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Short-run impact of the Russian invasion of Ukraine on housing prices in Helsinki: A quantile regression analysis

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ABSTRACT:
The housing market is closely tied to the national economy, and dwellings represent the most significant asset class for households. Thus, fluctuations in housing prices can have a significant impact on households' wealth. Prior research has found that 60% of variation of real estate return can be explained by macroeconomy. Therefore, even though housing markets must be considered regionally, macroeconomically variables plays a remarkable role.

The Russian invasion of Ukraine in 2022 was a significant dramatic event that sparked widespread uncertainty and potential risks for the Finnish economy, including the housing market. Motivated by that, this thesis investigates whether the invasion affected housing prices in Helsinki by adopting a quantile regression. The benefit of quantile regression is its ability to capture the effects of explanatory variables at different points of the distribution, providing more comprehensive insights compared to traditional OLS regression. Furthermore, the study also aims to identify significant macroeconomic variables by utilizing a MIDAS regression, as this approach enables the assessment of the effects of macroeconomic variables with different frequencies on housing prices. Due to the lagged nature of the housing market and the period analyzed (January 2020-December 2022), the study primarily focuses on short-term effects. The dataset comprises 31,632 observations of housing prices collected from Hintaseurantapalvelu.

The empirical results indicate that the Russian invasion of Ukraine did not have a negative impact on Helsinki housing prices, as indicated by the insignificant results in OLS and MIDAS regressions. However, the quantile regression results show a positive impact on both the lower (25th) and highest (90th) quantiles, implying a varied impact at different price levels. Further, combining results with the findings that the Economic Policy Uncertainty index lack of significance leads to the conclusion that global events and news may not have a strong influence on the Finnish housing markets. Furthermore, the short-term impact of macroeconomic variables on housing prices appears to be relatively insignificant, except for interest rates and household income, with Euribor 12-months being the most significant factor explaining house price movements.

KEYWORDS: Housing market, Housing prices, Quantile regression, MIDAS, Macroeconomy, Helsinki, Russia-Ukraine war, Crisis

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TIIVISTELMÄ:
Asuntomarkkinat ovat tiiviisti kytköksissä kansantalouteen, ja asunnot ovat kotitalouksien merkittävin varallisuusluokka. Siksi asuntojen hintavaihtelut voivat vaikuttaa merkittävästi kotitalouksien varallisuuteen. Aiemmat tutkimukset ovat osoittaneet, että 60 % kiinteistöjen reaalituottojen vaihtelusta voidaan selittää makrotaloudella. Vaikka asuntomarkkinoita onkin tarkasteltava alueellisesti, myös makrotalouden muuttujilla on merkittävä selittävä rooli.

Venäjän hyökkäys Ukrainaan vuonna 2022 oli dramaattinen tapahtuma, joka aiheutti laajaa epävarmuutta ja mahdollisia riskejä Suomen taloudelle, mukaan lukien asuntomarkkinat. Tästä syystä tämä tutkielmaa tarkastelee, vaikuttiko hyökkäys todellisuudessa asuntojen hintoihin Helsingissä käyttämällä kvartiiliregressiota. Tässä tutkimuksessa menetelmän etuna on sen kyky havaita muuttujien vaikutukset eri hintatasoilla, mikä johtaa kattavimpiin tuloksiin verrattuna keskiarvomuuttujaa hyödyntävään perinteisen pienimmän neliösumman menetelmään (OLS). Hintavaikutuksen lisäksi tutkimuksessa analysoidaan merkittävät makrotaloudelliset muuttujat käyttämällä MIDAS-regressiota, joka mahdollistaa päivä-, kuukausi ja kvartaalitasolla olevien kansantalouden muuttujien vaikutusten arvioinnin asuntojen hintoihin ilman datan konsolidointia. Koska asuntomarkkinat reagoivat viiveellä markkinamuutoksiin ja analysoitava jakso on tammikuu 2020 – joulukuu 2022, keskittyy tutkimus pääasiassa lyhyen aikavälin vaikutuksiin. Aineistona käytetään Hintaseurantapalvelusta kerättyjä asuntokauppatietoja ja lopullinen otosmäärä on 31 632 havaintoa.

