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BACHELOROPPGAVE

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TITTEL: Hva påvirker boligprisene i Stavanger kommune?

ENGELSK TITTEL: What factors influence house prices in Stavanger municipality?

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Preface

This bachelor’s thesis marks the end of our journey on our bachelor's degree. The choice of topic is motivated by the turbulent time of our days and the many news articles published that talk about the evolution of house prices on the market. We would like to give a big thank you to our supervisor, Ola Barkved, and Dengjun Zhang for being always available, providing great feedback and challenging our thesis to make it grow. Conducting this research we have learned a lot about the mechanisms and challenges of quantitative research. We hope that you as a reader learn something new while reading our research.

Summary

The Norwegian housing market operates under the influence of numerous factors, which impact its stability and expansion. As the oil capital of Norway, Stavanger holds significant influence over the nation's economy. This thesis seeks to illuminate the intricate workings of Stavanger's housing market, aiming to interpret the key forces driving its behavior. Our analysis delves deep into the fundamental drivers of Stavanger's housing market, with a focus on identifying the primary factors that drive fluctuations in housing prices. Through this exploration, we aim to uncover the underlying influences on the housing market and their contributions to price dynamics.

We embarked on our research journey by engaging ourselves in various housing market theories and conducting a thorough review of existing literature, including numerous articles and dissertations focused on the Norwegian housing market. This extensive review provided us with valuable insights and guided our research direction. Drawing inspiration from the model developed by Jacobsen & Naug (2005), we selected our explanatory variables, which encompass income, interest rate, unemployment, finished housing units, and population growth. Additionally, we introduced the oil prices variable, not previously explored by Jacobsen & Naug, to examine its influence on the housing market dynamics specifically in Stavanger.

Our findings indicate that income levels, interest rates, oil prices, and population growth serve as key factors influencing the housing market in Stavanger. Interestingly, our analysis reveals that unemployment rates and the rate of finished housing units do not exert a significant impact on housing prices in Stavanger, contrary to expectations. However, further investigation is needed for these variables as their behavior diverges from established research trends.

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1.0 Introduction

Human beings have some basic needs to survive like food, clothing, and shelter. Housing plays a vital role in meeting the essential need of shelter. It is also an essential sector of the country's economy. Additionally, housing serves as a significant avenue for investment, often comprising a substantial portion of wealth accumulation. Consequently, many households prioritize homeownership as a primary means of accumulating wealth, favouring tangible assets like their homes over financial instruments (Zhu, 2014).

Stavanger is the oil capital of Norway. It has emerged as a vibrant hub for resource-based industries such as energy, aquaculture, and agriculture. Strengthened by a well-educated workforce, top-notch infrastructure, and expertise in engineering and information technology, the city thrives as a powerhouse of economic activity and innovation (Stavanger kommune,2022). This quality makes Stavanger an attractive city to live in, driving high demand and expansion in its housing market.

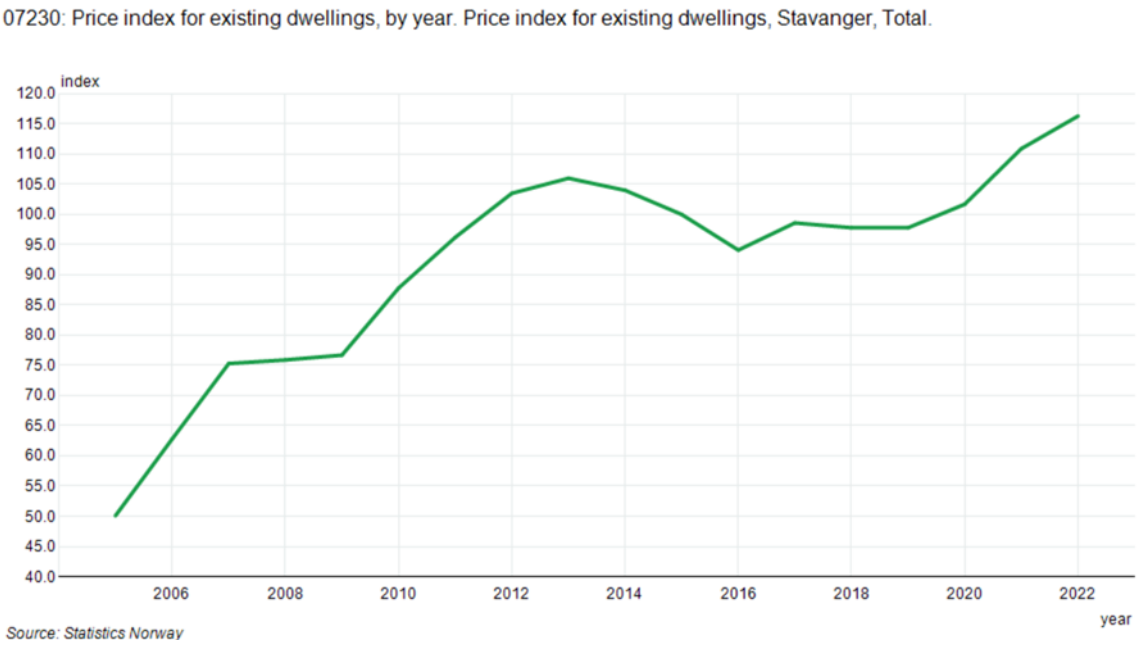

Figure 1: House price index, Stavanger.Sources:(SSB,2024a)

Figure 1 shows that house prices in Stavanger have increased more than double from 2005 to 2022. This upward trajectory commenced in the early 2000s and has persisted despite economic challenges, both domestically and globally. This shows that the housing market in Stavanger is strong and stable, even during tough times. According to Lundesgaard(2023),

house prices in Stavanger are expected to rise 7% in 2024. Such a substantial rise in house prices carries significant implications for various stakeholders across the Norwegian economy.

This report delves into the factors that shape the housing market in Stavanger, a city of significant economic importance in Norway, primarily due to its role as the country's oil capital. To conduct our analysis, we gathered data from reputable Norwegian online sources such as SSB, NAV, and FRED. Additionally, we sourced information on oil prices from the Federal Reserve Economic Data. We opted for secondary data sources because they are readily available and known for their reliability. These sources are widely respected for their consistent and thorough data collection methods.

In this bachelor thesis we are seeking to address the question:

"What factors influence house prices in Stavanger municipality?"

This thesis explores various factors that affect the rise in house prices, with a particular focus on key elements derived from the theoretical framework of Jacobsen & Naug(2005), elaborated in Chapter 3. The methodology adopted for this thesis revolves around multiple regression analysis which is detailed in Chapter 4. Chapter 5 provides an overview of the data utilized for analysing the drivers of house prices. The findings of the regression analysis and ensuing discussions are encapsulated in Chapters 6 and 7 respectively. Lastly, Chapter 8 encapsulates the conclusions drawn from our study.

2.0 Background

2.1 Historical Context

Understanding the trajectory of house prices in Norway is crucial, and it is appropriate to begin by examining their evolution. Figure 2 illustrates the quarterly house price index in Stavanger for the years 2005-2023. By comparing data from other regions, we gain valuable perspective on the current state of house prices. Notably, the price growth in Stavanger closely mirrors that of Oslo, Bergen, and Trondheim from 2005 to 2015, but at a higher price point. However, a significant divergence occurred in 2015 when Oslo experienced a substantial surge in prices compared to Stavanger, and to a lesser extent, Bergen, and Trondheim. The price index in Stavanger declined, with a gradual recovery observed since 2016, while Trondheim and Bergen have maintained an upward trend throughout this period.

The pivotal shift can be traced back to the decline in oil prices, which subsequently led to reduced production within the petroleum services industry and the construction sector (Berg, 2016). At that time, Stavanger boasted the second-highest employment rate in the petroleum industry at 13.7% (Ekeland, 2017, p. 5). The collapse of oil prices in 2014 resulted in increased unemployment rate and decreased housing demand in Stavanger, contributing to the observed decline. Throughout the entire period (2002-2023), house prices experienced significant increases, with Stavanger rising by 247%, Oslo by 309%, Bergen by 239%, and Trondheim by 254%[1] (SSB, 2024a). To gain a comprehensive understanding of the evolution of house prices, we will delve into key underlying statistics specific to Stavanger.

[1] Numbers found by using the formula $\frac{2022-2005}{2005}$ on the house price index for each city.

