models for
modeling and forecasting economic variables, such as unemployment, a nation’s GDP, inflation and interest rates, made their appearance, not infrequently leading to new insights and high recognition. Nowadays, econometric techniques are daily used by among others financial institutions and governments, and play an important role in their businesses and decision and policymaking processes.

6.6.3 Econometrical regression analyses and limitations
As already mentioned in chapter 5, the trend and cyclical yield elements will be modeled by using the various selected trend and cyclical drivers in a regression analysis. A (multiple) regression analysis is a statistical tool for examining the relations between one or more independent variables on the one hand, and one dependent variable on the other hand. Various regression methods have been developed over time, such as for example linear regression and logistic regression, of which only the former one will be used in this study.

Using linear regression methods when modeling the office investment market yields in the Central European capital cities is, however, inconsistent with the conditions for applying parametric statistics, due to the small data sets of the various drivers. Since linear regression is a parametric statistical tool, it requires a certain length of the examined times series and moreover requires the examined variables to be normally distributed (recall paragraph 6.3). Furthermore, applying linear regression techniques implies that relations between the examined variables are supposed to be linear. Despite these objections, linear regression techniques will be used for creating trend and cyclical yield models, as linear regression is the clearest and most straightforward method which is moreover expected to be comprehensible to practitioners. However, the decision to use linear regression techniques in this study entails some implications, in terms of the validity of the outcomes. Consequently, the violation of certain conditions implicates that one must be a little more distant when interpreting and generalizing the regressions’ outcomes.

In the most basic form of linear regression, variable \( y \) (dependent variable) will be estimated from a single variable \( x \) (independent variable), based on the following formula:

\[
Y = \alpha + \beta \cdot x
\]

[5]

The regression analysis provides values for the intercept \( \alpha \), the regression coefficient \( \beta \) (i.e. the slope of the linear regression line), and the error of residue, so that the value of \( y \) can be predicted based on the value of \( x \). The value of the error of residue refers to the difference between the predicted value of \( y \) (based on \( \alpha \), \( \beta \) and \( x \)) and the actually observed value of \( y \), since not all variation of dependent variable \( y \) can be explained by the variation of independent variable \( x \). Hereby, the values for \( \alpha \) and \( \beta \)
are obtained by a process of optimization. Logically, a lower value for the error of residue corresponds to a better prediction. Therefore, when conducting a regression analysis, the values for $\alpha$ and $\beta$ will generally be quantified in such a manner that the sum of the squared errors of residue is as small as possible. By way of illustration, the various elements of formula [5] are visually expressed in the following figure.

![Single linear regression](image)

**Figure 6.1** Visual expression of a single linear regression [Adapted from De Heus et al., 2003]

Whereas a single linear regression can be used to estimate relations between $y$ and $x$, a multiple (i.e. multivariate) linear regression can be used to estimate relations between $y$ and more than one independent variable, as may the case in this study. In case of several independent variables, the regression formula is expressed as:

$$Y = \alpha + \beta_1 \cdot x_1 + \beta_2 \cdot x_2 + \beta_3 \cdot x_3 + \ldots$$

[6]

An important condition when conducting a regression analysis is the absence of correlated regression residuals (i.e. regression residuals being 'white noise') [de Heus et al., 2003]. This implies that the regression residuals follow a random pattern and are not related over time, meaning that the

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33 This method is more commonly known as the Ordinary Least Squares (OLS) method at which the values of $\alpha$ and $\beta$ result from the process of the least square error value. A OLS linear regression is the most basic estimation procedure for econometric modeling [Hayashi, 2000].
regression residuals are independent from one another and randomly vary around zero. When studying and analyzing time series this condition plays an important role, as will come clear in the following sections.

Until the 1980s time series were generally modeled using the classical linear regression model, based on the ordinary least squares method. Hereby, the purpose of applying regression techniques was to model and predict the value of an economic variable (e.g. return performances of equities) based on a number of selected drivers, such as for example inflation rates and GDP growth. Numerous studies were conducted using such methods, not uncommonly resulting in apparently high degrees of fit (i.e. high values for the coefficient of (adjusted) multiple correlation $R^2$). However, as Granger and Newbold [1974] have shown, such apparently high goodness of fit measures can very likely be a result of auto correlated errors in the regression analyses.

Even though earlier studies elaborated on the issue of auto correlation, and econometrical textbooks contained explicit warnings for the dangers of auto correlated errors, it was very often neglected in econometric studies on time series analysis using regression techniques. Auto correlation in a regression analysis using time series data, means that the regression residuals are correlated over time and show a certain pattern, as a result of which misleading and erroneous results will be found [Mukherjee et al., 1998]. Auto correlation may best be explained by the following example.

"Suppose you are using monthly data to estimate a model that explains the demand for ice cream. Typically, the state of the weather will be an important factor hidden in the error term $e$. Clearly positive and negative residuals will group together, resulting in auto correlation. In macro-economic analyses, business cycle movements may have very similar effects" [Verbeek, 2004].

However, thanks to their study, Granger and Newbold succeeded in bringing the subject to the notice, and thereby contributed to a turn in the way of thinking and conducting time series analyses. Granger and Newbold hand two major consequences of auto correlated errors in regression analyses (i.e. spurious regressions):

- Forecasts based on the regression equations are sub-optimal
- The usual significance tests on the coefficients are invalid
Thus, when modeling the trend and cyclical yield, the presence of auto correlation should be taken into account, as it can have considerable negative effects on the outcomes and reliability of the executed regression analysis. Additionally, using time series data when conducting regression analyses leads to a greater risk of the presence of auto correlation, as time series are quite often non stationary by nature, and, therefore, do not comply with an important condition of a regression analysis (i.e. regression residuals being 'white noise'). Stationary series are characterized by properties which are unaffected by a change of time; in other words, parameters such as the variance and mean do not change over time (Verbeek, 2004).

A classical example of a non-stationary time series is a country's annual GDP, which will record a rising course over time (see figure 6.2). Because of its rising course, the time series' variance, mean and covariance will be dependent of the moment of measurement, i.e. indicating non-stationarity. However, this non-stationary time series can easily be transformed into a stationary time series by calculating the annual growth of the GDP. As can be seen in figure 6.2, the annual growth figures have a different course relative to the country's annual GDP, and its mean, variance and covariance will hardly change over time.

Using non stationary time series in a regression analysis will result in systematic patterns of the residuals (i.e. auto correlation), which is therefore inconsistent with regression conditions. Conversely, it must be noted that the presence of auto correlation does not necessarily imply non stationarity.

![Annual GDP and GDP growth per capita in The Netherlands (1970-2006)](image)

Figure 6.2 Actual GDP and GDP growth in The Netherlands [EUROSTAT, 2007]
Until the 1980s, the issue of non stationary behavior of time series was commonly believed by econometricians to be curbed by using stationary series which had been obtained by differencing the original non stationary series, and using these resulting derived (so called de-trended) time series in the regression analysis. Such a de-trended time series is constructed by calculating the differences between two successive measurements, and using these obtained values as a new time series. By differencing non stationary times series, the newly obtained times series will generally be more stationary, as can be read from figure 6.2. Should the obtained times series still turn out to be non stationary, the procedure can be repeated by calculating the second difference, in an effort to come to stationary times series. However, a more suitable method was introduced in the 1980s when Granger [1983] and Engle and Granger [1987] introduced the cointegration technique which enabled econometricians to test the correlation between non stationary time series variables. Engle and Granger were awarded with the 2003 Nobel Memorial Prize (i.e. Nobel Prize in Economics) for their contribution to the development of this innovative and valuable insight in time series analysis.

Altogether, the just discussed issues related to modeling time series logically have considerable consequences with regards to modeling the trend and cyclical yield elements of the office investment markets in Prague, Budapest and Warsaw. Consequently, the following subparagraph will elaborate on this and will provide a strategy for tackling the discussed issues and generating a reliable modeling method.

6.6.4 Dealing with auto correlation and non-stationarity

Whereas earlier cited property yield modeling studies by, among others, McGough et al. [2001], Karakozova [2004], De Wit and Van Dijk [2003] used advanced econometrical techniques (such as cointegration, vector autoregression (VAR), autoregressive integrated moving average (ARIMA) and panel data analyses) based on the just outlined issues of auto correlation and non stationary time series, a less advanced and innovative approach is chosen for modeling and forecasting the office investment yields in the Central European region. This consideration is mainly motivated by this study's ambition to construct yield models which can be of use for practitioners. Consequently, constructing highly advanced models this study would surpass this study's ambition as it would lead to less easily applicable and understandable models. Nonetheless, the issue of non stationary behavior of time series and the presence of auto correlation will be taken into account by the construction of the trend and cyclical yield models.

For taking the presence of non stationary time series and the occurrence of auto correlation into account when modeling the trend and cyclical yields, several statistical tests can be conducted to give a decisive answer about the stationarity of time series, or the presence of autocorrelation in a conducted
regression analysis. The Augmented Dickey Fuller (ADF) test, which tests the presence of a unit root\textsuperscript{34}, would be the best test for determining the presence of non stationarity in the collected time series datasets, since the presence of a unit root in time series indicates that a time series is non stationary. Unfortunately, SPSS does not include the ADF test, which can therefore not be used to deal with the issue of possible non stationary time series. A suitable alternative for taking stationarity and auto correlation into account is to use the Durbin Watson statistic, which provides a measure for the presence of auto correlation in a regression analysis. When conducting a regression analysis in SPSS, the Durban Watson statistic (DW) can be retrieved via the regression statistics submenu.

**Durbin Watson statistic**

For the interpretation of the DW statistic, the statistic's value, which can be found in the SPSS regression output, must be compared to a so-called upper and lower boundary as provided in Durbin Watson significance tables. Since the critical values for the DW test not only depend on the sample size (i.e. number of measurements), but also on the particular values of the regressors, it is not possible to hand a single critical value. Consequently two values are handed in a DW significance table; an upper (\(dU\)) and a lower (\(dL\)) boundary [Mukherjee, 1998]. Should the value of the DW statistic (\(d\), as computed by SPSS, be less than the lower boundary (\(dL\)) then the null hypothesis of no autocorrelation is rejected in favor of positive autocorrelation. Likewise, the null hypothesis is rejected if the value of \(d\) lies above \(4 - dL\) in favor of negative auto correlation. If the value of \(d\) lies between \(dU\) and \(4 - dU\), the null hypothesis is accepted, meaning that auto correlation is out of the question. Finally, if the value of \(d\) lies between \(dL\) and \(dU\) or between \(4 - dU\) and \(4 - dL\), the test is inconclusive\textsuperscript{35}. For a better understanding, figure 6.3 provides a graphical overview of the various boundaries and areas.

<table>
<thead>
<tr>
<th>Reject (H_0)</th>
<th>Inconclusive</th>
<th>Accept (H_0)</th>
<th>Inconclusive</th>
<th>Reject (H_0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(dL)</td>
<td>(dU)</td>
<td>2</td>
<td>(4 - dU)</td>
</tr>
</tbody>
</table>

*Figure 6.3*\noindent Interpretation of the Durbin Watson statistic [Adapted from Mukherjee, 1998]

As earlier noted, using non-stationary series in a regression analysis results in serial correlation (of which positive or negative autocorrelation are examples) in the regression residuals. However, the

\textsuperscript{34} If the hypothesis (\(H_0\)) that a variable's time series is a unit root cannot be rejected, then there is statistical evidence that the time series is non-stationary [Mukherjee et al., 1998]

\textsuperscript{35} Appendix III provides an overview of the upper and lower boundaries of the Durbin Watson statistic.
The presence of positive or negative autocorrelation does not necessarily imply non-stationarity of the used time series. Consequently, based on the outcomes of the Durbin Watson test, unfortunately no decisive answer can be given on the presence of non-stationary time series.