Käyttämällä OLS- ja MIDAS-regressioita, tulokset osoittavat, että Venäjän hyökkäys Ukrainaan ei vaikuttanut negatiivisesti asuntojen hintoihin Helsingissä. Kvantiiliregressio puolestaan havaitsee varovaisen positiivisia vaikutuksia sekä alhaisimmilla (25.kvartiili) että korkeimmassa (90.kvartiili) hintaluokissa, mikä viittaa hintaluokkien erilaisiin vaikutuksiin. Kun nämä yhdistetään tuloksiin, joissa Economic Policy Uncertainty -indeksi osoittaa merkityksettömyyttä, johtopäätös on, että globaalit tapahtumat ja uutiset eivät välttämättä ole omiaan vaikuttamaan merkitsevästi Suomen asuntomarkkinoihin. Makrotaloudellisten muuttujien syvempi analyysi osoittaa lisäksi, että näiden lyhyen aikavälin vaikutukset ovat suhteellisen merkityksettömiä, lukuun ottamatta korkoja ja kotitalouksien tuloja. Kaikkein merkittävin tekijä selittämään asuntojen hintaliikkeitä valitulla ajanjaksolla on 12-kuukauden Euribor.

AVAINSANAT: Asuntomarkkinat, Asuntojen hinnat, Kvantiiliregressio, MIDAS, Makroekonomia, Helsinki, Venäjä-Ukraina sota, Kriisi

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1 Introduction

1.1 Research background

Russia seized the Crimean Peninsula in 2014. On February 24, 2022, the capture escalated to a war against Ukraine. Besides everything else, the Finns began to worry about the housing market. Real estate agents reported the prolonged marketing times, and the world was incredulous about the geographical location of Finland. However, since real estate is an illiquidity asset, no rapid price changes are likely to be captured after an unexpected event. In contrast, stock indexes fell 3-4 % in Europe on the same day of the unprecedented Russian invasion. Some individual stocks plunged several tithes. In housing prices, volatility is rather low. The transactions appear to be laborious compared to liquid asset classes due to factors such as substantial transaction costs and lack of centralized information gathering. Therefore, the price information comes with a lag, and changes in the general price level can be captured several months after (Dolde and Tirtioglu, 1997).

Besides the uncertainty caused by the war, Finland and the housing prices have faced several other factors that have risen and created an uncertain atmosphere. McCue and Kling (1994) state that the macroeconomy can explain 60 % of the variation in real estate returns. War in Europe came up with multifarious consequences, and several are likely to deal with macroeconomy. Therefore, it is well-founded to examine the macroeconomic factors when aiming to understand the housing price movements. Moreover, the level of activity in the housing market can serve as an indicator of overall economic conditions. As stated by Leamer (2015), residential investments are the foremost indicator of economic activity, and the real estate sector has a greater impact on output than any other industry. Furthermore, a remarkable amount of loan is used when purchasing a dwelling, thus a significant correlation to financial sectors performance is related to house price fluctuations (Goodhart & Hofmann, 2007). Further, a high level of leverage in the housing market results in a reduced responsiveness to

positive shocks, while negative shocks have a more pronounced effect on housing, exacerbating the economic downturn (Iacoviello and Pavan, 2013).

Besides the impact on the national economy, dwellings are households' most significant asset class. Thus, it is also linked to the "wealth effect," where changes in housing prices affect consumption. In fact, this effect is even more substantial than that of financial assets, as demonstrated by studies such as Case et al. (2001) and Campbell and Cocco (2004), among others, leading to reduced consumption and a further decline in the national economy. Furthermore, Oikarinen (2011) points out that residential buildings constitute the majority of the building stock, only underscoring the significance of housing, its ownership, and the broader effects on the national economy. Given the crucial role of the housing sector in the economy and the fact that a significant portion of individual wealth is tied up in housing, Shiller (1998) argued that the risk associated with the housing market is one of the most substantial financial risks faced by individuals. Hence, price fluctuations have a considerable impact on a household's wealth, and life overall. While housing is a consumption good, housing assets possess a distinctive characteristic of serving also as an investment. This dual functionality sets them apart from other types of investments and consumption goods. Housing's longevity and durability give it a unique quality in terms of consumption. As an investment, housing differs from other assets by having a physical presence and providing housing services to its owner.