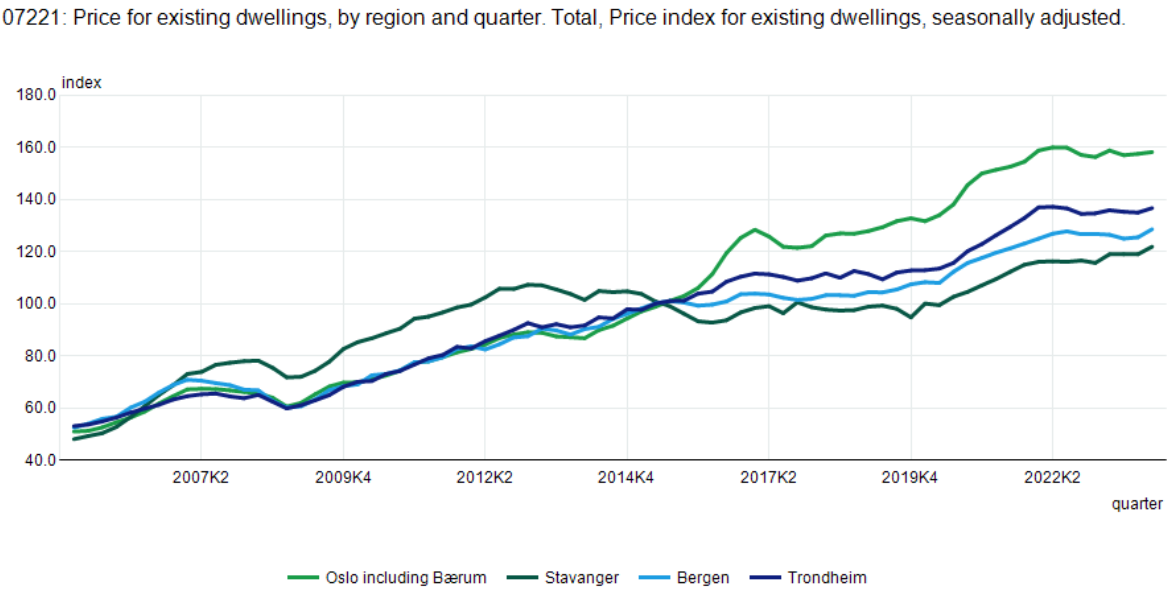

Figure 2:House price index in Oslo, Stavanger, Bergen, and Trondheim. Sources: (SSB,2024a)

2.2 The role of housing on the economy

As students of economics, we are naturally drawn to discussions surrounding economic phenomena, whether within academic settings or our social circles. When tasked with selecting a topic for our bachelor thesis, we sought to identify an issue of broad societal relevance. It became apparent that the housing market, along with interest rates and mortgage loans, was a subject of widespread concern among people. After extensive deliberation, we decided to delve into the intricacies of the housing market to illuminate the crucial factors that shape its dynamics. This thesis serves as an earnest struggle to deepen our understanding of the housing market's functioning, explaining key influences such as interest rate, income, unemployment rate, oil price, population growth and finished housing which shape the supply and demand dynamics in the market.

We noticed that people are interested in following the housing market for several compelling reasons. Firstly, housing is often the largest financial investment that individuals and families make in their lifetime (Jansen,2011). Consequently, tracking the housing market allows them to monitor the value of their homes and assess potential returns on investment. Secondly, fluctuations in the housing market can directly impact personal finances. Changes in house prices, mortgage rates, and rental costs can influence affordability, equity, and monthly

housing expenses. Therefore, staying informed about housing market trends enables individuals to make informed decisions about buying, selling, or renting properties. Moreover, the housing market is intricately linked to broader economic conditions. Mortgage-secured loans constitute over 80% of bank's lending to households, highlighting their pivotal role in the financial landscape. When house prices experience a decline, the collateral value may drop below the outstanding loan balance for certain households, potentially leading to financial strain. In such scenarios, banks face heightened risk of loan defaults and increased loan losses, particularly if borrowers struggle to meet their debt obligations. Consequently, banks may adopt a more cautious approach to lending, tightening their credit standards and reducing loan availability to households. This cautious stance could exacerbate the downward pressure on house prices, creating a feedback loop that further impacts market dynamics (Jacobsen and Naug, 2005, page 2).

Hence, following the housing market provides valuable insights into the overall health of the economy. Additionally, for those involved in real estate transactions, such as homebuyers, sellers, investors, or real estate professionals, understanding housing market trends is essential for making strategic decisions and navigating competitive market conditions. Overall, the housing market holds significant importance for individual's financial well-being, economic stability, and strategic decision-making, which motivates people to closely follow its developments.

Interest rates play a significant role in house prices. When interest rates are low, borrowing costs decrease, making mortgages more affordable for potential homebuyers. This typically stimulates demand for housing, as individuals are more inclined to purchase homes or invest in real estate. Increased demand, in turn, tends to drive up house prices as buyers compete for vacant properties. Conversely, when interest rates rise, borrowing becomes more expensive, leading to a decrease in affordability for homebuyers. As a result, demand for housing may decline, causing a slowdown in the housing market and potentially putting downward pressure on house prices. Therefore, fluctuations in interest rates can have a pronounced impact on house prices, shaping affordability and influencing the overall dynamics of the housing market.

Most houses are financed through mortgage loans, with approximately 70% of homeowners having a mortgage, and one-third of them carrying loans exceeding two million kroner,

according to data from the SSB (Oppøyen, 2023). Floating interest rates have been the preferred choice among Norwegians, with fixed-rate mortgages accounting for less than 10% of outstanding mortgages between 2005 and 2019, as noted by Bjørnlo & Winje (2019). This reliance on floating rates implies that changes in interest rates significantly impact household consumption.

In recent years, there has been a notable increase in interest rates, rising from 0% on May 7, 2020, to 4.5% as of March 21, 2024, according to the Norge's Bank. This level has not been seen since December 8, 2008, at the end of the financial crisis when Norway began decreasing rates (Norge's Bank, n.d.). The shift in interest rates affects households by increasing their interest payments. An article by Oppøyen (2023) indicates that total housing costs for consumers rose by an average of 45% from 2021 to 2023. Specifically, housing costs for mortgage loans exceeding three million kroner surged by 66%, by 55% for loans between two and three million, 41% for loans between one and two million, and 11% for loans under one million. However, renters have experienced minimal changes in housing costs.

Stavanger is the oil capital of Norway and is on the path to become the energy capital of Norway. The petroleum industry provides Norway with the highest income and economic growth (Hernes et al., 2021, p.3). This holds also true on the regional level where the petroleum industry provides the municipalities with direct and indirect employment, taxes which finance the welfare production created by the municipality and economic growth. Stavanger have the highest share of total employment with 40% of the employed which is related to the petroleum industry and taxes from the petroleum industry make up 30-40% of the municipalities "free income" (Fjose, 2021, p.6). The county, Rogaland, which Stavanger is a part of is estimated to create wealth of 291 billion. All these numbers are for the year of 2021 (Fjose, 2021, p.3). The petroleum industry as showcased plays a pivotal role in the economic activity of Stavanger and we can thus hypothesize that the oil price should have a role on the housing market in Stavnager. Research done by Cappelen et. Al. (2014) indicates that with a reduction of oil price by 1/3 on the supply side, the estimated effects are an increase of 1% in the unemployment rate over 5 years, real income reduced over this period by 3.6%, and household and public sector consumption is estimated to be reduced by 4% and 6%. All these factors can influence the purchase of a house for the households on the market.

3.0 Theory

This chapter provides an overview of previous literature on the driver of house prices followed by an econometric model created by Jacobsen & Naug (2005).

3.1 Literature review

This section represents several studies from different authors about the Norwegian housing market. We have decided to review the studies on the national level because of the lack of reputable studies done on the regional level.

Sila (2020) explores the numerous factors influencing house prices, including income, demographics, macroeconomic conditions, housing supply, and institutional features. It suggests that in Norway, high and increasing house prices primarily result from strong market fundamentals such as high household incomes, accumulated wealth, low interest rates, and population growth. Since 2000, real house prices in Norway have doubled, but there has been a slowdown since 2017. Prices have risen faster than incomes, leading to concerns about affordability and high levels of household debt, which pose systemic risks. Additionally, the housing supply in Norway is less responsive to demand compared to Sweden or Denmark, further driving up prices.

The results reported by Sila (2020) show that all the coefficients, household disposable income, real interest rate, housing stock, population growth, share of urban population and household financial net wealth have expected signs. A one percent increase in household disposable income per capita leads to a 1.3% rise in house prices, which suggests that housing is a luxury good. The real interest rate affects house prices negatively. A 1% increase in the real interest rate decreases house prices by 0.8%. Lower interest rates make mortgage loans more affordable for households and results in increased demand for housing. Similarly, increased housing supply results in lower house prices, and the results show that 1% increase in housing supply lowers the house prices by 0.25%. Population growth and urbanization affect housing prices positively.

Jacobsen & Naug(2005) conducted a study to find out what the drivers of house price is in Norway. They find that key variable like income, interest rate, unemployment rate and housing construction have been the driving forces. They found that a 1% increase in the interest rate, the house prices are estimated to increases by 2.25% in the first quarter and 3.25% in the long run. The effect of unemployment rate is slow, a permanent increase by 1%

decreases house prices by 11% over 40 quarters (=10 years). Real disposable income had an estimated effect of 0.5% over the first year and a long run effect of 1.75%. Housing stock has an estimated effect of 1.75 % in the long run if the parameter increases by 1%.

Jansen (2011) conducted similar research and found similar results. He found that the house prices have increased 50% more than the disposable income has increased in the same period i.e. from 1970 to 2010 and coupled with the increase in the number of households has been a factor in the rising house prices. The ratio between the total housing value (quantity housing multiplied by housing price) and households' disposable income has tripled from 1970 to 2007 which has resulted in increased debt levels for households.

