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**Detecting bubbles in the Finnish housing markets
2006-2023**

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ABSTRACT:

The research motivation for this study derives from the importance of understanding housing markets as it has a great effect on people's lives, their financials and the macroeconomy. Throughout the history, housing markets have also been an important factor in a variety of economic crises. Therefore, a housing bubble detection study contributes a lot in order to analyze the housing markets and detect possible price bubble scenarios.

The housing prices from the Finnish capital area and from Finland are collected from the secondary housing price data from the first quarter of 2006 to the second quarter of 2023. OLS regression analysis is then performed with real housing prices as the dependent variable and disposable aggregate income and unemployment rates as independent variables. From the fitted values, it is assessed whether the determined bubble thresholds are exceeded during the sample period. The results from the regression analysis are compared to the results received from the ratio analysis conducted with the price-to-rent ratio and price-to-income ratio using the same data that the regression analysis to again evaluate whether the determined bubble thresholds are exceeded.

The results indicate that the hypotheses about a housing market bubble between 2020 and 2022 for the Finnish housing markets and for the Finnish capital area housing markets are somewhat confirmed with small variations in the actual bubble periods between the different research methods. The results from the OLS-regression model, price-to-rent ratio and price-to-income ratio indicate that there is notable bubble activity from 2019 to 2022 depending on the research method.

KEYWORDS: Housing bubble, housing market, bubble detection, price bubble

UNIVERSITY OF VAASA**Laskentatoimen ja rahoituksen yksikkö**

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TIIVISTELMÄ:

Syynä tämän tutkimuksen tekemiselle toimii asuntomarkkinoiden ymmärtämisen tärkeys, sillä on suuri vaikutus ihmisten elämään, talouteen ja makrotalouteen. Asuntomarkkinat ovat myös kautta historian olleet tärkeä tekijä erilaisissa talouskriiseissä. Siksi asuntokuplien havaitsemiseen tähtäävä tutkimus auttaa huomattavasti asuntomarkkinoiden analysoinnissa ja mahdollisten hintakuplaskenaarioiden havaitsemisessa.

Tätä tutkimusta varten arvot asuntojen hinnoista pääkaupunkiseudulla ja koko maassa kerätään vanhojen asuntojen hintatiedoista vuoden 2006 ensimmäiseltä vuosineljännekseltä vuoden 2023 toiselle neljännekselle. OLS-regressioanalyysi on tehty asuntojen reaalihinnoilla riippuvaisena muuttujana ja tutkimusta varten laskettu arvo alueellisista käytettävistä olevista tuloista sekä työttömyysasteet riippumattomina muuttujina. Sovitetuista arvoista arvioidaan, ylitetäänkö määritetyt asuntokuplan raja-arvot tutkimuksen aikajakson aikana. Regressioanalyysin tuloksia verrataan tuloksiin, jotka on saatu asuntojen hintojen suhteesta vuokratason ja asuntojen hintojen suhteesta käytettävissä oleviin tuloihin. Myös näissä suhdanalyyseissä vertailukohtana on määritetty raja-arvo asuntojen hintakuplalle.

Tulokset osoittavat, että hypoteesit asuntomarkkinoiden kuplasta vuosien 2020 ja 2022 välillä Suomen asuntomarkkinoiden ja pääkaupunkiseudun asuntomarkkinoiden osalta vahvistuvat suurelta osin. Ainoastaan pieniä vaihteluita on tarkoissa asuntojen hintakuplien aikajaksoissa eri tutkimusmenetelmien välillä. OLS-regressioanalyysi, asuntojen hinta suhteessa vuokratason ja asuntojen hinta suhteessa käytettävissä oleviin tuloihin osittaa raja arvojen ylittyvän tutkimuksen aikajakson loppupuolella vuosien 2019 ja 2022 välillä.

AVAINSANAT: Asuntokupla, kiinteistöcupla, asuntomarkkinat, hintakupla

Contents

1	Introduction	6
1.1	Purpose of the study and research hypotheses	7
1.2	Thesis structure	8
2	Theoretical background	10
2.1	Concept of a price bubble and different types of bubbles	10
2.2	Price bubble formation	11
2.3	Housing price formation	14
2.4	Brief overview of the current state of Finnish housing markets	17
3	Literature review	20
3.1	Previous literature about housing bubble detection	20
3.2	Fundamental level of house prices	22
4	Data and methodology	26
4.1	Data description	27
4.1.1	Data for OLS-regression	27
4.1.2	Data for price-to-rent and price-to-income ratios	35
4.2	Research methodology	36
4.2.1	Regression analysis	36
4.2.2	Ratio analysis	38
5	Empirical results	41
5.1	Results from the OLS-regression	41
5.1.1	Regression analysis in the Finnish capital area	41
5.1.2	Regression analysis in Finland outside the Capital area	41
5.2	Results from the ratio analysis	45
5.2.1	Price-to-rent ratio	45
5.2.2	Price-to-income ratios	46
6	Conclusions	49
	References	52

Figures

Figure 1. Nominal quarterly house prices in Finnish capital area from 2006Q1 to 2023Q2. (Stat.fi)	29
Figure 2. Nominal quarterly house prices in Finland from 2006Q1 to 2023Q2. (Stat.fi)	29
Figure 3. House price index in Finland from 2000Q1 to 2023Q1. (stats.bis.org)	30
Figure 4. Real aggregate disposable income from the Capital area and from Finland... 33	
Figure 5. Unemployment rates from the Capital area and from Finland, % (Statistics Finland, labour force survey)	34
Figure 6. Average real rent rate in Finnish capital area. (Statistics Finland, rents of dwellings).....	35
Figure 7. Comparison of actual values and bubble thresholds in Finnish capital area between 2006Q1 and 2023Q2	43
Figure 8. Comparison of actual values and bubble thresholds in Finland between 2006Q1 and 2023Q2	44
Figure 9. Price-to-rent ratio, Finnish capital area between 2015Q1 and 2023Q2	45
Figure 10. Price-to-income ratio, Finnish capital area between 2006Q1 and 2023Q2 ..	47
Figure 11. Price-to-income ratio, Finland between 2006Q1 and 2023Q2.....	48

Tables

Table 1. Initial list of variables considered for the regression model and ratio analysis	28
Table 2. Shortened list of variables inserted into the regression model and the sources of data	32
Table 3. Results from the regression models.....	42

1 Introduction

The subject for this research derives from the importance of the housing market to the overall economy and wealth of people. One of the necessities of people is satisfied by the housing industry. Naturally, housing also plays a significant role in investments. Furthermore, housing accounts for most of the wealth in many nations.

For example, in the United States, about one-third of all the assets owned by the private sector are housing assets. Rather than having financial assets, most people own wealth in the form of their homes: in France, for instance, fewer than 25% of households own stocks, while over 60% are homeowners. The role of housing to the economies has been described as a facilitator of effective labor mobility and a method adjusting to adverse shocks. During times housing sector has also been a key factor for economic crises. Especially the boom-bust cycles have been associated with many major distresses. Therefore, it is essential to monitor the housing market to avoid them compromising the financial stability. (Xhu 2014)

It is extremely important to understand the risks at the housing markets as those markets can cause a real threat to the economical stability. This research aims to evaluate the housing market bubbles. As the definition of housing bubble is a rapid increase in home prices exceeding the price level reasonable by market fundamentals. (Shiller 2000) (Case and Shiller 2003)

According to an article written by Lehtinen (2020) from Statistics Finland, covering the recent crises in the Finnish housing markets, the 1990s recession has hit the housing market the hardest. Before COVID19, the Finnish economy had seen four crises in the previous three decades: the 1990s recession, the IT bubble, the 2008 financial crisis, and the 2012–2014-euro crisis. Recently, there has been discussion on several forums on the predictive power of prior crises on the current state of the national economy. Additionally, some attempts have been made in order to forecast how the housing market would behave. The 1990s saw a severe and protracted recession. Finland's GDP

decreased by 10 percent between 1990 and 1993 and the 1990 level was not regained before 1996. The financial crisis halted the housing markets almost completely during the third and fourth quarter of 2008. Between the second quarter of 2008 and the end of the year, there was a more than forty percent decline in the selling on the secondary housing markets. However, the housing market was not significantly affected by the financial crisis while the effects were rather short term. The markets returned to the prior crisis level in 2010.

The housing market recovered quite rapidly after COVID crisis and in 2022 the housing market seemed relatively well. However, interest rates and inflation increased significantly because of the conflict in Ukraine. The market was decreasing fall 2022 while there was a drop in transaction volumes, an increase in yield needs, and a decline in real estate prices. Simultaneously, building decreased or ceased entirely. It had been years since such drop had occurred previously. The real estate market remained relatively quiet during 2023. (ubpankkiiriliike.fi)

1.1 Purpose of the study and research hypotheses

Besides the influence of housing markets to the overall economy and the importance of housing market analysis, the motivation for this study derives from the past and the recent movements of the housing market and the market price levels in Finland as well as from the interest whether it is possible to detect housing bubbles in the markets with OLS-regression analysis and ratio analysis using common price-to-rent ratios and price-to-income ratios.

The purpose of this study is to find out whether there is a price bubble or bubbles in the Finnish housing markets between 2006 and 2023. The study uses quarterly data about real housing prices from the secondary housing markets and real rental rate of housing, disposable real aggregate income (a measure determined for the research based on income data and population in the sample area) and unemployment rate.

According to a recent Housing market review, single-family houses in the areas around the Greater Helsinki Area have had the largest price rises in recent years, with hikes of about 20% in only two years. The prices of homes purchased for investment purposes in the Greater Helsinki Area, Tampere, and Turku have increased in relation to rentals during the last five years due to low interest rates. Because financing costs were cheap and property prices increased due to the low interest rates, property investment was profitable. Therefore, the real estate markets saw a small bubble that burst due to the extended period of low interest rates. (corporate.nordea.fi) In line with these findings and the timeframe of the results, two hypotheses were set for this research as follows:

H1: There was a positive housing bubble in the Finnish capital area housing market between 2020 and 2022.

H2: There was a positive housing bubble in the Finnish housing market, excluding the capital area, between 2020 and 2022.

We have set the same hypothesis for both the Finnish capital area and for the other parts of the country, since we expect the housing markets to behave somewhat similarly across the country due to the similar interest rates and financing for housing, but we test these hypotheses separately.