6.6.5 Conducting a regression analysis in SPSS; selected method and output interpretation

When conducting a linear multiple regression analysis in SPSS, a number of different regression procedures can be applied: enter, backward, forward and stepwise. These regression procedures differ in the method of how independent variables are added to the regression analysis. Since unrestrainedly including a large number of independent variables in a regression model is never a good strategy, especially when the data sets are small [Norusis, 1983], as is the case in this study, the stepwise procedure has been chosen. In a stepwise regression procedure, the independent variables are entered step by step at which the p-value (p) of the earlier selected or removed variables is checked. Should $p > PIN$, then the independent variable in question will be removed, after which the selection and elimination procedure will be resumed with a following independent variable. The procedure will continue until the most appropriate model is found [De Heus et al., 2003].

Generally, when conducting regression analyses, the maximum number of independent variables to be included in the regression analysis is related to the number of available observations. In order to conduct truly reliable regressions, a rule of thumb for the ratio of the number of independent variables versus the number of observations is 1:50. Unfortunately, such ratios are unfeasible when studying real estate, as real estate time series are generally still much too short. Since the maximum available length of the time series of the various selected drivers in this study is limited to fourteen, a maximum of two independent variables is selected per yield element model.

For the selection of the most appropriate model, the following statistical figures in the SPSS outputs will have to be interpreted.

- Durbin Watson statistic
- F test

36 More specifically, including a large number of independent variables in case of small data sets entails the sacrifice of the degrees of freedom, which consequently negatively affects the praiseworthiness of the created models.

37 The default PIN value (Probability of F-to-enter) in SPSS is 0.05. Thus for a variable to be selected and used in the regression model, its p-value must be $\leq 0.05$. 
First of all, the value of the DW statistic will have to be interpreted, as its value determines whether or not the model must be rejected because of the presence of autocorrelation. Should the test indicate the presence of autocorrelation, this may possibly be a result of non-stationary time series. Subsequently, should the value of the DW statistic be acceptable, the F test is of importance, since the F-test tests whether the created model is better than a model without any variables. A failed F test implies that the created regression model is not better than a model without parameters $\alpha$ and $\beta$, which consequently dismisses the regression model.

The adjusted R square ($R^2_{\text{adjusted}}$) is a measure for the appropriateness of the regression model as it reflects the proportion of variation in the modeled variable (i.e. trend or cyclical yield) that is accounted for by the constructed regression model. The adjusted $R^2$ value differs from the 'normal' $R^2$ value, as it is corrected for the number of parameters within the constructed regression model. The value of $R^2$ ranges from 0 to 1 at which a value of 0.86, for example, implies that 86 percent of the variation in the modeled variable is accounted for by the model. However, the adjusted $R^2$ can have a slightly negative value due to the correction procedure. Generally, a model with a higher $R^2_{\text{adjusted}}$ value will be chosen, however, when the values hardly differ between different models, other considerations may be decisive as well.

The regression coefficients and their significance are of importance as they indicate whether an independent variable is significantly related to the dependent variable, how strong this relation is and what the direction of the relation is. Hereby, a higher value of the regression coefficient logically implies a stronger linear relation between the independent and dependent variable. Finally, the direction of the relation can be compared to the theoretically expected direction.

### 6.7 Modeling the trend yield elements and interpretation

#### 6.7.1 Introduction

The correlation analysis of the trend yields and its pre-selected drivers in paragraph 6.4.1 led to the exclusion of some trend drivers. The remaining trend drivers will be used in this paragraph for constructing custom-made trend yield models for the office investment markets in Prague, Budapest and Warsaw. Since the trend line of the interest rates cannot directly be used as an independent
variable for modeling the trend yields\textsuperscript{30}, these times series will therefore be converted by differencing them before they will be used as independent variables. Furthermore, as it is preferable from a uniformity point of view to construct models using the same independent variables, an effort will be made to construct uniformed models with a maximum of two independent variables.

The first step of the actual modeling of the trend yield elements will consist of separate regressions of the actual trend yield elements with the selected trend yield drivers. Subsequently, additional regression analyses will be conducted to determine whether an additional second trend driver will be added to create more appropriate models.

\textbf{6.7.2 Modeling the trend yield elements; selection of the first useful driver}

\textit{Prague}

By reason of the outcomes of the conducted correlation analyses between the actual trend yield and the various selected trend yield drivers in paragraph 6.3, six regression analyses have been conducted. The following table provides a summary of the results of these regressions, while the complete SPSS outputs can be found in appendix IV.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|}
\hline
Model & R & N & \textbf{Beta} \\
\hline
Model 1 & 0.861 & \textit{N} & 0.701 & -0.630 \\
FTE employment in the service sector & 0.586 & \textit{N} & 0.707 & -0.002 \\
Model 2 & 0.839 & \textit{N} & 0.763 & 0.024 \\
Extent of the class A office stock & 0.384 & \textit{N} & 0.479 & -0.149 \\
Model 3 & 1.727 & \textit{N} & 0.815 & 0.290 \\
Growth of the class A office stock & 0.553 & \textit{N} & 0.861 & -1.531 \\
Model 5 & \\
Actual inflation rates & \\
Model 6 & \\
Growth of the Interest rates trend line & \\
\hline
\end{tabular}
\caption{Statistical outcomes of the regression analyses of Prague’s trend yield}
\end{table}

As can be concluded from table 6.4, model 5 which uses the actual inflation rates as independent variable is evidently pushed forward as the best model, as all other models suffer from the presence of

\textsuperscript{30} Using the trend line of the short term interest rates as an independent variable would mean that the trend yields (which are a trend line as well) would be modeled by and compared to a trend line, which would not make any sense.
auto correlation (i.e. have a too low Durbin Watson statistic value). Furthermore, the model's F test did not fail, its adjusted R² value is high and the regression coefficient has the expected positive value.

Budapest

Like in Prague's case, six regressions have been conducted to determine the usefulness of the various selected trend yield drivers to model Budapest's trend yield. The outcomes of these regressions are plotted in table 6.5, the complete SPSS regression outputs can be consulted in appendix IV.

<table>
<thead>
<tr>
<th>Model</th>
<th>R²</th>
<th>N</th>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>0.351</td>
<td>N</td>
<td>FTE employment in the service sector</td>
<td>-0.993</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.448</td>
<td>N</td>
<td>Extent of the class A office stock</td>
<td>-0.004</td>
</tr>
<tr>
<td>Model 3</td>
<td>0.916</td>
<td>N</td>
<td>Growth of the class A office stock</td>
<td>0.041</td>
</tr>
<tr>
<td>Model 4</td>
<td>0.750</td>
<td>N</td>
<td>Investment market liquidity</td>
<td>-0.222</td>
</tr>
<tr>
<td>Model 5</td>
<td>0.864</td>
<td>N</td>
<td>Actual inflation rates</td>
<td>0.232</td>
</tr>
<tr>
<td>Model 6</td>
<td>0.533</td>
<td>N</td>
<td>Growth of interest rates trend line</td>
<td>-1.193</td>
</tr>
</tbody>
</table>

Table 6.5 Statistical outcomes of the regression analyses of Budapest's trend yield

Unlike in the case of Prague, none of the conducted regression analyses of Budapest's trend yield element turned out to be immune for the presence of autocorrelation. However, as the actual inflation rates have proven to be a useful driver in the case of Prague, and the statistical characteristics (rather high adjusted R² value, non-failed F test, and the presence of the expected positive regression coefficient) are favorable, model 5 will be used in the further statistical modeling, despite its adverse DW statistic value.

Warsaw

Just like in the cases of Prague and Budapest, six analyses have been conducted in the case of Warsaw, to select the first useful driver for modeling Warsaw's trend yield. Table 6.6 contains the outcomes of the conducted regressions. The complete SPSS outputs of these regressions can be found in appendix IV.
The outcomes of the regression analyses are very similar to the outcomes of the regressions in the cases of Prague and Budapest in terms of low DW statistic values and the presence of the expected regression coefficient values. Like in Prague, the model using the actual inflation rates as the independent variable leads to the best result, as it does not contend with auto correlation. Furthermore, the model's adjusted $R^2$ value is very high and the regression coefficient has the expected positive value.

Since the actual inflation rates have shown to be a valuable trend yield driver in terms of high adjusted $R^2$ values and non auto correlated regression residuals, in both Prague and Warsaw, the actual inflation rates will be used for modeling the trend yield elements. Albeit, the Durbin Watson statistic value of Budapest's trend yield element regression using the actual inflation rates as independent variable indicates the presence of auto correlation, the model will not be retracted. This retention is justified by the absence of auto correlation in the cases of Prague and Warsaw, and the intention to generate uniform models for the individual markets. In an effort to optimize the appropriateness of the trend yield models, the added value of adding a second independent variable will be examined in the following section.

### 6.7.3 Modeling the trend yield elements; selection of a second driver

Now that the first independent variable for modeling the trend yield elements has been selected, a second independent variable will be added to the existing models, in an effort to construct more appropriate models (i.e. higher adjusted $R^2$ values). The first step will hereby be to add the originally
selected trend drivers one by one, using a stepwise procedure, to the existing models (containing the actual inflation rates as the first independent variable) and interpret the results.

Prague

The following table provides a summary of the outcomes of the regression analyses with the addition of a second trend yield driver. In addition to these summarized results, the complete SPSS outputs of the conducted regression analyses can be retrieved in appendix V.

<table>
<thead>
<tr>
<th>Model 1</th>
<th>FTE employment in the service sector</th>
<th>Added variable excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 2</td>
<td>Extent of the class A office stock</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Model 3</td>
<td>Growth of the class A office stock</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Model 4</td>
<td>Investment market liquidity</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Model 5</td>
<td>Growth of the trend line of the interest rates</td>
<td>1.352 N 0.914 -1.136</td>
</tr>
</tbody>
</table>

Table 6.7  Statistical outcomes of the regression analyses of Prague's trend yield with an added second driver

The addition of a second independent variable seems to have little result as can be read from table 6.7, since most of the added variables are excluded. Only the addition of the growth of the trend line of the interest rates as a second driver results in a higher adjusted R² value. However, the addition of this second driver also lowers the DW statistic value, consequently resulting in an inconclusive answer on the presence of auto correlation.

Budapest

The statistical outcomes of the addition of a second trend yield driver to the existing trend yield model are summarized in the following table. For a complete overview of the SPSS outputs of these regression analyses, appendix V can be consulted.
Albeit, the addition of the FTE employment in the service sector or the growth of the trend line of the interest rates would result in better fitting models, including one of these variables considerably lowers the DW statistic value, which strengthens the indication of the presence of positive autocorrelation.

Warsaw

The statistical outcomes of the addition of a second trend yield driver to the existing trend yield model are summarized in the table 6.9 (see appendix V for a complete overview of the SPSS outputs).

