BI Norwegian Business School
Preliminary report

"To what extent do different variables determine the commercial rental prices for the various submarkets in Oslo?"

Course code:
GRA 19502 – Preliminary Thesis report

Supervisor:
Artashes Karapetyan

Hand-in date:
15.01.2018

Campus:
BI Oslo

Study program:
MSc in Business, Major in Finance

Name and Student-ID:

Gunnar Harris-Christensen

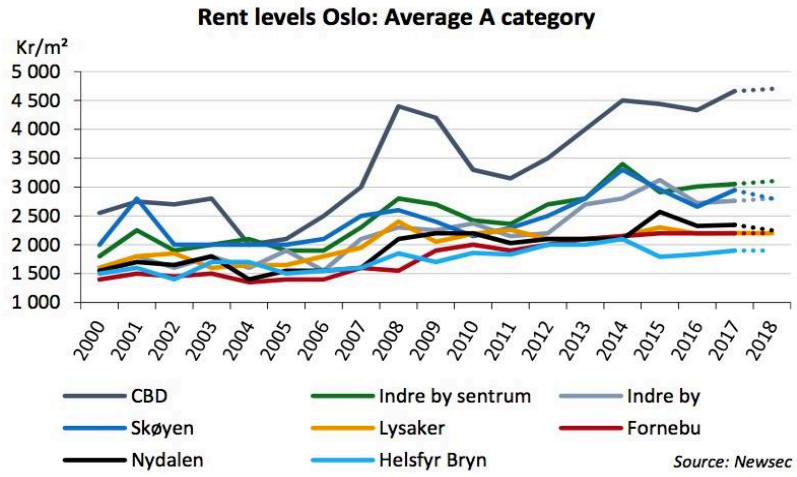
Henrik Sandvik

Table of contents

1.0 Introduction

In this paper, we will look closer into commercial rental prices, which is one of the main drivers for commercial real estate value (Isaac & O'Leary, 2013). Further on, we will consider what drives the rental prices in Oslo and in its various submarkets. The rental prices per square meter (NOK /m^2) you are willing to pay are depending on the building's location, and the building's characteristics and standard. In Oslo, the average rental prices differ among the different areas, and within many areas, the building's characteristics and standard differs. By looking on the potential drivers for the rental prices we will investigate it by compare it to some selected macro variables to look for correlation between the variables and the rental prices, and examine whether some of them can be explanatory. As we will come back to later in this paper, several macro variables have had significant changes the last few years, like the dramatically drop in the oil price back in 2014, and interest rates that are at a record low level.

Graph 1.1 below shows the development in rental prices for the different areas for the past 17 years. As we can see there have been some fluctuations, and in our thesis we will look closer into whether some macro variables have had a bigger impact on some areas.



Graph 1.1
(NRP Finans - Market Report, December 2017)

Moreover, the variables we will look further into are unemployment rate, GDP, interest rate (NIBOR) and oil price.

Furthermore, another important aspect of the development in rental prices is the level of supply and demand. Analysts and researchers are therefore paying careful attention to the level of vacancy and absorption or conversion in the market, as well as the level of new-builds coming into the market. Figure 1.1 below shows vacancy in percent of supply and demand in the market for Oslo in terms of total space, and Figure 1.2 below shows the geographical areas in Oslo that we will be focusing on.

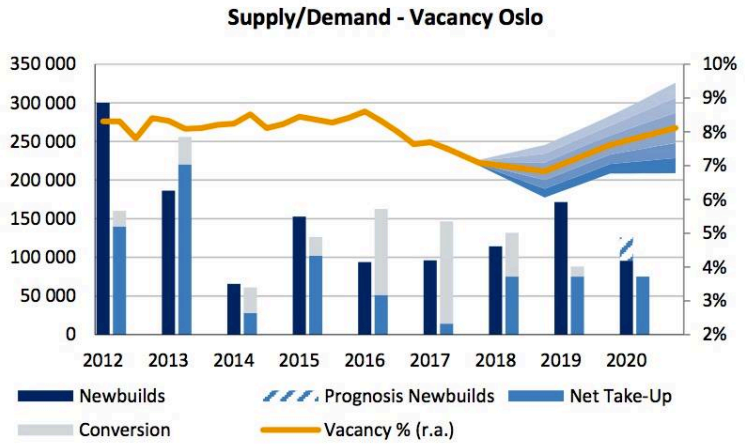


Figure 1.1
(NRP Finans - Market Report, December 2017)