1.2 Thesis structure

After covering the introduction and hypotheses set for this research, the theoretical background and brief history of price bubble as a concept is reviewed as well as the price bubbles and bubble formation. The mechanisms behind housing prices are evaluated, price formation and assessment of the recent trends is covered. The current state of the Finnish housing market, as the housing market trends and price fluctuations act as a strong motivation for this research, are presented based on the most recent housing market analyses from the Finnish housing markets.

When it comes to the literature review, previous literature about housing bubble detection and housing bubbles are presented in order to gain understanding about the current state of the housing bubble research across the housing markets and the background of the selected research methodology is presented based on previous research and theory about fundamental house prices.

In the empirical part of the thesis, the data selection and evaluation are presented. Reasoning about the commonly used variables for this type of research is made and the data set for this study will be selected. Methodology for the study is presented and the thresholds for housing price bubbles are determined. After the theory about the performance of the research is made the results are evaluated and the results from different research methods, OLS regression and ratio analysis is performed.

In the conclusion part the results are compared along with the hypotheses set for the research and the main limitations of this research are explained. Also, some potential further research topics are covered.

2 Theoretical background

2.1 Concept of a price bubble and different types of bubbles

According to Aliber & Kindleberger (2005) Since investors respond to changes in economic variables as if they always fully understand their long-term effects, or as if they had Superman-like kryptonite vision, this is known as the "rational expectations" assumption in economic models. Accordingly, the adage "all the information is in the price" expresses the idea that prices in any market respond instantly and completely to every piece of news such that "no money is left on the table." Compare the adaptive expectations assumption, which holds that the values of certain variables in the future are extensions of these values in the recent past, with the rational expectations assumption. The adage "the trend is your friend" refers to the idea that if prices have been rising, they will do so indefinitely. The reasonable expectations approach, which is in fact a backward-looking view from the future to the present, contends that prices predicted for next week and next month impact prices that are in existence today.

In his book Famous First bubbles, Garber (2000) explains by market fundamentals three of the most famous price bubbles across history, Tulipmania in the Netherlands between 1634-1637, the Mississippi Bubble between 1719-1720, and the quite closely connected South Sea Bubble in 1720. Since the Tulipmania is the event that most today's observers consider to be totally insane, he concentrates on it the most. Upon examining the price decrease trend from bulbs from the eighteenth century compared to bulbs from the seventeenth century, he deduces that the unusually high cost of extraordinary bulbs and their swift decline are indicative of standard pricing practises. He characterises the asset markets and financial machinations that were engaged in the Mississippi and South Sea Bubbles and presents them as market fundamentals.

A variety of situations might be referred to as a price bubble for an asset (such as a share). The uncertainty brought on by fast economic expansion (the so-called "bubble economy"), which is accompanied by an asset price bubble, may be discussed at the

broadest level. A price bubble may also refer to a circumstance in which it is discovered after the fact that asset prices have changed as a result of economic fundamentals, or the so-called values according to fundamentals, after it has transpired that the price expectations of economic actors were incorrect. This may occur, for instance, if assumptions about the fundamentals prove to be unfounded. On the other hand, it's possible that the market price of asset has deviated from the price supported by the anticipated fundamentals for other reasons, such as owing to demand pressure, leading to a bubble in the asset's values. This article uses the final term provided by economic theory. Determining the price level that is supported by the fundamentals is the most difficult step in identifying a price bubble. A pricing model has often been used to address this issue. In this approach, all anticipated cash flows associated to the asset are discounted to the present, and as a result, the asset's current value is established. Then, a market price that greatly deviates from its existing value might be regarded as a bubble. Defining expectations becomes difficult with this strategy. The price of the asset is determined by the anticipated cash flow, and it is nearly impossible to discriminate between reasonable and irrational expectations. As a result, it is difficult to positively establish the occurrence of a bubble. Even if there are issues with how a bubble is defined, there have been several instances in history of such rapid jumps in asset values that have been universally and rather unanimously labelled as bubbles. Price speculating on tulip bulbs in 1630s Holland is a prime illustration. Other instances include the sharp rise in stock prices in the United States that peaked in 1929 and the so-called "techno bubble" in recent history, during which the share prices of several ICT companies in particular rose sharply due to exaggerated growth expectations. (Melolinna & Taipalus 2006)

2.2 Price bubble formation

Aliber and Kindleberger described the formation in their book *Manias, Panics, and Crashes*, published in 2005. Sometimes general "irrationality" or mob psychology are linked to manias. The interaction between a group of irrational people and reasonable people may be complicated. There are a few differences that may be noted. One theory

is mob psychology, a kind of "group thinking" in which almost all market participants alter their opinions at the same time and behave like a "herd." Alternately, different people have varied perspectives on market changes at various points in a continuous process; most start off logically before losing more and more of their sense of reality over time, first gradually and later more rapidly. A third scenario is that various groups of traders, investors, and speculators exhibit differing levels of reason, and as asset values rise, more and more members of these groups give in to the panic. The 'fallacy of composition,' which holds that sometimes a group of people behaves differently from the sum of the behaviours of each person in the group, is the fourth scenario in which all market players fall victim. The final point is that, particularly when there are delays between the stimulus and the response, markets with reasonable expectations about the quality of a given reaction to a stimulus fail to estimate the proper amount. Finally, irrationality may manifest as a result of investors' and individuals' incorrect model selection, neglect of a specific and critical piece of information, or suppression of information that does not fit the implicitly chosen model. (Aliber & Kindleberger 2005)

A study from 2003 by D. Sornette, discussing the limitation of standard analyses for characterizing how crashes are special. Large financial crashes are "outliers," according to research on the frequency distribution of drawdowns, or streaks of consecutive losses; as can be observed from their statistical characteristics, they belong to a distinct class. Large financial disasters that are "outliers" need a unique explanation, a particular model, or even their own theory if they are to be considered such. Additionally, their unique qualities may be used to their prediction. The primary processes of positive feedbacks, or self-reinforcement, such as imitative behaviour and investor swarming are covered with extensive citations to pertinent literature from fields outside of physics. Positive feedbacks accelerate the growth of speculative bubbles, setting the stage for instability leading to a significant fall. We provide a number of intricate mathematical simulations of stock market booms and collapses. According to a first model, the market price is driven by the accident danger. The collective behaviour of "noise traders," individuals who move based on little information even when they believe they "know," may cause

the collapse risk to spike at times. The rationale is reversed in a second version, which contends that the collapse risk is driven by pricing. Prices may spike sometimes again as a result of investors' speculative or imitation behaviour. The rational expectation model states that this inevitably results in an increase in the likelihood of a collision. We also examine two additional models: the conflict between value investors and technical experts, as well as the rivalry between imitation and contrarian behaviour. The finding of reliable and universal crash approach signatures is the key message. Almost all collapses in established and emerging stock markets, currency markets, company stocks, and so forth have these precursory tendencies recorded. We go through this finding in great depth and show how to anticipate crashes using this understanding and the specific predictions made by these models. For this, we evaluate the most significant stock market crashes in the past and provide the empirical data that supports the crucial log-periodic precursory crash signature's universality. The idea of a "anti-bubble" is also briefly explained, using the Japanese decline from the start of 1991 to the present as a notable example. Up until recently, a January 1999 prognosis that properly foresaw multiple shifts in trend has been realised with amazing accuracy. This achievement is famously difficult when utilising conventional methods of economic forecasting. The behaviour of the US S&P500 index from 1996 to August 2002 and the projection for the two years after are also summarised in this relatively recent study. We wrap off by outlining how we see the financial markets structured. (D. Sornette 2003)

In his book written in 2005 Robert Shiller writes about efficient markets, random walks and bubbles. He argues that The primary conceptual foundation for arguments against the notion that markets are susceptible to very irrational exuberance or bubbles is the hypothesis that financial markets are extremely efficient, as well as the extensive research examining this theory. According to the efficient market's hypothesis, all financial prices always appropriately represent all available public information. In other words, financial assets are always valued fairly in light of the information that is generally available. The efficient markets hypothesis states that while price may sometimes seem to be too high or too low, this appearance must be a delusion. According to this idea,

stock prices roughly correspond to "random walks" across time. Price changes are unexpected because they only happen in reaction to truly new information, which is unpredictable. In several research that were published in scientific journals of finance and economics, the efficient markets theory and the random walk hypothesis were tested using data from stock markets. Despite the theory's repeated statistical rejection in these articles, various interpretations nevertheless allow for it to be roughly correct. The body of study on the evidence supporting this idea is highly established and of the highest quality. The efficient markets hypothesis must thus be taken seriously, whether we finally agree with it. (Shiller 2005)

Shiller (2005) uses the term irrational exuberance to describe many market movements in history where prices have risen to abnormally and unsustainably high levels due to herd behaviour. Shiller argues in his book that irrational exuberance is the basis of a speculative bubble. He then defines a speculative bubble as a state where news of rising prices excites investors, after which the prices rise even more. This attracts more investors to the market, who want to get a share of the profit generated by the price increase, causing prices to rise even more, in other words, a speculative bubble is formed when irrational enthusiasm causes the market to react to price increases with price increases.

2.3 Housing price formation

When studying about the house price formation in Finland, Oikarinen (2009) demonstrates that since Finland's financial liberalisation in the late 1980s, there has been a considerable two-way interaction between house prices and the stock of home loans. The relationship was much weaker prior to financial liberalisation. Furthermore, the outstanding stock of consumer loans is significantly benefited by real estate appreciation. It indicates that stock prices and credit do not have a comparable connection. Understanding the mutual relationship between house prices and credit is crucial because it might exacerbate boom-bust cycles in the economy and make the financial system more fragile.

Typically, housing markets have been macroeconomically modelled using the stock-flow technique. The stock-flow model provides a sound foundation for this study's requirements. The stock-flow hypothesis states that a metropolitan area's housing demand may simply be predicted by:

$$H^d = f(P, U, R, D) \quad (1)$$

where,

P = *real house price level*

U = *expected real cost of owning a house*

R = *real rental price level*

D = *other fundamental variables affecting housing demand*

Similarly, the supply of the market can be defined as:

$$H^s = f(P, S) \quad (2)$$

where,

S = *other fundamental variables affecting housing supply*

In equilibrium $H^d = H^s$ therefore, the reduced form of the equation for the housing price level is:

$$P = f(D, S, U, R) \quad (3)$$

The actual mortgage rate after taxes and the opportunity cost of invested capital in housing determine the anticipated real user cost of home ownership, or U . Greater interest rates on mortgages, less tax deductions for mortgage payments, and greater capital opportunity costs all raise user costs. U naturally includes additional expenses related to house ownership, including real estate taxes and depreciation or maintenance expenditures. Additionally, because of anticipated capital gains, the estimated rate of future price increase reduces the anticipated user cost.