1.2 Purpose and contribution

The purpose of this study is to assess the impact of the Russian invasion of Ukraine on Helsinki housing prices. Finland has approximately 1 300km of border with Russia that executes an offensive war. At the time of invasion, Finns and the rest of the world became uncertain on also the location of Finland. The uncertainty regarding escalating war could lead to uncertainty in housing markets, or the greatest wealth of Finns. Trojanek and Gluszak (2022) studied how the refugee crisis following the war that affected also Poland indirectly. The evidence indicates a substantial increase in rents,

while prices experienced only a marginal rise. However, it is worth noting that Finland, and Helsinki in particular, did not encounter a refugee crisis of a similar magnitude creating pressure on price increase. In fact, prices began to fall, more referring to the negative effects of war. On the other hand, significant changes were observed in the macroeconomy. These changes were partly a result of the war and partly attributable to other factors, such as the energy crisis that began prior to the war and the subsequent inflation. In other words, one of the objectives of this thesis is to establish a basis for determining whether war was the primary factor influencing housing prices in Helsinki. In terms of the other objectives of this study, Kang and Liu (2014) discovered that the financial crisis had varying effects on different quantiles within the housing market. In a similar vein, this study contributes to the housing market research by employing a quantile regression approach to capture price changes in various quantiles.

When the significance of the housing market is acknowledged, gaining insight and comprehending the specific fluctuations in house prices can have advantageous effects on making either investment or consumption decisions, formulating housing policies, or managing assets, portfolios, and risk. Besides, because the macroeconomy and housing market are significantly linked, it is essential to understand the causalities. This is the broader picture of the contribution of this thesis. To sum up specific contribution of this study, to my knowledge, the impact of the Russian and Ukrainian war on the Finnish housing market has not been studied, not to mention the quantile study. Additionally, the use of quantile regression in the Finnish housing market is not extensively researched, making this study particularly valuable. Nyholm and Voutilainen (2021) examined the relationship between the distribution of future GDP growth and household debt accumulation in Finland. However, housing prices remain an area that has not been explored using quantile regression. Hence, insights into different quantiles within the housing market in Finland is a novel contribution. Moreover, MIDAS is neither a familiar approach within the housing market, not to mention Finland. Given the fact that Hintaseurapavelu provides specific data, and data is on three level frequencies, applying also MIDAS provides a unique input on housing market analysis in Finland.

1.3 Research approach and questions

The research is conducted by using quantitative econometric techniques, and data collection. The primary data is obtained from Hintaseurantapalvelu (HSP), a platform to which a majority of real estate agents and other players in the real estate sector report realized price transaction information of sold apartments, along with information on the dwellings' features. The data period is from January 2019 to December 2022, consisting of 31 632 transactions of old dwellings in Helsinki. Focusing solely on Helsinki as the research sample highlights the challenges in obtaining comprehensive data on blocks of flats sales across other cities in Finland. Regions with higher market activity tend to have more transactions, making it easier to estimate house prices. Conversely, areas with lower market activity make it more difficult to determine prices, leading to greater measurement uncertainty. Thus, deciding to study only Helsinki enhances the validity of the data collected. Moreover, Helsinki is notable for its distinctive housing prices and has been an attraction during times when regional disparities begin to emerge.

As for studying the house price movements, besides the ordinary least square method (OLS) also Quantile regression is obtained. The use of quantile regression is suitable because it allows for examining the entire distribution of housing price variables, instead of focusing solely on a single measure of the distribution's central tendency. By using quantile regression, it becomes possible to assess whether the impact of an invasion on house prices varies across different quantiles. Additionally, a MIDAS regression is employed to gain a more comprehensive understanding of price movements and macroeconomic variables. MIDAS regression is advantageous as it enables the analysis of data with different frequency levels without the need for data aggregation.