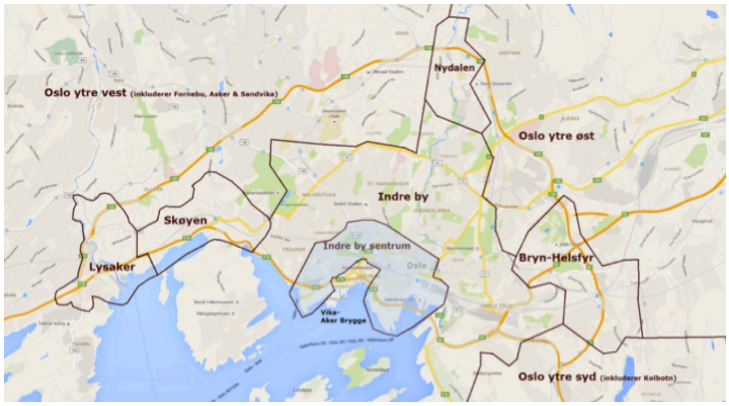


Figure 1.2 Areas / Submarkets
(Arealstatistikk AS)

2.0 Motivation

Real estate is something all people and companies have a relation to and will continue to have a relation to in the future. This can be whether they are whole or

part owners of a building, or that they rent space in a building. Over the years there have been done a lot of research on different topics related to real estate. However, we are interested to look further into and examine whether there are explanatory and correlated macro variables to the development in rental prices for commercial real estate in Oslo, and for its various submarkets.

During the analysis period, we have seen that the selected macro variables we will investigate have varied a lot. The Norwegian economy is highly exposed to the oil price, and the price made a dramatically drop in 2014 which affected a lot of oil related companies, and therefore also the Norwegian economy. Today the interest rates are at a record low level, and the rates have been on a low level for a long time. Taking these macro variables into account we find it interesting to examine what the impact have been on the rental prices, and if some of the areas have been influenced more than others.

Previous literature and research have compared the development in rental prices in different cities across the world, as well as between cities within the same country. They have also compared similar buildings within the same areas. However, there have not been written any literature on comparing the different submarkets in Oslo, and in what extent the different macro variables influences the various submarkets. The aim of this thesis is to contribute to further research on this topic.

3.0 Literature review

We want to find out which variables that are driving the rental prices in commercial real estate. The previous research and literature written on commercial real estate is mostly about different valuation and forecasting methods. To be able to forecast you should find the variables that are significant in order to get an accurate forecast. The latter is related to our topic, as we are interested in finding the relevant variables that are driving the rental prices, and being able to compare the main drivers that determine the rental prices for the different areas in Oslo. Further, forecasting commercial rental prices is useful in helping to determine future trends, valuation of properties and the yield.

In a study done by McGough and Tsalacos (1994) they aim to make a short-run forecast of commercial rental values in the UK for three commercial property sectors. The sectors that are examined are the office sector, the retail sector and the industrial sector. In our thesis, we want to limit the commercial sector and only apply data concerning the office sector. In their study, they use Autoregressive (AR), moving average (MA), and integrated autoregressive moving average models (ARIMA). An AR-model assumes that future rental prices can be predicted based on previous prices. The MA model is used to find situations of supply and demand shocks that will influence rents in subsequent periods.

Further, the use of these models determines if whether the AR- or MA-model are relevant in determination of rental values. These models indicate which past rental values that should be incorporated into more general models, like regression or VAR models. Moreover, ARIMA models are then used to develop dynamic structures of real rent determination. The accuracy of the forecasts that are made in the study is determined by comparing the predicted values with the actual rental values of JLW rental value index.