Household's debt has also increased by 200% over this period meaning that the effect of higher interest rates can put financial constraints on certain indebted households. Low interest rates throughout this period have led to an increase in house prices. Other factors that can be attributed to the growth in house prices are the low amount of housing supply coupled with the increase in population and the number of households. They also found indication that house prices and debt can create a negative spiral of increasing house prices (Annundsen & Jansen,2011, as cited Jansen,2011).

3.2 House price model

Jacobsen & Naug's(2005) house price model offer a comprehensive framework for understanding the determinants of housing prices, integrating various economic, demographic, and market factors. This model explains the intricate dynamics of the housing market, seeking to explain the relationships between housing supply, demand, and pricing outcomes. By considering a range of observable variables, including demographic trends, lending policies, and expectations regarding future income and housing costs, the Jacobsen and Naug model aims to provide insights into the complex relation between forces shaping house price dynamics. Grounded in economic theory and empirical analysis, this model serves as a valuable tool for policymakers, researchers, and practitioners seeking to navigate the complexities of the housing market and develop informed strategies for addressing housing affordability, market stability, and socio-economic outcomes.

House prices are influenced by both housing supply and demand. Housing supply, which is represented by the available housing stock, tends to remain relatively stable in the short term due to the time required to construct new dwellings, coupled with the modest annual rate of housing construction compared to the overall housing stock. Consequently, short-term

fluctuations in house prices are primarily driven by changes in demand. However, over time, the housing stock adjusts to meet changes in demand. A comprehensive model for understanding house prices in the long term should incorporate factors related to housing stock developments, such as construction costs and prices of new dwellings. For this analysis, we focus solely on explaining movements in house prices relative to the existing housing stock.

Demand for housing comprises two main aspects: households seeking homes for personal occupancy and those looking at properties purely as investment assets. It's logical to assume that the former significantly outweighs the latter. Therefore, our primary focus will be on the demand for homes for personal use. Housing services can be consumed through either ownership or rental arrangements. The theory specifically examine the demand for housing services stemming from owner-occupied dwellings, which includes flats within housing cooperatives. Additionally, the theory operates under the assumption that this demand is directly related to overall housing demand. Our analysis is grounded in the following aggregate demand function:

$$H^D = f\left(\frac{V}{P}, \frac{V}{HL}, Y, X\right), \qquad f_1 < 0,\ f_2 < 0,\ f_3 > 0$$

Equation 1: Aggregate demand function

H^D = Housing demand

V = Total housing costs for a typical owner

P = Index of prices for goods and services other than housing

HL = Total housing costs for a typical tenant (rent)

Y = Households' real disposable income

X = A vector of other fundamentals that affect housing demand

f_i = The derivative of f (•) with respect to argument i

Equation (1) says that the demand for owner-occupied dwellings rises with increasing income and declines when housing costs associated with ownership rise compared to rents or prices for other goods and services. Vector X comprises observable variables that encompass the impact of demographic factors, lending policies of banks, and household expectations

regarding future income and housing expenses. Anticipations regarding future income and housing costs hold significance because housing serves as a durable consumer good, acquiring a dwelling represents the most significant expenditure for many households over their lifetimes, and a substantial portion of households relies on debt financing when purchasing their first home or upgrading within the housing market. Further elaboration on the components of X is provided below.

The housing cost for an owner represent' the value of goods that the owner gives up by possessing and living in a home for a certain period. To simplify, the real housing costs for owners can be defined as:

$$\frac{V}{P} \equiv \frac{PH}{P} BK = \frac{PH}{P}[i(1-\tau) - E\pi - (E\pi^{PH} - E\pi)]$$

Equation 2:Real housing costs equation

Where:

BK = Housing cost per real krone (NOK) invested in a dwelling

PH = Price for an average dwelling (in NOK)

i= Nominal interest rate

τ = Marginal tax rate on capital income and expenses

$E\pi$ = Expected inflation (expected rise in P and HL, measured as a rate)

$E\pi^{PH}$ = Expected rise in PH (measured as a rate)

The expression $[i(1-\tau) - E\pi]$ represents the real after-tax interest rate, indicating the actual interest expenses associated with a housing loan and the lost interest income from investing in a house. When interest rates rise, both interest costs and returns from bank deposits increase, leading to higher housing expenses. On the other hand, the term $[E\pi^{PH} - E\pi]$ denotes the expected real increase in house prices. Expected housing wealth increases if $[E\pi^{PH} - E\pi]$ increases and thus the real housing expenses for homeowners decrease. Consequently, owning a dwelling becomes comparatively more advantageous than renting, prompting an increase in demand for owner-occupied homes.

Equation (2) can be simplified as

$$\frac{V}{P} \equiv \frac{PH}{P} BK = \frac{PH}{P}[i(1-\tau) - E\pi^{PH}]$$

Equation 3: Simplification of the housing costs equation

The variable BK is the nominal after-tax interest rate minus the expected increase in nominal house prices. Equations (1) and (3) describe the demand for owner occupied housing. The variables in (1) and (3) will also affect the demand for housing as an investment instrument. It is reasonable to assume that the demand for owner occupied housing increases as income increases. Increase in the house rents relative to the prices would increase investment in the housing market for rental purposes, increasing the demand for housing. In the same manner, lower interest rates encourage investment in the housing market and are more beneficial in comparison to bank deposits. This results in higher demand for dwellings as an investment instrument.

As we know, the housing supply is relatively stable in the short term. The house price (PH) is the level at which the demand for housing equals the supply of housing. By inserting (1) in (3) and using semi-logarithmic function we get:

$$\ln PH = \beta_1 \ln P + (1-\beta_1) \ln HL + \beta_2 \ln Y + \beta_3 BK + \beta_4 \ln H + \beta_5 g(X)$$

Equation 4: House price model

Where H is the total housing stock

Real disposable income can be defined as

$$Y = \frac{YN}{P^{\alpha_1} HL^{\alpha_2} PH^{\alpha_3}}$$

$$\alpha_1 + \alpha_2 + \alpha_3 = 1, \quad \alpha_1 < \beta_1, \quad \alpha_2 < \beta_2$$

Equation 5:Real disposable income

Where YN = Nominal disposable income

Equation (5) considers that increased housing prices will reduce the purchasing power in the housing market for households overall. By rearranging (4) and (5) with respect to PH we get

$$\ln PH_t = \varphi_1 \ln P_1 + \varphi_2 \ln HL_t + \varphi_3 \ln YN_t + \varphi_4 BK_t + \varphi_5 \ln H_t + \varphi_6 g(X_T) + \varepsilon_t$$

Equation 6: Final house price model

4.0 Method

Research methodology is defined as the procedure used to answer the thesis question at hand (Ghauri et. Al.,2020, p.42). The steps involved in the process are choice of design, data type, gathering of data, method of analysis and diagnostics of the model.

4.1 Research design

Research methodology can be divided into two categories: qualitative and quantitative research. The qualitative research method is collecting information about the study objects "…experiences, perceptions and behavior" (Tenny et al., 2022), while the quantitative research method collects data in the form of numbers and uses statistics to analyses the data (Wikipedia,2024). We have chosen quantitative research method because it suits our research question best due to our desire to estimate the effect of the variables that impact house prices.

To measure the effects of the variables, we need to collect data. There are two types of data: secondary and primary (Ghauri et al., 2020, p.153). Secondary data are data which is collected by agencies and is available through open public sources, while primary data are gathered by the researcher himself though surveys, interviews, and experiments (Ghauri et. al., 2020, p.153). The data type of our choice is secondary data. Secondary data fits the best due to the aggregation of variables we are using in this research. Public institutions like Statistics Norway and NAV have greater access to a larger sample size due to access to administrative data (Børke, 2011, p.10) and personal data (NAV, 2023) and can thus create a more representative and of higher quality parameters than we could with the collection of primary data. Data collection has been done to find either the same or the best replacement of variables in accordance with the house price model mentioned in chapter 3.2, house price model. Discussion of this is done in chapter 5, Data. The data we have collected is also classified as time series data, data which is ordered by time. This type of data requires a specific kind of methodology to create sound results.

4.2 Time series data

One of the presumptions of using the OLS method with time series data is that the data must be stationary, meaning that the data has constant mean, variance, and autocorrelation over time (Nau, 2020, "Stationary…" Ch. 1.7). This means that our data needs to have statistical properties that are independent of time (Hyndman & Athanasopoulos, 2021, Ch. 9.1). If not, there will be problems with the regression results.

OLS with time series data has issues which needs to be addressed to acquire sound results from the regression analysis. Time series data is mostly trending upwards, or in some cases downwards (Wooldridge, 2019, p. 351). The house price index data can be a good example of this type of data. Regression containing trend can lead to spurious regression (Wooldridge, 2019, p.354). This was pointed out early by Granger & Newbold (1974) which found that many econometric models had high R^2 (bigger then 0.9) and low Durbin-Watson test (a test to measure the autocorrelation) without transformation, making inference wrong.

To avoid spurious regression the data requires transformation, in the form of first differencing (seen by the Δ sign) which removes the trend from the data similarly to how Jacobsen and Naug (2005) did it. The first difference is the change from one quarter and to the previous quarter (Nau, 2020, Ch. 1.7 "Stationary…"). We conducted tests to see what kind of transformation our data should have with the augmented Dicker-Fuller (ADF) test and the results of these test are going to be provided in chapter 6.4. The ADF-test conducts a test with the hypothesis as followed (Wooldridge,2019,p.611):

H_0: The time series sample is non-stationary.