This thesis includes two research hypotheses, as well as an examination of which macroeconomic variables are significant. Hypothesis construction is motivated by following underlying facts. First, housing is the most important asset class of households' and composes a significant portion of households wealth. Secondly, Finland's housing

market faces a distinct risk due to its close proximity to a country engaged in aggression. While assessing the likelihood of such a risk as expanding invasion materializing may be difficult, it should be regarded as a tail risk, as recent global events have demonstrated the importance of considering such low-probability but high-impact scenarios. Moreover, a negative impact on housing prices could lead to reduced consumer spending, thereby adversely affecting the national economy. In addition, if the conflict creates instability and uncertainty in the Finnish capital region, it could dissuade besides the households, also foreign investors, and result in a larger decline in housing prices. These factors emphasize the significance of closely monitoring fluctuations in house prices. Hence, the first hypothesis is formulated as follows:

H1: The Russian invasion of Ukraine had a negative impact on housing prices

Assuming that the invasion impacted Helsinki housing prices, the second hypothesis aims to exhibit whether the consequences vary at different levels of housing prices. Motivated by the quantile findings by Kang and Liu (2014), examining different quantiles allows for a more nuanced understanding of how consumers at the top and bottom of the wealth spectrum are affected differently. For instance, Jill's (2011) research suggests that half of the poorest households in the United States did not experience any decline in their wealth during the financial crisis. However, Finland's income distribution is one of the most equal in the world, suggesting that the impact of the housing price changes may not vary significantly across different consumer groups. Nevertheless, this has yet to be studied to the best of my knowledge. Therefore, it is a unique approach to investing whether the impact of housing price varies on different quantiles. Thus, the second hypothesis is structured as follows:

H2: The effect of the Russian invasion of Ukraine varied at different housing price levels.

Furthermore, although housing markets vary on regional differences, the macroeconomy is still a significant explanatory as McCue and Kling (1994) state.

Therefore, the study aims to examine closer the macroeconomic variables while aiming to understand price movements.

1.4 Structure of the Thesis

The thesis comprises seven chapters, with the first chapter outlining the underlying motivation for examining the subject matter, as well as specifying the thesis's purpose, contribution, and research hypotheses. The second chapter discusses the previous studies regarding the selected explanatory macroeconomic variables providing a comprehensive background of the key variables. To sum up the second chapter, a concise table of the impact of variables is conducted. In the second chapter, a broader approach is taken in discussing relevant studies, whereas the third chapter narrows the focus to the Finnish perspective on the housing market. This chapter gives attention to the history and current state of the housing market, as well as an examination of Helsinki as a distinct region. Furthermore, the discussion also encompasses an analysis of housing companies.

As the paper is concerned with the concept of invasion, which can be classified as a crisis, the fourth chapter delves into past crises for further exploration. The emphasis lies in tracing the evolution of crises and their influence on housing prices. Chapter Five provides an overview of the data and methodologies employed in the study. This is followed by the empirical section, which first outlines the analytical framework before presenting the results generated using various methods. Finally, the last chapter, or chapter seven, offers concluding remarks and suggests avenues for future analysis.

2 Macroeconomy as a determinant of housing prices

Multiplicative effects are significant in the housing market due to its interconnectedness with various areas of the national economy. According to Harris and Arku (2006), the housing market impacts the economy through employment, consumption, and investments. Zhang and Liu (2016) argue that housing prices, in addition to money supply, play a crucial role in a country's macroeconomic performance. Additionally, Loutskina and Strahan (2015) suggest that the housing sector has a direct correlation to general economic development, and the real estate market can serve as an indicator of the level of national economic development. However, the crucial relationship between housing markets and the macroeconomy has not always been acknowledged. It was not until the late 1990s that academic literature started to acknowledge this interconnection, as stated by Oikarinen (2011). Previously, the literature had primarily focused on other asset classes. However, the recent financial crisis and its repercussions forced a wider audience to recognize the critical role that housing markets play in macroeconomic fluctuations, as highlighted by Iacoviello and Neri (2010) and Cesa-Bianchi (2013).