The time series model, which is used in the forecast of commercial rents, is an ARIMA (p, d, q) model.

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + \theta_0 + \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \ldots - \theta_q \varepsilon_{t-q}$$

where:

- $y_t = \Delta^d Y_t$;
- Δd = the dth difference of variable Y at time t;
- thus d = the degree of integration;
- θ_0 = a constant;
- ε = the error term;
- p = number of lagged terms of y_t; and
- q = the number of lagged terms of ε.

Figure 3.1 – *ARIMA-model*
(McGough & Tsalacos, 1994)

After making sure that the data series are transformed to be stationary and non-seasonal, procedures to model selection is presented. The preferred specification for office rents is an ARIMA (0, 2, 1) model.

The forecast of using the model is then compared with the actual nominal rental values of the JLW property index. The ARIMA (0, 2, 1) model has a satisfactory prediction, as the predictive value is 190.4 compared to the actual rental value of 188, which shows that the predicted value is almost the same as the reported value. For office rents, the result of the analysis suggests that past shocks affect present and future changes in rental values. Therefore, the models provided good insight for short-term investors regarding forecasting of turning points of rental values.

A limitation of the study by McGough and Tsalacos is that they only incorporate previous rental values in the determination of future values. However, in our thesis, we will also examine if other variables are relevant in determining rental values. Further, the study compares the forecasted values to a broader property index, while we intend to compare our forecasting accuracy with the respective areas.

Tonelli (2004) argues that there has been a continuous evolving of office rent models. The majority of the models quantify relationships between the change in rent levels and input variables of building, industry and macroeconomic determinants. Further he identifies 20 different models and provides a representation of the relative level of adaption of explanatory variables that are used in the models.

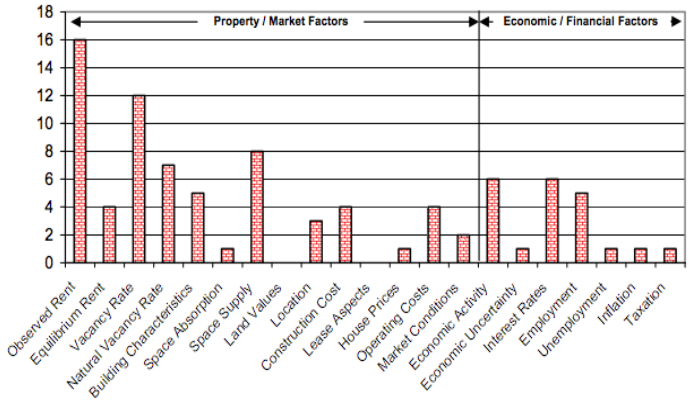


Figure 3.1
(Tonelli, 2004)

Observed rent, vacancy rate and space supply are the dominant used explanatory variables from property/market factors used in the model. From the

economic/financial factors we see that the dominant explanatory variables used in the models are economic activity, interest rates and employment.

McDonald (2002) surveyed econometric models for the office market and the study focused on models developed by Wheaton, Torto and Evans (1997) and Hendershott, Lizieri and Matysiak (1999). McDonald argues that the model developed by Wheaton, Torto and Evans (1997) arguable has the best theoretical framework of all the available models. Further, DiPasquale and Wheaton developed a varied version of this model (1996). This model incorporates the dominant explanatory variables that are found from the econometric models that have evolved over time. Figure 3.2 shows the main drawings from the produced model.

In our thesis, we intend to incorporate the dominant explanatory variables found from the evolving research. In addition, we seek to find other variables that might be specific for the city of Oslo. Since we are only examining one city, our goal is to see if some variables are more area specific than others, and potentially address why this may be the case. Some of the areas contain businesses that are in the same segments, i.e. finance, insurance, retail, attorney etc. These segments may react differently to changes in the different variables than for instance oil service companies.