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Added variable excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTE employment in the service sector</td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Extent of the class A office stock</td>
<td></td>
</tr>
<tr>
<td>Model 3</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Growth of the class A office stock</td>
<td></td>
</tr>
<tr>
<td>Model 4</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Investment market liquidity</td>
<td></td>
</tr>
<tr>
<td>Model 5</td>
<td>Added variable excluded</td>
</tr>
<tr>
<td>Growth of the trend line of the interest rates</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.9 Statistical outcomes of the regression analyses of Warsaw's trend yield with an added second driver

In line with the findings in the cases of Prague and Budapest, the addition of a second trend yield driver has no added value for modeling Warsaw's trend yield elements, since the added variables are excluded in all five models.
All in all, the outcomes of these regression analyses indicate that the addition of a second trend yield driver has no added value for any of the individual models, since these models generally struggle with the presence of positive auto correlation and will, therefore, probably be less reliable. Furthermore, from a uniformity point of view the addition of a second driver is not supported, as there is no single second driver which leads to more appropriate models in all three cases.

6.7.4 Construction of the definite trend yield models

Prague

Based on the outcomes of the earlier conducted regression analysis, the actual inflation rates have been selected as the independent variable for modeling the actual trend yields. This regression analysis resulted in the following formula for modeling the trend yields in Prague's office investment market.

\[
\text{Trend yield}_{P,t} = 6.875 + 0.29 \cdot (\text{Actual inflation rates}_{C,t}) + e
\]

By using this formula, the trend yields can be modeled during the examined period (1993-2006) and graphically be compared to the actual trend yields. In the following figure, the modeled and actual trend yields are plotted.

Modeled and actual trend yields in Prague (1993 - 2006)

Figure 6.4 Actual and modeled trend yields of the Prague office investment market
As can be seen in figure 6.4, both trend yield lines have a rather similar course, although the line of the modeled trend yields is rather volatile. Nonetheless, the downward course of the actual trend yields is clearly present in the modeled yields and moreover the model seems to get a better fit from 2000 onwards. All in all, the results of the trend yield modeling are pretty satisfying with an adjusted $R^2$ value of 0.815.

**Budapest**

Like in Prague, a model using the actual inflation rates as the independent variable has been constructed to model the trend yields in Prague’s office investment market. By filling in the actual inflation rates in the following formula, Budapest’s trend yields can be modeled at which the model’s adjusted $R^2$ value is 0.711.

Trend yield$_{Bx}$ = \[ 5.782 + 0.232 \cdot (\text{Actual inflation rates}_B) + e \]  

Based on formula [10], the trend yields can be modeled for the examined period by implementing the actual inflation rates in the formula and be related to the actual trend yields in Budapest, as can be seen in figure 6.5.

![Modeled and actual trend yields in Budapest (1993-2006)](image)

*Figure 6.5 Actual and modeled trend yields of the Budapest office investment*

The course of the modeled and actual trend yields in Budapest is pretty similar, as can be seen in figure 6.5. As the Hungarian inflation rates have been rather volatile in the early 1990s, the modeled
trend yields in the period 1993-1997 are quite divergent with respect to the actual trend yields. However, since 1998 both lines show a strong resemblance as the volatility of the Hungarian inflation rates levels off. Altogether, the model's appropriateness is pretty high with an adjusted $R^2$ value of 0.711.

Warsaw

The regression analyses of Warsaw's trend yields resulted in the selection of the actual inflation rates as the sole independent variable and the following algebraical expression of Warsaw's trend yield model.

$$\text{Trend yield}_{\text{W}} = 7.564 + 0.193 \cdot (\text{Actual inflation rates}_{\text{P}}) + e$$  \[9\]

When the actual and modeled trend yields of the Warsaw office investment market are plotted, the following image arises.

![Modeled and actual trend yields in Warsaw (1993 - 2006)](image)

In comparison to Prague and Budapest, Warsaw's office investment market trend yields can be modeled extremely well, as can be read from figure 6.6. The courses of the modeled and actual trend yield lines are virtually equal, consequently resulting in a very high adjusted $R^2$ value of 0.957.
6.7.5 Conclusions

Based on regression analyses, custom made models have been constructed for modeling the trend yields of the office investment markets in Prague, Budapest and Warsaw, at which only a single independent variable is selected for modeling the trend yield lines. The statistical analyses have shown that the actual inflation rates turn out to be a useful and valuable variable in all three cases. The results are encouraging, especially because of the limited length of the available times series and the high adjusted $R^2$ values that can be achieved by using only a single independent variable.

Additionally, using the actual inflation rates as a sole independent variable for modeling the investment markets' trend yields is in line with the theoretical basic principles as expressed in chapter 4. As the trend yield line primarily reflects the development process from a challenged market towards maturity with declining perceptions of risk, the actual inflation rates are a logical and theoretically arguable driver since inflation rates are generally seen as a strong risk indicator. Thus, the outcomes of the trend yield regression analyses are in line with the previously expressed theoretical expectations.

6.8 Modeling the cyclical yield elements and interpretation

6.8.1 Introduction

By using the selected cyclical yield drivers per investment market from paragraph 6.4.2, unique and specific cyclical yield models can be constructed for the office investment markets of Prague, Budapest and Warsaw. Consequently, this paragraph describes the actual construction of the cyclical yield models based on regression techniques. Like with the selection of the most appropriate trend yield model, the selection of the cyclical yield models is founded on both the statistical figures of the regression analysis and the uniformity of the cyclical yield models.

6.8.2 Modeling Prague's cyclical yield element

According to the outcomes of the conducted correlation analyses, either the one year leading rental growth rates or the two year leading rental growth rates should be used when modeling the cyclical yields in Prague. Since the same cyclical driver (i.e. rental growth rates) is selected twice (i.e. one and two year leading), two regression analysis have been conducted, at which the cyclical yield element is the dependent variable and the 1 year leading or 2 year leading rental growth is the independent variable. The statistical outcomes of these regression analyses are summarized in the following table. Appendix VI provides the complete SPSS outputs of both regressions.
Model 1
1 YR leading rental growth
0.905  N  0.293  -0.112

Model 2
2 YR leading rental growth
0.737  N  0.232  -0.102

Table 6.10  Statistical outcomes of the regression analyses of Prague’s cyclical yield

The red values for the Durbin Watson statistic indicate that in both regressions, the regression residuals are positively autocorrelated. Despite the presence of autocorrelation, Prague’s cyclical yield model will be used, in an effort to generate a better fitting yield model. Since the DW statistic of the model using the 1 year leading rental growth rates is a little less problematical, and the 1 year leading rental growth rates will turn out to be a useful cyclical driver in Warsaw as well, this cyclical driver is selected for modeling the cyclical yield in Prague, consequently resulting in the following formula for modeling Prague’s cyclical yield:

\[
\text{Cyclical yield}_{Pt} = -0.320 - 0.112 \cdot (1 \text{YR lagged rental growth rate}_{Pt}) + e
\]  \[10\]

When this cyclical yield model is used for calculating the cyclical yield on the Prague office investment market, based on the constructed model and plotted next to the actual cyclical yields, the following picture comes into being.

Modeled and actual cyclical yields Prague (1993 - 2006)

Figure 6.7  Modeled and actual cyclical yields in the Prague office investment market
Despite the regression's adjusted $R^2$ value being rather low, both lines have quite a similar course, as can be read from figure 6.7. Especially since 2001 the modeled cyclical yields catch up pretty good with the actual cyclical yields, although, the steep downward course of the cyclical yields since 2003 cannot be modeled to full extent (i.e. the modeled yields have a less steep course). All in all, the results are quite strong, particularly because the cyclical yield model only includes one independent variable. Consequently, the 1YR leading rental growth rates turn out to be a very valuable driver for modeling Prague's cyclical yield element. However, when interpreting Prague's modeled cyclical yield, one must keep in mind that the model struggles with positive autocorrelation.

### 6.8.3 Modeling Budapest's cyclical yield element

Only one possibly useful driver resulted from the conducted correlation analysis of the selected cyclical yield drivers and Budapest's actual cyclical yield. Therefore, only one cyclical yield model can be constructed, namely a model with the calculated cyclical short term interest rates as the independent variable. Table 6.11 contains the most essential outcomes of the conducted regression analyses, additional information can be found in appendix VI, which provides the complete SPSS output.

<table>
<thead>
<tr>
<th>Model 1</th>
<th>1.094</th>
<th>$N$</th>
<th>0.542</th>
<th>0.099</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclical interest rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.11 Statistical outcomes of the regression analysis of Budapest's cyclical yield**

Although, the outcome of the Durbin Watson test is inconclusive, the outcomes of the executed regression analysis will be used for modeling the cyclical yields in the Budapest office investment market. Using the outcomes of the conducted regression analysis results in the following formula for modeling Budapest's cyclical yield element:

$$\text{Cyclical yield}_{t_0} = 0.099 \cdot (\text{Cyclical interest rate}_{t_0}) + \epsilon \quad [11]$$

In the following figure, both the modeled cyclical yields and the actual cyclical yields have been plotted. Once again, when interpreting Budapest's cyclical yield model, one must keep in mind that the model is possibly affected by positive autocorrelation.
As can be seen in figure 6.8, Budapest's modeled cyclical yield course is very similar to the course of the actual cyclical yields, as a result of the model's high adjusted R² value. Since only a single independent variable (cyclical short term interest rates) has been used to model the cyclical yields in Budapest's office investment market, this driver is evidently pushed forward as a valuable driver. Furthermore, it must be noted that, just like in the case of Prague, the constructed cyclical yield model is not able to fully model the steeply declining course of the cyclical yields since 2003.

6.8.4 Modeling Warsaw's cyclical yield element
In comparison to Prague and Budapest, more significant correlations were found between Warsaw's cyclical yield and the various selected cyclical yield drivers. Consequently, more than one independent variable could be selected for modeling the cyclical yield per model. Based on the correlation outcomes, two different regression analyses have been conducted using different combinations of drivers. The main outcomes of these regressions are plotted in table 6.12, the complete SPSS outputs provided in appendix VI can be consulted for additional information.
Based on the outcomes of the conducted regression analyses, the first model will be used to construct a model for the cyclical yields in Warsaw's office investment market. Unlike model 2, model 1 does not struggle with the presence of positive autocorrelation in its regression residuals. Selecting this model is furthermore supported from a uniformity point of view, as the model includes cyclical yield drivers which are used in the cyclical yield models of Prague and Budapest as well. Using model 1 results in the following cyclical yield model:

\[
\text{Cyclical yield}_{\text{w},t} = -0.791 - 0.158 \cdot (1\text{YR leading rental growth}_{\text{w},t}) + 0.155 \cdot (\text{Cyclical interest rates}_{\text{w},t})
\]

Based on formula [12], Warsaw's cyclical yields can be modeled and plotted in a graph. When these modeled yields are compared to the actual cyclical yields, the course of both cyclical yield lines is quite similar as can be seen in figure 6.7.
Whereas Prague's and Budapest's cyclical yield models include only a single independent variable (the 1YR leading rental growth rates and cyclical short term interest rates respectively), Warsaw's cyclical yield model includes both these variables, consequently resulting in a higher adjusted R² value. As can be read from figure 6.9, the pretty high adjusted R² value logically results in quite similar courses of the actual and modeled cyclical yields. In line with the cases of Prague and Budapest, the cyclical yield model cannot completely catch up with the steep downward course of the actual cyclical yields over the past few years, although, the gap is much smaller, as can be seen when comparing figures 6.7, 6.8, and 6.9.