Credit plays a vital role as a wealth-building tool for households. Since home purchases involves high costs, it is typically acquired through significant debt financing and serves simultaneously as collateral. Consequently, the correlation between house prices and credit is of significant importance, as housing wealth and collateral have a significant impact on credit demand and supply. Furthermore, credit supply also affects house prices, resulting in a mutual connection between the two, according to Ortalo-Magné and Rady (2006). The life cycle-model of household consumption states that a permanent increase in housing wealth is clearly connected to increasing household spending and borrowing because households tend to level consumption over the life cycle. In particular, the wealth effect of housing stimulates more consumption than the same effect of other financial assets (Case et al., 2001; Campbell and Cocco, 2004). Besides the wealth effect, houses also have a collateral effect that creditors appreciate. The immobility of houses makes them a reliable form of collateral that cannot be easily seized by creditors. Homeowners use their homes not only as collateral for mortgages

but also for other types of loans. Consequently, higher house prices not only encourage homeowners to spend more but also render them to borrow more by enhancing their borrowing capacity. (Aoki et al., 2004; Iacoviello, 2004; Iacoviello, 2005; Muellbauer, 2007; Campbell and Coco, 2007). On the contrary, Lönnqvist (2015) states that increased housing expenses are likely to contain the consumption possibilities for other goods.

Furthermore, because of requirements of external financing, the housing market has a clear connection to bank lending and, therefore, also to capital markets. Specifically, bank lending and housing price development are linked (Liang and Cao, 2007; Oikarinen, 2009; Öhman and Yazdanfar, 2018). Öhman and Yazdanfa (2018) conducted an analysis of housing prices in Sweden from 2005 to 2013 using VECM-based Granger causality tests besides other methods. They discovered a cointegration between bank lending and housing prices. Furthermore, any housing or mortgage market fluctuations can affect others, ultimately influencing household consumption and the overall economy. Therefore, not only are houses interconnected to creditors, but house prices also have a significant impact on the financial sector. According to (Oikarinen 2007) banks tend to lend more when housing prices are steep. Besides stimulating national consumption, it may also be a risk for the financial sector. Banks are exposed to credit losses when housing prices decline because of borrowers' weakened debt service capacity. Often the financial and housing market cycles reinforce each other, and hence, the whole economy's cycles. As an illustration, Oikarinen (2007) cites the recession of the 1990s, where the financial and housing markets may have reinforced each other, exacerbating the difficulties of the recession.

Moreover, the construction industry has significant input on the national economy. The construction sector, which encompasses construction and construction production, employs around 250,000 people in Finland. Further, when also including building management and related services, the approximate total number rises to 520 000. In short, the cluster is Finland's largest employer, and one-fifth of Finns work in the industry. Besides, an investment of one million euros amounts to 15 man-years in construction.

Beyond that, taxes and parafiscal charges account for more than 40% of construction. (Rakennusteollisuus, 2022). Also, Oikarinen (2007) emphasizes the importance of the housing market to the construction industry. A drop in housing prices is reasonable to negatively impact housing construction, aggregate output, and employment. Moreover, Bahadir and Mykhaylova (2014) emphasize the importance of anticipating the shock nature of the construction industry early on. Furthermore, the construction industry cannot respond immediately to changes in housing demand, resulting in a lag in supply. This lag can create volatility in housing markets, although housing prices still typically exhibit large cycles. As a result, housing prices, as noted by Barot and Takala (1998), can be somewhat unpredictable.

Iacoviello and Neri (2010) argue that the housing sector may be a driving force behind the business cycle, leading to the question of how significant the spillover effects from the housing market to the macroeconomy really are. Demary (2010) seeks to address this question by examining ten countries (Australia, Denmark, Finland, France, Germany, Japan, the Netherlands, Spain, the UK, and the USA) from 1970 to 2005. The results provide strong evidence house price shocks contribute significantly to the economy’s well-being. This finding is consistent with Iacoviello and Neri's (2010) earlier findings, indicating that house price shocks are a determinant of macroeconomic fluctuations, rather than the other way around. The results of the study are robust.

China's rapid economic development and growth serve as an example of how investing in the housing sector can benefit the overall economy. Simultaneously when the economy grows, it also raises people’s living standards and incomes. Hence it affects housing prices more sustainably by increasing demand. Economic development is frequently accompanied by urbanization, which creates demand for local housing as people migrate to urban areas, ultimately driving up housing prices (Yao et al., 2014; Li and Chand, 2013). In China, nearly 230 million rural workers moved to urban areas. Even though Finland's numbers are not even close, the effect is noticeable with smaller quantities also. Oikarinen (2007) points out that regional differences in housing price

development are also affected by the attractiveness of industrial structure and the competitiveness of local firms. Hence, housing prices can rise due to a specific employment structure that demands higher salaries, which can then make it difficult for low-income buyers to afford homes in those areas. Although, the co-movement is stronger between the submarkets of the metropolitan area than between the remote regional housing markets. That is, closeby areas have a stronger effect.