It is crucial to have the anticipated future housing appreciation in U . The anticipated increase is inevitably based on assumptions about the fundamental factors that influence property prices. As a result, even if the equations given are static, the predictions for the basic variables' future values affect the current housing market. Additionally, the predicted price level and, thus, the expected values of the essential variables, have an impact on house development now and, consequently, housing supply in a few quarters from now.

According to the justification given above, if the real interest rate remains constant regardless of the rate of inflation and that the after-tax mortgage rate matches the opportunity cost of capital, the user cost may be written as follows:

$$U = [(r + i)(1 - t) + T + d - (g + i)]P, \quad (4)$$

where

r = *real mortgage rate*

i = *inflation rate*

t = *rate of tax deductibility of interest payments for mortgages and T*
 = *real estate tax rate*

d = *depreciation and maintenance as a percentage of P*

g = *expected growth rate of real housing prices.*

In several equations, inflation plays two distinct roles. In (4), the inflation rate affects U negatively, and (3), when the inflation rate rises, nominal costs decrease. This happens because the capital gains are not taxed when nominal house loan interest payments are tax deductible. The level of the rental price is considered in (3) for two different reasons. First, the rental level depicts the costs that owners would incur if they didn't own their property. Second, for investors, the rent symbolises the revenue flows from housing investments. (Oikarinen 2005)

Other factors, such as demographics, income, and unemployment, also have an impact on housing demand (D). These elements are often considered to have little bearing on property prices. The demand for housing will inevitably rise as income levels or the

number of families increases. Whether genuine permanent income or current income should be included in this model is up for discussion. The question of a household is another contentious one since, in the short term, a home's structure may change substantially. The variables in (D) may sometimes be considered to be extrinsic, but they may also be intrinsic. The number of households in a metropolitan region is likely to suffer from the price of housing. For instance, Hämäläinen and Böckerman (2004) discovered that housing costs had a negative impact on net migration in Finland. Oikarinen 2005)(Hämäläinen& Böckerman 2004)

2.4 Brief overview of the current state of Finnish housing markets

According to the recent report prepared by KTI Finland, an independent research company providing data and information from the Finnish housing markets the Finnish real estate market began a new and unsettled period in 2022. The end of the more than ten-year period of historically low interest rates and inflation will have a significant influence on the real estate investment and rental markets, as well as on development activity across various property sectors. Behind the insights from the housing markets is the overall economic situation in Finland. In 2022, the Finnish economy expanded by around 2.0%. In the first half of the year the growth was relatively rapid and investments, exports, and private consumption helped the growth. However, the economy decreased by 0.2% in the third and fourth quarters due to a combination of factors including growing economic uncertainty, increasing interest rates, an escalation of the energy crisis, and a sharp rise in consumer prices brought on by the conflict between Russia and Ukraine. The Finnish economy is predicted not to increase nor decrease during 2023. When it comes to the rent prices, the quick expansion in supply has recently led to the low growth in residential rental prices in the Finnish capital area in recent years. In the late 2022 new rental residential property building began to significantly slow down. The demand for rentals is predicted to rise in 2023. The prices have been increasing faster in other Finnish cities Tampere and Turku than in the Capital area. (kti.fi)

According to a recent analysis about the Finnish real estate markets prepared by Newsec, a real estate investing company expertising in real estate and energy transition, 2022 was rather uncertain year in real estate prices due to the volatile nature of the economic situation. A revaluation of pricing resulted in a decreasing trade as the gap between the risk-free interest rate and real estate yield became smaller. When it comes to real estate trade, they expected 2023 to start with smaller real estate trade volumes than the same quarters of past years. Apart from the disparity in pricing, the decline in finance availability in Finland and Europe has had a particular negative impact on the trade. Still, there has been some trade activity in the real estate market, although on a lower scale. The volumes of the real estate trade greatly depend on how the interest rates develop during 2023 and the following quarters. Altogether the market is rather hard to predict now and the level of uncertainty is large. (newsec.com)

Interest rates are at their highest point since the financial crisis and there are fewer housing transactions than in thirty years, tells the article from Finland's national statistical institute. Pricing on the secondary housing markets are also declining across the whole nation. Forecasts from banks and real estate organisations indicate that the housing market has reached all-time low. Between 2015 and 2021, the average price of housing on the secondary markets in the capital area grew by three percent. While prices in Finland's decreasing areas have been progressively lowering since 2015, prices elsewhere have also stalled. Between 2015 and 2023, an average of 66,000 units will be sold in the secondary housing markets. While over 80,000 agreements were made in 2021, 53,500 agreements are expected to be made in 2023 which is more than 20% less than usual. The cost of studios and bigger family flats in the metro region increased by a solid 26% between 2015 and 2021. Nonetheless, since 2021, when prices peaked, studio apartments have dropped by 13%, two-bedroom apartments by 9%, and family flats by 3%. Over the evaluation period, the cost of older detached homes has not increased. Prices have dropped and business has been challenging in many areas. Between 2015 and 2021, the number of single-family home sales increased nationwide very rapidly,

notwithstanding the gradual growth in prices. Every year, on average, fifteen thousand trades were done. A few years ago, the equity required to purchase a new apartment was just 20–30 percent, and an investor could get a loan to purchase an apartment at almost zero interest. The investment flat seemed to be a very promising goal, especially when in many instances the financial considerations only became relevant after two or three years after the deal was made. After COVID, there was no longer a need for rental flats. Following Russia's invasion of Ukraine, interest rates started to climb while the communal costs started to rise simultaneously with rising energy and building costs. (stat.fi)

3 Literature review

3.1 Previous literature about housing bubble detection

In a study from 2005 an economic theory-based framework for evaluating the current status of home prices was provided, including whether a bubble is present and what underlying variables drive housing demand. Four widespread myths about how expensive the housing market is was scattered. The level of housing expenses is sometimes not adequately reflected by traditional pricing indices used in the housing market, especially price-to-income ratio or price-to-rent ratio, for a variety of reasons. Analysts utilising these metrics may see housing markets as "exuberant" even in situations when home prices are reasonable. In their study they developed an economic standard for measuring the cost of house ownership: the imputed yearly rental cost of home ownership, which is a variation of the user cost of housing. Then they applied this measure to 25 years of data in a broad range of housing markets. Temporal patterns of housing markets and housing costs were analysed within their research. Finally, the data showed minimal indication of a housing bubble as of the end of 2004. (Himmelberg et al. 2005)

There is some similarity between the rent-price ratio in the housing market and the dividend yield ratio in stock markets. Benefiting from this definitional similarity, real estate bubble detection may then be investigated using the conventional unit root test for log dividend yield, or in this instance, the log price-to-rent ratio. These unit root tests are carried out for Finland, the US, the United Kingdom, Spain, and Germany; the results of the basic tests clearly imply the presence of bubbles in almost all these nations. Furthermore, a system based on continuous and monthly rent-price data that tracks the times when real estate values deviate from their basic levels was created. This indicator seems to function rather well most of the time, identifying bubbles during times when the mainstream literature views as significant upward or downward movements in housing values. (Taipalus 2006)

Engsted et al. (2016) conducted an econometric model when studying bubbles in housing markets in the OECD area. They used quarterly data for 18 countries and focused mainly on explosiveness in their econometric model. The first stage was to apply the univariate unit root test on the countries price-to-rent ratio and on the second stage they utilise co-explosive framework to test for bubbles in the housing market to support the bubble hypothesis.

In rather recent study from a developing country, Ahmed et al. (2021) studied the housing markets in Pakistan. The trend in the housing prices in Pakistan is upward in line with the prices around the world overall. Their study aims to identify housing bubble detection from 1072 to 2018 with the Generalized Supremum Augmented Dickey–Fuller test that is commonly used to identify multiple bubbles. Two periods of potential bubble were identified in each case when analysing yearly and quarterly data.

Tomal (2021) aimed to determine if the housing markets in Poland have experienced a price bubble in recent years. The log price-to-rent ratios in regional cities in Poland were examined in order to detect the possible bubble. The log price-to-rent ratio was divided into fundamental and non-fundamental components using the instrumental variable estimation and ordinary least squares techniques in order to prevent drawing erroneous results. After that, the latter was inspected for explosive and downward motions utilising the rather well-known Phillips, Shi, and Yu method. The study's findings demonstrated that there was a negative price bubble during 2011 as real log price-to-rent ratios in the cities under analysis were lower than their fundamental values. Nonetheless, the non-fundamental component of the index under consideration has been present in the analysed markets since about the beginning of 2013, and its especially explosive swings have been seen in the first quarters of 2014.

A recent study conducted by Anundsen (2021) estimated the fundamental house prices in the Nordic countries over the past 20 years. Denmark, Finland, Norway, and Sweden

to be more specific. According to his findings, home values were overvalued in every country during the years leading up to the global financial crisis, but during the housing market slump that followed, prices recovered to normal. The findings imply that, at the end of 2019, home values were overvalued in Norway and Sweden and undervalued in Denmark and Finland. Using a different bubble test, it was found that the Danish housing market only had bubble-like characteristics prior to the global financial crisis.

3.2 Fundamental level of house prices

Annett (2005) presented a basis for evaluating the basic level of home values utilising a model that was assessed using fixed effects and used to analyse the short term to medium term movements in real home prices in a regression for the eight nations. In order to determine a basic level of housing prices, this article used real disposable income per person, real interest rate for long run and credit.

Skaarup and Bødker (2010) studied the house prices in Denmark related to the financial crisis. They found that Up to the mid-2000s, Denmark had a sharp rise in investments and house values. The housing market's trends sharply reverted after interest rate rises until the end of 2008 and the intensification of the financial and economic crisis, but they then seemed to have steadied. They designed and evaluated a conventional demand-supply housing model to explain these patterns. The multivariate econometric analysis and simulations indicated that the upswing in home prices was consistent with fundamentals, and that the exceptionally robust price increase that occurred between 2004 and 2007 was supported by mortgage rates that were much lower than historical averages. Furthermore, measured in relation to an assumed equilibrium value, the price peak of the most recent upturn does not seem to vary much from that of earlier upturns. They found that by the middle of 2010, investments and home prices were both quite near to their predicted equilibrium values. The model indicated that real home values continued to stabilise throughout 2010 before beginning to appreciate.