6.8.5 Conclusion
Despite the fact that only a few cyclical yield drivers were left after the conducted correlation analysis in paragraph 6.3, these remaining cyclical yield drivers turned out to be valuable for modeling the cyclical yields. Both the 1YR leading rental growth rates and the cyclical short term interest rates have proven to be valuable drivers. Unfortunately, only in the case of Warsaw both drivers are included in the model since statistical analyses excluded either the cyclical short term interest rates or the 1YR leading rental growth rates as an independent variable in the cases of Prague and Budapest. Nonetheless, the outcomes are encouraging as they support the hypothesized relations between the cyclical drivers and the cyclical yields and moreover high adjusted R² values can be obtained by using only one or two drivers.
Finally, it must be noted here as a preliminary conclusion that the retrieved relations between yields and interest rates are remarkable since the relations turned out to be non-lagged while the relation is commonly believed to be lagged.

6.9 Interpreting the constructed yield models

6.9.1 Introduction
Now that custom made trend and cyclical yield models have been constructed for the Central European office investment markets in the previous paragraphs, the actual yields can be modeled. The course of these actual yields is obtained by simply combining the constructed models for the trend and cyclical yields per market, at which the results can thereupon be interpreted. Additionally, a goodness of fit measure has been calculated to assess the appropriateness of the generated yield models. This paragraph will conclude by answering to what extent the cyclical yield models is a valuable supplement to the trend yield element models since the yield development is expected to be mainly
driven by the structural development of the markets (i.e. market maturing). This structural
development is represented by the trend yields.

6.9.2 Goodness of fit measure

To quantify the appropriateness of the generated yield models, the Root Mean Square Error (RMSE)
will be used as a goodness of fit measure\(^\text{39}\). The RMSE is a frequently used measure of the difference
between values predicted by a model or an estimator and the actually observed values of the modeled
series. Consequently, in this study the RMSE will be used to provide a measure of the difference
between the yields predicted by the constructed yield models for Prague, Budapest and Warsaw, and
the actually recorded yields in these three markets during the period 1993-2006.

Suppose that the actual yields time series is expressed as \(\theta_a\), and the modeled yields are expressed as
\(\theta_m\), then the RMSE is calculated by using the following algebraical expression.

\[
\text{RMSE} (\theta_a, \theta_m) = \sqrt{\text{MSE}(\theta_a, \theta_m)} \tag{13}
\]

This formula can subsequently be re-written as:

\[
\text{RMSE} (\theta_a, \theta_m) = \sqrt{E((\theta_a - \theta_m)^2)} \tag{14}
\]

Finally, formula 16 can be re-written as:

\[
\text{RMSE} (\theta_a, \theta_m) = \sqrt{\frac{\sum_{i=1}^{n}(x_{ai} - x_{mi})^2}{n}} \tag{15}
\]

By using formula (15), the RMSE of the actual yields and their modeled counterparts can easily be
calculated for each of the individual cities. Logically, a lower value of the RMSE hereby corresponds to

\(^{39}\) The RMSE value is a frequently used goodness of fit measure. McGough and Tsolacos [2001] for example used
the root mean squared percent error to determine the appropriateness of their constructed yield models.
a better model, since it indicates that on average the modeled yields deviate less from the actually recorded yields.

6.9.3 The modeled and actual yields in Prague

In paragraph 6.6 and 6.7 both Prague’s trend and cyclical yield have been modeled and algebraically expressed. By combining these algebraical expressions (formula 7 and 10 respectively), the following formula arises for modeling Prague’s yields.

\[
Y_{P,t} = 6.555 + 0.29 \cdot (\text{Actual inflation rates}_{c,t}) - 0.112 \cdot (1\text{YR lagged rental growth rates}_{P,t}) \quad [16]
\]

When the actual yields in Prague’s office investment market are plotted versus the modeled yields based on formula [16], the following image comes into being.

---

**Figure 6.10** Modeled and actual yields in the Prague office investment market

As can be read from figure 6.10, the modeled yields in Prague are much more volatile in comparison to the actually reported yields by PMA [2006a]. Whereas the actual yields show a rather flat, downward course, the modeled yields dispose of a more cyclical pattern. Nonetheless, the modeled yields incorporate the downward course as well, which represents the structural development of Prague’s office investment market from a challenged starting point towards maturity.

When taking a narrower look on the period 2003-2006, the model seems to be unable to catch up with the yields’ rapid decline in this period. This notion is likely to be related to the earlier noted
inadequacy of Prague’s cyclical yield model to catch up with the steep downward course of Prague’s actual cyclical yields since 2003 (recall figure 6.7). All in all, the outcomes are slightly disappointing since the modeled yields are quite deviating from the actual yields. Logically, it is therefore not surprising that the RMSE value is rather high with 1.1733, given the range of the actual and modeled yields.

6.9.4 The modeled and actual yields in Budapest

Based on the constructed trend and cyclical yield models in paragraph 6.6 and 6.7, the following formula for modeling the yields in Budapest’s office investment market has been constructed.

\[ \text{Yield}_{B_{t}} = 5.782 + 0.232 \cdot (\text{Actual inflation rates}_{B_{t}}) + 0.099 \cdot (\text{Cyclical interest rates}_{B_{t}}) \]  

[17]

By filling in formula [17], the yields can be modeled and graphically be plotted against the actually recorded office investment yields in the Hungarian capital. The following figure provides these actual and modeled yields.

![Modeled and actual yields Budapest (1993-2006)](image)

In comparison to the case of Prague, the modeled yields in Budapest are much more in line with the actually reported office investment yields by PMA, as can be seen when comparing figures 6.10 and 6.11. Whereas Prague’s modeled yields display a rather volatile course, their Budapest counterparts show a more gradual and flat course, apart from the period 1993-1995.
Whilst in Prague the modeled yields had significant problems in catching up with the actual yields in the period 2004-2006, a narrower look on the modeled and actual yields shows that Budapest's modeled yields are able to catch up pretty well with the steep decline of the actual yields in this period. This higher appropriateness is very likely to be related to the better fit of Budapest's cyclical yield model in comparison to Prague's one (see figures 6.7 and 6.8), since the steep decline of the yields since 2003 is merely a cyclical matter. Despite the convergence of the modeled and actual yields, the RMSE value of 1.1456 is still rather high and only slightly lower than in the case of Prague. As one can easily read from figure 6.10, this high value is however mainly a result of the divergent courses of the modeled and actual yields in the period 1993-1995. Thus, despite the high RMSE value, the modeling results are pretty satisfying.

6.9.5 The modeled and actual yields in Warsaw

Just like in the cases of Prague and Budapest, a yield model is constructed by combining Warsaw's trend and cyclical yield models. This combination leads to the following formula for modeling Warsaw's office investment market yields.

\[
Yield_{W,t} = 6.773 + 0.193 \cdot (\text{Actual inflation rates}_{P,t}) - 0.158 \cdot (1\text{YR lagged rental growth rates}_{W,t}) + 0.155 \cdot (\text{Cyclical short term interest rates}_{P,t}) \tag{18}
\]

Plotting the actually recorded yields and their modeled variants based on formula [18] leads to the following graph.

![Modeled and actual yields Warsaw (1993-2006)](image)
Warsaw's modeled yields are quite similar to the actually recorded yields by PMA, as can be seen in figure 6.12, although the modeled yields once again display a more volatile course. Like in the case of Budapest, Warsaw's modeled yields are able to catch up with the rapid decline of the actual yields in 2004-2006 quite well. However, the modeled yields in the previous period (2001-2003) are deviating from the actually reported yields, as the latter ones show a downward course while the modeled yields display an opposite course.

Nonetheless, the overall modeling capacities of the constructed model are superior to Prague's and Budapest's models with a RMSE value of 0.8080. Accordingly, the outcomes of the modeling of Warsaw's office investment market yields give cause for satisfaction.

6.9.6 The importance of the cyclical yield elements

As earlier reported in this thesis, the office investment markets in the Central European capital cities experienced a turbulent development since their origination in the early 1990s. This rapid development of these markets is clearly reflected by the strong declining office investment yields since the markets' originations (recall paragraph 5.3). Since the markets' developments in the examined period were mainly driven by the development from challenged starting points towards maturity, being represented by the trend yields, one can expect the trend yields to have a strong relation with the actual yield levels. However, next to the trend yield development, the cyclical yield elements are expected to play a role as well. Hence, the RMSE values of the actual yield levels and the modeled yield levels will be compared to the RMSE values of the actual yields and the modeled trend yields, to determine to what extent the modeled cyclical yield elements contribute to better fitting models. According to this line of reasoning, the models' modeling capacities are expected to be improved when including the cyclical yield element.

| Actual versus modeled yields | 1.17% | 1.15% | 0.81% |
| Actual yields versus modeled trend yields | 1.21% | 0.86% | 1.33% |

Table 6.15  RMSE values of the actual versus modeled yields and the actual versus modeled trend yields.

The different RMSE values, as plotted in table 6.15, are partly in line with the just expressed expectations. In the case of Prague, the yield model is improved when including the cyclical yield, although the improvement of the goodness of fit measure (i.e. RMSE) is rather limited as can be read from table 6.15. Meanwhile, in the case of Warsaw, the model's goodness of fit is strongly improved when including the cyclical yield element. Whilst the inclusion of the cyclical yield model in the cases
of Prague and Warsaw led to better fitting models, including the cyclical yield model in Budapest's case negatively affects the model's goodness of fit measure. Thus, albeit the development of the office investment market yields in Prague, Budapest and Warsaw is mainly driven by the markets' development towards maturity (i.e. trend yield), including the cyclical yield models does lead to better fitting models. Nonetheless, the effects of including the cyclical yield models leads differ per individual market as including Budapest's cyclical yield model negatively affects the goodness of fit measure.

6.10 Conclusions

This chapter elaborated on modeling the actual cyclical and trend yield drivers by using a number of pre-selected trend and cyclical yield drivers based on a study of relevant literature at which various statistical methods and tests have been used to construct profound models. Hereby, the conducted statistical analyses demonstrated that using the actual inflation rates results in the most appropriate trend yield models and that the cyclical yields can be modeled the best by using the cyclical short term interest rates and/or 1YR leading rental growth rates. When the constructed trend and cyclical yield models are subsequently used to model the actual yields of the office investment markets in Prague, Budapest and Warsaw the results are quite satisfying. Nevertheless, the goodness of fit measures differ per individual market, and the inclusion of the cyclical yield models leads to a less appropriate model in the case of Budapest. However, when forecasting Budapest's yield development, the cyclical yield model will be included as well because of uniformity principles. The outcomes of the conducted tests are encouraging for a number of reasons. First of all, despite the limited length of the times series, the actual yields can quite decently be modeled by using only a few variables. Secondly, the statistical analyses demonstrated that the theoretically hypothesized relations between the pre-selected drivers could be traced in the collected data sets. These findings are remarkable, since this study focuses on markets which have experienced turbulent development processes in the modeled period, whereas the hypothesized relations as expressed in chapter 4 are generally derived from the operation of mature markets. Consequently, these findings suggest that the relations which have earlier been found in mature markets can also be traced in markets which are in the middle of the development towards maturity. Accordingly, these findings partly refute the commonly believed notion that the operation of developing property investment markets can hardly be modeled and are merely caused by incidents and a concurrence of circumstances. Furthermore, all three composed yield models turn out to be unable to fully model the rapid yield compression which characterized the Central European office investment markets, as well as, office investment markets on a global scale over the past years, although the model's capacities differ per
modeled market. However, this incapacity is not very surprising since it is very hard to quantify the causes of this global yield compression (amongst others, the growing maturity of real estate investment as an asset class and the resulting growing popularity among institutional investors). Although, the investment market liquidity might be a valuable measure for quantifying this development, the driver was unfortunately rejected based on the statistical analyses.