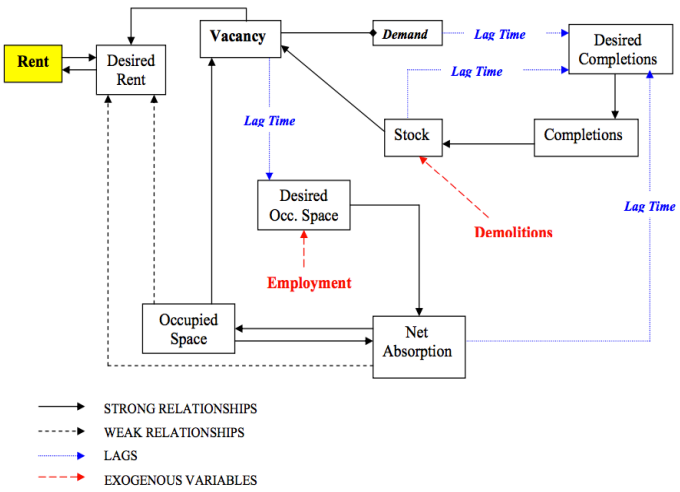


Figure 3.2

(Tonelli et.al., 2004)

In an article written by Wheaton et.al., the authors argue that "the primary instrument driving office space demand is employment in selected sectors of an economy" (Wheaton et.al., 1997). A study presented by Wheaton (1999) from the United States shows that companies within the sectors, Finance, Insurance, Business, Real Estate, or Professional services are counting for 75% of the space in larger office buildings. Further, manufacturing, trade and utilities mainly occupy the rest of the market. They further argue that employment and occupied space move differently due to the space per worker varies across occupations. By applying this to the Oslo markets, our hypothesis is that that the rental prices in some areas will be more affected of a change in some of the macro variables, due to the clustering of similar business in the same areas.

Another aspect that is highlighted in the article is vacancy and rental movements. Researchers have found strong and negative relationships between change in rental rates and vacancy (Wheaton et.al., 1997). Another research from the United States shows that for an owner of a building to find the right tenant can be very time-consuming and expensive process. After a tenant finds the appropriate space, the tenant will in many situations require certain configuration changes and starts bargaining on the terms of the contract, which not always will be profitable for the owner of the building. The owner of the building has therefore a price he would be indifferent between renting the space out or keep it vacant (Wheaton et.al., 1997). Findings show that with the use of long-term leases, rents are also likely to adjust slowly as well (Wheaton et.al., 1997).

Furthermore, the authors of the article are also paying attention to the supply in the market. The authors argue that the level of new office construction would depend on the asset price of office space relative to its replacement cost. The asset price is based on its net effective rental income and a capitalization rate (Wheaton et.al., 1997). The authors are concerned with the net absorption, when analyzing the market. Further, the authors are including several macro variables in their regression as employment rate and interest rate for instance.

Similar to the findings in the article can be used in analyzing the markets in Oslo, when looking further into the macro variables effect on the rental prices for the various submarkets or areas.

A study by Orr and Jones (2003) focus on analysis and prediction of local office rents, and the development of an econometric model for the two cities Edinburgh and Glasgow. In the paper the authors review the sparsity of the existing urban office rent models. They claim that the existing models experience data problems, and they either make the mistake of ignoring supply constraints or that supply is considered in terms of net change in floor space. The object of the paper is to address these deficiencies in the existing empirical work on the office rental market. This is attempted by using a local take-up variable in order to model the urban rents. The authors develop two models to capture the urban rents. The first model uses a single reduced – form price equation with the use of direct demand and supply measures and the second model is a structural three-equation model. The analysis shows that Edinburgh responds more quickly than Glasgow to fundamental imbalance changes in the supply and demand. The two cities are in the same administrative region. The article therefore argues that you should favor urban analysis, and refers to the deficiencies you witness when choosing a regional line to forecasting.

This study narrows their prediction down to city level of two cities located close to each other, where a lot of studies are examining rental prices at a regional or national level. This urban analyze is closer to our own analysis, but we intend to narrow it further as the areas examined are even smaller.

