Czech University of Life Sciences in Prague

Faculty of Economics and Management

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Diploma Thesis

Economic Analysis of Commercial Real Estate Properties in the CEE Region

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Diploma Thesis Assignment

Affirmation:

I hereby declare that I worked on the diploma thesis “Economic Analysis of Commercial Real Estate Properties in the CEE Region” on my own. All sources that I used are mentioned in the references of this diploma thesis.

Prague _____

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Economic Analysis of Commercial Real Estate Properties in the CEE Region

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Ekonomická analýza trhu s komerčními realitami v CEE regionu

Summary

The aim of the diploma thesis is to analyze the market for office properties in the CEE region. Content analysis and econometric modeling will help to identify which macro and micro economic factors influence the yield rates for office properties in the selected cities – Prague, Budapest, and Warsaw. The theoretical background about commercial real estate and specifics of the office market is provided in the literature review. The overview of the CEE market for office properties and the basis of time series analysis and econometric modeling is described in the practical part of the diploma thesis (chapter 4). Furthermore the practical part (chapter 5) focuses on creation of an econometric model for the office market in Prague, Warsaw, and Budapest and its comparison. The final part of the diploma thesis evaluates the outcomes.

Souhrn

Cílem diplomové práce je analyzovat trh s komerčními nemovitostmi v regionu střední a východní Evropy. Pomocí obsahové analýzy a ekonometrického modelování jsou identifikovány hlavní makro a mikroekonomické faktory, které ovlivňují výnosy kancelářských budov ve vybraných městech – Praha, Varšava, Budapešť. V první části práce je popsán teoretický základ komerčních nemovitostí a specifika trhu s kancelářskými budovami. Přehled trhu v CEE regionu a také základ analýzy časových řad a ekonometrického modelování je popsán v praktické části diplomové práce. Dále je praktická část věnována vytvoření ekonometrického modelu pro trh s kancelářskými budovami v Praze, Varšavě a Budapešti a jejich porovnání. V závěrečné části jsou hodnoceny výsledky.

Keywords: Real estate, econometrics, office, Prague, Warsaw, Budapest, CEE, vacancy rate, yield rate, ocupancy, rent, GDP.

Klíčová slova: Realitní trh, ekonometrie, Praha, Varšava, Budapešť, výnos, míra obsazenosti, míra neobsazenosti, nájemné, HDP.

Content

1 Introduction

Real estate plays important role in national economy. It represents up to 40% of household's wealth. Institutional and private investors perceive real estate assets as relatively safe type of an investment. Therefore it is often used to diversify an investment portfolio. Modern portfolio theory suggests investing into combination of assets that do not correlate perfectly (Modern Portfolio Theory developed by Markowitz). Such a combination has the ability to reduce risk while maintaining the same level of returns. [1] [2]

Real estate investment can be made either directly into a selected property or through an investment into trusts and funds. Countries, evaluated in the diploma thesis (Czech Republic, Poland and Hungary), entered European Union in 2004. Removing barriers of capital movement helped to fully develop the market with commercial real estate. Integration processes lead toward creation of single market. Political and economic integration of all EU countries increased the information flow and positively stimulated overall growth of the economy. [1]

In comparison with other assets real estate investment has been historically seen as a relatively safe long-term type of investment. At the same time it is still able to generate higher returns than long term government bonds. Central and Eastern Europe has experienced a massive inflow of foreign direct investments (FDIs) and portfolio investment during the 1990s. Large privatization and changes in the legal framework made cross border investment possible. This was due to the changes from centrally planned economy to free market economy caused by the political changes. Czech Republic, Poland, and Hungary share not only recent political history but have also other commonalities. One of them is the economic dominance of their capital city. Large city markets with developed infrastructure and concentrated business and service sector attract more investment inflows than the rest of the country.

Comparative advantage of relative importance of the cities influence provides more investor opportunities. [2]

Success of large agglomerations of Prague, Warsaw and Budapest depends on the ability to adapt to market economy and to be able to capture all economic flows. Cities which failed to improve their service sector and infrastructure during the transformation to market economy now face wider gap in prosperity between them and Western Europe.

Real estate value is derived from current local market condition, as it is given by its definition of an asset permanently connected to ground. Determinants such as local supply and demand are major factors influencing the value of real estate. Constraints such as zoning, planning or urban policy can attract or drive investors away.

Complexity of real estate market and its importance as investment option and ale its connection to economy has forced researchers to study the dynamics of this sector.

2 Objectives and Methodology

2.1 Aim of the diploma thesis

The overall aim of the diploma thesis is to analyze which macro and micro economic factors influence yield rates for office properties in the CEE region. This goal will be achieved by the analysis of the economic environment in Prague, Warsaw, and Budapest. Data collected from the databases of CBRE Global Investors will be used to formulate an econometric model and to prove or disprove following hypotheses.

1. **Yield rates are influenced by GDP, prime rents, vacancy rates, and take-up**
2. **Yield rates of office properties in Prague, Warsaw, and Budapest are influenced by the same micro and macro-economic factors.**

2.2 Methodology

The method used in the third chapter of the diploma thesis - Literature review, is based mainly on content analysis of documents. The aim of the literature review is to: [1] be familiarized with the real estate market, [2] to provide sufficient knowledge background for yield forecasting, [3] to summarize the main economic factors influencing development of the commercial real estate market in Prague, Warsaw; and Budapest, and [4] to familiarize with the main terminology of econometric modeling.

The main method used in the fourth chapter is time series analysis followed by econometric modeling. Results derived from econometric model will prove or disprove hypotheses. Model is derived from quarterly data from the period 2002Q2-2011Q2 (Czech Republic), annual data for the period 1995-2011 (Poland), and quarterly data for the period 2005Q1 – 2011Q2 (Hungary).

3 Literature Review

3.1 Real Estate System

The real estate system (market) as a whole can be divided into three main sub-categories:

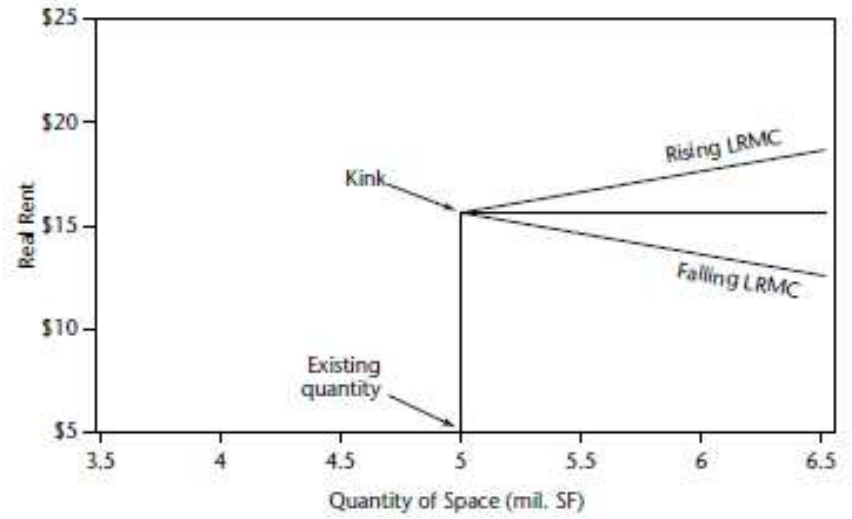
- Space market
- Asset market
- Development market

Space market

Space market is often referred to as rental market or usage market. Space market is the market for the right to use a real estate property. Individuals, households, and firms demand space to rent. Real estate owners are on the supply side and price (rent) is determined from the interaction of supply and demand.

Demand curve follows the usual pattern of declining slope; supply curve of real estate market is kinked. Level of supply is nearly constant in short run (The supply of existing buildings cannot be reduced if demand decreases, and reaction to increasing demand is delayed due to construction time). The kink represents the current level of built space and rents that equal the long run marginal cost of supplying additional space to the market. The effect of kinked supply curve on prices in is depicted in Chart 1. [3].

Chart 1 Real Estate Space Market - Supply curve



Source: Commercial Real Estate Analysis & Investments, page 7; [3]

Specifics of the space market lie in the immobility of real estate. Supply side of the market is therefore limited to specific location and in most cases is also limited to the specific type of real estate. Limitations on the supple side resulted into segmentation of space market into several sub categories according to (micro) location and type of use. [3]

Asset market

Asset market is also referred to as a property market. Real estate properties are assets that can generate future cash flows (rents the building can generate to its owner). The real estate asset market is part of the capital market; i.e. market for capital assets of all kinds. General division of capital market is depicted below in Table 1. [3]

Table 1 Types of Capital Asset Market

	Public Markets	**Private Markets**
Equity Assets	Stocks REITs Mutual Funds	Real Property Private Equity Hedge Funds
Debt Assets	Bonds MBS Money Instruments	Bank Loans Whole Mortgages Venture Debts & LBOs

Source: Commercial Real Estate Analysis & Investments, page 11; [3]

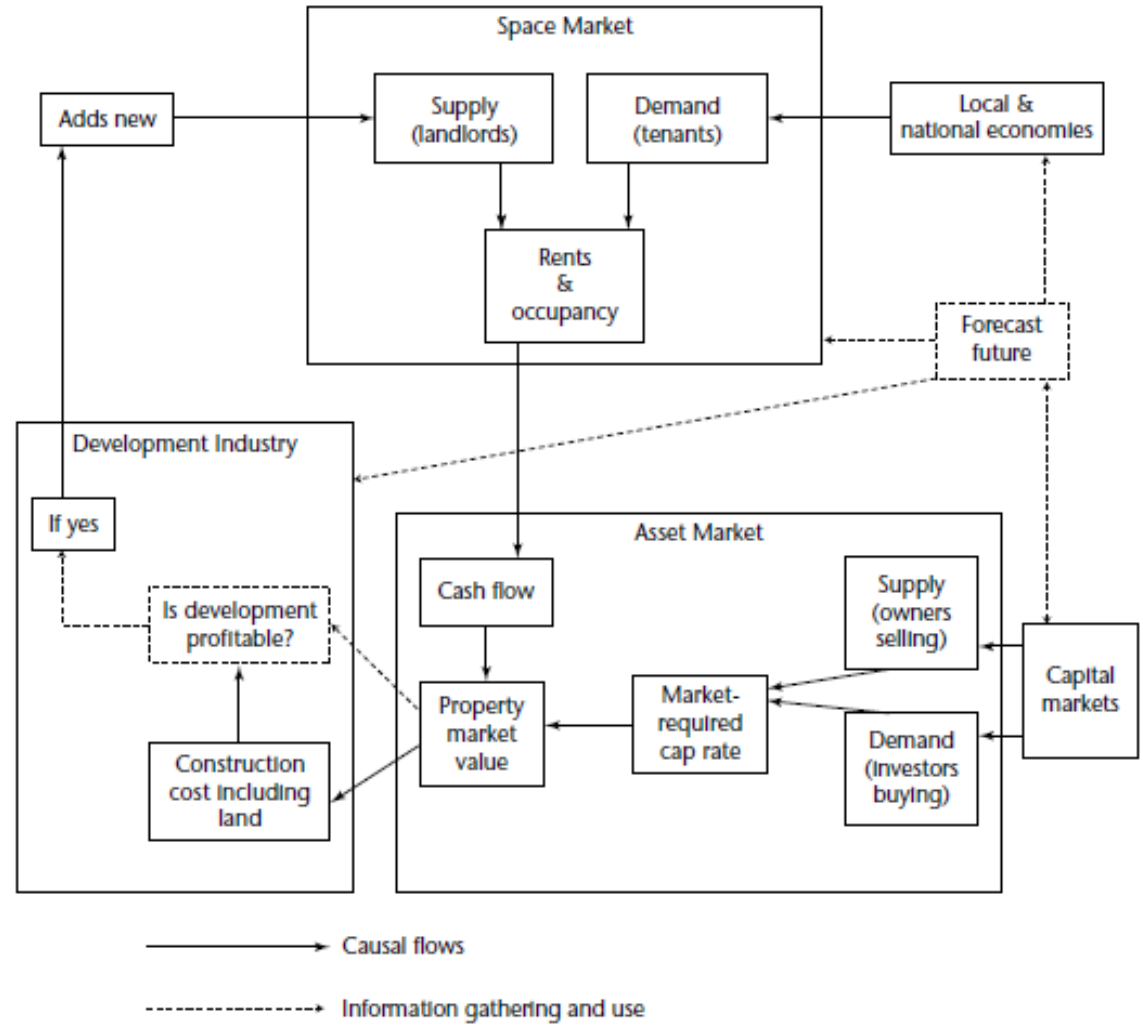
Development Market

Development industry affects the short run supply of real estate space market. Development market is a result of interaction among government officials and private and public investors. [3]

Chart 2 depicts interaction of space market, asset market, and development market and also the linkage among these main components. It also shows the linkage to external markets.