Finally, it is hard to estimate the value of the models' modeling capacities and put them in perspective, since most known yield modeling studies elaborated on modeling yields in mature markets whilst this study focused on modeling yields in developing markets.
Part III  Forecasting and conclusions & recommendations

- Chapter 7  Forecasting office investment yields in Central Europe
- Chapter 8  The development and outlook for the case of Bucharest
- Chapter 9  Conclusions and recommendations
Forecasting office investment yields in Central Europe

7.1 Introduction

Based on the theoretical framework of chapter four and the collected data as discussed in chapter five, trend and cyclical yield models have been constructed for the office investment markets in the Central European capital cities. Now that these models have been constructed in the previous chapter, the constructed yield models can be used for forecasting the office investment yields to thus meet the objective of this study, as expressed in the first chapter. Consequently, this chapter elaborates on forecasting the office investment market yields in Prague, Budapest and Warsaw by using the findings of the previous chapters. Contiguously, the findings of this chapter will be used to provide an outlook for the development of Bucharest's office investment market in the following chapter.

7.2 Forecasting method and implications

As already noted in this chapter's introduction, the yield models constructed in chapter six will be used for forecasting the course of the office investment market yields. Quantitative yield forecasts will hereby be obtained by filling in forecasts for the models' independent variables (i.e. trend and cyclical yield drivers), consequently resulting in forecasted yield levels. However, using the models constructed in chapter six for generating profound yield forecasts entails some consequences and limitations which should be kept in mind.

Since the constructed models are based on past relations between the actual yield elements and the various selected trend and cyclical yield drivers, two assumptions are made with regard to the forecasts. First of all, the assumption is made that past relations between the yield elements and the various selected drivers, as incorporated in the trend and cyclical yield models, will persist in the future. However, as the statistical analyses in the previous chapter have shown that some relations could not (yet) be traced in all three markets one can expect that these relations will sooner or later manifest themselves. This notion may best be illustrated by the case of Prague's cyclical yield model.
Currently, Prague’s cyclical yield model does not include the cyclical short term interest rates due to the insignificant relation between this driver and Prague’s cyclical yield. However, this driver is included in both Budapest’s and Warsaw’s cyclical yield models as the relations between their cyclical yields and interest rates turned out to be significant. Consequently, forecasts for Prague’s cyclical yields can be impaired, as it is not inconceivable that Prague’s cyclical yield model should eventually be adjusted due to the occurrence of a significant relation between Prague’s cyclical yields and interest rates. The same argumentation likely applies in the case of Budapest, since its cyclical yield model currently does not yet include the leading rental growth rates as a driver. Secondly, by using forecasts for the trend and cyclical yield drivers (i.e. actual inflation rates, cyclical short term interest rates and the 1YR leading rental growth rates), the assumption is made that the forecasts for these drivers are correct. Since any forecast is affected by uncertainty, the forecasts for the drivers will also be affected by a certain degree of uncertainty. Accordingly, the most reliable, available forecast data for the various drivers will be used to generate the best possible yield forecasts\(^4\).

Finally, due to the limited length of the examined and modeled period, the length of forecasting period is limited as well. The length of the forecasted period is furthermore limited by the length of the available times series of the trend and cyclical yield drivers. Altogether, the shorter the forecasted period, the more reliable the forecasts will be and vice versa.

### 7.3 Data collection

#### 7.3.1 Introduction

Based on the outcomes of the statistical analyses on modeling the trend and cyclical yields in Prague, Budapest and Warsaw, one trend yield driver and two cyclical yield drivers have been selected for modeling the office investment market yields. Thus, for yield forecasting, forecasts for the actual inflation rates (trend yield driver) and the 1YR leading rental growth rates and the cyclical short term interest rates (cyclical yield drivers) will have to be collected. Due to the limited length of forecast data on the 1YR leading rental growth rates and the cyclical short term interest rates, the length of the forecasted yield period will be limited to three years. Consequently, yield levels will be forecasted for 2007, 2008 and 2009.

\(^4\) Hereby the reliability of a driver’s forecast is negatively related to the length of the forecasted period, meaning that the longer the forecasted period, the less reliable this data will be [Elliot et al., 2006].
7.3.2 Actual inflation rates

Inflation rates forecasts provided by the Economist Intelligence Unit's data stream database will be used for forecasting Prague's, Budapest's and Warsaw's trend yield elements. Although the database provides inflation forecasts until 2011, only forecasts until 2009 will be extracted due to the limited availability of forecasts of other yield drivers.

As can be read from figure 7.1, the inflation rates in all three Central European countries dispose of the expected downward course in the modeled period (1993-2006) as earlier observed in chapter five, and display the expected flattening course in the forecasted period as the economies are experiencing growing maturity. Additionally, it must be noted that the forecasts for the Hungarian inflation rates are quite deviating by showing a more volatile course, which is likely to be related to the earlier noted weaker state of the Hungarian economy in comparison to its Czech and Polish counterparts. In sum, the forecasts seem to be in line with the expectations by showing the expected flat course.
7.3.3 Rental growth rates

Rental growth forecasts provided by the earlier quoted PMA Office Occupier Forecast database could be used as input for the 1YR leading rental growth rates\(^41\). However, these figures will not be used as recently generated rental growth projections by ING Real Estate Investment Management\(^42\) are considered more reliable than the PMA rental growth forecasts. Thereupon, ING REIM's rental growth projections will be used for the yield forecasting.

![Actual and forecasted rental growth rates (1993-2009F)](image)

**Figure 7.2 Actual and forecasted office rental growth rates [PMA, 2006b and ING REIM, 2007]**

Although the statistical analysis ruled out the rental growth rates as a useful driver for modeling Budapest's cyclical yield, they are nonetheless plotted in figure 7.2 so that Budapest's rental growth rates can be compared to Prague's and Warsaw's rental growth rates. As can be seen in figure 7.2, the rental growth rates in Prague and Warsaw are expected to show positive rental growth in the period 2007-2010 after a long period of negative or flat rental growth. This expected positive rental growth indicates the appearance of a cyclical pattern in the course of the rental growth rates, and, moreover, supports the earlier made observation that the Central European office investment markets are more

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\(^41\) Given the leading character of the relation, rental growth forecasts until 2010 are required, to generate yield forecasts until 2009.

\(^42\) These are qualitative consensus forecasts of ING REIM's Central and Eastern European acquisitions and research team and ING REIM's research & strategy department in The Hague. In addition, ING REIM also generated yield consensus forecasts which will be used for comparing purposes in the following paragraph.
and more mature. Furthermore, the forecasted positive rental growth suggests that there may be room for continuation of the current yield compression which characterized the CE property investment markets over the past years.

Albeit the forecasted rental growth rates seem to initiate a cyclical pattern, the growth rates are still rather moderate in comparison to forecasted rental growth rates in other European markets such as London and Paris. This more moderate growth can be explained by a stronger and more direct interaction between supply and demand for office space in the less mature markets of Central Europe (recall paragraph 4.2).

7.3.4 Cyclical short term interest rates

Short term interest rates projections by Bloomberg L.P. [2007] have been used for calculating the forecasted cyclical short term interest rates in the Czech Republic, Hungary and Poland. These cyclical short term interest rates projections, as plotted in the following figure, will subsequently be implemented in the cyclical yield models.

![Actual and forecasted cyclical interest rates (1993 - 2009F)](image)

Figure 7.3 Actual and forecasted cyclical short term interest rates (OECD, 2006 and Bloomberg L.P, 2007)

Albeit the statistical analysis excluded the cyclical short term interest rates as a useful driver in the case of Prague, the Czech cyclical short term interest rates are included in figure 7.3 for comparing purposes. Whilst the patterns of the cyclical short term interest rates were volatile and varying per country in the 1990s, more similar courses appear since 2000, as the economies continued their
development and the interest rates were less volatile. This flattening course is expected to persist in the future according to Bloomberg's forecasts. The forecasted upward course of the cyclical interest rates, which can be read from figure 7.3, moreover indicates that there is upward potential for the office investment yields in the Central European capital cities. Furthermore, it must be noted that quite a clear cyclical pattern can be observed since 2001 in both the Czech Republic and Poland, consequently indicating the ongoing development and growing maturity of these economies.

7.4 Forecasting

7.4.1 Introduction
Now that the forecast data for the selected trend and cyclical yield drivers has been collected in the previous paragraph, forecasts can be made for the office investment market yields in Prague, Budapest and Warsaw. These forecasts are generated by filling in the collected forecast data for the drivers of the trend and cyclical yield models and counting up both models. To put the generated yield forecasts in perspective, the outcomes of these forecasts will be related to yield forecasts provided by PMA and ING Real Estate Investment Management.

7.4.2 Forecasting Prague's office investment market yields
Based on formula [9], Prague's trend yield has been forecasted for the period 2007-2009; likewise by using formula [12], Prague's cyclical yield element has been forecasted for the same period. When the outcomes of both the trend and cyclical yield forecasts are subsequently counted up and combined with the modeled and actual yields for the period 1993-2006 and the PMA and ING REIM yield forecasts, figure 7.4 arises.
Actual, modeled and forecasted yields in Prague (1993-2009F)

Figure 7.4 Modeled and forecasted yields versus the actual and forecasted office investment yields in Prague by PMA [2007a] and ING REIM [2007].

As can be read from figure 7.4 and table 7.1, the forecasted yields are quite divergent from the yield forecasts by both PMA and ING REIM, as the forecasted yield levels are much higher than their PMA and ING REIM counterparts. This deviation is, however, not very surprising, considering the substantial difference between the actual yield levels and the modeled yields in the preceding period (2004-2006). The model’s incapacity to catch up with the actual yields and forecasts by PMA and ING REIM is explained as the model turned out to be unable to capture the rapid yield compression which characterizes Prague’s office investment market and property investment markets on a global scale in this period (recall paragraph 3.3). Unfortunately, the (massive) weight of money targeting property investments over the past years cannot be dealt with. Consequently, the modeled yield levels are structurally higher than the actual yields since 2004 and the yield projections by PMA and ING REIM. Not surprisingly, because of the considerable differences between the generated forecasts and PMA and ING REIM’s forecasts, the RMSE value in the forecasting period (2007-2009) is significantly higher than the model’s original RMSE value. Whilst the original model’s RMSE value is 1.17, the RMSE value adds up to 1.98 in the forecasted period.
<table>
<thead>
<tr>
<th>Yield forecast 2007</th>
<th>7.41%</th>
<th>4.80%</th>
<th>5.30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield forecast 2008</td>
<td>6.66%</td>
<td>4.90%</td>
<td>5.15%</td>
</tr>
<tr>
<td>Yield forecast 2009</td>
<td>7.00%</td>
<td>5.20%</td>
<td>5.00%</td>
</tr>
</tbody>
</table>

Table 7.1  Forecasted yield levels by the constructed model, PMA [2007] and ING REIM [2007]

Despite these considerable differences between the actual and modeled yields and the high RMSE value, the model turns out to be able to catch up with the forecasted yield course as the gap between the dark blue line and the pale and orange line slightly narrows. Thus, the course of the generated forecasts is quite similar to the PMA and ING REIM forecasts, apart from the higher yield levels.