H_1: The time series sample is stationary.

The test is conducted on our variable with no difference, difference, and difference with log-transformation.

4.3 Regression model

The methodology of analysis used for this thesis is multiple linear regression (MLR). Multiple linear regression is a common technique used to estimate the effect of different variables on the dependent variable (Ghauri et al., 2020, p.210). The functional form of the equation follows the semi-logarithmic relationship, this is done in line with the house price model (see chapter 3.2).

The semi-logarithmic relationship between the dependent variable, Y, and the independent variables, X_1, I..., X_n is represented by the following linear equation:

$$\Delta \log(House\_price) = \beta_0 + \Delta\beta_1 \log(Inocme_t) + \beta_4(interest\_rate_t) + \Delta\beta_2 \log(Unemployment_t) + \Delta\beta_5 \log(Oil\_price) + \Delta\beta_3 \log(Finished\_housing_t) + \Delta\beta_6 \log(population\_growth_t) + s2 + s3 + s4 + \varepsilon_t$$

Equation 7: Multiple regression model used for estimation.

Where:

House_price = House price index for existing dwellings

Income = Household median income after tax, adjusted for inflation

Unemployment_rate = unemployment rate

Finished_housing = Buildings completed

Interest_rate = Banks Mortgage lending rate

Population_growth = population growth

Oil_price = oil price

S_i = seasonal dummy for quarter 2,3 and 4

Δ = difference operator ($y_t - y_{t-1}$)

House price is the dependent variable (Y), represented by house price index for exiting dwellings. The parameter β_0 is the intercept, representing the value of Y when all independent variables are zero. The parameters β1, β2…, βn are the coefficients, representing the change in Y for a one-unit change in each independent variable, holding all other variables constant. ε_t is the error term, representing the difference between the observed values of Y and the values predicted by the model (Ghauri et. al.,2020, p.220). These variables are estimated using the ordinary least squares (OLS) method. The OLS method calculates the values of the coefficient that has the lowest sample variance by minimizing the sum of the squared residuals (Ghauri,2020, p.221). OLS requires assumption to be met to conduct inference.

4.4 Regression diagnostics

After conducting the regression analysis, it is important to run diagnostic tests to measure whether the model has valid results or not. The regression analysis uses OLS to estimate the coefficient, but this is only correct methodology if the asymptotic properties of OLS are present in our data. There are five assumptions, of which the first three relates to the consistency and the next two to the lowest variance. When the assumptions are satisfied, they allow us to make inference based on our data:

1)“linear parameters and weak dependence” (Wooldrige,2019, p.370)

2)“no perfect multicollinearity” (Wooldrige,2019, p.371)

3)” zero conditional mean” (Wooldrige,2019, p.371)

4) “Homoscedasticity” (Wooldrige,2019, p.373),

5) “No serial correlation” (Wooldrige,2019, p.373)

Tests done to measure the assumption are as followed:1) Fitted vs. residual plot, 2) Correlation matrix, 4) The Breusch-Pagan test and 5) Autocorrelation function (ACF) plot. For the 3) assumption, zero conditional mean, states that the explanatory variables cannot correlate with the error terms. Issues that can arise are omitted variables, wrong functional form, and measurement error (Wooldridge,2019,371). Test for wrong functional form is done with the Ramsey reset test and discussion of omitted variables and measurement error will be discussed in Chapter 6.5, regression diagnostics.

5.0 Data

5.1 House price index

The house price index is the quarterly index of existing total dwellings collected from SSB. This index encompasses the dwelling types of detached houses, row houses and multi-dwelling (SSB,2024a). The index is based on the sales report from finn.no which is provided to SSB on monthly basis. The indices are then weighted based on the weight of each of the categories to make the index. The data is indexed to year 2015 (SSB,2024e). The graphical description of the data is provided under.

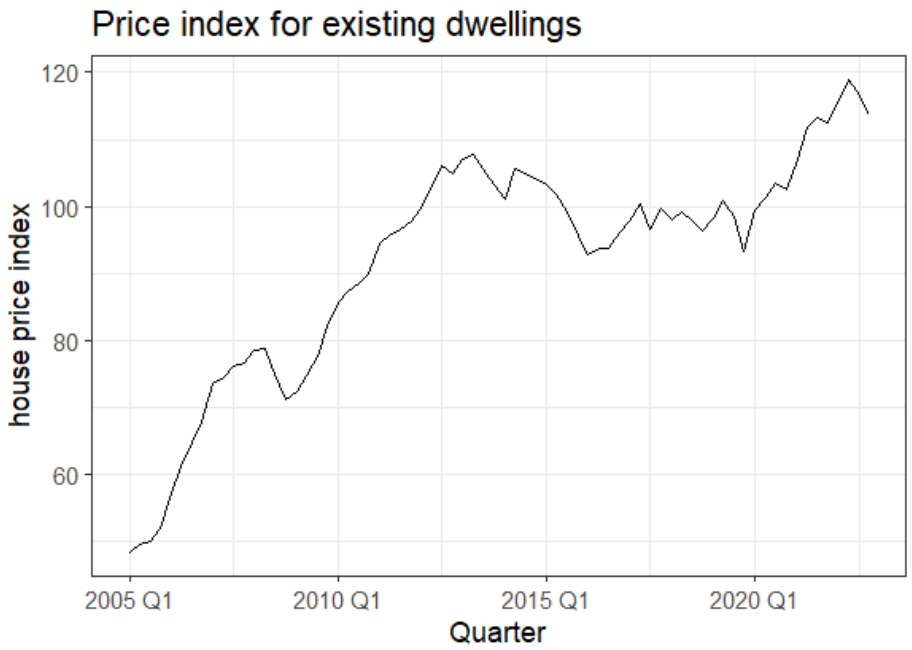

Figure 3::Table 07221: Price for existing dwellings, region = Stavanger, Quarter =2005Q1 – 2022Q4, type of dwelling = total. Source:(SSB,2024a).

5.2 Income

The income variable is based on household median income after tax and adjusted for inflation. Households, as defined by SSB, are all the people living in a private household permanently. Total income refers to income derived from "…employment payment, self-employment, income from property and transfers". The income is afterwards adjusted for taxes and negative transfers (SSB,2024h). We have adjusted the income variable for inflation by dividing income by the consumer price index adjusted for taxes and exclusion of energy products (CPI-ATE) (SSB,2024i). We have chosen this index because SSB states that this is the best index to measure the growth of general prices in Norway (SSB,2024d).

Income data, real disposable income, that Jacobsen & Naug(2005), used in their study is not available on a municipality level. Real disposable income is defined as "… income available to households such as wages and salaries, income from self-employment and unincorporated enterprises, income from pensions and other social benefits, and income from financial investments (less any payments of tax, social insurance contributions and interest on financial liabilities)" (OECD,2024) and adjusted for inflation. There are similarities between both variables in the fact that they account for households, have same underlying variables that constitute the income, are adjusted for taxes, and adjusted for inflation. The only difference is that real disposable income adjusts for interest on debt while the income variable of our choice does not. This means that the data should convey the same level of price evolution as the disposable income, but at a lower level.

The data is published in yearly format, but we have converted the data into quarterly. The conversion is done using temporal disaggregation in R with the "temdisagg" package. We have used the "Denton-cholette" method. This method mimics the movements of the yearly data where the sum of the quarterly data is the same as the yearly data gathered from SSB (Sax & Steinar,2013, p.84). When data aggregates it smooths out the data of the lower interval data. The method of converting from yearly data to quarterly data does not have the capability to capture this meaning that some of the effect of the quarterly changes cannot be captured.

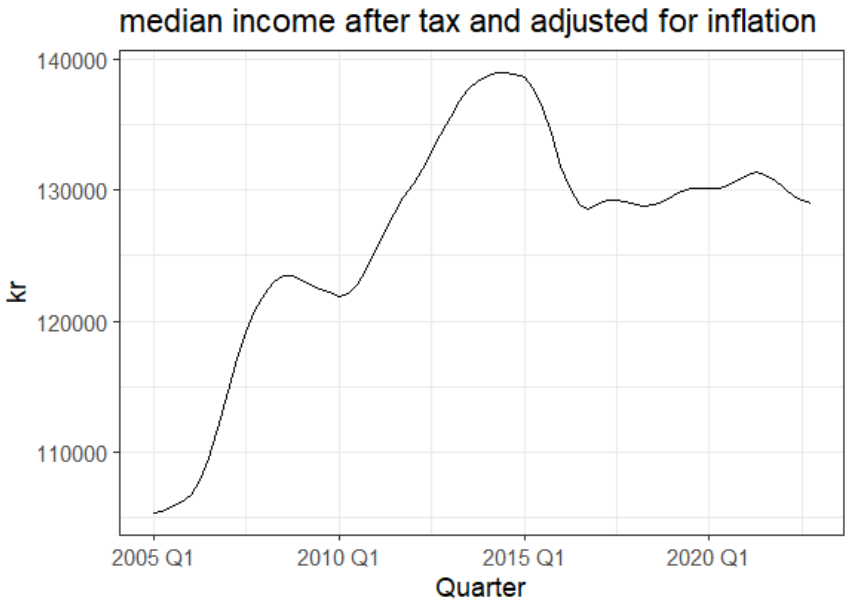

Figure 4:Income data: table 06944, Year = 2005-2022, Municipalities (2024-) = Stavanger, Type of households = All households. Adjusted by the yearly consumer price index (CPI-ATE), table 05335, before the conversion to quarterly data Sources: income data (SSB,2024d), CPI-ATE(SSB,2024i).