The three large boxes represent the three real estate markets and the interactions within these markets. [3]

Chart 2 The Real Estate System



Source: Commercial Real Estate Analysis & Investments, page 22; [3]

3.2 Property classification

Real estate properties are divided into several categories; based on their primary use and the attractiveness or quality of the property itself. Very basic division is according to their predominant type of use to **1) residential properties** and **2) commercial properties**. Residential property is defined as a type of land use where the predominant use is housing. This category is usually divided into four main types: [3]

1. **Single family and small multifamily properties**
2. **Garden apartment buildings**

3. **Mid-rise apartment buildings**
4. **High rise apartment buildings**

The main use of commercial properties is business are divided into below categories. [3]

1. **Commercial office properties**

Office properties can be found in both downtown and suburban areas of central business districts. Office properties are usually located in rather small buildings in premium locations in the city centers, or in large office parks in suburban areas.

Office properties are further divided into class A, B, or C. There are no exact criteria or methodology on how to divide office properties into these subcategories. Generally, class A buildings are located in the most desired location in the city, and are also built and equipped according to modern trends (AC, elevator, green technology, ICT infrastructure, proximity to transportation, parking lots, design, etc.). Buildings of class B and C are missing some of these key features. The important fact is that building that is only class B in one market may be considered class A in another less developed market. [3]

2. **Industrial properties**

Industrial properties include warehouses and manufacturing plants which are usually large one storey buildings. Due to their vast land requirement industrial properties are usually built outside of the city centers and close to main roads.

Because of the negative externalities such as pollution and high traffic that are carried out with large industrial properties, city officers tend to locate these facilities as far as possible from the residential areas. [3]

3. Retail properties

Retail properties represent significant category of commercial real estate market. Because of their use they are located close to commercial centers and residential centers.

Retail properties can be further divided into following categories:

a) Convenience centers
b) Neighborhood shopping centers
c) Community shopping centers
d) Regional shopping centers/ malls
e) Superregional shopping centers/ malls
f) Specialty centers
g) Lifestyle centers
h) Off-price outlets and discount centers/ malls
i) Highway commercial centers [3]

4. Hotels

Classification of hotels and lodging properties is usually based on their size, amenities, and level of service they provide. [3]

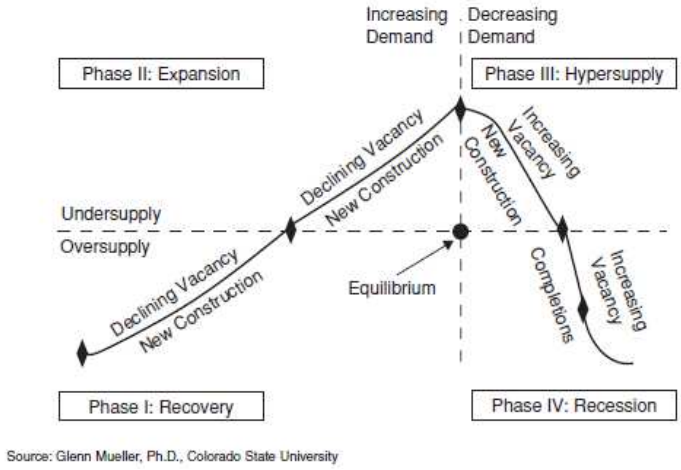
3.3 Life Cycle of a Real Estate Property

One of the reasons why is real estate investment considered to be safe option is its long useful life cycle compared to investments into shares and bonds. Long life cycle requires investment and operation costs during its useful life to prevent the decline of value of a property. One of the factors strongly influencing the value of a property is location. Real estate is permanently connected to the ground by its definition, therefore location is crucial. Investors seeking lower costs often invest into rural areas on boundaries of existing metro areas. These rural areas which border urban areas are the first ones to be transformed in to urban areas. [4]

Interaction of physical real estate cycle with the financial cycle was illustrated in research conducted by Glen Mueller. Physical cycle consists of interaction of supply

and demand. Rent value is derived from their interaction. Financial cycle concentrates on capital inflows and the value of property. More detailed real estate cycle is shown on Picture 1.

Picture 1 Real Estate Cycle



Source: The Handbook of Commercial Real Estate Investing, page 16; [4]

Phase 1 – Recovery

Market is on its bottom. Vacancy rate is high and landlords are under pressure to lower rents. As the bottom phase passes, entire market moves towards positive expectation. Demand rises, vacancy decreases and rent rates increase as a consequence.

Phase 2 – Expansion

Market moves towards equilibrium. Demand for space is higher, vacancy rate continues to decline and higher rents motivate investors into new development projects. Equilibrium is reached when demand and supply grow at the same rate.

Phase 3 – Hyper supply

Supply is higher than demand which causes vacancy rates to rise. Vacancy rate still remains higher than the long term average.

Phase 4 – Recession

Landlord now compete themselves in order to keep their tenants. Rents begin to fall and entire real estate market fall to the bottom and to phase one. [4]

3.4 Metro Areas

Metro areas attract both investors and tenants. Location of office buildings tends to occur in "nods" of business and community. Scheme of such nod is depicted on Picture 2. Offices are traditionally located in CBD (= Central Business District) areas. Later when demand overcomes the available supply of space, firms move into office parks in suburban areas. Office buildings located in the CBD district tend to be small to medium size and accommodate firms that wish for prestigious addresses.

Office parks on the other hand tend to be much larger. They are often located near major arterials or near former industrial areas. As they grow larger and attract more investors, office parks create nodes of their own. [4]

Picture 2 Metro Areas

Source: The Handbook of Commercial Real Estate Investing, page 49; [4]

3.5 Effect of clustering

Office center in large cities tend to form clusters. This trend is obvious especially in large agglomerations in modern cities and also in cities in the CEE region where the market for office properties is relatively new..

General real estate theory states that office rents are decreasing function of distance to the central business district. Clustering is in opposite to this theory, because large office centers achieve economies of scale. Clustering therefore results in higher rents. Locations with higher density of office properties have higher asking rents in comparison with locations with lower density but similar other external factors. Research conducted in Amsterdam area suggests that doubling the size of a cluster increases the asking rents up to 4.5%.

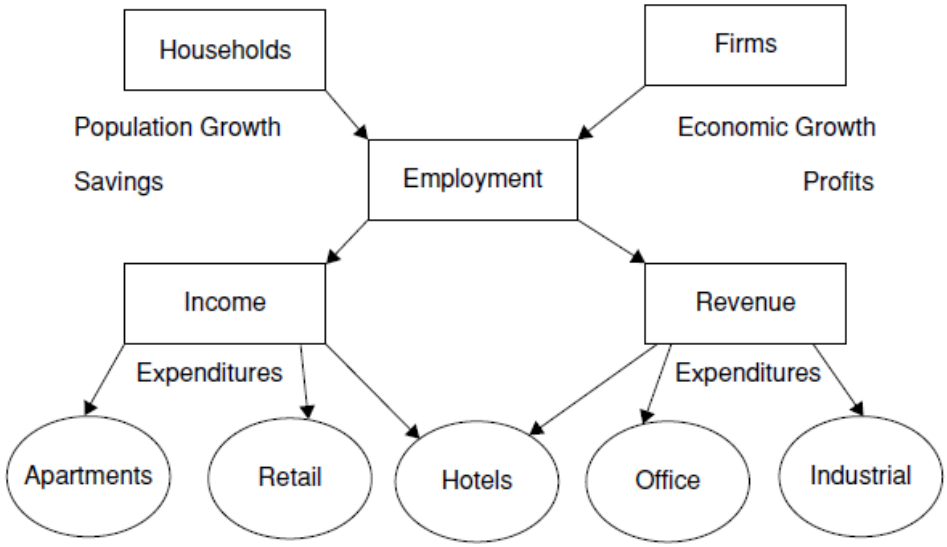
Furthermore; clusters attract more tenants because of the of the image effect they represent. Favorable clusters are perceived by tenants as the “right address”. [5]

3.6 Market demand drivers

The most influential demand drivers for real estate properties according to McMahan are: economics, technology, and population and demographics. Aggregated demand and supply of both commercial and private real estate property is a result of interaction among these factors. Further research conducted by Hartzell, Eichholtz and Selender (1993) pointed out the importance of additional economic driver - employment rate. [2] [4]

Interaction among these major factors is described on Picture 3. Market demand drivers can be divided into two categories: a) driven by households, and b) driven by firms. These two categories are connected through employment, which generates profit for firm and income for households. [4]

Picture 3 Sources of Demand for Property Types



Source: The Handbook of Commercial Real Estate Investing, page 37; [4]

3.7 Performance Measurements

Performance measurements vary from simple comparison of asset value to more sophisticated calculations of financial ratios. Performance measurement can be divided into two groups: 1) single period measurements and 2) multiple period measurements. General performance measurements according to Berges are as follows: [5]

Single period measurements

Single period measurements focus on cash inflows and outflows within one year. These measurements are often used as a series of measurements for comparison on year on year basis.

Net income return on investment (ROI)

ROI is used as a performance index and to compare investments with each other. Generally ROI takes into account gains from investment minus the cost of an

investment, divided by costs of investment. Because of the general definition ROI measurement can be modified according to given situation.

ROI measurement should not be used as a sole indicator. Its versatility in calculation means that in can be easily manipulated to provide desired results. [5] [6]

Formula according to Berges:

$$Net\ income\ ROI = \frac{gross\ income - operating\ expenses - interest - depreciation}{owner's equity\ (= invested capital)}$$

Cash return on investment (CCR)

Cash return on investment, or cash-on-cash return, or equity dividend rate is ratio between remaining cash after debt service and owner's equity. Cash-on-cash return excludes all noncash items and includes non-income portion of loan payments.

Cash-on-cash return is often used to evaluate long term investment with the emphasis on cash flow. This measurement does not take into account the property depreciation until the year of sale. [5] [7]

Formula: $Cash\ on\ cash\ return = \frac{before\ tax\ cash flow}{equity\ invested}$

Net operating income (NOI)

Net operating income is key measurement to analyze profitability of commercial real estate property. It is derived as difference between annual gross income of property and total operating expenses. [5]

Capitalization ratio (cap rate, yield)

Cap rate is calculated as net operating income divided by value of property. It measures the conversion of series of payment into a single value.

Cap rate is used in income approach method which is used to calculate the value of a property.

Capitalization ratios change frequently according to current market conditions and overall political-economic stability and the potential risk of investment. Higher yields lower the value of a property. [5]

Debt service coverage ratio (DSCR)

Debt service coverage ratio measures the relationship of annual income generated by the investment and the debt requirements (annual interest, principal payments, sinking funds, etc.) to the investment

According to Berges, most lenders look for debt service coverage ratio of 1.00 to 1.20. [5]

Formula: $Debt\ service\ coverage\ ratio = \frac{net\ operating\ income}{principal\ |\ interest}$

Gross rent multiplier (GRM)

Gross rent multiplier measures the relationship between asking price and expected gross income of the property.

Operating ratio (OR)

Operating ratio is often used to assess commercial properties and their efficiency relative to property's income. It measures the relationship between operating expenses and gross income. Unusually high operating ratio may signalize that maintenance costs or repairs are too high. Low operating ratio on the other hand may signalize that the property is in excellent condition or that not all expenses are being reported. [5]

Break-even ratio (BER)

Break-even ratio seeks point, at which the total inflows are equal to total outflows, i.e. the cash flow is positive. Investors invest in properties with positive cash flow; when BER is lower than 1. [5]

Formula:

$$Break-even ratio = \frac{total\ operating\ expenses + debt\ service}{gross\ income}$$

Multiple period measurements

Multiple period measurements allow investors to determine the value of an investment in the future, and also to determine the present value of an investment.