7.4.3  Forecasting Budapest's office investment market yields
Budapest’s office investment market yields can be forecasted by filling in the forecasted inflation rates in Budapest’s trend yield model and the forecasted cyclical short term interest rates in the cyclical yield model and adding up the outcomes of both models. The following figure provides a graphical overview of the actual and modeled yields for the period 1993-2006, the forecasts generated by the yield model, and the yield projections by PMA and ING REIM.

![Actual, modeled and forecasted yields in Budapest](image)

Figure 7.5  Modeled and forecasted yields versus the actual and forecasted office investment yields in Budapest by PMA [2007a] and ING REIM [2007]
In line with Prague's forecasted yield levels, the generated office investment yields for Budapest's office investment market are quite divergent from the forecasted yields by PMA and ING REIM (see figure 7.5 and table 7.2). Again this notion is not very surprising, since Budapest's yield model turned out to be unable to model the 2004-2006 yield compression to full extent as paragraph 6.8 has shown. Consequently, the yields generated by the constructed yield model are considerably higher than the yield forecasts by PMA and ING REIM. However, in comparison to the generated forecasts in the case of Prague, the generated forecasts are more in line with PMA's and ING REIM's yield forecasts.

<table>
<thead>
<tr>
<th>Yield forecast 2007</th>
<th>6.96%</th>
<th>4.90%</th>
<th>5.80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield forecast 2008</td>
<td>6.26%</td>
<td>5.10%</td>
<td>5.50%</td>
</tr>
<tr>
<td>Yield forecast 2009</td>
<td>6.29%</td>
<td>5.50%</td>
<td>5.40%</td>
</tr>
</tbody>
</table>

Table 7.2 Forecasted yield levels by the constructed model, PMA [2007] and ING REIM [2007]

Although the forecasted yields are quite deviating from other yield projections, the differences between the various forecasted yields are smaller in comparison to the case of Prague. This observation is moreover supported by the RMSE values of the available forecasts, since the RMSE of the generated yield forecasts versus the PMA and ING REIM forecasts is 1.34 in the case of Budapest, which is only a little higher than the model's original RMSE value of 1.15 (recall paragraph 6.9). Additionally, apart from the structurally overestimated yield levels, the course of the yields in the forecasted period is more or less in between the forecasts by PMA and ING REIM.

7.4.4 Forecasting Warsaw's office investment market yields

By using formula [11], Warsaw's trend yield has been forecasted for the period 2007-2009; likewise by using formula [14], Warsaw's cyclical yield element has been forecasted for the same period. Combining the outcomes of these trend and cyclical yield projections leads to yield forecasts as plotted in figure 7.6. To put the generated yield forecasts in perspective, again yield forecasts provided by PMA and ING REIM are plotted in figure 7.6 as well.
Actual, modeled and forecasted yields in Warsaw

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Modeled</th>
<th>PMA</th>
<th>ING REIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>16%</td>
<td>14%</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td>1994</td>
<td>14%</td>
<td>12%</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>1995</td>
<td>12%</td>
<td>10%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>1996</td>
<td>10%</td>
<td>8%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>1997</td>
<td>8%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>1998</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Figure 7.6 Modeled and forecasted yields versus the actual and forecasted office investment yields in Warsaw by PMA (2007a) and ING REIM (2007)

Based on the promising goodness of fit measure of Warsaw’s yield model as provided in the previous chapter, the model’s yield forecasts are disappointing, as they strongly deviate from the other available yield forecasts. In contrast to the latter forecasts, the yield forecasts generated by Warsaw’s yield model are much higher and moreover show quite a strong upward course. Whilst the forecasted yields in Prague and Budapest are indeed too high, at least the courses of these forecasted yields are quite in line with the forecasts by PMA and ING REIM. This does however not apply to the case of Warsaw, since the course of the generated forecasts is clearly not in line with the PMA and ING REIM forecasts. The inadequacy of the generated forecasts is furthermore supported by the high average RMSE value (2.13) of the generated yield forecasts versus PMA and ING REIM’s forecasts, which is more than twice as high as the model’s original RMSE value of 0.81 (recall paragraph 6.9)

The outward shift in the case of Warsaw is mainly caused by a strong upward course of the modeled cyclical yield element as of 2007, which results from a declining rental growth and a growing cyclical interest rate (see figures 7.2 and 7.3) Hence, one can question the utility of the constructed cyclical yield model and its coefficients. Since the model’s coefficients are based on the period 1993-2006, a period in which the market experienced a turbulent development, their values may be less useful for
forecasting yield levels in the coming years, as the market can be considered to be more or less mature and relations may, therefore, have changed.

<table>
<thead>
<tr>
<th>Yield forecast 2007</th>
<th>6.86%</th>
<th>4.70%</th>
<th>5.20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield forecast 2008</td>
<td>7.09%</td>
<td>4.80%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Yield forecast 2009</td>
<td>7.19%</td>
<td>5.10%</td>
<td>5.00%</td>
</tr>
</tbody>
</table>

Table 7.3 Forecasted yield levels by the constructed model, PMA [2007] and ING REIM [2007]

The precise yield forecasts, as plotted in table 7.3, clearly indicate the deviation of the generated yield forecasts versus the PMA and ING REIM forecasts. All in all, the generated forecasts are disappointing because of the substantial differences with other forecasts and the strongly deviating course of the yield development.

7.5 Conclusions

When the overall findings of this chapter are drawn together, the generated yield forecasts are rather deviating from the other available forecasts, as they all are considerably higher than the more qualitatively generated yield forecasts by PMA and ING REIM. These deviations are quite disappointing, especially when the goodness of fit measures of the modeled periods (1993-2006) are related to the goodness of fit measures of the forecasted period (2007-2009). Both in the cases of Prague and Warsaw, the goodness of fit measures considerably worsen. However, in the case of Budapest, the RMSE value of the generated forecast versus PMA's and ING REIM's forecasts is significantly lower. Nevertheless, when interpreting the generated forecasts and relating them to the other available forecasts, one must however understand that the forecasts of PMA and ING REIM are forecasts as well, i.e. that they will likely deviate from the actual yields in the future. Nonetheless, given the models' incapacies to catch up with the rapid yield compression which characterized the Central European office investment markets since 2003, the generated yield forecasts are likely too high.

In sum, one must not attach too much value to the numerical outcomes of the forecasts generated by the composed yield models, but rather interpret the course of the forecasted yields in the cases of Prague and Budapest, since the flattening course of the yields which is forecasted by both PMA and ING REIM for 2007-2009 can also be traced in the forecasts generated by the constructed yield models. This does, however, not apply for the case of Warsaw as its generated yield forecast course is far more deviating by showing a contradictory course.
The development and outlook for Bucharest's office investment market

8.1 Introduction

Now that the development of the office investment markets in the Central European capital cities has been examined, yield development models have been constructed, and yield forecasts have been generated in the preceding chapters, this chapter will focus on the development of the office investment market in Romania's capital city of Bucharest. In an effort to gain a deeper insight in the development process of Bucharest's office investment market, the findings of the previous chapters will be reflected to the development process of Bucharest's office investment market. The chapter will conclude by providing an outlook for the development of the office investment market in Romania's capital city.

8.2 The lagging development of Bucharest's office investment market

8.2.1 Introduction

As earlier noted in chapter two, Romania's political and economical background is very similar to those of the Czech Republic, Hungary and Poland due to their mutual era of communism and Soviet suppression in the period 1945-1989. Just like in the Central European nations, conventional property markets could therefore not exist until the collapse of the Soviet Union and abolition of communism in December 1989.

8.2.2 Romania's lagged economic restructuring

Whilst the Czech Republic, Hungary and Poland experienced turbulent and rapid transition processes from communist governments and centrally planned economies towards democracy and free market economies, Romania's development was far less swift. This lagging development of Romania in
comparison to the Central European countries is mainly explained by the inheritance of Nicolae Ceauşescu's autocratic and devastating regime. During his rule (1965-1989) Romania’s communist party leader systematically oppressed the Romanian population and abused his appropriated power to carry his megalomania into effect. Ceauşescu’s megalomania is best illustrated by the construction of The House of the People43 during the final stage of his regime. After his execution in 1989, Romania was burdened with a completely exhausted and devastated economic system, which consequently heavily impeded the country’s economical and political restructuring processes in the 1990s.
Until the late 1990s the country would be plagued by recessions, hyperinflation, and negative GDP growth, whereas the Czech Republic, Hungary and Poland experienced prosperous developments [Campos and Coricelli, 2002]. However, since 2000, the Romanian economy experiences an ongoing growth and strengthening, which is reflected in rapidly declining inflation rates and steady and prosperous GDP growth [EIU, 2006]. Altogether, the country’s structural and progressive economic development in the last decade resulted in Romania’s EU accession as of January 1st, 2007.

8.2.3 Lagged development of Bucharest’s commercial property markets
Logically because of Romania’s lagging, less stable and less prosperous economic development and restructuring in the 1990s in comparison to the Central European region, the emergence of conventional property markets in Bucharest was delayed. Whereas property (investment) markets rapidly developed themselves in Prague, Budapest and Warsaw in the 1990s, and the first known property investment transactions were recorded in 1997, it would last until 2003 for the first institutional investment deals to be reported in Bucharest’s property market [Colliers, 2001]. Not unsurprisingly, these first investments involved two Austrian investors. CA Immo bought the 14,300 sqm. Europe House, and Europolis bought the 11,480 sqm. Opera Center.
The lagging development of Bucharest’s property markets may best be illustrated by comparing the extent of the city’s class A office stock to the office stocks in Prague, Budapest and Warsaw. As can clearly be read from figure 8.1, the extent of the office stock in Bucharest is marginal in comparison to the Central European capital cities, thereby underlining the lagging development.

43 One fifth of Bucharest’s historical city centre was demolished to construct this gigantesque building. During the construction of the building (1984-1989), Romania’s economy was almost entirely devoted to the construction of the Casa Republicii (original name).
Additionally, this lagging development is illustrated when comparing the extent of the class A office stock relative to the cities' populations (see figure 8.3). Whilst Prague, Budapest, and Warsaw dispose of well over 1.0 square meter office space per inhabitant, Bucharest disposes over less than 0.22 square meter office space per inhabitant by year-end 2006.