5.3 Interest rate

The interest rate reflects the quarterly bank's lending rate on total outstanding loans to households. Total outstanding loans consists of repayment loans, credit lines and loans secured on dwellings (SSB,2024f) and the data is collected from SSB. Figure plots the policy rate over these years. The rate was relatively high in 2008 due to the financial crisis, with a sharp fall and eventually a gradual decline until it was set to 0 in 2020 due to the covid-19 crisis and a sharp increase due to end of covid-restrictions and normal economic activity.

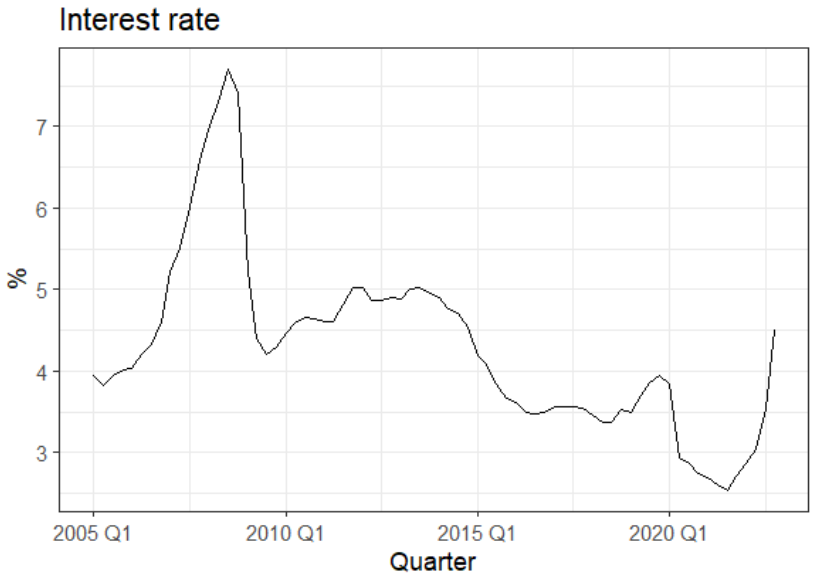

Figure 5:07200: Interest rates on outstanding loans, Quarter = 2005Q1 – 2022Q4. Financial corporation = Banks, Type of loans = Total loans, Sector = Households. Sources: (SSB,2024b).

5.4 Unemployment

We sourced data for unemployment rate for Stavanger from the Norwegian Labor and Welfare Administration (NAV), originally recorded on monthly basis and then converted to quarterly intervals. Unemployment is defined by NAV as “an applicant who is looking for an income giving job and has not worked for the last two weeks, while having the capability and capacity to work” (NAV,2024). Spanning from 2005 to 2022, the data reveals a noteworthy trend: a downward trajectory from 2005 to 2008, followed by a sharp increase in 2008 corresponding to the onset of the economic crisis. This upward trend persists until 2010 before gradually declining, reaching its lowest in 2013. However, in 2014, a substantial drop in oil prices precipitates a surge in the unemployment rate, marking its highest level in a decade. The onset of the Covid-19 crisis in 2020 catapults the unemployment rate to record highs within a short span, swiftly followed by a rapid decline, ultimately normalizing in 2022.

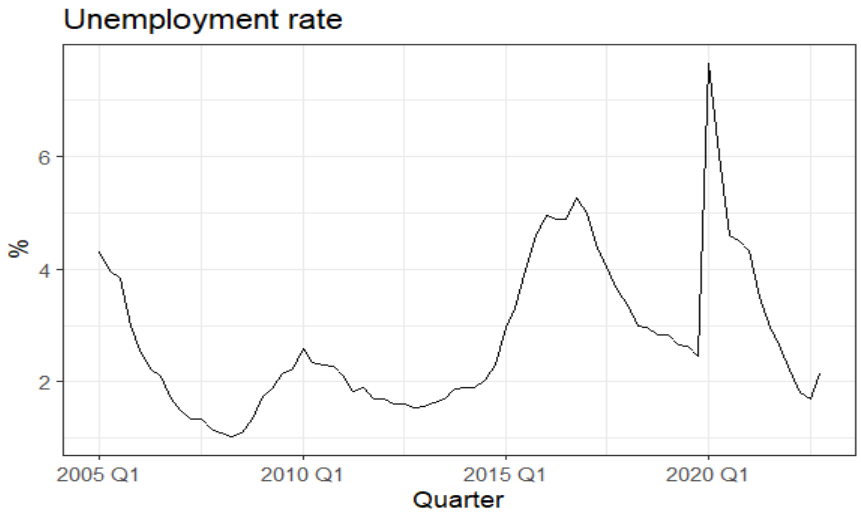

Figure 6:Unemployment rate converted to quarterly basis. Cont“nt = "Helt ”edige", Months = 2005m1 -2022m12, Municipalities = Stavanger. Sources (NAV,2024).

5.4 Population growth

The variable for population growth is represented by the quarterly population growth from 2005 to 2022. The choice of the operationalization of the parameter is based on the research of Sila (2020) which used the population growth as the parameter in her research to measure the effect of supply and demand on the Norwegian house prices. The population growth is estimated in two ways: 1) by taking the difference between one period and the previous period, in this case, a quarter, and 2) is to take the difference between birth and death and adding it to

the net migration. SSB states that the end result should be the same, but this is not always the case in practice. They state that method 2 was used up until the last quarter of 2005 and method 1 is in practice since then. In our sample, this means that only four of the quarters use the previous method and the rest uses method 2 (SSB,2024j). It is hard to say what kind of impact it has on our study because SSB does not state the measurement error between the methods.

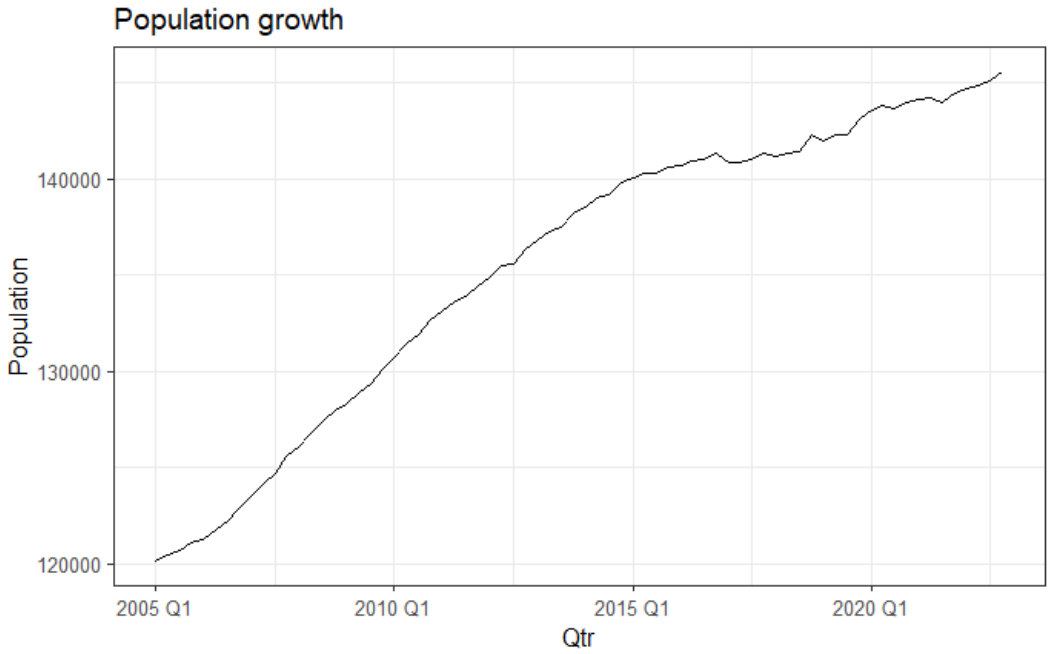

Figure 7:Table: 01222, Contents = Population at the beginning of the quarter, Quarter= 2005Q1 –2022Q4, Region (Municipalities 2024-) = Stavanger. Sources: (SSB,2024c).

5.5 Supply of housing

Jacobsen and Naug used the housing stock to measure the effect of the supply channel, but the data of this variable is only available on yearly basis and starts from 2008. We have thus tried to use an alternative data to measure the effect of the supply channel. We have decided to create a variable that represents the stock of finished housing per quarter. The reason for choosing this data is that the difference between the housing stock of two periods should be the supply of new housing. Thus, we believe that this can have the possibility of measuring the same effect. Finished buildings are buildings which the owner can use or when the building is certified as completed (SSB,2024k). The data for housing that is finished can vary a lot from detached housing to multi dwelling houses. The type of housing is decided based on the consideration of house price index. The house price index differentiates between the dwellings and name them as detached houses, row houses and multi dwelling (see chapter

5.1). This encompasses the type of buildings with the start code from 11 to 14. The data for each quarter are calculated by adding the data of each building that was completed in that period.