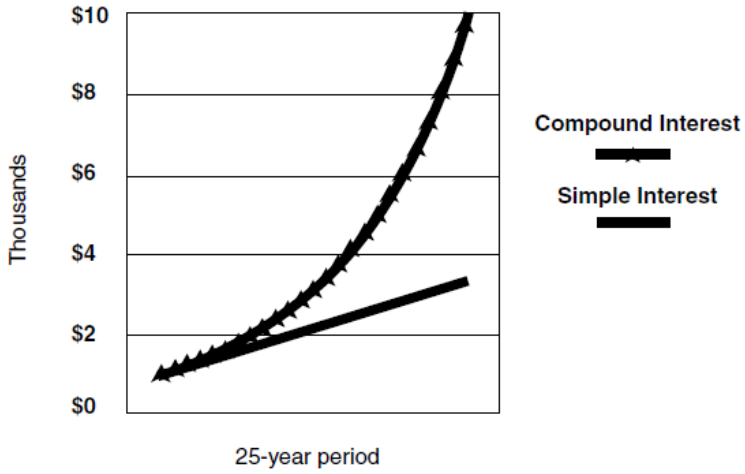
Future value of investment (FV)

Real estate properties tend to have long life span and therefore calculating future value of an investment provides crucial information to investors. Compounding method is used to calculate future value of an investment in present values.

Formula: $Future\ value = Present\ value(1 + i)^n$

Future value of an investment is derived from present value of an investment times, interest rate (r) and number of time periods (n). The effect of compounding interest in comparison to simple interest is shown on Chart 3. [5]

Chart 3 Effect of Compound Interest



Source: The complete guide to real estate finance for investment properties, page 105; [5]

Present Value (PV) and Net Present Value (NPV) analysis

Present value is derived from known future value of an investment and known interest rate. Investors calculate present value of an investment in order to determine the value of future investment in today's currency.

Formula: $Present\ Value = Future\ Value \frac{1}{(1+i)^n}$

Net present value analysis takes into account also the cost of the investment. Potential investors seek positive net present value, which means that the investment exceeds the minimal rate of return. [5]

Formula: $Net\ Present\ Value = Present\ Value - Costs$

Internal rate of return (IRR)

Internal rate of return measures the rate of return (yield) from series of cash flows during a period of time. Because of the fact that internal rate of return does not take into consideration the present value of an investment but only yields over time, it serves a suitable method for investment comparison.

Internal rate of return is also often used as a property valuation method. [5]

3.8 Property valuation approaches

Determining the value of a property is a key element for investors. Valuation has become a prosperous field. Although according to Adair et al. [1997] investors tend to invest into properties in one location and simple market comparison approach seems as a suitable valuation method, other more sophisticated method are used more often. Some of these approaches are cost approach, income approach, or the rate of return on an investment.

Market comparison approach

Market comparison approach is not used as a sole valuation method in practice. It consists of comparison of properties with similar characteristics. Finding identical properties is almost impossible in reality and therefore value of property derived by this approach requires a lot of adjustments. [8]

Cost approach

Cost approach is also referred to as reproduction cost approach. Value of a property is derived from the amount of money it would require to reproduce the property in current prices minus depreciation. [8]

Formula:

$$\text{Market value (V)} = \text{Reproduction costs of improvements} - \text{Accrued depreciation} + \text{Land value}$$

Income approach

Income approach is used to calculate the value of property which is reflected the amount of income it generates. Value of a property derived by income method it is able to generate and can be described as capitalized annual net operating income. [8] [9]

Formula: $$\text{Market value (V)} = \text{Net Operating Income (NOI)} - \text{Capitalization rate (R)}.$$

Net operating Income records the incomes accrued during one accounting period minus operating costs of the property. Capitalization rate or Cap rate or Yield reflects rate which helps to estimate the value of a property. [10] [9]

Rate of Return

Rate of return is an important element to evaluate the investment profitability. Average rate of return is calculated as total net earning divided by number of years the investment was held. The result is then divided by initial acquisition costs. Internal

rate of return (IRR) can be described as rate of growth that we expect our investment will generate. [9]

3.9 Real Estate Investment Portfolio

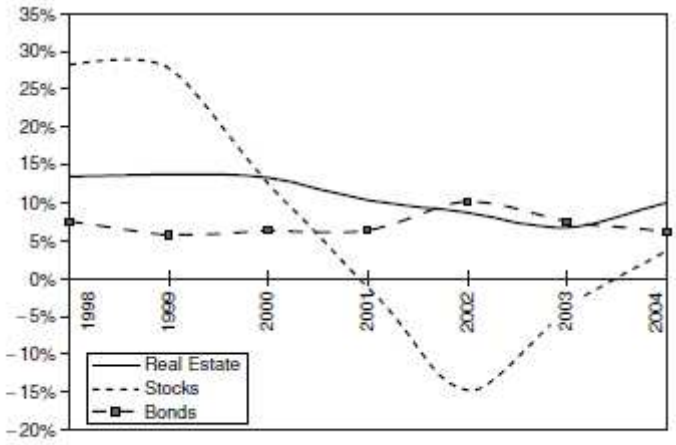
Investment into real estate assets has gained a lot of attention from both private and institutional investors. Integration processes within Europe and enlargement of European Union creates wide opportunities for cross-border investments. Real estate assets are often acquired in order to a) diversify traditional portfolio of stocks and bonds, or b) as an investment into real estate fund.

In order to reduce the investment risk, investors ought to diversify their portfolio. Modern portfolio theory states, that any investment portfolio should consist of different types of assets that do not correlate perfectly. Real estate portfolio can be diversified according to following variables:

- Location – invest into more than one country or region
- Purpose – invest into more than one types of property
    - Privately owned
    - Commercial (office, retail, industrial, land,…) [12]

Chart 4 depicts returns of three major assets over the period of 1998-2004 (example of USA). Real estate assets provide safe type of an investment while maintaining relatively high returns.

Chart 4 Mixed Assets Return

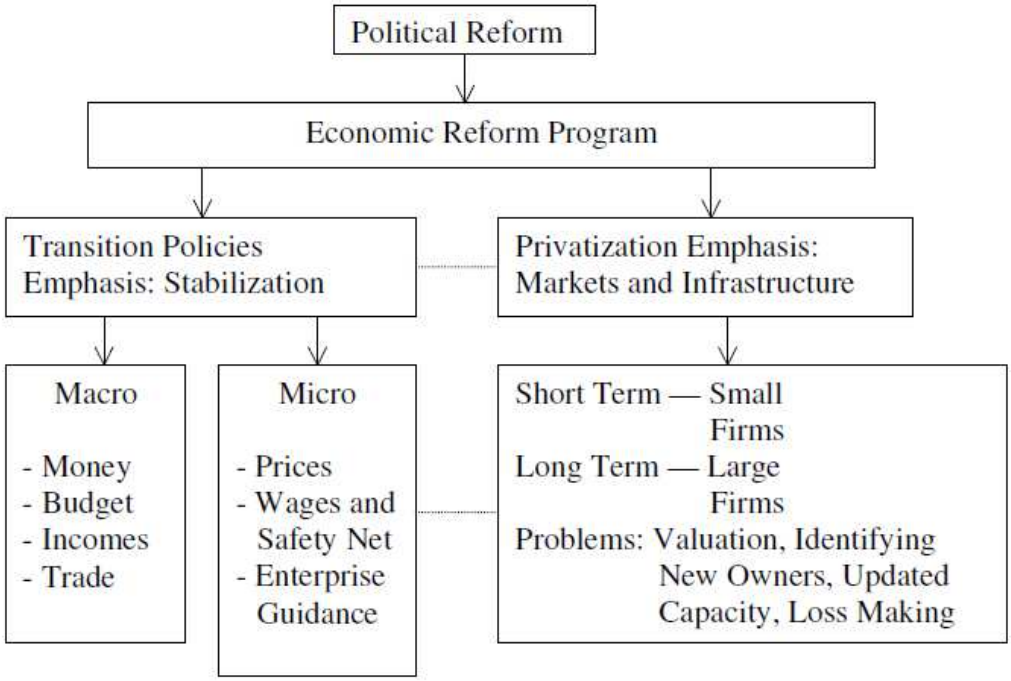


Source: NCREIF, S&P 500, Lehman Brothers Aggregate Bond Index
Source: The Handbook of Commercial Real Estate Investing, page 264; [4]

3.10 Transition processes

Countries evaluated in the diploma thesis went through the process of transition from centrally planned economy towards market economy. These processes in the entire CEE region were challenging not only for politicians but also for economist. Until the fall of Iron Curtain in 1989 no other country has abandoned the communism, and therefore there was no historical parallel to learn from. Major changes undertaken during the early stages of transition processes were: liberalization, macroeconomic stabilization, privatization, and legal and institutional reforms. Simplified reform scheme is depicted on below scheme. Although the pace of reform differed largely among countries – from very slow changes in Romania to “shock therapy” in Poland, the pattern remains same as seen on Picture 4. [11] [12]

Picture 4 Transition Processes



Source: Market economy in Transition economy; [11]

Aim of these processes is to create market economy which encourages entrepreneurs and follows the rule of law. Best results of transformation processes of all post communism countries (regions: CEE, Baltics, CIS) were achieved in Hungary, Poland and Czechoslovakia (Czech and Slovak Republic since 1993). [12] [11]

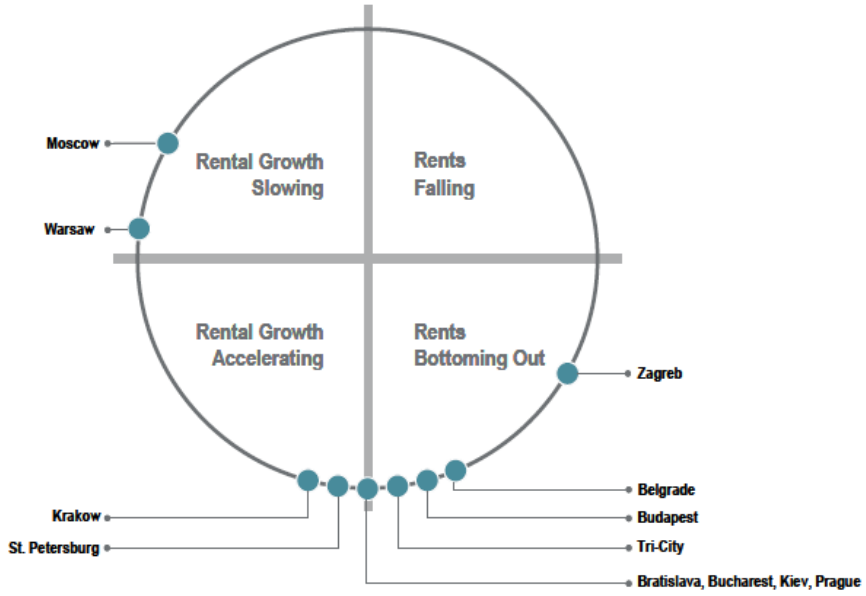
4 Economic Analysis of the Office Properties in the CEE Region

4.1 General overview of the CEE office market

Countries of the Central and Eastern European (CEE region) share many similarities from the economic and historical point of view. All countries evaluated in the diploma thesis were members of the so called “Eastern Bloc” and experienced the transition from command economy to market economy. Czech Republic, Poland, Hungary, and Slovakia are members of the Visegrad Group and also member states of the European Union since 2004. Romania joined the European Union in 2007. All countries are also members of NATO. The globalization alongside transformation processes created many cross border opportunities for investors. Importance of real estate sector in the Central and Eastern Europe during transformation processes cannot be undermined – it determined the spatial economic development in cities. [1]

Picture 5 shows the Central and Eastern Europe office occupier clock as of 2012. Prague, Bucharest, and Bratislava are currently at the bottom of the market circle. Rents and demand are expected to rise. Office market in Budapest is expected to fall down and to reach the market’s bottom soon. Office market in Warsaw is on the opposite side of the occupier clock. Rents are growing, but the rate growth is expected to slow down. [1] [13]

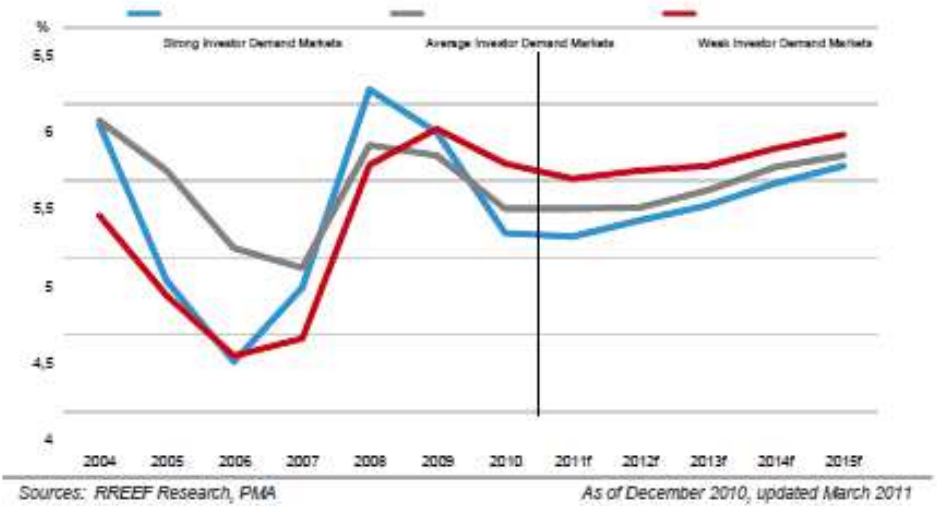
Picture 5 Central and Eastern Europe Office Occupier Clock



Source: Central & Eastern Europe: Corporate Occupier Conditions, Jones Lang LaSalle; [13]

Chart 5 depicts the development of yield rates of office properties in Europe over time for the period of 2004 till 2010 and forecast until 2015. Blue line represents markets with strong rental growth expectations, in particular London, Paris, Stockholm, and Warsaw. Average rental growth expectation and marked grey and represents Germany, Benelux, France (except Paris), and Prague. Third group – red color- includes countries of Southern Europe, Hungary and Ireland. Economic uncertainty in these countries is likely to reduce any potential investor interest. [17]

Chart 5 European Average Office Yields



Source: 2011 European Real Estate Investment Outlook and Market Perspective, page 17; [17]

4.2 Czech Republic

Czech Republic is located in the Central Europe, it covers the area of nearly 79 thousand square kilometers and its population is approximately 10.5 million. It is divided into 8 NUTS2 regions, and 13 NUTS3 regions + capital Prague. Region with the highest GDP is the capital city Prague.