![Figure 8.3](image_url)
The lagging development can, furthermore, also be traced when comparing the liquidity of the Central and Eastern European office investment markets, expressed by the annual percentage of traded office stock. Figure 8.4 evidently illustrates the differences between Bucharest and Prague, Budapest and Warsaw. Next to illustrating the lagging development of the investment market liquidity, the figures in figure 8.4 indicate an accelerated development of Bucharest's office investment market relative to the office investment markets in the CEE capital cities, by recording a much steeper growth of the market liquidity.

![Office investment market liquidity in CEE capital cities (1997-2006)](image)

*Figure 8.4  Development of the office investment market liquidity in the Central and Eastern European capital cities [ING REIM, 2006]*

The rapid increase of the liquidity of Bucharest's office investment market is believed to be related to a number of factors, according to, among others, Colliers [2006] and the Urban Land Institute and PWC [2006]. First of all, the excessive 'wall of money' which has been flooding property markets on a global scale over the past years (recall paragraph 3.3) triggered property investors to tread on new markets such as Romania, due to a lack of suitable and affordable properties in their domestic markets. The resulting rapidly growing demand for property investments in Bucharest was, furthermore, boosted by the forthcoming EU accession, as a result of which statutory barriers to invest in Romanian properties would fall away for some investors and investment vehicles. Furthermore, given the similarity of the cultural, political and economical background of Romania and the Central European region, one can expect there to be a learning effect from the development process of the property
markets in Central Europe. Consequently, such a learning effect can make investors less reluctant to invest in Bucharest’s office investment market.

8.2.4 Conclusion
Altogether, this paragraph has shown the lagging development of Bucharest’s office (investment) market relative to the markets in Prague, Budapest and Warsaw. The retarded development of Bucharest’s property markets is generally believed to be a consequence of Romania’s far less stable, swift, and prosperous economic restructuring and transition in the 1990s in comparison to the transition and restructuring processes in the Czech Republic, Hungary and Poland. However, as of the turn of the millennium, Romania’s economic restructuring gains momentum and Bucharest’s property markets rapidly develop themselves in the wake of the country’s prosperous economic development. Moreover, this paragraph demonstrated the rapid growth of the office investment market, which indicates a rapid market maturing process in Romania’s capital city. Consequently, the effects of this rapid development in the past few years on the office investment yields in Bucharest will be discussed in the following paragraph.

8.3 Comparing yield developments in the Central and Eastern European region

8.3.1 Introduction
Following the findings of the previous paragraph, this paragraph will elaborate on the effects of the rapid development of Bucharest’s property markets on Bucharest’s office investment market. In particular, the development of the office investment market yields will be examined. In analyzing the development of Bucharest’s office investment yields, their development will be related to the development of the office investment yields in Prague, Budapest and Warsaw. Once again, the courses of the office investment yields will hereby be anatomized in a trend and cyclical element.

8.3.2 Bucharest’s office investment yield development
As earlier noted, Bucharest’s office investment market only recently emerged, whilst the office investment markets in the Central European capital cities already emerged back in the 1990s. Consequently, the available time series on office investment yields in Bucharest are very short, as the first available yield level dates from 2003. The actual yield levels in the Central and Eastern European capital cities are plotted in figure 8.5.
The effects of the 'wall of money' which has been flooding property investment markets over the past years, and the resulting turbulent acceleration of Bucharest office investment market liquidity, as discussed in the previous paragraph, clearly affected the course of the office investment yields in Bucharest. As can clearly be seen in figure 8.5, office investment yields in Bucharest have rushed down with a staggering pace since 2003.

To compare and examine the development of the office investment yields in Bucharest relative to the Central European office investment markets, the actual yields have been anatomized in trend and cyclical yield elements as can be seen in the following figures. For comparing purposes, Bucharest's anatomized yield elements have been put back in time. Therefore, when interpreting figure 8.6, one must note that the years on the horizontal axis do not apply for Bucharest, since Bucharest's trend yield element has been put back in time.
Trend yield elements of the office investment markets in CEE capital cities

\[ y = -2.25 \cdot \ln(x) + 12.75 \]

\[ y = -3.99 \cdot \ln(x) + 12.75 \]

Figure 8.6  Trend yield elements of the office investment yields in Prague, Budapest, Warsaw and Bucharest and corresponding formulas [Adapted from PMA, 2006a and ING REIM, 2007].

Whereas the courses of the trend yield lines in Prague, Budapest and Warsaw are quite similar, the course of Bucharest's trend yield is quite deviating as it is much steeper (see figure 8.6). This steepness logically corresponds to a higher absolute value of Bucharest's trend yield line coefficient (3.99) relative to those of Prague (2.25), Budapest (2.88), and Warsaw (3.11). This steeper course indicates a more rapid development and maturing process in Bucharest relative to Prague, Budapest and Warsaw. Due to this rapid development, as of 2006, Bucharest's trend yield level is almost equal to those in the Central European capital cities, as can be read from figure 8.6. Furthermore, the courses of the actual yield levels in Bucharest and Bucharest's trend yield element are very similar, as can be seen when comparing figures 8.5 and 8.6.
As can be seen in figure 8.7, the course of Bucharest's cyclical yield element is almost flat in comparison to the cyclical yield elements in Prague, Budapest and Warsaw. Analogous to figure 8.6, it must, once again, be noted that the years on the horizontal axis do not apply for Bucharest. This flat course logically results from the largely comparability of the actual yields and the trend yields. Thus, the development of the yields in Bucharest's office investment market seems to be mainly driven by the trend yield development (i.e. market maturing process), with a marginal role for the cyclical yield elements. This notion is supported when comparing the RMSE values of the actual yields versus the trend yields in the first four recorded years of the office investment markets in Prague, Budapest, Warsaw and Bucharest. Table 8.1 provides the RMSE values for the individual markets.

The RMSE values clearly indicate the dominance of the trend yield course in the case of Bucharest relative to the Central European capital cities. Whilst in Bucharest the difference between the actual yields and the trend yields is very low, the differences are much higher in the cases of Prague, Budapest and Warsaw. Albeit the figures evidently indicate that the yield development in Bucharest is
largely fostered by the market maturing process (i.e. trend yields), which on its turn is strongly influenced by the vast amount of capital pouring into the market, one must be a little distant in attributing too much weight to this notion because of the small data sets.

8.3.3 Conclusion

The rapid yield compression which characterizes the development of the office investment market in Bucharest over the past few years is predominantly fueled by the market's turbulent maturing process. In comparison to neighboring and comparable markets, such as Prague, Budapest and Warsaw, Bucharest's yield compression is impressive. When comparing these markets' liquidity, yields and anatomized yield elements, the dominance of Bucharest's maturing process (represented by the trend yields) is abundantly.

The market's extremely rapid development, in terms of yield compression, is expected to be fostered by two factors. On the one hand the wall of money which has been flooding property investment markets over the past years, greatly contributed to this rapid development. Secondly, the prosperous development of the neighboring and comparable office investment markets in the Central European region contributed as well.

8.4 Forecasting the development of the office investment market in Bucharest; yield outlook

8.4.1 Introduction

Next to generating yield forecasts for the office investment markets in Central Europe, this thesis also sets out to provide an outlook for the development of Bucharest's office investment market. As the previous paragraphs have shown, the development of the office investment yields in Bucharest's office investment market is quite deviating from the development pattern of yields in the Central European region. This will inevitably influence the development of Bucharest's office investment market in the coming years. Consequently, these factors will have to be taken into account when generating an outlook for Bucharest's office investment market.

8.4.2 Outlook for the development of Bucharest's office investment market

Prior to generating an outlook for the development of Bucharest's office investment yields in the following section, this section will more generally examine the future development of Bucharest's office investment market. Hence, market characteristics, such as, the expected development of the
office investment supply (i.e. class A office stock) and liquidity, the expected rental growth development, and market transparency, will be discussed.

For any property investment market to function properly, a certain extent of office stock is required. As figure 8.3 has earlier shown, the extent of Bucharest's office market significantly lags the Central European markets. The relatively small extent of Bucharest's office market, however, did not restrain property investors from purchasing office properties in Romania's capital, considering the very high liquidity of Bucharest's office investment market as from 2003 (recall figure 8.4). The city's office stock is projected to experience a considerable growth in the coming years, with the completion and delivery of a large number of newly developed office properties [Colliers, 2006 and CBRE, 2006]. Large, new office schemes, such as, City Gate (40,000 sqm), S Park (35,000 sqm), and Baneasa Business & Technology Park (30,000 sqm) are to be completed in 2007 and will significantly boost Bucharest's class A office stock. The office stock growth is furthermore fueled by the completion of several smaller office schemes.

The projected boost of office stock can be expected to have its effect on the liquidity of the office investment market, as the available investment supply increases. The expansion of investment supply will likely have a relaxing effect to the current, strained office investment market in Bucharest, and may lead to more conventional liquidity figures, which are more in line with the neighboring markets of Prague, Budapest and Warsaw (recall figure 8.4 again).

The considerable growth of the office supply will inevitably have its effect on office rents in Bucharest, notwithstanding the demand for office space is expected to remain quite strong in the coming years [CBRE, 2006 and Colliers, 2006]. According to ING REIM [2007], the current lack of space in the city centre will be reflected by a 2.5 percent rental growth in 2007. However, due to strong development activities, and the delivery of new office schemes in the next years, negative rental growth is forecasted as from 2008 until 2010, since supply will start to exceed demand. The following figure plots both the actual rental growth according to Colliers, as well as, ING REIM's rental growth projections.
Finally, the growing transparency, which characterized property (investment) markets in Bucharest over the past years, can be expected to persist in the coming years. This notion is supported by the growing professionalism of the markets, which results from a growing number of property professionals (e.g. brokers, advisors, and consultants) and the widening spectrum of active investor types. Altogether, the transparency of Bucharest’s property (investment) markets can therefore be expected to keep on growing in the coming years.

In sum, the outlook for Bucharest’s office investment market is rather rosy, as the market is expected to continue its development. However, the development is expected to be different in comparison to the past few years. Whereas the development pace has been very turbulent, rapid and staggering over the past few years, the market’s development in the coming years will likely be less hectic and strained. The projected growing supply of investment products\textsuperscript{44}, will make the market more able to manage the expected, ongoing capital flow into the property investment markets. Additionally, the ongoing market professionalization will contribute one’s mite.

\textsuperscript{44} Not only will the office investment market be unburdened by a growing investment supply, due to the completion and delivery of new schemes, but also, due to a growing supply of retail and industrial investment properties.
8.4.3 Outlook for the development of Bucharest's office investment yields

Contiguous to the painted picture of the development of Bucharest’s office investment market in the previous section, this section will enlarge upon the development of office investment yields in this market. In doing so, the findings of the previous sections will be taken into account when generating a yield outlook.

Whereas the generated forecasts for the office investment yields in Prague, Budapest, and Warsaw are based on statistically generated yield models, generating statistically modeled office investment yield forecasts for Bucharest’s office investment market is impossible, due to the very small size of the available datasets. Alternatively, forecasts could be generated by applying the earlier constructed yield models of Prague’s, Budapest’s, and Warsaw’s office investment markets to the case of Bucharest. However, given the findings of the previous paragraphs, which have shown the strongly deviating development of Bucharest’s trend and cyclical yield elements relative to those in Prague, Budapest and Warsaw, this will not be a good strategy.