4.0 Theory & Methodology

To answer our research question, we will use statistical methods in order to generate models. By creating different models we're hoping to see both relationships and a forecast for future rental prices in the different areas. As we are using historical data in our forecast we will be focusing on AR-, MA-, ARIMA- and VAR-model, and classical linear regression model.

4.1 ARIMA-model

When using univariate time series models, one is attempting to model and predict variables with the use of information contained in the variables, past values, and current and past values of an error term. One big advantage of using ARIMA-models is that they are quite flexible in that they can represent different types of time series (Zhang, 2003). The construction of time series models is usually a-theoretical, i.e. there is no underlying theoretical model of the behavior of a variable. The essence of time series models is to capture relevant empirical features from the observed data that have arisen from unspecified structural models. One of these time series models is the ARIMA-model, which is associated with Box and Jenkins (1976).

When we are searching for the model that best explains and produces forecast for commercial rental prices, the ARIMA-model may be useful if the structural model is unfitting. When aiming to explain the movements in rental prices, there might be some variables that are unobservable or not measurable. For this purpose, we may therefore use a time series model.

The ARIMA (p, d, q) model is created by combining and autoregressive AR(p) and a moving average MA(q) model, where the data is differenced d times. An autoregressive model is a model where the current value of a variable, y, depends upon the values of the variable in previous periods, plus an error term. A moving average model is one where Y_t depends on the current and previous values of a white noise disturbance term.

When building the ARIMA-model we want to use the Box and Jenkins (1976) approach. The estimating of the model is using their systematic approach, which includes three steps. The first step is identification where we need to determine the order of the model required. Here we will use graphical procedures in order to determine the most appropriate specification. Step two of this approach will be the estimation of the parameters of the model, which is found in step one. The estimation of the parameters will be done by using either least squares or maximum likelihood. The third step of the Box and Jenkins approach is the model checking. This will be done by either over-fitting or residual diagnostic.

Using information criteria will do the identification stage of the ARIMA-model selection. The object of this is to choose the numbers of parameters that minimizes the value of the information criteria. The three most commonly used information criteria are AIC, SBIC and HQIC, and we will approach the model selection by using these information criteria.

4.2 Classical linear regression model

In linear regression model, we can see if there is a linear relationship between the selected variables and the dependent variable that can explain the development in the rental prices. In other words, we will see if there is a linear relationship between the above-mentioned macro variables and the previous rental prices that can explain the development of the rental prices. The variables we want to include will be checked for unit root by running a Dickey Fuller test. By using a classic linear regression model, we will be able to predict a forecast for the next period based on these variables. As we are using a linear regression model we will minimize the ordinary least squares and see if it's BLUE (Best Linear Unbiased Estimators). If the five assumptions of Gauss-Markov theorem hold, we have BLUE. To see if the assumptions hold we will be testing each assumption with its appropriate tests using the computer software.

4.3 Vector autoregressive model

Vector autoregressive model (VAR) is a systems regression model that can be looked as a hybrid between univariate time series models and simultaneous equations models (Brooks & Tsolacos, 2010). According to Brooks, a VAR-model is a multivariate time series specification where lagged values of all the variables appear on the right hand side in the equations of the model (Brooks, 2014). The model is commonly used in macro econometric analysis and for forecasts. VAR-models come in three different varieties, which are reduced form, recursive and structural, and in an article written by Stock and Watson they are looking further into how different macro variables can be examined using the VAR-model (Stock & Watson, 2001). This is relevant for our thesis as we are investigating the relationship between selected macro variables and the rental prices. The variables in a VAR-model are all endogenous. In a VAR-model we

can have several variables that are depending on different combinations of the previous k values of both variables and error terms. The number of lags to be used in the model in this case is how many previous years we will include, and the proper number of lags will be decided by running a AIC and BIC test mentioned earlier, using computer software. We will also test the performance of the model and run other appropriate tests using computer software.

4.4 Forecasting

The forecasting accuracy of the different models is an important test of the models' adequacy. Further, businesses respond differently to changes in macroeconomic variables. When negotiation on rental values, agreements made today will be of great importance when you later may witness changing business environments. Being able to produce accurate forecasts is therefore important when going into negotiations of long-term rental contracts.