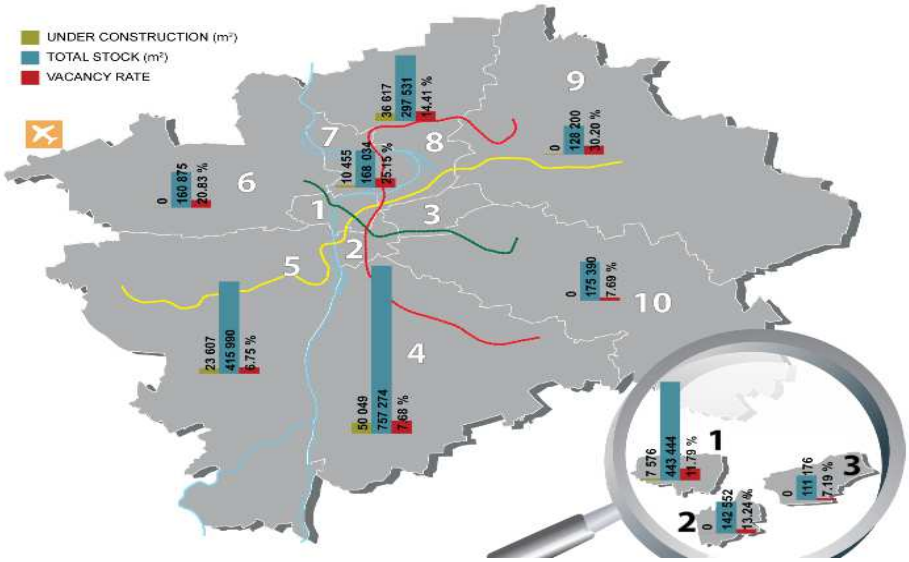
The political situation of the Czech Republic is perceived as relatively secure, but it is suffering by many corruption scandals. Political instability slows the process of adopting reforms needed to lower the pressure of public finances. Czech economic performance is export oriented. Its economic growth rests largely on Germany which was evident especially during and after the economic crisis of 2008 and following years. Pace of economic recovery in the Czech Republic in 2011 has slowed down and the outlook is expected to worsen in 2012. Even though the Czech Republic is not member of the Euro zone and therefore not directly affected by the Euro crisis, it is influenced by the current situation. In spite of recent problems, the Czech economy shows the best results among countries of emerging Europe. [14]

Prague

Prague is the center of business and political life in the Czech Republic. According to Eurostat statistics, it is the only NUTS2 region in the Czech Republic that has higher gross domestic product per inhabitant in purchasing power standards than average region in the EU 27. Other regions in the Czech Republic achieve only 50 %-75 % of the average GDP. [15]

Beginning of the 1990s was strongly influenced by privatization and rapid liberalization of prices. Privatization and restitution caused redistribution of state assets to many private owners. Real estate acquired during restitution has been sold freely on the property market since 1991. In line with economic growth grew also the demand for office space. Demand for office space was largely influenced by foreign companies, which entered Czech market, or by newly developing service sector of domestic companies. Prague, same as many European cities, had to apply strong rules in order to preserve its historical heritage mainly in districts Prague 1 and Prague 2. Although there were some new development projects in the city center, such as the Dancing House building, the key characteristic is refurbishment of existing properties for commercial usage. With lowering options for refurbishment investors concentrated more in new office parks outside of city center, such as The Park in Prague 4 or Avenir Business Park in Prague 5. Main office districts are at present time equally distributed across most Prague districts, as shown on map below. [16]

Picture 6 Districts of Prague

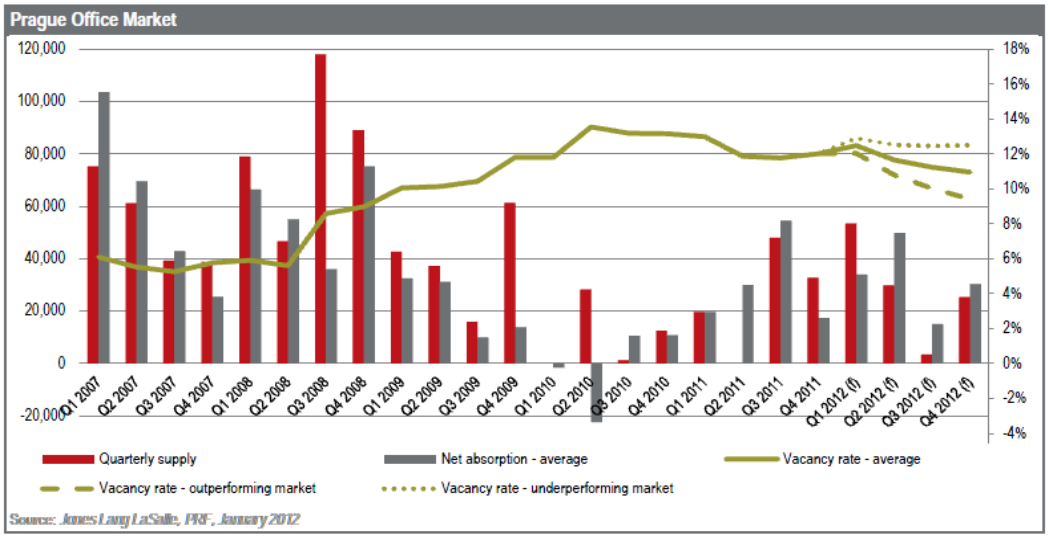


Source: Prague Office Market – Q4 2011, Jones Lang LaSalle; [16]

As of beginning 2012,price levels vary significantly depending on the location. Highest rents are in the city center (20-21€/m^2/month), followed by the inner city such as Pankrác and Smíchov (15-16€/m^2/month). Lowest rents are in the Outer city areas (13-14.5€/m^2/month). [16]

Development of main indicators over time (according to Jones Lang LaSalle) is shown on Chart 6 . High supply together with low vacancy rate was significant prior and at the early stages of global financial crisis. Rapid growth of vacancy rate culminated in the middle of 2010 and is slowly decreasing since then. Positive scenario for 2012 forecast vacancy rate of approximately 10%. Negative scenario of underperforming market forecast growing vacancy rate over 12% by the end of the year 2012. [16]

Chart 6 Prague Office Market



Source: Prague Office Market – Q4 2011, Jones Lang LaSalle; [16]

4.3 Hungary

Hungary is located in the Eastern Europe, it covers the area of approximately 93 thousand square kilometers and its population is approximately 10 million inhabitants. It is divided into 7 NUTS2 regions and 19 NUTS3 regions + capital Budapest. [17]

In spite of Hungary being one of the largest economies within the region (after Czech Republic and Poland), it is heavily affected by current economic crisis. Fragile Hungarian economy was hit especially after the downgrade by Moody's rating agency in late November 2011. Downgrade was caused mainly by the level of state deficit and the negative outlook into the future. Government as a result outlined new economic growth plan and cooperation with European Union as well as with the International Monetary Fund. [18]

Budapest

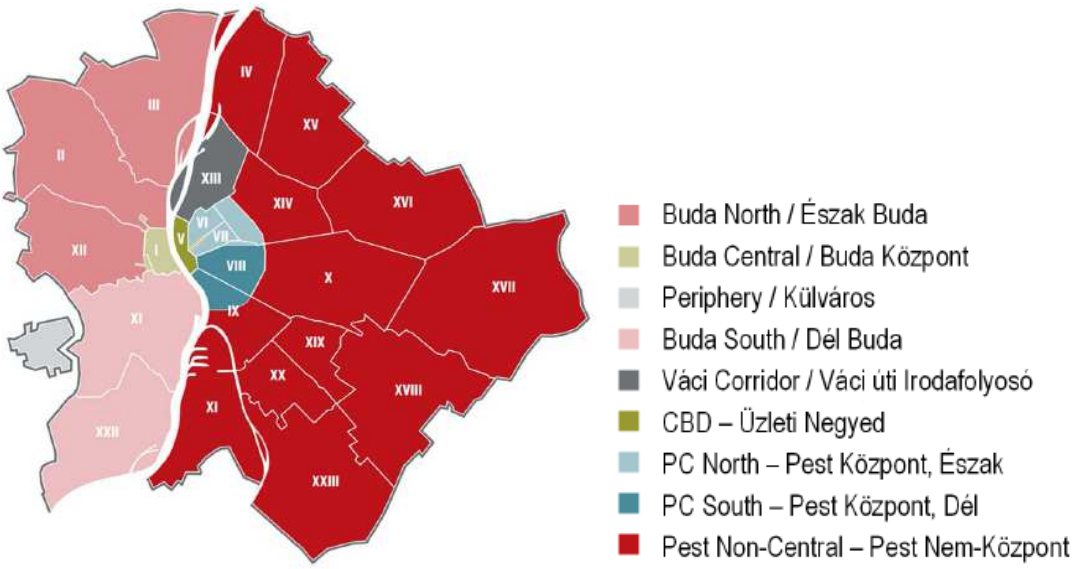
Budapest is economically dominant region where live nearly 20 % of the Hungarian population. According to Eurostat statistics, Budapest gross domestic product is at the same level as EU 27 average. Regions in the western part of Hungary achieve only 50%

- 75% of the EU 27 average, gross domestic product of the eastern regions is below 50% of the EU 27 average. [15]

Position of Budapest in the Central and Eastern European real estate market was strongly influenced by the fact, that Hungary was the first country in the region which re-established open market environment after the fall of communism in 1989. Lack of domestic supply of investment together with Budapest's prime position in the region helped Budapest to received more than any other Central European city (with the exception of eastern part of Berlin). By 1999 Hungary received approximately $20.5 billion of FDI and more than half of the total investment was received the capital city. [19]

Office rents in Budapest vary significantly and are very dependent on location. As of late 2011, highest rent are achieved in Central Business District (13-20€/m^2/month), followed by pest Central and Buda Central (12-15€/m^2/month), and asking lowest rents are at the Periphery (7-10.5€/m^2/month). Office market became very active at the beginning of 1990s. Restructuring of available properties in the city center took place during the first stages. Large office parks in other districts emerged later. Main office areas are shown on map below. [20]

Picture 7 Districts of Budapest



Source: Budapest Office Market – Q4 2011, Jones Lang LaSalle; [20]

4.4 Poland

Poland is located in the northern part of Central Europe. It covers area of more than 300 thousand square kilometers and its population is approximately 38.6 million inhabitants. It is divided into 16 NUTS3 regions and 43 NUTS2 regions. Most regions of Poland generate either less than 50% of GDP average of EU27 or 50% - 75% of GDP.