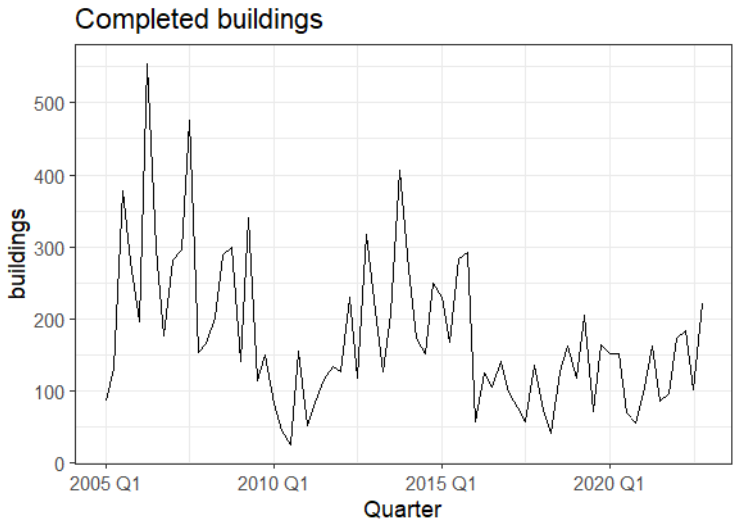

Figure 8:Table,05889, Contents = Buildings completed, Quarter =2005Q1-2022Q4, Region (Municipalities 2024-) = Stavanger, Type of building = code starting with 11-14. Source: (SSB,2024g).

5.6 Oil price

The values for oil price variable are taken from the global price of brent crude oil. The data is on quarterly basis and denoted in U.S dollar per barrel of oil. The data is gathered from the Federal Reserve Bank of St. Louis (FRED). The graph of the data is shown below.

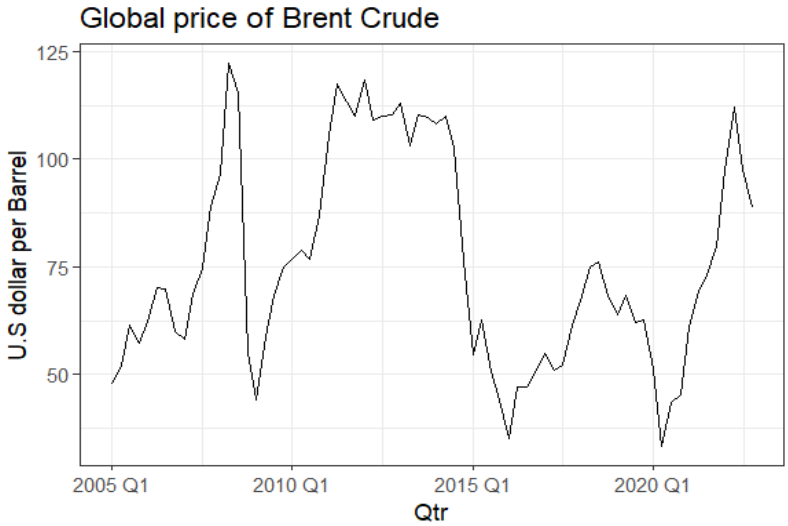

Figure 9:: Global oil prices. Sources (IMF,2024).

6.0 Analysis

This chapter presents the analysis of the results of our findings. First, we will present the stationary test results. then a correlation matrix is presented, after that the results of the regression analysis and at the end the diagnostics are presented which state that if our variables have the necessary statistical properties to make good inferences.

6.1 Stationary test

The results of the test are shown in a table below. The test indicates that when we conduct log-transformation and differencing in the oil price, finished housing and unemployment rate variables, all reject the null hypothesis of non-stationarity at a 0.1% significance level. The results for the interest rate indicate that it is stationary without any transformation which is different from Jacobsen and Naug (2005, p.36) results, who used differencing on this variable. We have decided not to use differencing due to our results. Both income and population growth cannot reject the null hypothesis of the non-stationarity. Looking at the plot of income it may be non-stationary since the data exhibit heteroskedasticity (higher variance in the beginning and lower variance as time increases) and outliers[2]. Population growth, likewise, has issues of heteroskedasticity (same issues as income)[3]. House price rejects the null hypothesis of non-stationarity with a p-value less than 5% significance level.

Variable	No difference	First difference	First difference of log
House_price	0.2879	0.1454	0.0733*
Income	0.3322	0.5153	0.4877
Interest_rate	0.03378***		
Unemployment	0.1328	0.01***	0.01***
Oil_price	0.4193	0.01628***	0.0168***
Finished_housing	0.505	0.01***	0.01***
Population_growth	0.3708	0.1425	0.1314
Note: *p<0.5, **p<0.01, ***p<0.001			

Table 1:Results of the ADF test.

[2] See Appendix 1
[3] See appendix 2

6.2 Correlation analysis

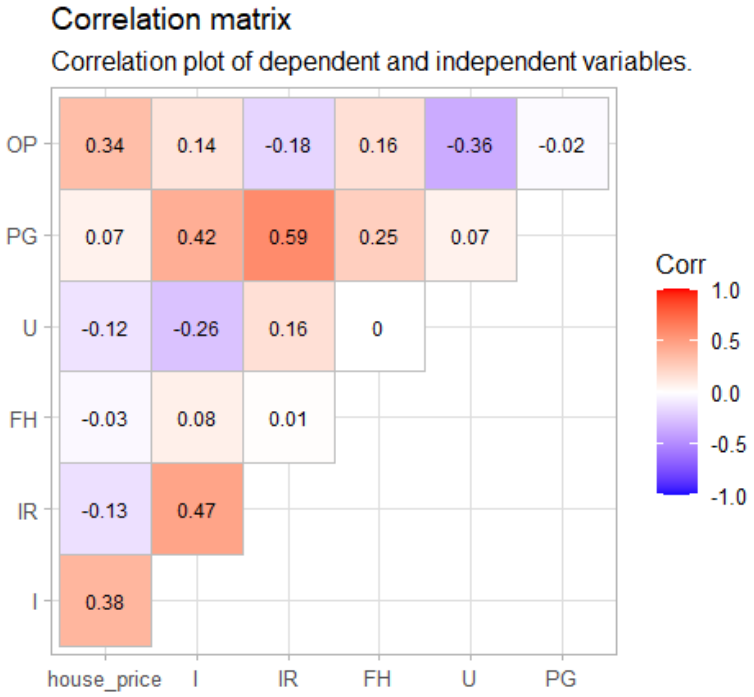

Figure 10:Correlation matrix. Created using the ggcorrplot package (Kassambara & Kassambara,2023)

The graph presented above is a correlation matrix of our variables (after differencing and log transformation. This matrix is created to show the correlation interplay between the variables. First, we can look at the correlation between the dependent variable, house price, and the independent variables which is presented in the first row. The variables which have the highest correlation are income (I) and oil price (OP) with a 38% and 34% positive correlation respectively. The interest rate (IR) and unemployment (U) are 13% and 12% negatively correlated while population growth (PG) and finished housing (FH) are +7% and -3% correlated with house prices. The dependent variables with the highest corelation are population growth and interest rate of about +59%. A general rule of thumb is that a correlation above 80% is considered to create problems of multicollinearity in a model (Field et. Al., 2012,276). From the figure 10, no dependent variable has such a correlation, and we can thus rule out the perfect multicollinearity.

6.3 Regression results

	Dependent variable:	
	$\Delta\log(House\_price)$	$p-value$
$\Delta\log(Income_t)$	2.04***	$> 5.7e^{-5}$
	(0.015)	
$Interest\_rate_t$	-0.014***	$> 3.47e^{-5}$
	(0.004)	
$\Delta\log(Unemployment_t)$	0.022	0.2617
	(0.019)	
$\Delta\log(Oil\_price_t)$	0.033*	0.0936
	(0.019)	
$\Delta\log(Finished\_housing_t)$	-0.004	0.3926
	(0.005)	
$\Delta\log(Population\_growth_t)$	3.81*	0.0940
	(2.239)	
$s2$	-0.004	0.6410
	(0.009)	
$s3$	-0.022***	0.0092
	(0.008)	
$s4$	-0.028**	0.0127
	(0.108)	
$Constant$	0.070***	$> 1.36e^{-5}$
	0.015	
Oberservation	70	
R^2	0.487	
Adjusted R^2	0.411	
Residual Std.Error	0.023(df = 30)	
F statistic	6.433(df = 9;61)	
Note:	*p<0.5,**p<0.01,***p<0.001	

[4]

Table 2:Regression results. Own creation.

[4] Numbers in parenthesis are the estimated coefficients of the standard error.

The intercept also known as constant in a regression model represents the mean value of the response variable when all predictor variables are zero. In our model, the intercept value explains that the house price in Stavanger has increased by 5.9 percent on average from 2005 to 2022, when all the other variables like income, interest rate, unemployment, finished houses, and oil price with the passage of time are zero. This value is significant at 0.01% level.

The model shows that the income variable has a significant effect on house prices. When income increases 1 percent and all the other variables remains constant, the house price increases by 2.04 percent. This result is also in line with the theoretical expectations that house prices should increase when income increases as there is more activity in the economy which leads to increased demand for housing and eventually expansive houses.