A study covering the development basis of fundamental housing prices then was conducted by Hlaváček and Komárek (2011) when they studied the variables influencing real estate values in the Czech Republic. Three distinct methods were used in their empirical study to determine periods of overvaluation in property prices: panel regression, simple analysis of temporal trends in a regional dimension, and ratios linked to home prices. Overpriced real estate was found in the study for the years 2002–2003 and, to some extent, 2007–2008. Given that fundamentals had a major role in driving up property values during this time, the magnitude of the home price overvaluation in 2007–2008 was very small when compared to basic HP filters in the panel regression. When examining individual areas, it seemed that those with higher property values had the tendency to have higher housing values. Prague is the lone exception to this rule since it seems to have several "specific" characteristics for a capital city.

Using a quarterly panel data set for 16 OECD countries from 1975q1 to 2013q2, a research conducted in 2014 examined the role that credit, and home prices play in predicting the risk of different financial crises. After estimating some multivariate logit models, it was discovered that increases in lending to non-financial firms as well as households should be taken into consideration when assessing the stability of the financial system. Furthermore, it was also discovered that changes in the global housing market may be used to forecast changes in the financial stability of a country. Positive and very significant coefficients were found in econometric measures of behaviour that was bubble type in the housing markets and credit markets. It was also found that the likelihood of a crisis rises noticeably when bubble type of behavior and excessive influence coexist. (Anundsen et al. 2014)

A 2017 study studied the fundamental house prices in Germany using regressions. The purpose of the research was to provide empirical evidence about the basic factors that influence real estate prices by examining a special panel dataset that included a variety of data from housing markets and other economic indicators for around hundred German cities. A number of strong basic characteristics were found, including the supply-

side elements of housing stock and building activity as well as the demand elements of flat rentals, size of a market, distribution of different ages, neighbourhood infrastructure, and rent prices. The findings show that these variables may be utilised to identify market price misalignments as they have a strong correlation with fundamental real estate values. (Belke et al. 2017)

Bourassa et al. (2019) Compared home price bubble measurement techniques utilising data from six major housing markets across three nations. They identified bubble periods retroactively using an asset pricing technique and compared the findings with those obtained using six other methodologies. It was also evaluated the different approaches recursively to see which ones are better at spotting bubbles as they emerge. The conclusion was that a straightforward price to rent ratio is a trustworthy technique both with actual results and in real time, given the complexity of the asset pricing strategy. The findings had significant policy ramifications since more rises in home prices may be prevented by using a consistent indicator that a bubble is developing.

In a rather recent study Maynou et al. (2021) established whether housing prices in a sample of economies from Europe—both members of euro zone and non-members—are convergent. Overall, little indication was found that home prices throughout Europe are convergent. The null hypothesis of convergence versus the alternative of divergence was tested using data from 12 countries between 2004 and 2016. It was then used a Bayesian dynamic panel model to identify the dynamics and causes of home prices. The findings pointed to the existence of five real estate market clubs across Europe, but no evidence of a club from euro zone was found. Furthermore, it was discovered that unemployment and fiscal issues were the primary drivers of actual property prices.

In 2021 research it intervals of extrapolative expectations in Canadian city housing prices was identified. For the housing market, the study included a non-linear heterogeneous agent model in which agents alternate between various home price forecasts. The first stage in the analysis was estimating the levels of home prices that were compatible with

standard demand-side factors, including population, real effective mortgage rate, and per capita disposable income. The conclusion was that improved modelling of the supply-side factors was still an essential area for future study since the model of the basic level of housing price appraisal did not have them (Emenogu et al. 2021) and (Bolt et al. 2019)

4 Data and methodology

The first step of the research process is to select range of determinants of housing prices specific to Finnish housing markets. These variables based on both supply and demand of the housing markets are then used to create a regression analysis of the housing markets to identify the possible housing bubbles during the sample period.

As the second approach of this research is to calculate price-to-income ratios and price-to-rent ratios, which are the widely used ratios to identify over-valuation and under-valuation of housing markets by linking housing price increase to income values and rent prices. The research methodology will be explained in more detail in the section 4.2 Research methodology.

The methodology of this research follows the one used in a 2022 article written by Shmygel and Hoesli developing dependable strategy for identifying housing price bubbles Ukraine. In the article they found the thresholds, which indicate that there might be a bubble, and that housing price increase might be a problem. Two general methods are used in the study to identify housing price bubbles: regression analysis and ratio analysis. There are two different sections and methods. First, they computed the Price-to-Rent ratios and Price-to-Income ratios, which might reveal a potential over valuation or undervaluation of home prices for several cities in Ukraine. After that, they carried out the regression analysis by creating separate multifactor models for each city and used an OLS regression to analyse the panel data. The only noticeable and protracted period of housing price bubbles, based on the data, is the one from late 2005 to early 2009 at the same time period with the Global Financial Crisis. These techniques often result in simultaneous bubble indications that make sound economic sense. The total risks arising from the housing market will be tracked using a measure of fundamental home prices and a bubble indicator on housing markets. (Shmygel & Hoesli 2022)

4.1 Data description

4.1.1 Data for OLS-regression

At first, a list of variables was gathered for the research that are commonly used for fundamental house price estimation in the literature to further evaluate the possible variables and to form the final dataset for the regression analysis. Below from the table 1 we can see the initial considered variable for this research before the variables were further evaluated and most suitable ones were picked.

Table 1. Initial list of variables considered for the regression model and ratio analysis

Dependent variable	Independent variable		
House prices	Supply fundamentals	Demand fundamentals	Lending factors
Nominal house prices	Commissioned dwellings in Finland	Rental prices for housing, EUR per sq.m	Mortgage portfolio, EUR
Real house prices	Building cost index for Finland	Average monthly income of a person/per household, EUR	Mortgage interest rates %
		Household capital saved for buying or building a home, EUR	New mortgage offering (flow of credit) in all currencies, over a period, EUR
		Unemployment rate, %	European Central bank interest rate rate, %
		Population	Google trend rate of "credit" search
		Share of disposable income of the households %	

4.1.1.1 Dependent variables

Housing prices are the dependent variable of this research and those are measured on quarterly basis. Data for both the commissioned dwellings as well as building costs are suitable for the analysis. The house prices for this study are accounted for inflation and therefore real house are used as dependent variables. The graphs below from Statistics Finland and Bank of International Settlements are inserted here for the illustrative purposes about the housing price levels from Finnish capital area and from Finland excluding the capital area from the secondary housing markets.

A significant portion of family wealth is comprised of housing property, while housing expenses account for a sizeable portion of overall household expenditure. Other household consumption is also impacted by housing costs. Furthermore, institutional

investors own substantial housing assets, including pension companies. Indeed, a significant portion of the overall assets of the national economy is comprised of housing property. (Oikarinen 2011)

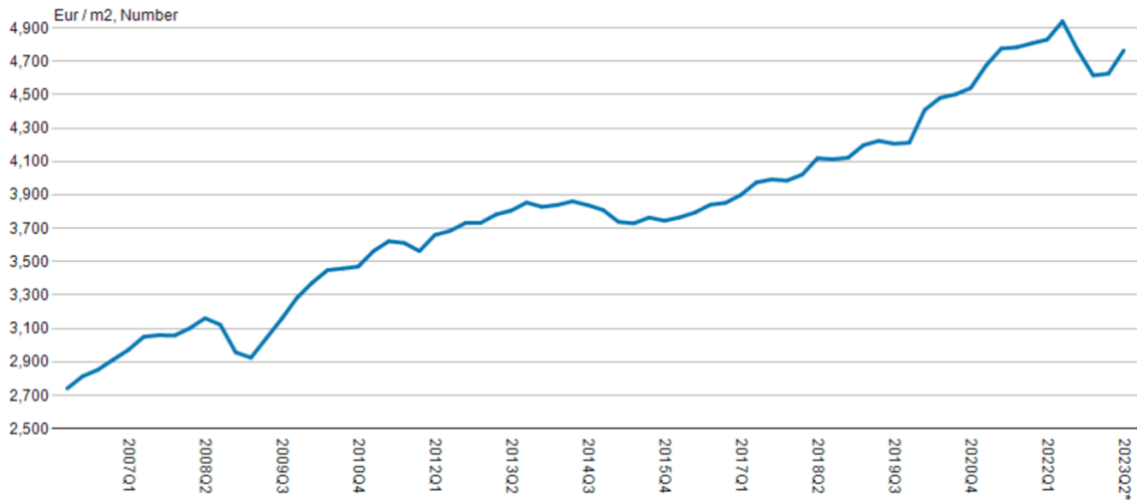


Figure 1. Nominal quarterly house prices in Finnish capital area from 2006Q1 to 2023Q2. (Stat.fi)

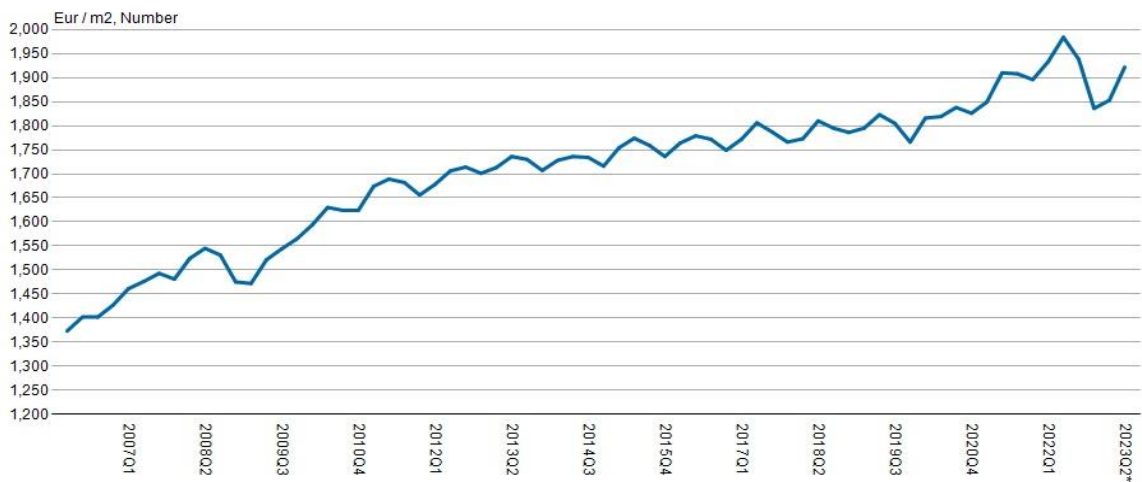


Figure 2. Nominal quarterly house prices in Finland from 2006Q1 to 2023Q2. (Stat.fi)

As can be seen from figure 1 and figure 2 above, the house prices have increased quite steadily from 2006 to 2023 in the Finnish capital area and in other parts of Finland while there has also been some more rapid movements at the price levels. The overall price level of the capital area being obviously at the higher level throughout the sample period.