The only exception is the region where is located capital city Warsaw, which achieve the GDP level of an average EU27 country. Warsaw's real estate marker emerged later than in Prague or Budapest due to unstable political conditions which did not attract foreign investors. After the investment conditions stabilized, the perception of the real estate market of Warsaw changed in a positive way. Being capital city of a large country provides better long term prospects. [21]

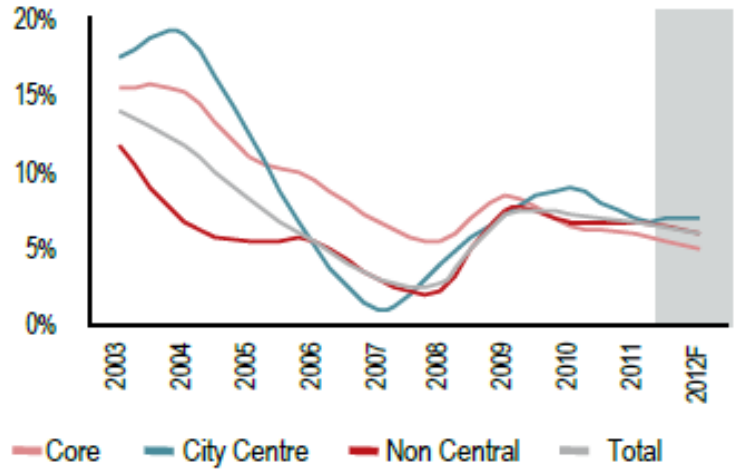
Warsaw

Warsaw, capital of Poland, is housing approximately 1.7 million inhabitants. It is located in the Mazovia district and represents approximately 4.5% of total population. Warsaw represents the political, economic, and cultural center of Poland. [1]

Although the real estate market emerged later than in other countries of Visegrad Group, thanks to the size of Polish/ Warsaw market, it now provides better long-term results than the other two cities. During late 1990s, office market in Warsaw experienced large demand from both international and local companies. Demand together with extremely low construction and overall supply (vacancy rate fell below 1%) caused significant increase of office rents. [22]

Development of vacancy rate during recent years is shown on Chart 7. Vacancy rate peaked during the year 2004 and was followed by steep decline, reaching its bottom during years 2007 and 2008. With the exception of the city center, vacancy rate remained relatively stable since 2009. [22]

Chart 7 Warsaw Office Vacancy Rate

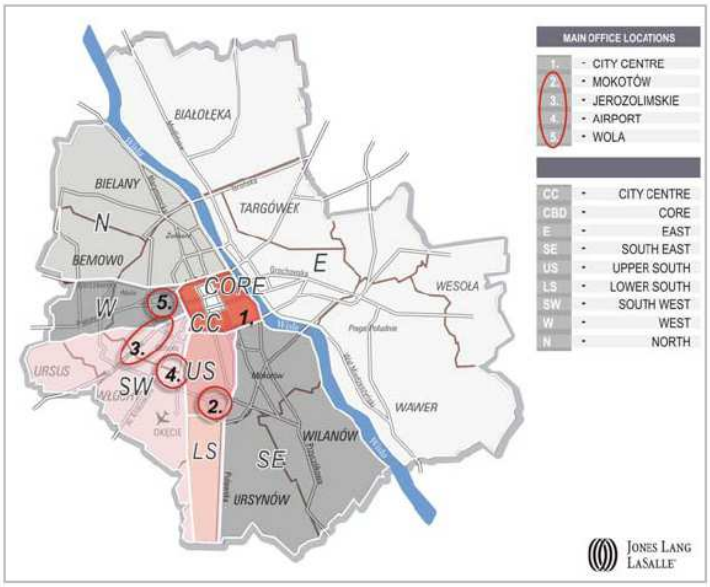


Source: Warsaw Office Market – Q4 2011, Jones Lang LaSalle; [22]

As of end 2011, office market in Warsaw is stabilized with relatively low vacancy rate of 6.7%. Thanks to the low vacancy rate, prime rents remain rather high. Prime rents of class A properties in the city are the highest in the CEE region (22-25€/m^2/month), properties located outside of the city center are being leased at about 15€/m^2/month.

The below map illustrate main districts of Warsaw. [22]

Picture 8 Districts of Warsaw



Source: Warsaw Office Market – Q4 2011, Jones Lang LaSalle; [22]

4.5 Slovakia

Slovak Republic is located in the Central Europe; it covers the area of approximately 19 thousand square kilometers and its population is about 5.5 million inhabitants. Slovak Republic is divided into 4 NUTS2 regions, and 8 NUTS3 regions. Slovakia was the first of Visegrad countries to adopt Euro in January 2009. Although directly affected by the Euro zone crisis, Slovak's economy recorded positive growth by the end of 2011. [23] [24]

Bratislava

Thanks to the relatively small size of the market and therefore low liquidity of real estate assets, Bratislava experienced slightly different pattern of post-communism development of the office market than the rest of Visegrad countries. Bratislava generally did not attract such significant amount of foreign direct investment during the transition period.

Market situation as of Q4 2011 reflects moderate supply of new stock without any speculative contraction. [25] [13]

4.6 Romania

Romania is located in the Southeast of Europe. It covers the area of almost 240 thousand square kilometers with population more than 22 million. It is divided into 8 NUTS2 regions. Romania entered European Union during the second wave of eastern enlargement, in 2007. Economic development of Romania was strongly influenced by the fall of Iron Curtain in 1989 and reform that followed. Second most important milestone was the entrance of European Union. Thanks to the EU funds, Romania was became one of the fastest growing economy in the Union until the beginning of the financial crisis. The economy of Romania was heavily hit by the financial crisis, pushing its GDP into negative numbers. Economic performance slightly improved during 2010 and 2011. [26] [27]

Bucharest

Bucharest is the capital city and also the largest city of Romania, housing approximately 2 million inhabitants. Thanks to its size, the capital city is a natural center of business and political life.

The Bucharest office market is experiencing large differences between prime location in central business district (with vacancy rate only about 10%) and periphery areas with vacancy above 15%. Overall office supple of class A buildings lags behind the demand. As of end of 2011 prime rents in Bucharest vary from 19.5€/m^2/month in the city center to 12€/m^2/month in less favorable locations. [28]

Below map describes the location of Bucharest submarkets and average prime rents in these locations as of the last quarter of 2011.

Picture 9 Districts of Bucharest

Submarket	Class A Headline Rent (EUR Sqm / month)	Vacancy R
North	16 -18	13%
North-Pipera	11 – 14	25%
CBD	17 – 19.5	10%
Center	15.5 – 18.5	11%
East	11 – 12.5	23%
West	12 – 15.5	8%
South	10 - 12	9%

Source: Bucharest Office Market View – Q4 2011, CBRE; [28]

5 Estimation of Parameters

5.1 Econometric modeling

Time Series

Time series are defined as a set of observation from past to the present time. Distance between observations has to remain constant through all observations. Stationary time series are defined as time series which main characteristic do not change between observations. Non-stationary time series change through time. Two main approaches toward time series observations are statistical and econometrical. Econometric approach to time series analysis can be further divided into 3 categories:

- Specific to general – specific econometrical model is generalized and then are tested its statistical and econometrical characteristics,
- general to specific – general model based on economic theory reduced in accordance with results from testing,
- co-integration analysis – is used for validation of long term relationship between economic variables. [35] [36]

Elementary Characteristics of Time Series

Elementary characteristics of time series analysis consist of first (second, etc.) **differences** and/or growth rate coefficient. Firs difference in a time series is defined as series of changes from one period to next.

Formula: $\Delta y_t = y_t - y_{t-1}$

Growth rate coefficient is a ratio of the value at current observation, divided by value from previous observation. [29]

Formula: $k_t = \frac{y_t}{y_{t-1}}$

Time series according to the **general model** consist of four main components:

- seasonal component (S_t)
- trend component (T_t)
- cyclical component (C_t)
- random/ error/ irregular component (ε_t)

Functional relationship between these components can result either into the **additive model** ($X_t = TC_t + S_t + \varepsilon_t$) or **multiplicative model** ($X_t = T_t * C_t * S_t * \varepsilon_t$). [29]

Prior estimation of parameters, existence of **spurious regression** must be tested. Spurious regression indicates a problem of false relationship between two unrelated non-stationary time series. **Unit root** test is suggested to identify stationary and non-stationary time series. [30]

Variable is non-stationary if it contains unit root, "and unless it combines with other non-stationary series to form a stationary co-integration relationship, then regressions involving the series can falsely imply the existence of a meaningful economic relationship." [30] Therefore every variable in a model has to be tested for unit root. If found, variable needs to be differenced until it results into stationary series.

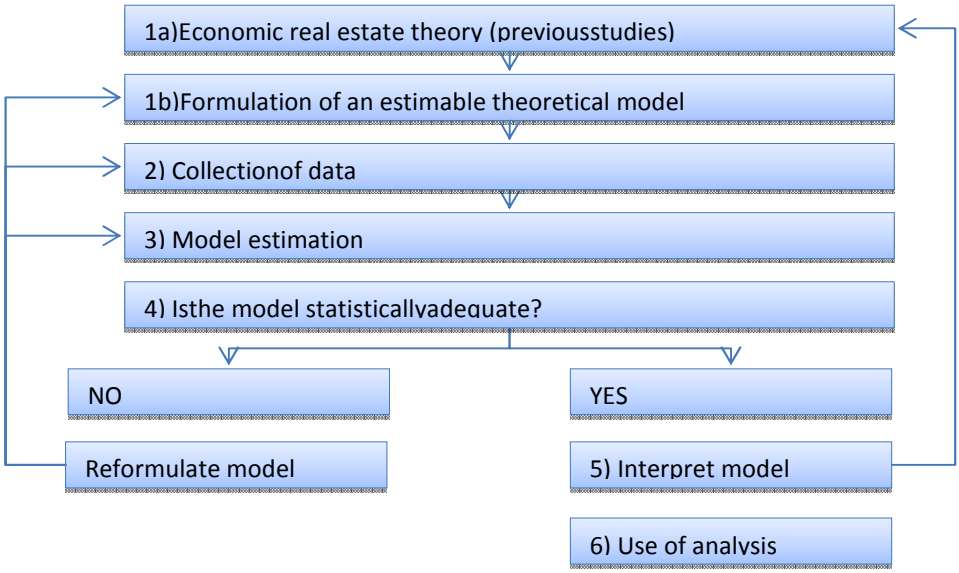
The Dickey-Fuller (Augmented Dickey-Fuller) test tests:
null hypothesis H_0: Time series contains unit root (i.e. is non-stationary, I(I)),
alternative hypothesis H_1: says that time series does not contain unit root (i.e. is stationary, I(0)).
ADF can be tested according to three models. Model A tests random walk, model B contains constant, and model C contains both constant and trend. All models are defined as on below formulas. [30] [31]

- model A: $\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{K} \rho_i \Delta y_{t-1} + \varepsilon_t$;
- model B: $\Delta y_t = \mu + \gamma y_{t-1} + \sum_{i=1}^{K} \rho_i \Delta y_{t-1} + \varepsilon_t$;
- model C: $\Delta y_t = \mu + \beta t + \gamma y_{t-1} + \sum_{i=1}^{K} \rho_i \Delta y_{t-1} + \varepsilon_t$.

Econometrics

Exact interpretation of the term econometrics is economic measurement. Econometrics describes key economic forces by using mathematical and statistical methods. Real estate econometrics can be defined as application of statistical data to real estate market, for examining changed in economic conditions and its linkages to real estate market. Picture 10 explains steps involved in an econometric model. [32] [33]

Picture 10 Econometric Modeling Steps



Source: Real estate modeling and forecasting, [33]

Step 1a and 1b – Formulation of econometric model

In this phase is usually formulated theoretical model. Model should be related to real estate theory and should describe the linkage between variables. Models always simplify reality and therefore cannot depict all real-world phenomenon, but it should be able to present sufficient approximation. [32] [33]

Step 2 Collection of data

Collection of sufficient amount of data is crucial part of econometric model. Real estate data can be collected from national and supra national statistical offices, directly from firm or even from specialized researcher agencies.

Empirical analysis may use three types of data:

Time series data is a sequence of observation of a given variable at different times. The interval between each measurement should remain consistent. Different variables use different frequency of observations. Below list shows different frequency of observation and a practical example:

- daily – stock prices, weather reports
- weekly – money supply
- monthly – unemployment rate, consumer price index
- quarterly – GDP
- annually – government budgets
- quinquennially – census of manufactures
- decennially – census of population [32] [33]

Cross section data are observations of different variables at the same point of time. An example of cross section data is census of population. At the year of the census, statistical office collects many variables.