Paragraph 8.3 illustrated the dominance of the trend yield element in the development of Bucharest’s office investment yields over the past few years. For a number of reasons, this dominating role of the trend yield element (reflecting the market maturing process) can be expected to continue in the next few years. First of all, the ‘wall of money’ which has been flooding property investment markets over the past few years is expected to continue in the coming years, consequently driving further yield compression. Furthermore, the prosperous projections for Romania’s economic development and growth in the coming years in combination with the benefits of the country’s recent EU accession will keep up the country’s attractiveness to investors. Additionally, the learning effect of the development of the office investment markets in Central Europe can be expected to significantly contribute to the narrowing of gap between yields in CE and Bucharest. All in all, the yield course development can therefore be expected to still be predominantly driven by the market’s trend yield course. Accordingly, a forecast for the development of the office investment yields in Bucharest can be obtained by extending Bucharest’s trend yield element line as plotted in figure 8.6. By using the formula of Bucharest’s trend yield line, as plotted in figure 8.6, yield forecasts can thereupon be used. These forecasts are plotted in the following figure.
Extending the trend yield line results in the expected flattening course of the trend yields as can clearly be seen in figure 8.9. This flattening course is explained by the ongoing maturing process of the market (recall paragraph 4.2 and 4.3). Moreover, the flattening course is in line with the findings paragraph 8.4.2, which concluded by arguing that the market would become less hectic and strained, which is represented by the flattening course of the yields.

To put the generated yield forecasts in perspective, yield forecasts by ING REIM have been plotted in figure 8.9 as well. As can be seen in the figure, the generated yield forecasts are very similar to yield forecasts by ING REIM. In addition to figure 8.9, the following table provides the actual values of both forecasts.

<table>
<thead>
<tr>
<th>Modeled</th>
<th>6.33%</th>
<th>5.60%</th>
<th>4.99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ING REIM</td>
<td>6.10%</td>
<td>5.50%</td>
<td>5.25%</td>
</tr>
</tbody>
</table>

When interpreting the generated yields forecasts, one must keep in mind that these forecasts are merely a result of extending the trend yield line. However, as property investment markets mature, yields will be more and more affected by cyclical patterns (recall paragraph 4.2). Moreover, chapter 6 has shown that cyclical yields elements do play a significant role in the Central European office
investment markets. All in all, this illustrates the growing importance of cyclical yield element as markets continue their development and trend yields start to flatten. Accordingly, the generated forecasts, as plotted in figure 8.9 and table 8.2, are likely to be affected by a growing importance of the cyclical yield element.

Figure 8.5 has earlier shown the rather flat course of Bucharest’s cyclical yield elements in the period 2003-2006. However, as Bucharest’s office investment market continues its development, and will increasingly be affected by cyclical patterns, the cyclical yield elements can be expected to display a less flattened course. As chapter 6 has earlier shown that Prague’s, Budapest’s, and Warsaw’s cyclical yield elements are driven by the cyclical element of interest rates and leading rental growth rates, Bucharest’s cyclical yield element will eventually also be influenced by these drivers. Analogous to this reasoning, the projected negative rental growth in the coming years can be expected to have a driving effect on the yields. Consequently, the generated yield forecasts, as plotted in table 8.2 and figure 8.8, will probably be underestimated.

8.5 Conclusions

This chapter has shown the turbulent and hectic development of Bucharest’s office investment market, relative to the markets in Prague, Budapest and Warsaw. Fueled by vast amounts of capital pouring into the market, Bucharest’s office investment yields have rushed down with a staggering pace since 2003. As of the overture, the office investment market in Bucharest was strongly influenced by the ‘wall of money’. Since the development process of Bucharest’s office investment market was shown to be rather deviating from the development processes in the Central European capitals, the constructed yield models for modeling the yields in Prague, Budapest or Warsaw could not be used for forecasting the yield development in Bucharest.

Considering the outlook for Bucharest’s office investment market, the market is expected to be in smoother waters in the coming years, as the yield compression is forecasted to level off and the market is expected to expand significantly. Nonetheless, since the ‘wall of money’ is expected to persist in the coming years, further yield compression will occur and the current gap between office investment yields in Central and Eastern Europe is expected to narrow. Additionally, in the coming years, the yields are awaited to be increasingly affected by cyclical patterns.
Conclusions and recommendations

9.1 Introduction

After having extensively studied the development of the office investment markets in the Central and Eastern European region in the preceding chapters, conclusions will be drawn in this final chapter. These conclusions will relate to this thesis's objective and the subdivided sub-questions as stated in the first, introductory chapter. In addition to drawing conclusions, this chapter will hand recommendations for further research as well.

9.2 Conclusions

The conclusions, as presented in this paragraph, are bi-partly composed. In the first part, general, overall conclusions will be drawn with regards to the development processes of property (investment) markets in Central and Eastern Europe and their expected future. Subsequently, in the second part, more specific conclusions will be drawn with regards to the actual yield modeling and forecasting.

Overall, this study has proven to be useful for understanding the development processes of office (investment) markets in Central and Eastern Europe, by providing a deeper and more profound insight in the development processes of these markets. Accordingly, these findings can be valuable for understanding and examining the future development of these markets, and/or when studying the development processes of other property markets.

Whereas the performances (i.e. yield development) of the property investment markets in Central Europe can be modeled quite decently by using ‘traditional’ yield drivers, such as rental growth projections and interest rates until 2002, the rapid yield compression as of 2003, can hardly be modeled by the constructed yield models. This rapid yield compression is commonly believed to be fueled by the vast amounts of capital pouring into property investment markets on a global scale, due to growing interest in property investments (recall paragraph 3.3) over the past years. Secondly, the
increasing application of advanced finance methods, such as CMBS, which lower the cost of funding, enable investors to pay higher prices for properties, consequently resulting in lower yield levels. Thus, one can conclude that the yield development in Prague’s, Budapest’s, and Warsaw’s office investment markets over the past years, which could be modeled quite successfully until 2002, is likely to increasing driven by irrational factors over the past few years, rather than by property investment market fundamentals. The resulting effects may be best illustrated by the significant differences between the modeled yield forecasts and forecasts by ING REIM and PMA. Although flattening yield courses are forecasted by ING REIM, PMA and the constructed yield models, the yield forecasts, based on property investment market fundamentals (i.e. modeled yield forecasts) are significantly higher than the more intuitively based forecasts by ING REIM and PMA. Hence, these findings raise the question as to what extent the office investment markets in Central Europe are possibly overpriced, since the markets seem to be more and more driven by irrational factors, rather than by property investment market fundamentals.

When examining the development process of Bucharest’s office investment market, certain parallels can be drawn between Bucharest’s development process and the development processes in the Central European region. However, relative to Prague, Budapest and Warsaw, Bucharest’s development pace is even much faster. This faster development pace becomes clear when comparing the markets’ liquidity and yield course. The tremendous development pace of Bucharest’s office investment market and the market’s rapid yield compression since 2003, indicate that the market is likely to be more driven by irrational factors, rather than by property investment market fundamentals.

Altogether, this study demonstrated that, to a certain extent, the office investment yield development in Central and Eastern Europe can be explained by property investment market fundamentals. However, over the past few years, the course of office investment yields is shown to be increasingly affected by irrational factors. Consequently, the question rises as to what extent office property investments in Central and Eastern Europe are overpriced.

Additionally, the following conclusions have been drawn with regards to the actual modeling and forecasting of office investment yields in Central and Eastern Europe.

- According to the conducted study of literature, quite a number of drivers were shown to be related to office investment yields. However, as this study has shown, only a limited number of the expected relations could statistically be shown to be significantly related to the trend or cyclical yield elements.
• The actual inflation rates are shown to be a useful driver for modeling the trend yield elements of Prague, Budapest and Warsaw. This finding is plausible, since inflation rates are frequently used as a risk indicator, and the course of the trend yields is considered to be merely a result of market maturing (i.e. declining risk perceptions).

• Both in Budapest and Warsaw, the cyclical interest rates turn out to be significantly related to these cities' cyclical yield elements. This finding is, however, partly inconsistent with the theoretical expectations, since the relation between interest rates and yields is commonly believed to be lagged. Accordingly, this finding indicates that yields react more directly to changing interest rates than it is generally believed.

• Next to the cyclical interest rates being an important driver for modeling the cyclical yield element, 1 year leading rental growth rates are shown to be strongly related to the cyclical yield element. A correlation analyses has shown that in all three Central European office investment markets, the expected negative relation between leading rental growth rates and the cyclical yield elements could be demonstrated. Unfortunately, in the case of Budapest, this relation turned out to be too weak, to be implemented in the city's cyclical yield model.

• Although various studies found evidence for GDP growth rates to be related to yields and returns, no such relations were found in this study. This may be explained as the GDP growth rates are more likely to be related the rental growth rates (being a yield component), rather than to yields themselves.

• A yield forecast for Bucharest's office investment market has been generated by extending the current trend yield course, since the market was shown to be predominantly driven by the course of the trend yields. However, these yield forecasts are likely imperfect, as the yield course is expected to be increasingly affected by cyclical patterns as the market continues its development.

• Whereas the applied yield development model, which dissect the actual yields in a trend and cyclical element, was originally used for modeling high street retail investment yields, this study demonstrated the applicability of Teuben's yield development model for modeling office investment yields.

• Altogether, time will tell how reliable the generated yield forecasts for the office investment markets in Prague, Budapest, Warsaw and Bucharest are, and will consequently judge the usefulness and quality of the constructed yield models.
9.3 Recommendations for further research

A number of recommendations ensue from the findings of this study, and may incite to further research on the Central and Eastern European investment markets or the applied methods and techniques. Based on this study’s findings, the following recommendations for further research are made:

- As the used data sets in this study are rather small, redoing this study can be valuable, since the findings will be more reliable, as larger data sets will make the outcomes more reliable and statistically more well-founded. Moreover, redoing the current research will indicate whether the currently retrieved relations do persist in the future, whether the yield models will become more uniform (i.e. containing the same drivers) and whether new relations do occur.

- In the current research, the regression coefficients of the various drivers are based on the whole examined period, which may lead to sub-optimal coefficients. In a future research it might, therefore, be useful and valuable to make distinctions between the different property market development phases when constructing yield models, as a specific driver might, for example, have a higher influence in a mature phase than in an emerging phase. This issue could possibly be taken into account by attributing different weightings to a certain driver per development phase. However, given the small size of the available data sets, attributing different weights would weaken the statistical power of the outcomes. Moreover, a division into different phases is arbitrary, as such a division would merely be subjective.

- Given the expected continuation of the ‘wall of money’, it would be interesting to examine the effects of this ongoing capital influx to the development of office investment markets in secondary cities in Central and Eastern Europe. Possibly, such cities may experience a turbulent and rapid development similar to the recent developments in Bucharest in the coming years.

- Although the applied methodology in this study led to useful findings, and can likely be successfully applied in other markets as well, using other methodologies and techniques for modeling and forecasting real estate times series would be valuable, as the applied methodology has its shortcomings. Additionally, using other methodologies will inevitably lead to a further expansion of the expertise in the field of real estate time series modeling, a discipline which is currently still rather underexposed.

- Finally, it could be beneficial to use quarterly data in future research, rather than using annual data, to come to more reliable and statistically stronger results. Given the growing availability of data and increasing transparency of property markets, this is not inconceivable.
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