Prior to 2008 financial crisis the prices have been growing quite rapidly while there is a sudden drop from mid 2008 to the early 2009, which after again somewhat rapid increase that later slows down. The second more significant drop can be seen during 2022 followed by what seems to be somewhat rapid increase towards the end of 2023. While looking at these number what must be considered is that the prices are nominal prices that are not accounted for inflation. Also, the prices from the secondary housing markets were used because of the data availability from longer sample period.



Figure 3. House price index in Finland from 2000Q1 to 2023Q1. (stats.bis.org)

Figure 3 above presents the house price index in Finland from 2006 to 2023 while 2010=100. The graph confirms the suspect that also the inflation accounted real house prices have been increasing prior to 2008 and the dropping rapidly followed by rapid increase from 2009 to 2010. Prices have been relatively steady from 2010 to 2019 followed by relatively large increase during 2020-2021 followed by quite a dramatic drop from 2021. Especially these relatively large increases or decreases below or above the base level 100 are potential under or overvaluation periods in the housing market indicating the possible housing bubble activity. Therefore, the inflation corrected values are used for the regression model.

4.1.1.2 Independent variables

When it comes to the independent variables, supply fundamentals of housing, demand fundamentals of housing and lending factors are included. Supply side fundamentals are supply factors for housing such as construction and housing stock variables. Most of the independent variables consists of demand factors as those include demand factors for housing that varies a lot depending on each individual situation of households current and desired living conditions.

Since financing circumstances characterise how easy it is for people to get a mortgages and financing for housing, they effectively are at demand role in the dynamics of housing prices. In this study, the lending related variables are separated from the model since, according to Bourassa et al. (2019), lending circumstances should not be referred to as basic factors as they explain the bubble's build-up rather than the underlying reasons. The claim that low interest rates and generally advantageous house loan lending conditions were the elements that led to the construction of a bubble prior to the Great Financial Crisis supports this premise. Furthermore, it was discovered that interest rates were mean reverting, making them an unimportant component in the long-term dynamics of housing prices.

In line with Shmygel & Hoesli (2022) the shortened list of variables was inserted to the regression model to simplify the model and to make shore that the variables are truly fundamental variables. Therefore, the lending conditions have been left out from the model avoiding to explain the bubble rather than explaining the fundamental real estate valuation. The principles for the model selection consists of three things: statistical significance, higher R2 and adjusted R2 and no significant correlation between different variables in order to avoid multicollinearity. To the table 2 below we have gathered the finalised list of variables that will be used for this research after evaluated wider range of variables listed above in table 1.

Where,

t = the given point of time

i = the area (Finnish capital area or Finland)

When it comes to the monthly average salaries in Finland, there is no comprehensive quarterly data about the salaries based on the area on living from the whole sample period. However, based on the average salary data from the Finnish tax administration between 2020 and 2023, the average salary in the capital area was 14,5% higher compared to the average salary of Finland. This percentage was then used to estimate the average salaries for the analysis. (vero2.stat.fi)

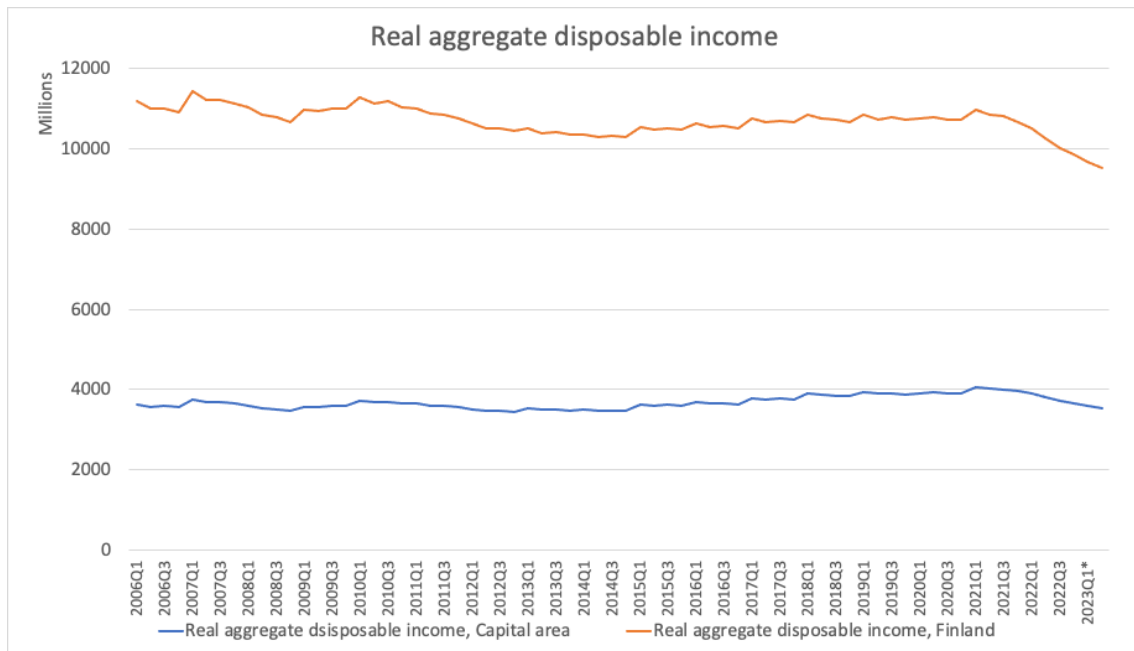


Figure 4. Real aggregate disposable income from the Capital area and from Finland

As seen from the Figure 4 above, the inflation corrected disposable income has been somewhat steady over the sample period from 2006 to 2023 with some fluctuation around 2008 financial crisis and the recent decrease from 2020 to this day. The graph illustrates the disposable income in the capital area as well as in the whole country. That is the reason for the two lines being so far away from each other.

The other demand variable for the regression analysis is the unemployment rate. Its importance lays on the fact that it indicates the current economic activity and the ability the households must buy housing.

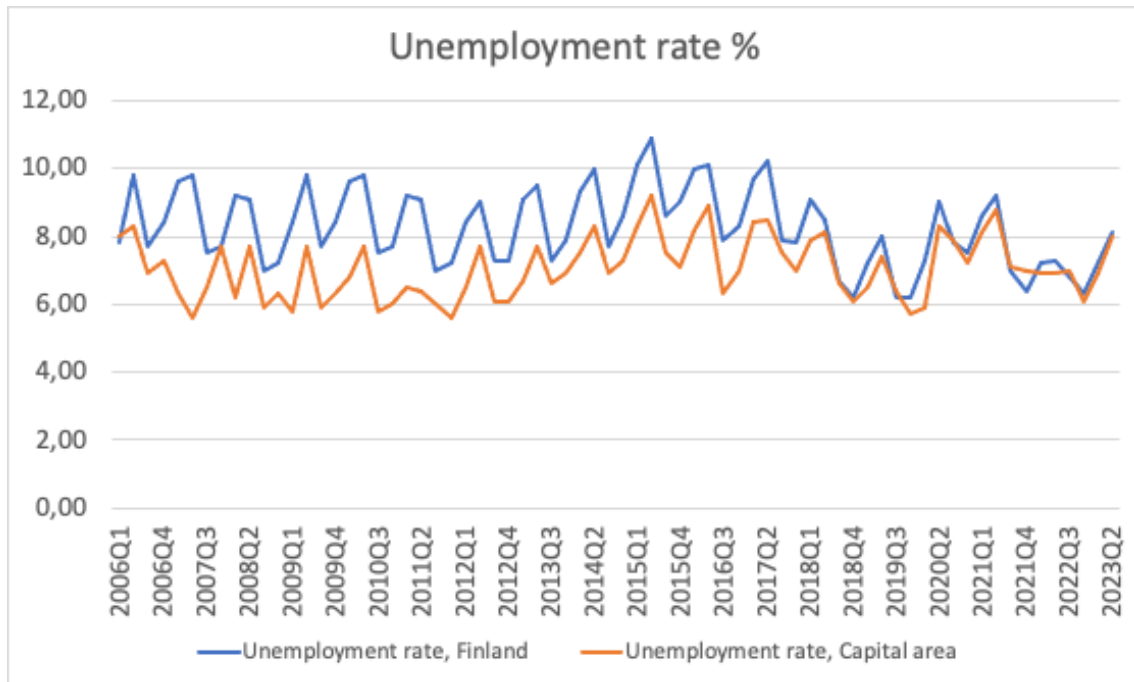


Figure 5. Unemployment rates from the Capital area and from Finland, % (Statistics Finland, labour force survey)

According to Figure 5 above, the unemployment rates from the capital area and from other parts of Finland can be seen varying between 6% and 10% quite steadily while the rate from Finland being slightly above the rate of the capital area. It can also be seen that the unemployment rates do not have a correlation with measure of real aggregate disposable income, which is generally a positive sign in order to avoid multicollinearity in the regression model. As we can see from the graph, the seasonal fluctuation is somewhat significant in unemployment rates from 2006 to 2023. For the actual model, the yearly fluctuation will be eliminated by seasonal adjustment.

4.1.2 Data for price-to-rent and price-to-income ratios

The information on the prices for housing, incomes, and housing rent prices are needed in order to calculate the Price-to-Income ratios and Price-to-Rent ratios. Since it is also needed for the regression analysis, the sources of the data on home prices and salaries, as well as the methods used to prepare it, are covered in depth in the preceding chapter. The rent data for this research is used to calculate price-to-rent ratio. Below is the table about average rents in the capital area of Finland. The rent prices in this research are used only for the capital area and for the period from 2015q1 to 2023q2 because of the limiting data availability reasons limiting the comparability of price-to-rent ratio analysis of this research.