The results above show that interest rate variable is significant at 0.1% level and has a negative effect on price development in the housing market. If interest rate increases 1 percent, the house prices will go down by 1.4%. The result follows the theoretical expectations which says that an increase in interest rate should have negative effect on demand for housing and consequently lower house prices.

Unemployment rate variable is not significant, and the positive value is not in accordance with the theoretical explanation of unemployment effect, which says that if unemployment increases, house prices should decrease. Unemployment occurs when economy is slowing down, or it is already in recession. This means that less activity in the market and lower demand for housing and hence lower house prices. According to our model housing price should increase by 0.022% when unemployment increases by 1% holding all other variables constant. The p-value for the test is 26% meaning that unemployment rate is thus statistically insignificant.

The variable for the finished housing is estimated to have a negative relationship with the house price and is statistically insignificant. The p-value for this coefficient is approximately 40% meaning that this estimate cannot reject the null hypothesis of the coefficient being equal to zero. The estimated relationship is in accordance with the theory that when supply of new housing increases there is more housing in the market and the competition for each housing decreases and so does the prices. This decrease however is very small with an increase of 1% of finished housing on average decreases the house price index by approximately 0.004%. We

can also look at the standard error which is estimated to be 0.005 which is the same as the estimated coefficient. These results can imply that the finished housing exhibit swings on its effect on the housing price index and that these effects are small.

The oil price is estimated to have a positive relationship with house price and is statistically significant at 5% level. The estimated coefficient is expected to have a 0.033% impact on the housing price when oil price increases by 1% holding all other variables constant. As mentioned previously the oil prices fell hard in 2014, specifically in quarter 3 to quarter 4 when the prices went from 102,57 to 76.57 USD per barrel. The price fell by 25% indicating that house prices should fall by $25 * 0.033 = 0.825\%$. The p-value of the test is 4.7% which is below the 5% significance level threshold meaning that the variable is statistically significant.

The result for the population growth is positive and is statistically significant. The p-value of our estimate is right below the limit of the 5% rejection region with a value of 4.7%. If we look at the population growth from quarter 3 to quarter 4 in 2022, we can see that we had an increase of $\frac{145568-145144}{145144} \cdot 100 \approx 0.29\%$ in population growth. This means that house price, holding everything else constant, is expected to increase on average by 1,1%. The effect is in line with theory, when population growth increases market participants and thus creates more competition for housing which increases the prices. If we look at the standard error, it can be regarded as high with a value of 2.24. The high standard error may indicate that the estimate is uncertain or that the effect of population growth is volatile.

The last three variables are seasonal dummy variables. The dummy variables for the quarter 3 and quarter 4 are statistically significant at 0.1% and 1% while the variables for the second quarter is not statistically significant. All the dummy variables are estimated to have a negative relationship with the housing price, which is different from the results Jacobsen & Naug (2005, p.36) presented, where each of them was positive.

The model that we have estimated has an R^2 of 48.7%. This implies that our model can explain 48.7% of the variance in the dependent variable house price.

6.4 Regression diagnostics

This section presents the regression diagnostics and how our model fits them. The results of the tests and graph are shown in figure 11 and 12. The first assumption is about the linear parameters which can be checked using a fitted vs. residuals plot (11) where the point should be randomly scattered around. From figure 11 we can see that most of the point lie around the 0 mark both horizontal and vertical with a few outlying points. There is also no indication of pattern. We conclude that assumption 1 of linear parameters is satisfied. The second assumption is about the multicollinearity. All our data had a low amount of correlation as shown in 6.2 and we can thus conclude that our model does not have perfect multicollinearity. The assumption three of zero conditional mean, we think may not be satisfied. One of the issues is the measurement error of the income variable which is only available in the yearly format. As mentioned before the yearly format smooths out the quarterly changes and thus this valuable information is lost. We can also have omitted variable bias since we don't have data for the housing stock. We have also not added any lagged terms with variables like interest rate and unemployment. The Ramsay reset test null hypothesis is that the model has correct functional form and the alternative hypothesis is that the model has the wrong functional form. The p-value of 96.6% means that we cannot reject the null hypothesis which rules out the misspecification of functional form (4).

The assumption of homoscedasticity was done using the Breusch-Pagan test. The null hypothesis of the test is that there is homoscedasticity, and the alternative hypothesis is that the model has heteroscedasticity. The test gives us a p-value of 0.55 which means that we cannot reject the null hypothesis of homoscedasticity at a 5% significance level. This means that our data satisfies the assumption of homoscedasticity.

The Figure showcases the autocorrelation function (ACF)-plot. ACF-plot is a graph which shows our regression model and the correlation between itself at different lags. When the black lines are past the blue dotted lines it means that the autocorrelation is present at a 5% significance level (Hyndman & Athanasopoulos, 2024, chapter 2.8). From figure 12 we can see that none of the black line passes through the blue dotted lines over the 18 lagged values. We can then conclude that the regression model has no autocorrelation.

Hence it is evident that our model satisfies four out of five assumptions and that there is indication that the zero conditional mean assumption is not satisfied. This implies that our coefficients are not consistent but have the lowest variance.

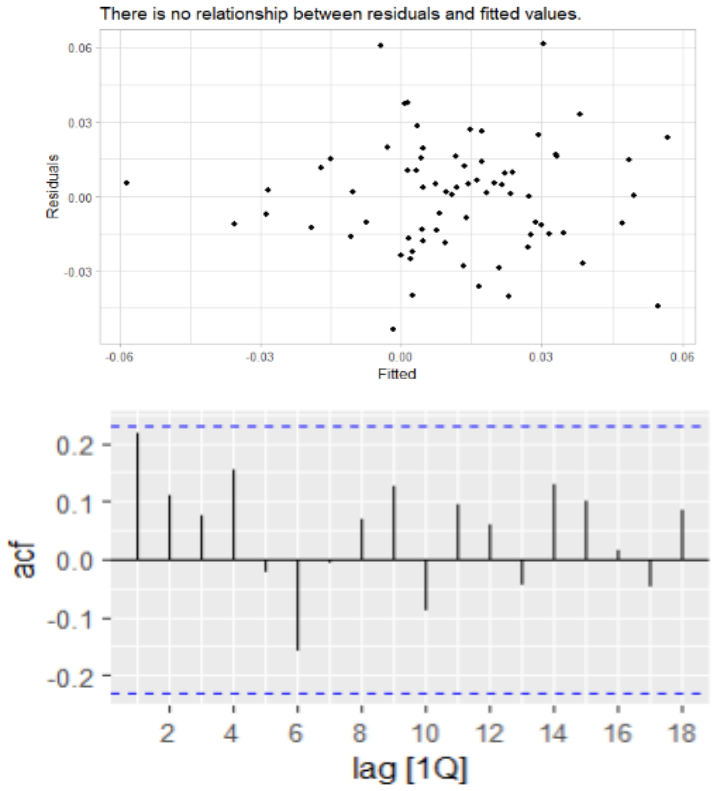

Figure 11-12: 12) Fitted vs. Residuals plot,12) ACF-plot.

studentized Breusch-Pagan test

data: house_price ~ Income + Interest_rate + Finished_housing + Unemployment + Oil_price + Population_growth
BP = 4.9343, df = 6, p-value = 0.5523

RESET test

data: house_price ~ Income + Interest_rate + Finished_housing + Unemployment + Oil_price + Population_growth
RESET = 0.034637, df1 = 2, df2 = 62, p-value = 0.966

Table 3-4: Breush-Pagan test and Ramsey-Reset test

7.0 Discussion

According to our model house prices in Stavanger are mostly affected by income, interest rate, oil prices and population growth. Out of these four variables income explains most of the variations in house prices. Jacobsen & Naug(2005) research (see 3.1) says that the house prices will rise approximately in pace with the household income in the long term. Our model suggests that the rise in the house prices will be double than the rise in income (1% increase in income leads to an increase in house prices by 2%). Jacobsen & Naugs research suggest that the house prices may increase by 1.75% in the long term when income increases 1% permanently considering all the other variables constant, while our model suggests that house prices may increase by 2% for 1% increase in income. Sila (2020) found that 1% increase in income increases the house prices by 1.3%. Both studies mentioned above are done on the national level which can be an explanation for the different results between their studies and ours. The national level studies include regions, urban areas, where the effect of increased income does not increase the house prices as much as in the more competitive areas like cities. This would reduce the effect of income on house prices in the national studies, compared to studies done on a city. This can explain the difference between the results of their studies and ours. Because of these factors we would say that our results are in line with previous studies.

Now the interest rate is the second most influential variable in our model. It suggests that the house prices may decrease by 1.40% on average if interest rate increases by 1 percent, assuming all the other variables are constant. Increase in the interest rate affects negatively to the economy and slows down the economic activity in the country. According to Jacobsen & Naugs research “a higher interest rate leads to expectations that house prices will fall.” Households wishing to enter the housing market or trade up may then choose to postpone their purchase. This may lead to house prices falling more in the short term than in the long term when interest rates rise (Jacobsen and Naug, 2005, p.36). Similarly, falling interest rate will lead to higher house prices in the short run and Jacobsen & Naug suggest that in this scenario buying a house immediately after the fall in interest rates will be more beneficial rather than later. Jacobsen & Naugs model suggest that house prices may go down by 2.25% immediately when interest rate rises by 1% while our model suggest it may decrease 1.40%, while Sila (2020) found the effect to be 0.85%. Our results falls in between both of these studies.