Pooled data is a combination of both mentioned approaches. Example of pooled data may be surveys conducted by Eurostat. It collects data from EU member states (cross sectional data) and compares the results between years (time series data). [32] [33]

Step 3 Model estimation

Economic model enables mathematical and statistical formulation of economic theories. Econometric model broadens the economic model by adding stochastic variable – error term. [32] [33]

Step 4 Statistical verification of parameters

Statistical verification of estimated parameters is necessary for testing the significance of parameters. [33]

Types of variable

Variables are commonly referred as dependent and explanatory, other expressions are listed on Picture 11. [32]

Picture 11 Types of Variable

Dependent variable	Explanatory variable
⇕	⇕
Explained variable	Independent variable
⇕	⇕
Predictand	Predictor
⇕	⇕
Regressand	**Regressor**
⇕	⇕
Response	Stimulus
⇕	⇕
Endogenous	Exogenous
⇕	⇕
Outcome	Covariate
⇕	⇕
Controlled variable	Control variable

Source: Basic econometrics, page 50; [32]

Given by a number of explanatory variables, models are referred to as simple or two-variable (if we study dependence of one explanatory variable), multiple regression analysis study more than one explanatory variable.

Special type of variable which needs to be present in every econometric model is stochastic variable, often called error term. It consists of missing variables which may influence the model, errors in measurement, and errors cause by wrong function form. [34]

Criteria for classification of econometric models:

According to examined phases of reproduction process:

- Partial models study only a part of the reproduction process.
- Comprehensive models study the function of the whole economy.

According to model characteristics:

- Models of causal relations where explanatory variables influence endogenous variables as a cause. In reality majority of econometric models do not meet the criteria to fit into this category.
- Symptomatic models include strongly correlated endogenous and predetermined variables, but explanatory variables are not interpreted as causal factors.

According to form of matrix B (form of dependency among endogenous variables):

- Simple models with unitary matrix B arise from models with only one explained endogenous variable.
- Recursive models with triangle matrix B.
- Simultaneous models with at least one non-zero element over the main diagonal in matrix B. Simultaneous models are often used as they are able to describe mutual dependency of economic processes.

According to a degree of aggregation of variables:

- Aggregate models describe relationships between summary macroeconomic variables.
- Structural (desegregated) models focus on variables according to different branches of economy.

According to economic subject:

- Macroeconomic models focus on variables at a level of national economy and its branches.
- Microeconomic models focus on variables at a level of individuals and enterprises.

According to time factor

- Static models which do not contain lagged variables nor time variable.
- Dynamic models contain lagged variable, differential variable or time variable.

According to expression of endogenous variable:

- Models in a structural form describe relations among variables without consideration whether they are endogenous or exogenous variables.

  Formula: $\mathbf{B}y_t + \Gamma \mathbf{y}_t = u_t$

- Models in reduced form are modified in a way that every endogenous variable is dependent only on exogenous variables and stochastic variables.

  Formula: $y_t = Mx_t + v_t$ [34] [38]

Regression analysis

Term regression was first introduced by Francis Galton in the 19th century in his research paper evaluating height of children based on the height of their parents. Modern regression analysis is defined as dependence of one variable (the dependent variable) on one or more other variables (explanatory variables). Example of regression is depicted on Chart 8. Scatter points are actual measurements and curve depicts the regression line. Theoretical points based on regression analysis.

Chart 8 Regression Analysis

Source: Regression analysis basics

Regression analysis concerns with statistical dependence among variables (other relationships are functional or deterministic)

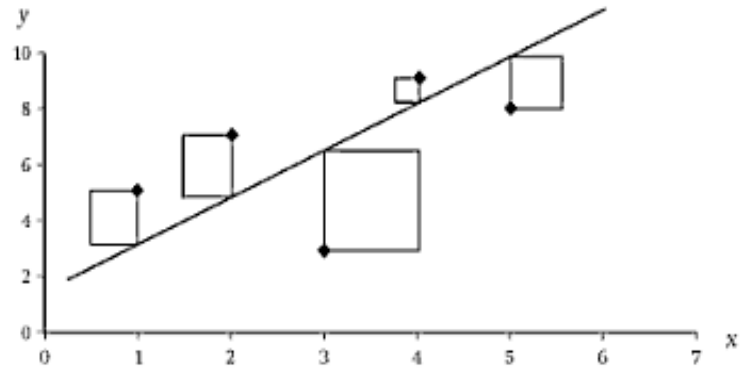
Main aim of regression analysis is to identify statistical dependence of one dependent variable on one or more explanatory variables. Once statistical dependence is identified, and goal is to estimate and predict the mean (average) value of dependent variable. [32]

Ordinary Least Square Method (OLS)

The principle of ordinary least squares method is fitting a line to the data by minimizing the sum of squared residuals as depicted on below chart. For regression model the OLS estimators are BLUE (Best, Linear, Unbiased, Estimator) when:

- The regression is linear in the coefficients, it is correctly specified and has an additive error term.
- Mean of the error term is zero.
- The independent variables are not correlated with the error term
- Residuals are not correlated with each other.
- The error term has a constant variance
- Multi-collinearity does not occur.

Chart 9 OLS Method



Source: Real estate modeling and forecasting, page 77; [37]

Causation

Strong correlation proved by statistics does not imply causation. Causation cannot be predicted only by statistics it generally requires proof by other theories. For example statistics can describe strong regression between yields of crop and temperature, but other theories are required to describe and assess this relationship. [32]

Correlation analysis

The main objective of correlation analysis is to measure the strength or degree of linear connection between two variables. Regression analysis treats differently dependent and explanatory variables. Dependent variable is assumed to be statistical and randomly distributed, explanatory variables are on the other hand assumed to have fixed values. Correlation analysis does not distinguish between those two types do variables, both are assumed to be randomly distributed. [32] [33]

Econometric Modeling in Real Estate

Model framework

Econometric models for real estate markets are driven by economic theory and follow the principles of factor of production market. Retail, industrial and office properties are used in production of goods and services. Therefore demand space is derived from demand for these goods and services.

Framework of the real estate market, as described by Geoffrey Keogh (1994), divides real estate market into three main categories – a) occupier market, b) investment market, and c) development market. All three categories interact with each other, and although price is similarly derived from the supply and demand curves, they differ in their primary focus on indicators. [33]

Occupier market

Occupier market focuses on vacancy rate, rent level, and rent growth. Indicators are influenced mainly by demand for space and supply of buildings. [33]

Investment market

Investment market focuses mainly on yield rates and capital values, which are determined by supply and demand of investments. It takes into account all factors influencing occupier market and adds to them wider economic relationships. [33]

Development market

Development market follows trends set up by both occupier and investment markets. It focuses on new development and refurbishment as well. [33]

Model variables

Real estate analysts focus mainly on performance measures described in chapter 3.7 and on estimation of below variables.

Take-up

Take up represents demand variable and is defined as amount of space take up during a given period of time. It includes new demand, as well as sub-leases and pre-leases. [33]

Net absorption

Net absorption is demand driven variable and is defined as change in the occupied stock within a market during a given period of time. Unlike take-up it accounts only new leases. [33]

Stock

Stock is a supply driven variable which refers to the total amount of space in the selected market. It reflects both vacant and occupied premises within a given period of time and location. [33]

Physical construction

Physical construction sums up the amount of construction at the given area. [33]

Vacancy

Vacancy rate describes total amount of vacant space or is often described as a percentage of total stock. Vacancy rate is often calculated in terms of square meters (square footage), or is expressed in term of Euros (USDs) of rental income. [33]

Rent

Rent is a payment for the privilege of using a space that is not owned by a person. Rents can be at the level of transaction rents at the level achieved in the occupier market. Other source of rent levels can be estimated from valuation. [33]

5.2 Office Yields - Prague

First hypothesis says that, **yield rates of office properties are influenced by GDP, prime rents, vacancy rates, and take-up**. In accordance to the first hypothesis, econometric model is in a formulated as β Yield= λ PRG RENT + λ TAKE UP+ λ VACANCY + λ GDP. Extended data table is attached in Supplement 1. All calculations were made in Gretl software.

Times series must be tested for **unit root**, prior construction of an econometric model. As majority of macroeconomic data have the signs of unit root, all variables that are included in the model had to be tested (y_1 Prague Yield, x_2 Prague Rent, x_3 Prague Take-up, x_4 Prague Vacancy, and x_5 GDP of the Czech Republic).

The evidence of co-integration in the econometric model was proved using the **Augmented Dickey-Fuller** test (Engel – Granger test). Original data showed signs of the existence of unit root. Using first differences, time series were transformed into stationary data. The hypothesis about existence of unit root can be rejected and alternative hypothesis accepted.

Construction of a model

Excerpt of data used for parameter estimation is shown in Table 2 and in more detail in Supplement 1. Sources of information were The Czech Statistical office and internal documents downloaded by the courtesy of CBRE Global Investors. Because of the fact, that information about prime rents, take up, yields, and vacancy rate are results of both internal and external analysis, these data are not to be disclosed in full extend.

Table 2 Yield Estimation - Prague

Variable	y_{1t}	x_{1t}	x_{2t}	x_{3t}	x_{4t}	x_{5t}
	PRG	UNIT	PRG	PRG	PRG	CR
Quarter	YIELD	VECTOR	RENT	TAKE UP	VACANCY	GDP
2002Q2	8.10	1	240	62.99	10.80	644988
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2011Q2	6.14	1	228	65.08	12.20	961512

Source: Databases of CBRE Global Investors, Czech Statistical Office

- Endogenous variable:
  - y_{1t} = prime yield rate in Prague.
- Exogenous variable:
  - x_{1t} = unit vector
  - x_{2t} = prime rents in Prague
  - x_{3t} = net take up in Prague
  - x_{4t} = vacancy rate in Prague
  - x_{5t} = gross domestic product in the Czech republic

Because original data showed signs of multi-collinearity, first difference had to be calculated for variable x_{2t} and x_{5t}. Thanks to sufficient amount of additional data, number of observation remained unchanged – 37. Adjusted correlation table is shown on table 2.

One of the assumptions of OLS (ordinary least square) method is that explanatory variables are not correlated to each other. Multi-collinearity occurs when variability between explanatory variables exceeds |0.8|.

Table 3 Correlation table - Prague

y_{1t}	x_{2t-1}	x_{3t}	x_{4t}	x_{5t-1}		
PRG_YIELD	PRG_RENT_1	TAKE_UP	VACANCY	GDP_1		
1.0000	0.3965	-0.0403	0.6140	-0.7251	PRG_YIELD	y_{1t}
	1.0000	0.1789	-0.1282	0.0425	PRG_RENT_1	x_{2t-1}
		1.0000	-0.2687	-0.2015	TAKE_UP	x_{3t}
			1.0000	-0.2869	VACANCY	x_{4t}
				1.0000	GDP_1	x_{5t-1}

Source: own calculation

Parameters were estimated using ordinary least square method $\gamma = (X^TX)^{-1}X^Ty$. Model in structural form, based on computation in Gretl software:

Equation 1: $\mathbf{Y_{1t} = 5.142 - 0.066\ x_{2t} - 0.011\ x_{3t} + 0.176\ x_{4t} - 6.16638e\text{-}06\ x_{5t}}$.

Economic interpretation and verification:

- If level of prime rents increases, yield rate increases
  - According to economic theory rents and yield should have inverse relationship. This is reflected in a property valuation approach where growing rents (i.e. cash inflows) increase the value of a property, while increase of yields reduces the value of a property.
- If net take up increases, yield rate decreases
  - Take up represents demand variable and therefore it is inversely related to yields.
- If vacancy rate increases, yield rate increases
  - Growing vacancy means that the real estate market is underperforming and the risk factor of the market increases. Vacancy is therefore the most influential factor which determines yield rates.
- If gross domestic product increases, yield rate decrease

- GDP is widely recognized as main economic indicator, it indicates the health of the market. GDP must and yield rates must be inversely related.

Statistical verification

First step of statistical verification is so-called **goodness of fit (R^2)**, which measures how well the regression model fits the data. Coefficient of determination lies between 0 and +1. Value of R^2 close to 1 indicates, that the model explains nearly all the variability of dependent variable. Adjusted R^2 takes into account the loss of degrees of freedom associated with adding extra variable.

Coefficient of determination derived from Equation 1 is equal R^2=95.4%, adjusted R^2=94.8%.