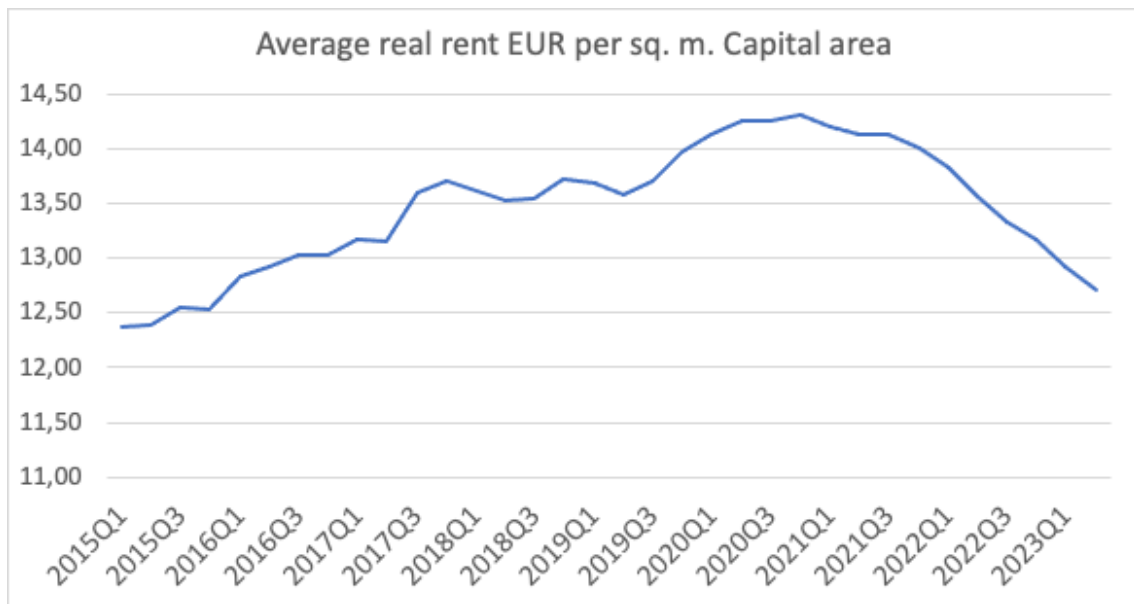


Figure 6. Average real rent rate in Finnish capital area. (Statistics Finland, rents of dwellings)

As seen on the Figure 6 above, the average inflation adjusted rent rate has been steadily increasing from 2015 until the mid 2020 in the Finnish capital area when it began to fall to the end of the sample period.

4.2 Research methodology

4.2.1 Regression analysis

This research work is conducted with common ordinary least squares technique (OLS-regression) as its primary research methodology. The answer Y in the basic linear regression model is dependent upon the explanatory variable X in accordance with the following linear relation:

$$E(Y) = \beta_0 + \beta_1 x \quad (6)$$

While multiple explanatory variables are used in the multiple regression model, the response Y depends on multiple explanatory variables and the linear function is assumed to be a linear function of these explanatory variables:

$$E(Y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p X_p \quad (7)$$

Therefore, when x grows by 1, the regression coefficient β indicates the amount that the value of the variable y changes. (Johnson and Wichern 1997)

To use OLS-regression to define the fundamental housing prices, the model in this study takes the form:

$$y_{t,i} = \beta_0 + \beta_1 X_{t,i,1} + \beta_2 X_{t,i,2} + \beta_3 X_{t,i,3} + \dots + \beta_p X_{t,i,p} + \varepsilon_{t,i} \quad (8)$$

where,

$y_{t,i}$ = Dependent variable in time "t" and the area "i" (Finnish capital area or Finland)

$X_{t,i,p}$ = the factors of housing prices of parameters p in time "t" and area "i"

We estimate the fitted values after the baseline model has been established, and they are then regarded as basic housing prices. Next, we contrast these fitted fundamental

home price values with the actual home price values for the same time periods. Next, we employ a criterion equal to two times the standard deviation outside the fitted time series to determine if there is a housing bubble on the market. Subsequently, we will compare the outcomes of the two research methodologies, OLS-regression and ratio analysis, to evaluate which one performed optimally in detecting occurrences of housing price bubbles for the capital area and the country.

When performing the regression analysis, it is essential to assess the regression model's quality. The value of R-squared (R^2 in this study) tells how much of the variance is explained by the model in percent. Because the adjusted value is adjusted for the sample size and number of estimated coefficients, it is often preferable to focus on the adjusted R-squared rather than the regular R-squared. The R-squared is always greater than the adjusted R-squared. Put otherwise, a model that has regular R-squared grows each time a new coefficient is added, which may easily result in an overly complicated model in real life. Therefore, the parameters of this study were carefully evaluated, and the number of parameters were decreased from the initial possible factors. The "more successful" the model, in general, higher the R-square. (princeton.edu)

It's critical to assess the findings' statistical significance while using regression analysis. One of the most popular and extensively used techniques for assessing the regression findings is the Fisher's significance test. This research study makes use of the p-value assessment. The null hypothesis, according to which a variable has no association with the dependent variable, is tested using the p-value for each variable. The P-value may be used to determine how significant the findings are. The less the p-value associated with the outcome, the less significant the coincidence effect and the more trustworthy the outcome. $P < 0,05$ is often used as the significant limiting value. The t-value is an additional statistical significance metric. Therefore, the number of standard errors that the coefficient deviates from zero is measured by the t-statistic. Any t-value that is less than -2 or larger than +2 is generally considered acceptable. Our level of confidence in

the coefficient as a predictor increases with the t-value. Low t-values are a sign that the coefficient's predictive capacity is not very reliable. (princeton.edu)

4.2.2 Ratio analysis

As a secondary method for this research is the ratio analysis. The Price-to-Income ratios and Price-to-Rent ratios are the some of the most often utilised ratios since they are simple to calculate and comprehend. These ratios connect the rise in home prices to the fundamentals of income and rent, which provide an indication of the relative over- or undervaluation of housing. Bourassa et al. (2019) shown via their study that the most effective method for accurately identifying bubble and non-bubble times is one that uses Price-to-Income and Price-to-Rent ratio analysis. The price per square metre of an apartment, multiplied by the standardised size 79 square meters in this study (stat.fi), and divided by the average yearly after-tax pay received by the household constitute the Price-to-Income ratio in this study. The price per square metre of an apartment that is divided by the yearly rent per square metre is known as the price-to-rent ratio.

Among the most extensively followed measures of the state of the housing market are the price-to-income ratios and price-to-rent ratios. Over the long run, these ratios tend to diverge from these standards over extended periods of time, even while they also tend to oscillate about a steady level or a modest trend. (André et al. 2014) (Shmygel & Hoesli 2022)

The price-to-income ratio, which indicates whether home is affordable for the typical buyer, is one summary metric often used to evaluate the state of the housing market. This ratio may indicate that prices were overpriced if it exceeds its long-term average. In such scenario, it would be difficult for potential purchasers to acquire a property, which should lower demand and drive down housing prices. (Girouard et al. 2006)

Simplified, high ratios indicate a real estate market where prices are noticeably out of reach for most buyers, while low ratios indicate that properties are reasonably priced and easily accessible to locals. (Sani 2015)

Objective A common metric for assessing imbalance and inefficiency in the housing market is the price-to-rent ratio. The degree to which rentals and home prices are components of the same market and, thus, whether they react to parallel stimuli similarly is a key issue. If they are dynamically close proxies, this offers useful market knowledge, especially in cases where causal links are obvious. (Lo et al. 2021) According to Girouard et al. (2006) the price to rent ratio, which may be thought of as the price difference between owning and renting a home, is comparable to the price-to-dividend ratio in the stock market. Potential purchasers may decide to rent rather than buy a home when house prices are excessively expensive compared to rentals; this should put downward pressure on house prices.

$$\text{Price – to – income ratio}_{t,i} = \frac{\text{Price per square meter}_{t,i} * \text{standardised area of an apartment}}{\text{Average annual household after tax wage}_{t,i}} \quad (9)$$

$$\text{Price – to – rent ratio}_{t,i} = \frac{\text{Apartment purchase price per square meter}_{t,i}}{\text{Annual apartment purchase price per square meter}_{t,i}} \quad (10)$$

Where,

t = given point of time

i = the area (Finnish capital area or Finland)

Regarding the interpretation of the results of the ratio analysis, Dreger and Kholodilin (2011) found that the likelihood of a housing bubble surpasses 50% if the Price-to-Income or Price-to-Rent ratio is more than one standard deviation added to the long-term average of the time series. A bubble is identified by Bourassa et al. (2019) when the ratio exceeds its long-term average by more than 20%. Furthermore, except for times when there is a structural break in the market, Czerniak and Kawalec (2020) claim that the link between property prices and rates for rental over an extended period is nearly consistent. In order to compare the present values to the long-term average added by

one standard deviation to the ratio values across the sample period, we will calculate the long-term average for the Price-to-Income ratios and Price-to-Rent ratios.

5 Empirical results

5.1 Results from the OLS-regression

Within the parameters of this study work, the primary way for determining the underlying level of housing prices is the regression approach. We did the regression analysis and estimated the fitted values that are thought to represent the basic home prices by using the regression equation from research methodology chapter 4.2.1, and variables, which are specified in data description chapter 4.1.1.

Before entering unemployment rate to the model, the values were seasonally adjusted to eliminate systematic calendar-related variation from the series.

5.1.1 Regression analysis in the Finnish capital area

The purpose of regression model 1 was to test the correlation of real aggregate disposable income and unemployment rate in the Finnish capital area on house prices in the capital area. From table 3 below, we can see that the explanatory power is at sufficient level as the adjusted R square is at 50%. From the results, we can see that there is a weak positive correlation between real aggregate disposable income and housing prices (at $p < 0,01$) and negative correlation between unemployment rate and housing prices (at $p < 0,1$). The results of this model are in line with the economic sense that disposable income has positive correlation and unemployment has negative correlation between housing prices.