In our model the estimated coefficient for the unemployment rate was positive which is a divergence from the theoretical expectation. The estimated unemployment coefficient from Jacobsen & Naug estimated an effect of a decrease of 11% over 40 quarters when unemployment increases from 4 to 5% (2005, p.37). It is then of interest to look at the evolution of house price and unemployment during this period to find out the causes for our results. Unemployment during this period was highest in 2010, 2016 and in 2020, while the house prices started climbing in 2010, 2014-2015 and 2020. This means that through the period when unemployment was rising the house prices were going upwards. This can be an indication that we mis-specified the model and should have added a lagged variable for the unemployment rate to account for this. At the same time the model estimates this variable to be statistically insignificant, it can indicate that the Norwegian households during this time were able to withstand the rise in the unemployment rate.

The price of oil in the international market is an important factor for the Norwegian economy. Stavanger being oil capital of Norway is more vulnerable to the changes in oil prices. This effect can be observed in the last two decades where oil prices has remained extremely volatile. Jacobsen and Naugs model do not include a variable for oil prices and therefore results cannot be compared. We added that variable because we think that oil prices are important for housing market in Stavanger. Our model suggest that house prices are positively related to the oil prices and house prices in Stavanger may increase 0.03% when oil prices increase by 1%, assuming all the other explanatory variables remain constant. This makes sense because increase in the oil prices effects Stavanger positively. Higher oil prices indicate that there is more activity in the market which leads to less unemployment and increased household income which again leads to the higher housing demand and expansive housing market.

The insignificance of the variable representing finished housing in our model may be influenced by numerous factors. This variable is a substitute for the housing stock variable presented in the house price model and seems to indicate that it was not a good substitute. The theory chapter states that the supply of new housing is low compared to the quantity of housing in the market. The reason could be that the supply has not accumulated over enough years to change the housing stock substantially in the market and thus not influencing the housing prices.

The estimate for the population growth had a high coefficient of 3.8% and a high standard error .In the analysis, we used a 1% increase in the coefficients but deviated when looking at

the population growth. This is to show that population grows slowly over time and a 1% increase per quarter for example is not expected and when we computed for a quarter it was down to 1.1%. The high estimate can also be hypothesized to be large due to the interplay between population growth and household size, as mentioned by Jansen (2011) which we discussed in the literature review. The amount of people per household has fallen over the years from 2.24 to 2.15 from 2005 to 2022 (Statistics Norway, 2024l). As the population grows coupled with the amount of people per household go down, reflects that there is a growing competition for new housing in the market. This should lead to expansive housing. This could also be an explanation that why the variable has a high estimated coefficient because it represents the increased competition over the years. The high standard error indicates that the estimation for population growth variable is uncertain.

8.0 Conclusion

This bachelor thesis sets out to investigate the housing market of Stavanger, with a specific emphasis on identifying the factors that impact housing prices in the area. Our primary objective is to answer the question: 'What factors influence house prices in Stavanger municipality?' To address this question, we employed a multiple regression model, based on the theoretical background of house price model and with a comprehensive review of relevant literature, we carefully selected six independent variables for our analysis, aiming to provide a comprehensive understanding of the determinants of housing prices in Stavanger.

Our model findings reveal that household income and interest rates are the primary drivers shaping house prices in Stavanger. There exists a positive relationship between household income and house prices, indicating that rise in income leads to higher house prices. Conversely, interest rates exhibit a negative effect on house prices, suggesting that rising interest rates result in decreasing house prices. Notably, our findings highlight that changes in income exert a more pronounced impact on house prices compared to fluctuations in interest rates.

The two additional significant variables in our model are oil prices and population growth, both of which play key roles in shaping the economic landscape of Stavanger. Given the city's heavy reliance on the oil industry, fluctuations in oil prices significantly impact its economic activity in Stavanger and leads to changes in house price. Our model indicates that an increase in oil prices corresponds to an increase in house price in Stavanger, however the effect of oil prices on housing is relatively weak.

The population growth variable emerges as significant, demonstrating a positive association with house prices. This suggests that an increase in population growth leads to housing expansion. While this outcome aligns with theoretical expectations, the presence of a higher standard error casts doubts on its reliability. Consequently, drawing conclusive remarks about the effect of population growth on the housing market in Stavanger proves challenging and warrants further in-depth analysis. We have not found unemployment and finished housing to impact the house prices in Stavanger.

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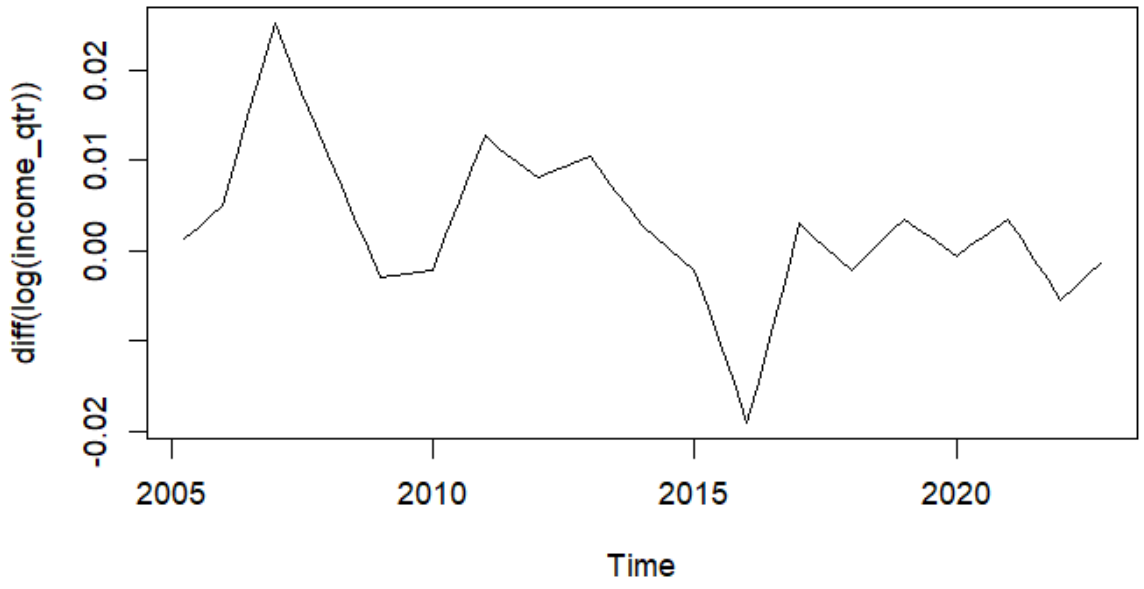
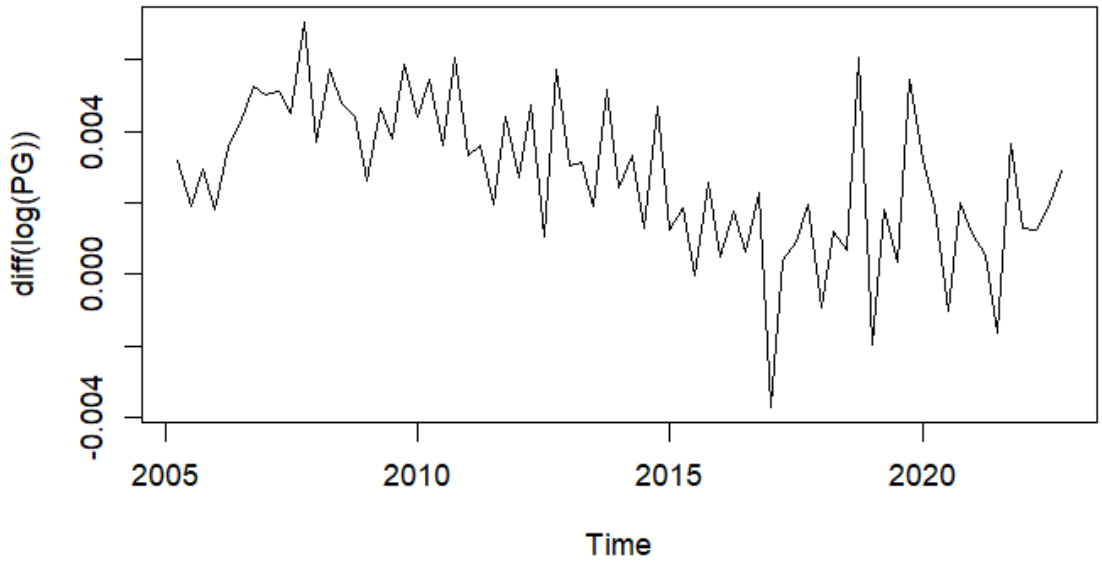
Appendix:

1


diff(log(income_qtr))
0.02
0.01
0.00
-0.02
2005
2010
2015
2020
Time

2


diff(log(PG))
0.004
0.000
-0.004
2005
2010
2015
2020
Time