Formula: $R^2 = 1 - \frac{s_R^2}{s_Y^2}$; $\overline{R^2} = 1 - (1 - R^2)\frac{n-1}{n-p}$

Statistical significance of the model was tested using F-test. Model proved to be statistically significant.

Second step of statistical verification is verification of structural parameters. All parameters included in the model proved to be statistically significant at the level of significance of 99%. P-value, t-ratios, as well as standard error and estimated coefficient are shown in Table 4.

Table 4 Statistical Verification - Prague

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	5.14231	1.21625	-4.2280	0.00018	***
PRG_RENT_1	-0.0657247	0.00502985	13.0669	<0.00001	***
TAKE_UP	-0.0108968	0.0033174	-3.2847	0.00248	***
VACANCY	0.17564	0.0162693	10.7958	<0.00001	***
GDP_1	-6.16638e-06	3.9944e-07	-15.4376	<0.00001	***

Source: own calculation; Gretl sw.

Autocorrelation of residuals

Autocorrelation is detected by Durbin-Watson test. It tests the relationship between an error and its previous value. According to the model, DW=1.72 which is value very

close to the upper critical value (d_u). Therefore it is difficult to say whether hypothesis of no autocorrelation should be accepted or whether the results are inconclusive.

Formula: $$DW = \frac{\sum_{t=2}^{n} (u_t - u_{(t-1)})^2}{\sum_{t=1}^{n} u_t^2}.$$

Elasticity

Elasticity measures how the percentage change of one variable affects the other variable. Generally high elasticity is observed among luxury consumer goods, where small change in price/income has significant influence on demand.

Formula: $$E = \frac{\partial y}{\partial x_i} \frac{x_i}{\hat{y}}$$

- Vacancy rate elasticity: If vacancy rate increases by 1%, yield rate increases by 0.1%.
- GDP elasticity: If GDP increases by 1%, yield rate decreases by 0.4%.

Functional form

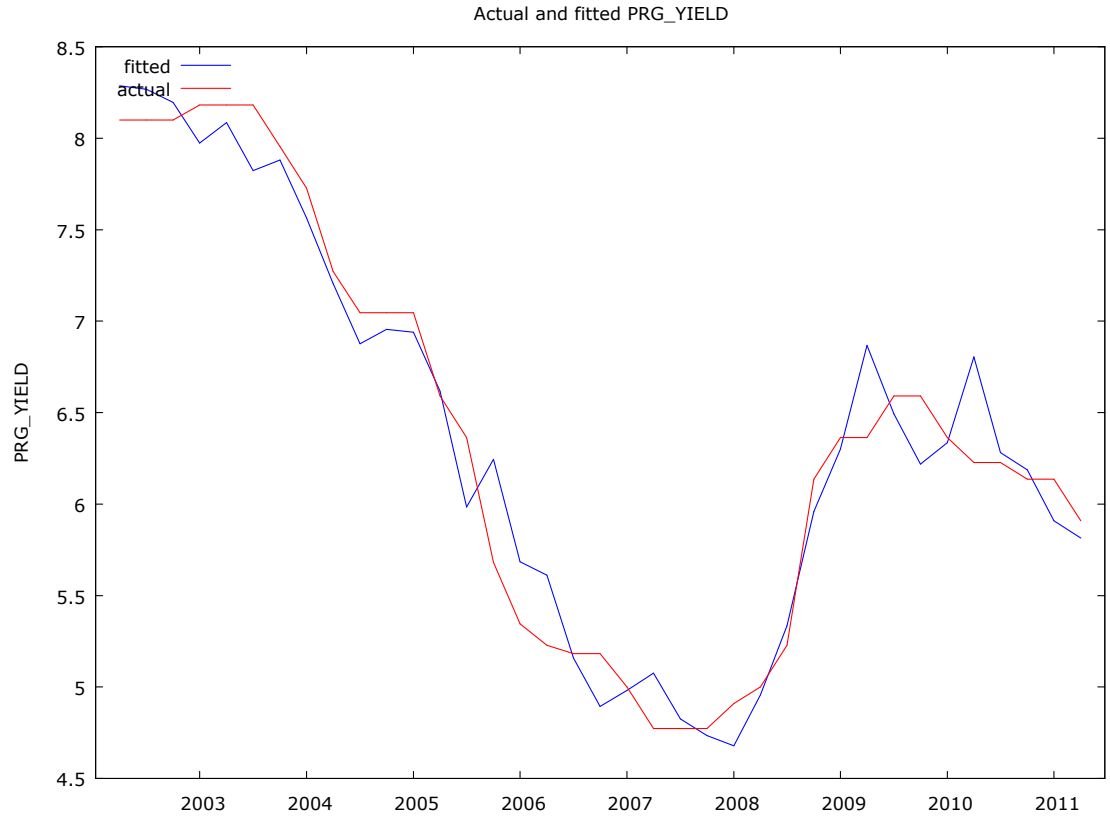
One of the assumptions of Ordinary Least Square method is that the functional form is linear, and the relationship between *y* and *x* can be expressed by a straight line. Ramsey's RESET test tests general misspecification of functional form.
Based on the below test statistics, it can be said that model for calculation Equation 1 is in an appropriate functional form.

Test statistic: F = 1.023732, with p-value = P(F(2,30) > 1.02373) = 0.371

Comparison

Comparison of real prime yields and calculated ones is depicted on Chart 10. Significant discrepancy between real and calculated yields is shown year in 2009 and 2010. This is caused by the fact, that the model uses only average values with very low elasticity.

Chart 10 Prague Yield - Actual vs Fitted



Source: own calculation, output from Gretl sw.

Conclusion

Although, suggested model has it flaws, it provides decent estimates. This statement is supported by economic theory and additional statistical tests. Estimation of parameters of office yields in Prague proves the first hypotheses formulated in the aim of the diploma thesis:

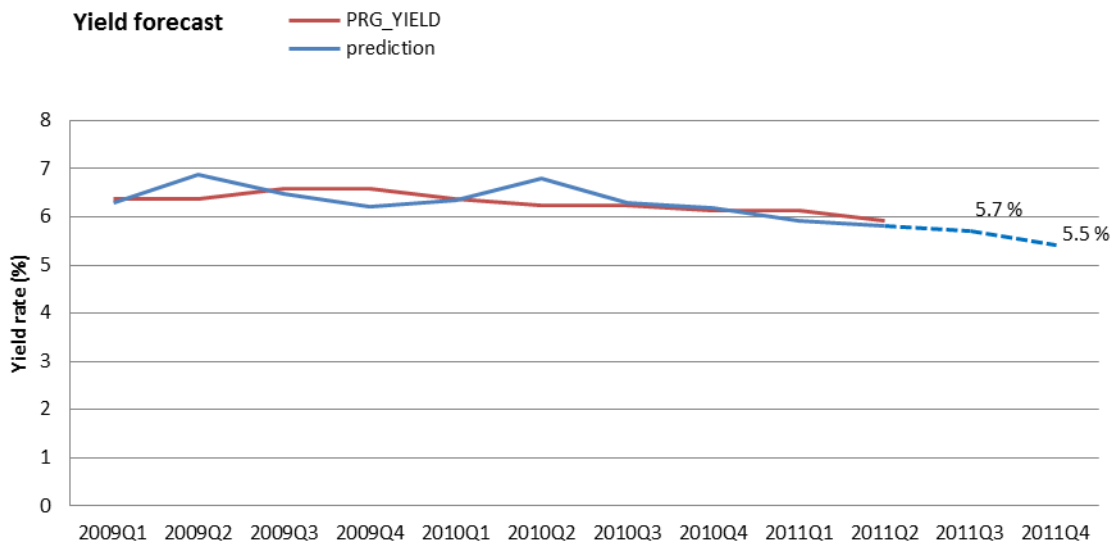
1. **Yield rates are influenced by GDP, prime rents, vacancy rates, and take-up**

Yield Forecast

Forecast of office yields in Prague is based on suggested econometric model. Thanks to improved macro and micro economic factors, yield rates are expected to fall down. Forecasted values for third and fourth quarter of 2011 are reaching the pre-crisis levels.

Yield rate forecasted for Q3 2011 is approximately 5.7%, prediction for Q4 2011 is even lower at 5.5%. Development in time is depicted in Chart 11. [1]

Chart 11 Yield Forecast



Source: own calculation

[1] Model in able to provide only short term forecasts, because of the loss of information caused by differencing variables in order to reject unit root hypothesis.

5.3 Office Yields - Budapest

First hypothesis states that, **yield rates of office properties in Budapest are influenced by GDP, prime rents, vacancy rates, and take-up.**In compliance with the first hypotheses, econometric model is formulated as follows:

β Yield= λ BUD RENT + λ TAKE UP+ λ VACANCY + λ GDP

Model is based on annual data for the period of 1995-2011.

All variables are to be tested for the existence of **unit root**. (y_1Budapest Yield, x_2Budapest Rent, x_3Budapest Take-up, x_4Budapest Vacancy, and x_5GDP of Hungary). Original data showed signs of unit root and had to be modified. Using the method of differences, time series were modified to stationary data.

Construction of a model

Due to insufficient quality of data available publicly, all data used for estimation of parameters in Budapest were completely taken from the databases of CBRE Global Investors. Because of confidentiality reasons, these data are not to be disclosed.

Definition of variables used in econometric model:

- Endogenous variable:
  - y_{1t} = prime yield rate in Budapest.
- Exogenous variable:
  - x_{1t} = unit vector
  - x_{2t} = prime rents in Budapest
  - x_{3t} = net take up in Budapest
  - x_{4t} = vacancy rate in Budapest
  - x_{5t} = gross domestic product in Hungary

Suggested model shows no signs of multi-colinearity.

Estimation of parameters was conducted using Ordinary leas square method (OLS); based on formula $\gamma = (X^TX)^{-1}X^Ty$. Model in structural form is as follows:

Equation 2: :$\mathbf{Y_{1t} = 12.605 - 0.046\ x_{2t} - 0.016\ x_{3t} + 0.183\ x_{4t} - 0.105\ x_{5t}}$

Economic interpretation and verification:

- If level of prime rents increases, yield rate decreases
  - Based on theoretical background rent and yield should be in an inverse relationship. This is reflected in a property valuation approach where growing rents (i.e. cash inflows) increase the value of a property, while increase of yields reduces the value of a property.
- If net take up increases, yield rate decreases
  - Growing take up implies increasing demand. Higher demand for office properties means higher confidence in the market and therefore is must be inversely related to yields.
- If vacancy rate increases, yield rate increases
  - Vacancy rate is the most influential factor which determines yield rates. Growing vacancy means that the real estate market is underperforming; the risk factor of the market increases, and therefore vacancy rate and yield rate must be directly proportional to each other.
- If gross domestic product increases, yield rate decrease
  - GDP is widely recognized as main economic indicator, it indicates the health of the market. GDP must and yield rates must be inversely related.

Statistical verification

Coefficient of determination or so-called **goodness of fit (R^2)** is first step of statistical verification. Coefficient of determination derived from Equation 2 is equal R^2=96.7%,

adjusted R^2=95.6%. Econometric model explains approximately 96% of dependent variable.

Formula: $R^2 = 1 - \frac{s_u^2}{s_y^2}; \quad R^2 = 1 - (1 - R^2)\frac{n-1}{n-p}$

Statistical significance of the model was tested using F-test. Model proved to be statistically significant.

Second stage of statistical verification is **verification of each structural parameter**. All parameters (except X_5 GDP) included in the model proved to be statistically significant at the level of significance of 99%. Gross domestic product is statistically significant on the level of significance 90%. This minor deviation can be caused by the relatively short time series.

Autocorrelation of residuals

Autocorrelation is detected by Durbin-Watson test. It tests the relationship between an error and its previous value. According to the model, DW=1.69. Hypothesis of no autocorrelation should be accepted.