5.1.2 Regression analysis in Finland outside the Capital area

The purpose of regression model 2 was to test the correlation of real aggregate disposable income and unemployment rate on house prices in Finland as a country excluding capital area which is evaluated separately in model 1. From table 3 below we can see that the explanatory power of the model 2 is significantly weaker than on model 1 covering only 5,8% even though the model was conducted the same way than the one

for the capital area. Therefore, we can argue that the model in use is more suitable to measure correlations on smaller regions rather than the whole countries. However, because we don't want the fundamentals in prices to follow the trend for prices too closely, we may accept underspecified models for this study. It may include the bubble build-up in this manner. The model must be underspecified in order to suit the basic home prices, which will be then used to identify housing price bubbles. If not, we run the danger of fitting and explaining the bubble as well. From the results, we can see that there is a positive correlation between real aggregate disposable income and housing prices (at $p < 0,1$) and positive correlation between unemployment rate and housing prices. The results of this model are also in line with the economic sense when it comes to the disposable income as it has positive correlation but as the unemployment has also positive correlation between housing prices it is somewhat against the common economic sense. However, as discussed previously, the explanatory power of the model being relatively low these results may derive from the dataset being somewhat deprived.

Table 3. Results from the regression models

	Model 1	Model 2
Constant	-181,1404*	1088,4127***
Real aggregate disposable income	1,0552E-06***	2,5941E-08*
Unemployment rate	-5841,5518*	1025,5050
Observations	70	70
R2	0,514	0,086
Adjusted R2	0,500	0,058
Standard error	191,815	42,812

Note: *** $p < 0,01$, ** $p < 0,05$, * $p < 0,1$

When it comes to the bubble detection and fitted values. It was mentioned in the methodology section that the threshold for possible bubble is the fitted value plus two standard deviations. Therefore, two standard deviations were added to the fitted values to see whether the actual price exceeds the value during sample period.

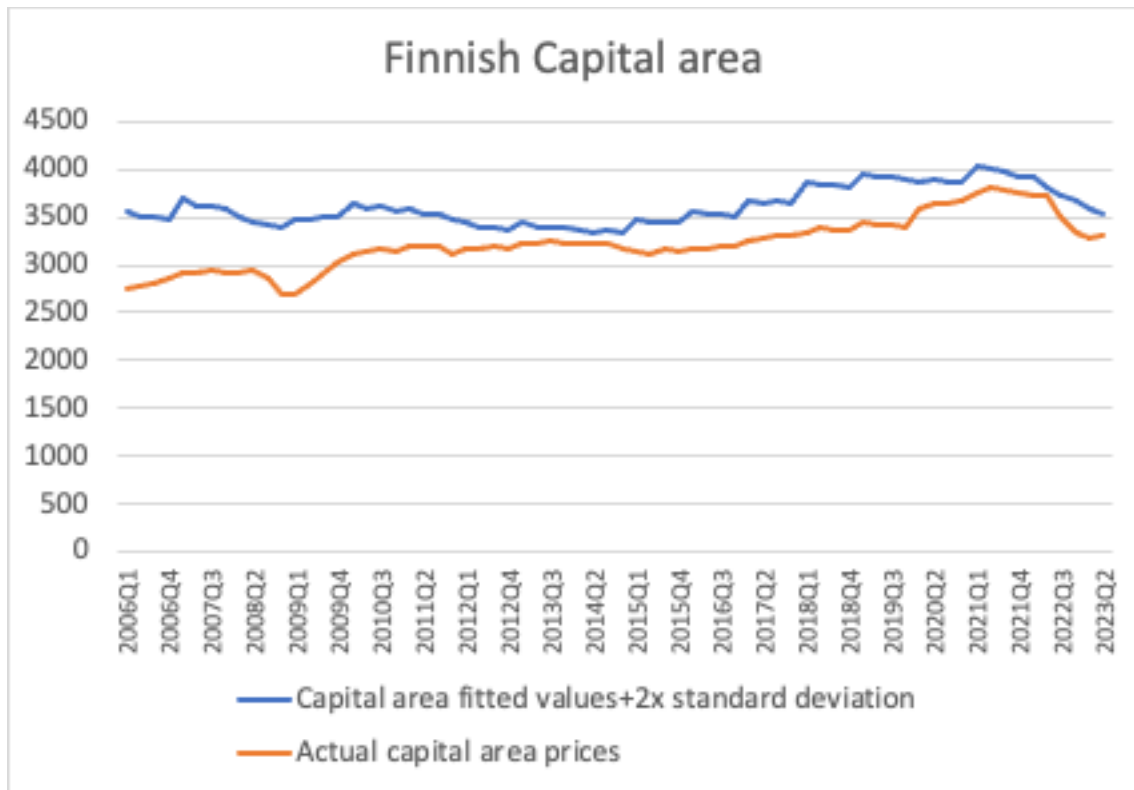


Figure 7. Comparison of actual values and bubble thresholds in Finnish capital area between 2006Q1 and 2023Q2

Regarding bubble thresholds in Finnish capital area, we can see from the figure 7 above that when 2x standard deviation has been added to fitted values, the actual housing prices do not exceed the threshold during the sample period and no housing bubble can be identified with the test. The actual prices follow the threshold somewhat steadily under the threshold prices and the price differences especially during the financial crisis in 2008 can be identified from the graph. During late 2022 and early 2023 we can see that actual prices almost exceed the threshold but then start to decrease slightly earlier than the threshold prices. Sometimes a threshold of fitted value added with just one standard deviation is used in bubble detection research due to the high variation of

prices and that may bring up more possible bubble periods, but in this research the nominal threshold was used. (Shmygel & Hoesli 2022)

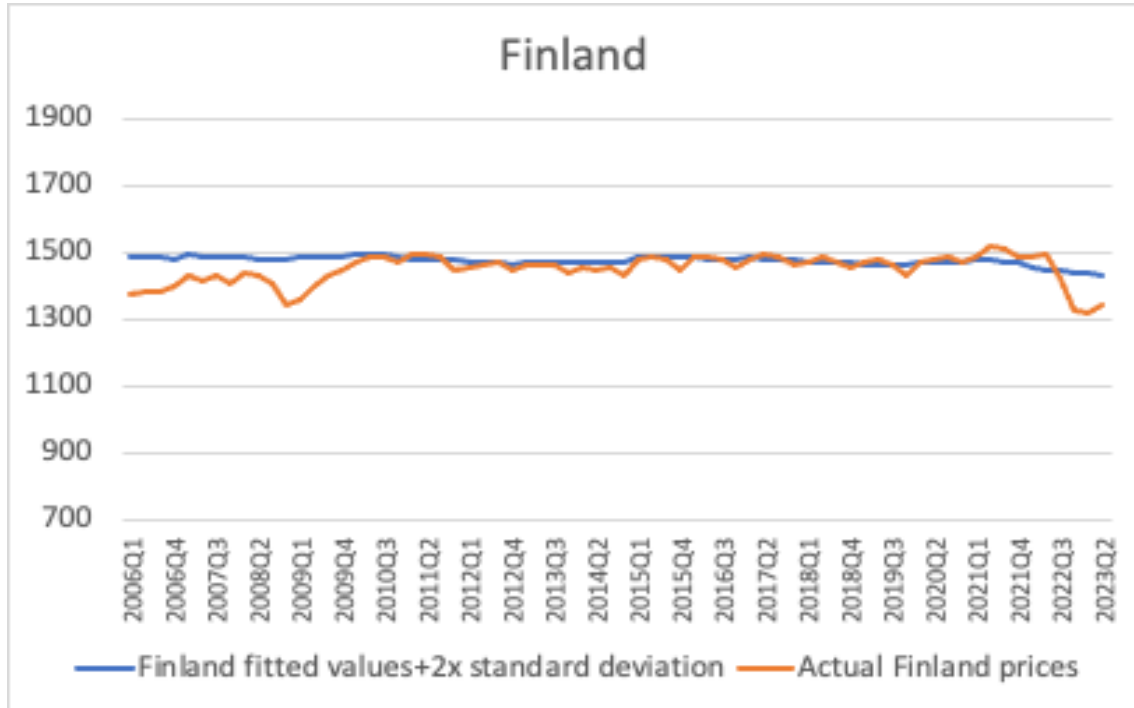


Figure 8. Comparison of actual values and bubble thresholds in Finland between 2006Q1 and 2023Q2

From the figure 8 above covering other parts of the country excluding the capital area we can see that the actual prices intercept the bubble threshold first time during 2010 during the sample period and follows the threshold somewhat closely until 2020 when it exceeds the threshold and finally decreases below the threshold in 2022. Especially the period from 2020 to 2022 when the actual housing price level in Finland clearly exceeds the bubble threshold set for this study indicates that a possible housing bubble has occurred during that period.

5.2 Results from the ratio analysis

5.2.1 Price-to-rent ratio

Price-to-rent ratio was only calculated for the capital area of Finland because of the data availability and accuracy reasons. The sample period will be from 2015q1 to 2023q2 so we will not be able to cover the same sample period than in regression analysis because the data from rent levels was not available from 2006 in the similar and usable form causing possible inaccuracy for the ratio. For the analysis, real inflation adjusted rent rates were used.

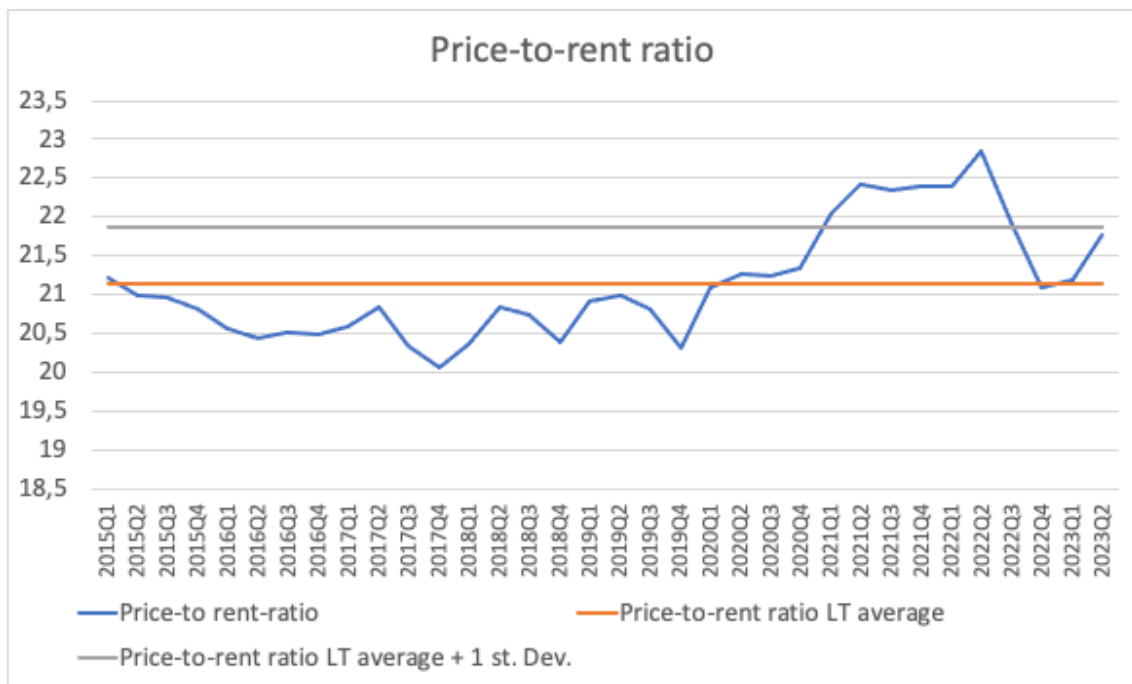


Figure 9. Price-to-rent ratio, Finnish capital area between 2015Q1 and 2023Q2

We have computed the long-term-average level for the ratio and the long-term average level for the ratio then added with one standard deviation. Those are then shown on the figure 9 above, to identify potential periods of either overvaluation or undervaluation of home prices. As we can see from the graph, price-to-rent ratio decreases below the long-term average just at the beginning of the sample period in 2015 and stays there until the first half of 2020 when it exceeds the long-term average. One year later, in the beginning