Econometric structural forecasting relates a dependent variable to independent variables, and these models often work well for long run relationships between the variables. Time series forecasting is one where you try to forecast future values given its previous values and/or previous values of an error term. The distinction between the two types of forecasting is however not always perfect as it is not clear where vector autoregressive models fits in this classification. We want to apply both dynamic and static forecasting of the rental values. The determining of whether the forecast is accurate or not will be determined by comparing a set of error measures of the different models, and the model with the lowest error measure value would be the model that is most accurate. The error measures that may be considered for the forecast evaluation is MSE, MAE, MAPE, AMAPE, RMSE, Theil's U-statistic, and the percentage of correctly predicted signs.

5.0 Data

In our thesis, we will use data provided by Arealstatistikk AS, which is a private Norwegian company that collects rental prices for real estate in the Oslo area. The dataset consists of detailed rental prices for different areas such as BCD, City

Centre and Lysaker etc. The data is reported on a quarterly basis. For each area, we are provided the total floor space of commercial real estate, its vacancy and the quarterly reported average price per square meter.

In our thesis, we will compare the development in rental prices with some selected macro variables as well as the level of supply and demand in the market. The macro variables we mainly want to focus on are GDP, interest rates (NIBOR), oil price, and unemployment rate. Our data set goes back to the beginning of the 2000s. We will take into account and adjust for the financial crisis during the analysis period as the Dotcom crisis and the financial crisis in 2008.

The data related to interest rates will be extracted from Oslo Stock Exchange (Oslo Børs). We will use NIBOR 3 month since our rental prices are one a quarterly basis. When it comes to the unemployment rate we will extract the AKU numbers from Statistical Central Bureau (SSB). The data related to oil price and GDP will be extracted from the Bloomberg database.

6.0 Research question

To what extent do different variables determine the commercial rental prices for the submarkets in Oslo?

7.0 Conclusion

In our master thesis, we will examine to what extent different variables influences commercial rental prices for the various submarkets in Oslo. Our hypothesis is that some of the areas are more exposed to changes in some of the variables than others. By testing different statistical models as ARIMA, CLRM and VAR we believe that we will find the most suitable model to see relationships between the rental prices and the variables, as well as predicting future prices. Based on the literature written by McGough & Tsolacos, Orr & Jones, and Tonelli, Cowley & Boyd, they are all looking on commercial real estate but have a different approach to it. In our thesis, we want to combine their research methods and do further research to investigate whether it can be applied on the Oslo market.

8.0 Reference list

Brooks, C. (2014). *Introductory econometrics for finance*. Cambridge university press.

Brooks, C., & Tsolacos, S. (2010). *Real estate modelling and forecasting*. Cambridge University Press.

Data provided by *Arealstatistikk AS*

Isaac, D., & O'Leary, J. (2013). *Property valuation techniques*. Palgrave Macmillan.

McGough, T., & Tsolacos, S. (1995). Forecasting commercial rental values using ARIMA models. *Journal of Property Valuation and Investment*, *13*(5), 6-22.

NRP-Finans. (2017). Market Report December 2017. Retrieved from http://www.nrp-finans.no/Reports/

Orr, A. M., & Jones, C. (2003). The analysis and prediction of urban office rents. *Urban Studies*, *40*(11), 2255-2284.

Stock, J. H., & Watson, M. W. (2001). Vector autoregressions. *The Journal of Economic Perspectives*, *15*(4), 101-115.

Tonelli, M., Cowley, M., & Boyd, T. (2004). Forecasting office building rental growth using a dynamic approach. *Pacific Rim Property Research Journal*, *10*(3), 283-304.

Wheaton, W. C., Torto, R. G., & Evans, P. (1997). The cyclic behavior of the Greater London office market. *The Journal of Real Estate Finance and Economics*, *15*(1), 77-92.

Zhang, G. P. (2003). Time series forecasting using a hybrid ARIMA and neural network model. *Neurocomputing*, *50*, 159-175.