Formula: $DW = \frac{\sum_{t=2}^{n}(u_t - u_{(t-1)})^2}{\sum_{t=1}^{n} u_t^2}$

Functional form

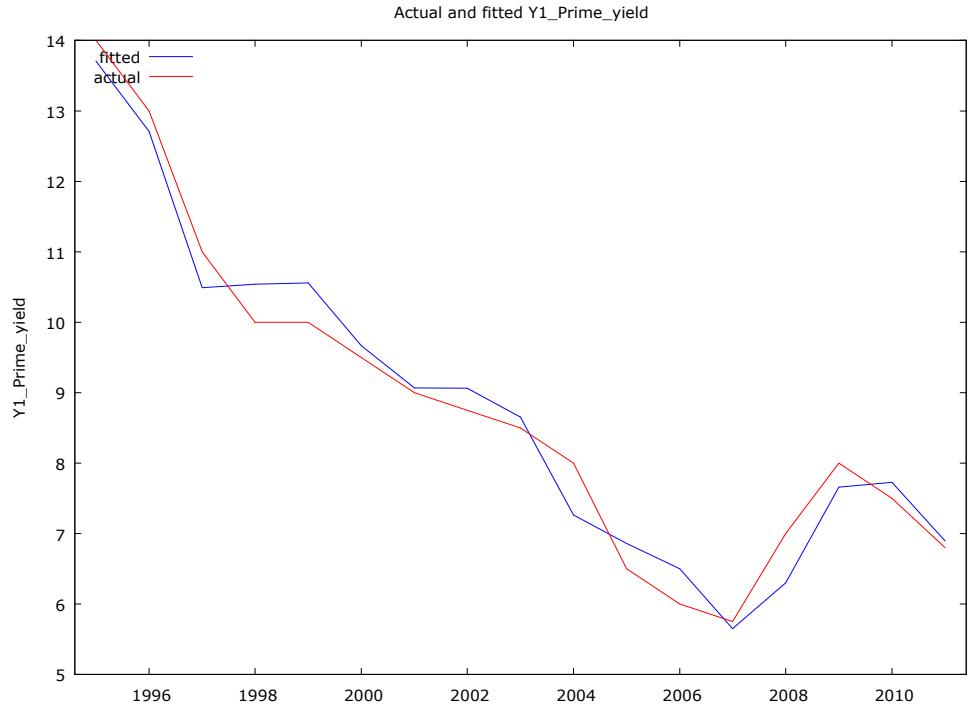
One of the assumptions of Ordinary Least Square method is that the functional form is linear, and the relationship between *y* and *x* can be expressed by a straight line. Ramsey's RESET test tests general misspecification of functional form. Based on the below test statistics, it can be said that model for calculation Equation 2 is in an appropriate functional form.

Test statistic: F = 1.541812, with p-value = P(F(2,10) > 1.54181) = 0.261

Comparison

Comparison of real prime yields and calculated ones is depicted in Chart 12. Most significant difference between actual and fitted results occurred during the early stages, in 1998.

Chart 12 Budapest Yields - Actual vs Fitted



Source: own calculation

Conclusion

Based on the test statistic, suggested model provides good estimates. First hypotheses formulated in the aim of the diploma thesis that **Yield rates in Budapest are influenced by GDP, prime rents, vacancy rates, and take-up** can be accepted.

5.4 Office Yields – Warsaw

First hypothesis formulated in the diploma thesis states that, **yield rates of office properties in Warsaw are influenced by GDP, prime rents, vacancy rates, and take-up.** In accordance with the first hypotheses, econometric model is formulated as follows:

β Yield= λ PRIME RENT + λ TAKE UP+ λ VACANCY + λ GDP

Model is based on quarterly data for the period of 2005Q1-2011Q2 .

Variables were tested for the existence of **unit root** using Dickey-Fuller test. In order to transform non-stationary data into stationary all data has to be differences. Variables subject to test were: y_1Warsaw Yield, x_2Warsaw Rent, x_3Warsaw Take-up, x_4Warsaw Vacancy, and x_5 GDP of Poland. Hypothesis H_0 about the existence of unit root in the time series was rejected and alternative hypotheses was accepted.

Construction of a model

Information about gross domestic product was taken from the Statistical Office of Poland. Other data were downloaded from the databases of CBRE Global Investors. Because of confidentiality reasons, these data are not to be disclosed.

Definition of variables used in econometric model:

- Endogenous variable:
  - y_{1t} = prime yield rate in Warsaw.
- Exogenous variable:
  - x_{1t} = unit vector
  - x_{2t} = prime rents in Warsaw
  - x_{3t} = net take up in Warsaw
  - x_{4t} = vacancy rate in Warsaw
  - x_{5t} = gross domestic product in Poland

Suggested model shows no signs of multi-colinearity.

Estimation of parameters was conducted using Ordinary leas square method (OLS); based on formula $\gamma = (X^TX)^{-1}X^Ty$. Model in structural form is as follows:

Equation 3 :$\mathbf{Y_{1t}= 0.73 - 0.016\ x_{2t} - 0.02\ x_{3t} + 0.26\ x_{4t} - 1.23872e\text{-}06\ x_{5t}}$

Economic interpretation and verification:

- If level of prime rents increases, yield rate increases
  - This relationship is not in accordance with economic theory and may suggest wrong model.
- If net take up increases, yield rate decreases
  - Inverse relationship is implied between demand variable (take up) and yield rate.
- If vacancy rate increases, yield rate increases
  - Growing vacancy rate is caused when supply is higher than demand.
- If gross domestic product increases, yield rate decrease
  - GDP is widely recognized as main economic indicator, it indicates the health of the market. GDP must and yield rates must be inversely related.

Statistical verification

Coefficient of determination or so-called **goodness of fit (R^2)** is first step of statistical verification. Coefficient of determination derived from Equation 3 is equal R^2=82.7%, adjusted R^2=79.4%. Econometric model for estimation yield rates in Warsaw explains only circa 80% of dependent variable.

Formula: $R^2 = 1 - \frac{S_R^2}{S_y^2}; \quad R^2 = 1 - (1 - R^2)\frac{n-1}{n-p}$

Statistical significance of the model was tested using F-test. Model proved to be statistically significant.

Statistically significant (level of significance 99%):

- x_{2t} = prime rents in Warsaw
- x_{4t} = vacancy rate in Warsaw

Statistically insignificant:

- x_{3t} = net take up in Warsaw
- x_{5t} = gross domestic product in Poland

Autocorrelation of residuals

Durbin-Watson test indicates autocorrelation of residuals. (DW=1.09)

Formula: $$DW = \frac{\sum_{t=2}^{n} (u_t - u_{(t-1)})^2}{\sum_{t=1}^{n} u_t^2}$$

Conclusion

Although Chart 13 depicts some similarities between actual and fitted values, model for yield estimation in Warsaw should be rejected based on economic and statistical verification.

Chart 13 Warsaw Yields - Actual vs Fitted

Source: own calculation

5.5 Common Macro and Microeconomic Factors

Second hypothesis formulated in the aim of the diploma thesis says that:

Yield rates of office properties in Prague, Warsaw, and Budapest are influenced by the same micro and macro-economic factors. Due to the fact, that model for estimation of yield rates in Warsaw had to be rejected, second hypothesis is also rejected. Office market in Warsaw is influenced by other factor, than office market in Prague or Budapest.

Factors influencing yield rates that are present in all three models are:

- Prime rents in selected market
- Vacancy rate in selected market

Factors influencing yield rates in Prague and Budapest

- Prime rents in selected market

- Vacancy rate in selected market
- Net take up in selected market
- Gross domestic product in respective country

Yield rates of office properties in the CEE region are primarily influenced by microeconomic factors related directly to the market, especially by prime rents and vacancy rate. Level of rents results of the interaction of demand and supply and provide representative overview of the creditworthiness of the market.

6 Conclusion

The diploma thesis “Economic Analysis of Commercial Real Estate Properties in the CEE Region” deals with factors influencing the yield rates of office properties. Hypotheses formulated in the aim of the diploma thesis estimated the influence of several macro and micro economic indicators. The influence of external market forces on the yield rates was confirmed in the literature review and also in the practical part of the diploma thesis.

Evolution of (commercial) real estate market is a sign of transition from the planned economy towards the market economy. Fall of the Iron Curtain in 1989 affected significantly the entire society of countries of the CEE region and enabled the establishment of real estate market (Real estate market occurred as result of privatization). These changes had positive effect on the entire urban dynamics and subsequently led to improved perception of these economies abroad and resulted in large inflow of FDIs. Real estate market for office properties; submarket of commercial real estate market; provides a good overview of the evolution from emerging economy towards developed economy. [1] [2]

Cities evaluated in the diploma thesis were: Prague, Budapest, and Warsaw. Similarities of real estate markets among these cities are examined from different perspectives by several authors for example by Adair [1], McGreal [2], or Stankeviciene [13]. They all have indentified commonalities such as: perception of the real estate market by foreign investors, successful transition from planned economy, FDI inflows during the 1990s, clustering of office centers, positive rent growth expectation, etc.

Econometric model created in the chapter 5 proved that the yield rates are influenced by the gross domestic product of a country, prime office rents in selected location, vacancy rate in selected location, and take-up in selected location. Econometric model was accepted for Prague and Budapest, but had to be rejected in case of Warsaw.

The influence of selected variables on the yield rate of office properties is as follows:

- If level of prime rents increases, yield rate decreases
    - This relationship is reflected in a property valuation approach where growing rents (i.e. cash inflows) increase the value of a property, while increase of yields reduces the value of a property.
- If net take up increases, yield rate decreases
    - Growing take up implies higher demand, which means higher confidence in the market and therefore is must be inversely related to yields.
- If vacancy rate increases, yield rate increases
    - Growing vacancy means lack of demand and therefore, the risk factor of the market increases. Vacancy rate and yield rate must be directly proportional to each other.
- If gross domestic product increases, yield rate decrease
    - GDP is widely recognized as main economic indicator, it indicates the health of the market, therefore GDP must and yield rates must be inversely related.

Based on the statistical and economic verification, econometric model for estimation of yield rate of office properties in Prague and Budapest provides good estimates and can be used for short term forecasting in practice.

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Supplements

Supplement 1

CZECH REPUBLIC
GDP - from the Income Side, Current Prices (mil CZK)

Year / Quarter	2 002			2003			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GDP at purchaser prices	644 988	654 986	679 312	612 939	675 255	687 205	712 708

Year / Quarter	2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GDP at purchaser prices	665 376	730 121	741 602	792 073	712 518	784 468	790 275	828 795

Year / Quarter	2006				2007			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GDP at purchaser prices	761 086	831 575	858 497	901 441	843 399	905 917	935 100	978 157

Year / Quarter	2008				2009			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GDP at purchaser prices	889 080	970 995	997 237	991 099	888 452	932 655	939 543	978 575

Year / Quarter	2010				2011	
	Q1	Q2	Q3	Q4	Q1	Q2
GDP at purchaser prices	872 980	956 630	959 164	986 463	883 682	961 512

Source: Czech Statistical Office [cited:4.1.2012] http://czso.cz/eng/redakce.nsf/i/hdp_ts
FX rate used for calculation: Fixed Conversion ration as of 2010: 1EUR=25.06 CZK

Supplement 2

HUNGARY
GDP - 2005 market prices :- Performance relative to the rest of 35 industrial countries: double export weights : EU-27, TR CH NR US CA JP AU MX NZ (OVGDQ)

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
GDP	98,99297	97,15192	97,62357	98,98277	99,45832	100	101,989	105,4064	108,2425
Year	2004	2005	2006	2007	2008	2009	2010	2011	
GDP	110,5571	112,5587	112,6861	108,9432	108,7632	105,9801	104,6208	103,9187	

Source: Eurostat [cited:4.1.2012] http://ec.europa.eu/economy_finance/ameco/user/serie/ResultSerie.cfm

Supplement 3

POLAND

GDP - Quarterly accounts by institutional sectors in 2005 - 2011, at current prices.

		Gospodarka narodowa				
		(National economy)				
		I kwartał	**II kwartał**	**III kwartał**	**IV kwartał**	**I-IV kwartał**
		(1st quarter)	(2nd quarter)	(3rd quarter)	(4th quarter)	(1st-4th quarters)
		w mln PLN (in PLN millions)				
PRODUKT KRAJOWY BRUTTO **(GROSS DOMESTIC PRODUCT)**	2005	229 396	238 094	241 760	274 052	983 302
	2006	242 785	255 497	261 511	300 238	1 060 031
	2007	270 132	282 922	291 059	332 624	1 176 737
	2008	299 129	310 865	314 722	350 716	1 275 432
	2009	312 784	325 203	332 222	373 157	1 343 366
	2010	323 089	343 960	350 897	397 416	1 415 362
	2011	349 342	369 310	375 060		1 093 712

Source: Central Statistical Office – Poland [cited:4.1.2012] http://www.stat.gov.pl/gus/5840_3825_ENG_HTML.htm,

FX rate used for calculation: Fixed Conversion ration as of 2010: 1EUR=6.31 PLN