of 2021 the price to rent ratio also exceeds the specified bubble threshold long term average price-to-rent ratio added with one standard deviation. In mid 2022 the ratio again decreases below the bubble threshold all the way to match the long-term average level. During the final two quarters of the sample period, 2023 Q1 and 2023 Q2 the ratio again starts to increase towards the bubble threshold. Therefore, the analysis indicates a possible price bubble in the Finnish capital area between 2021 Q1 and 2022 Q2. The results are part-way in line with the results of regression analysis from the capital area, as in that analysis the prices come relatively close to the specified bubble threshold but don't exceed it like happens in this ratio analysis.

5.2.2 Price-to-income ratios

Same way than the price-to-rent ratio calculation, here we have computed the long-term average level for the ratio and the long-term average level for the ratio added with one standard deviation. The results are then shown on the figures 10 and 11 below, to identify potential periods of overvaluations or undervaluation of home prices. The average annual after-tax income of an individual either in the capital area or in other parts of Finland is multiplied by the number of working persons per household to get the average annual income made by the household after taxes.

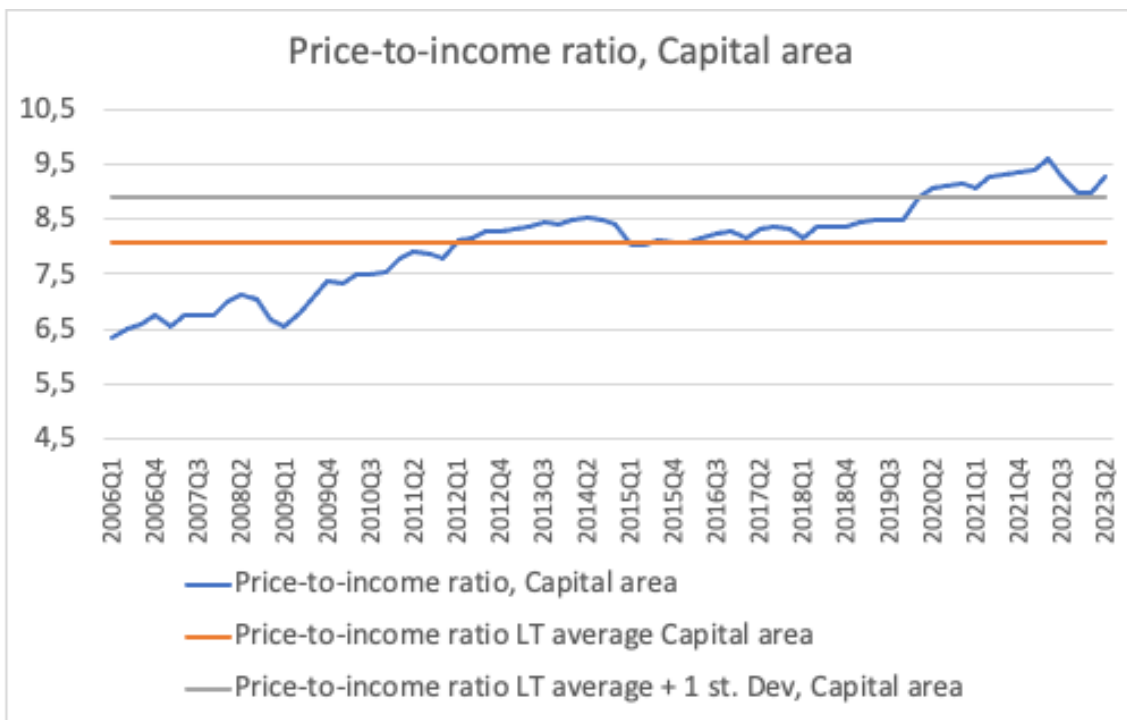


Figure 10. Price-to-income ratio, Finnish capital area between 2006Q1 and 2023Q2

From figure 10 above indicating price-to-income ratio in the capital area, we can see that there is an increasing trend in the ratio during the sample period from 2006 to 2023. During Q1 2012 the ratio first time exceeds its long-term average followed by the exceedingly also the bubble threshold from 2020. The ratio is above the bubble threshold from 2020 till the end of the sample period of this research indicating a possible bubble from 2022 in the Finnish capital area. Again, the results are somewhat in line with the regression model and the price-to-rent ratio in the previous sections of this study so we can be relatively satisfied with the model.



Figure 11. Price-to-income ratio, Finland between 2006Q1 and 2023Q2

From figure 11 above indicating price-to-income ratio in Finland again excluding the capital area, we can see that there is also an increasing trend in the ratio similarly like in the price-to-income ratio from the Finnish capital area discussed about in the previous section. On the other hand, the ratio quite steadily fluctuates between the long-term average and the bubble threshold between 2012 and 2022. The ratio first time exceeds its long-term average in early 2011 and exceeds the threshold for a possible bubble in early 2022 even though the ratio almost exceeds the bubble threshold already between 2015 and 2021. In 2022 it sharply decreases below the bubble threshold but bounces back above the threshold early 2023 and continues to increase till the end of the sample period. These results indicate a possibility for price bubble from early 2022 to late 2022 and again from 2023 to the end of sample period. These results are partly in line with the results from the regression analysis even though the timing is not the same but there is a difference of about one year in the possible bubble period the regression analysis indicating the possible bubble earlier than ratio analysis. Comparison for Finland between price-to-rent ratio and price-to-income ratio is not straight forward because the price-to-rent ratio only covered the capital area in this research.

6 Conclusions

This study investigates the existence of price bubble in Finnish capital area and in Finland between 2006 and 2023. Dataset for the research includes real housing prices from secondary housing markets as a dependent variable and real housing rent prices, real aggregate disposable income and unemployment rates as independent variables. OLS regression analysis was performed to investigate housing bubbles in the capital area and on the national level by comparing fitted values to the determined threshold for possible bubbles during the sample period. Price-to-rent ratio and price-to-income ratio was then calculated, and it was compared to the determined bubble thresholds during the sample period.

Based on the previous literature and previous analysis regarding the Finnish housing markets, two hypotheses were set for this research. The first hypothesis was set to cover the capital area of Finnish housing markets expecting the positive housing price bubble between 2020 and 2022. According to the regression analysis we cannot confirm the hypothesis as the housing prices from the secondary markets do not exceed the threshold set for the bubble detection. However, it is worth mentioning that between 2020 and 2022 the values are relatively close to the threshold. According to the ratio analysis for the capital area, the price-to-rent ratio partly confirms our hypothesis as the ratio exceeds the predetermined bubble thresholds between 2020 and 2022. Price-to-income ratio results are in line with the ones from price-to-rent ratio. To sum up the findings for H1, we can confirm that positive price bubble activity was detected with our analysis.

When it comes to the second hypothesis set for this research, we expected a positive price bubble in the Finnish housing markets between 2020 and 2022 in line with the first hypothesis. The regression analysis indicates that the threshold was exceeded between 2020 and 2022 and the price level closely followed the threshold already from 2010 to 2020. This indicates that the hypothesis for the Finnish housing markets was relatively correct, and it could be partly confirmed by the regression analysis alone. Only the

detected bubble period is somewhat longer than expected. Regarding the ratio analysis no price-to-rent ratio was not prepared for the national level due to the data availability, but price-to-income ratio again partly confirmed the hypothesis by indicating a price bubble for the Finnish markets between 2022 and 2023. To sum up, also the H2 was partly confirmed by our results.

Regarding coefficients from the regression analysis, it was found that in the model 1 to test the price bubble in the capital area we can see that there is a weak positive correlation between real aggregate disposable income and housing prices (at $p < 0,01$) and negative correlation between unemployment rate and housing prices (at $p < 0,1$). The model 2 to test the bubble in the national level we can see that both the real aggregate disposable income ($p < 0,1$) and unemployment rate has positive correlation on housing prices. The explanatory power of the model 1 was at rather satisfactory level as the adjusted R square is at 50% but looking at the model 2, we saw adjusted R square of only 5,8%, which tells us that there is relatively large difference in the explanatory power between the models indicating that the results from the regression model 2 cannot be considered as reliable than those from the model 1.

The main limitation of the research is related to the data availability and from the data is available. It would have been preferable to use monthly data for the entire sample period to increase the accuracy of the results. Sometimes it might be necessary to evaluate the bubble period at monthly level but in this research quarterly data was used as it was available. With more accurate data the sample period could also be lengthened. In this research the sample period began from 2006 even though it can be verified from the previous literature that there is bubble activity already before our sample period that would be beneficial and interesting to include in research like this one. For example, it would be particularly interesting to cover some years before the financial crisis of 2008 for comparison to more recent housing markets. However, the sample period was not lengthened with less accurate data.

There will be many interesting further research topics in the area of housing price bubble detecting. In this research the bubble characteristics were not evaluated as a part of the study but only tested whether the housing price levels exceed the determined bubble thresholds. Therefore, it will be somewhat complicated to separate normal housing price fluctuations from a bubble. It could also be beneficial to divide housing markets into smaller submarket areas to evaluate differences between different market areas. Housing bubble detection might interest especially the potential house buyers who are looking for information about the housing markets to support a decision about the good time to purchase. In case the markets are highly generalized the results might not be accurate enough or even misleading from time to time.

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