Finally, the housing market has a more significant impact on output than any other sector and is by far the leading indicator of economic activity, according to Leamer (2007, 2015). Next, this chapter presents significant individual macroeconomic factors that affect housing prices.

2.1 GDP

Gross domestic product (GDP) is a standard measure and one of the most critical indicators to capture economic activity. It measures how much a country can produce goods and services and add monetary value in a certain period. There are generally three methods for calculating the GDP, mentioned below:

1) Production (Output) Approach
2) Income Approach
3) Expenditure Approach.

The most common method is the Expenditure approach, and is formulated as follows:

$$\mathrm{GDP} = \mathrm{C} + \mathrm{I} + \mathrm{G} + (\mathrm{X} - \mathrm{M}) \qquad \textbf{(1)}$$

where the C stands for Consumption made by households, I for Investments that is expenditures that businesses make on capital goods and inventory, G for Government spending, X for Export, and M for Import.

Because of the great size of the housing market, it has a remarkable impact on the GDP. For instance, Acolin et al. (2022) study housing investments and housing services in emerging markets and find the contribution of GDP to be, on average, 13,1 %. In contrast, the National Association of Realtors (2021) reports real estate industry is responsible for nearly 17 % of the U.S. GDP. Furthermore, with a Granger causality test, Kuosmanen and Vataja (2002), and Oikarinen (2006) show that the housing market also anticipates GDP development. In short, GDP has generally been a famous topic while examining house prices because of its nature as a holistic indicator of the national economy's state.

The earlier literature proves that the GDP is an underlying determinant of housing prices. Most papers use real GDP, which is inflation-adjusted GDP, instead of nominal GDP. Égert and Mihaljek (2007) studied eight transition economies of central and eastern Europe and 19 OECD countries to capture housing price determinants. They find GDP per capita to be highly significant and have a positive sign in all regressions, indicating that housing prices are positively related to changes in GDP. Vogiazas and Alexiou (2017) find similar results. They studied seven advanced economies from 2002 to 2015 and concluded that higher GDP positively affected housing prices. Valadez (2010) as for examines the dependency in the U.S. from 2005 to 2009 or a time of financial crisis, and finds a significant correlation between GDP changes and house price development. Adams and Füss (2010) expand the time period to 30 years and consist of 15 countries with a dynamic least square method and find that GDP growth has an increasing impact on the housing market. More particularly, a one percent rise in GDP increases house prices by 0,34 % in the long term. As for Finland, the effect is more robust, and dwellings prices increase by 0,78 %. Adams and Füss (2010) also state that GDP is a major driver of the real estate market. Moreover, a major housing price crashes are likely to spread extensively. For example, the last crisis in 2008 and the office price crash in the early 1990s were felt nearly worldwide.

Besides Adams and Füss (2010), also above mentioned Kuosmanen and Vataja (2002), Oikarinen (2006) and Oikarinen (2007) have focused on the studies of the

macroeconomic determinants of the Finnish market. Similar to studies conducted in other countries, their findings indicate a direct correlation between house price fluctuations and GDP in Finland.

Even though the literature seems unanimous on the effects of GDP, several studies indicate that the short-term relationship is stronger than the long-term impact. Tsatsaronis and Zhu (2004) examine 17 industrialized countries with the Structural vector autoregression (SVAR) framework. The results indicate that the contribution of GDP to the total variation in dwelling prices is less than 10% in the long run. Additionally, findings suggest that GDP growth summarizes more itemized and direct measures such as unemployment and wages, which provide information on household income. Cesa-Bianchi (2013) utilizes Global VAR covering more than 90 percent of the world GDP and provides evidence that housing demand shocks lead to an extension of real GDP. However, the effect last only for a short period. Besides, results indicate that shocks in the U.S. housing market are rapidly transmitted to the global economy.

To conclude, even though conclusions on short- and long-term effects vary, GDP seems to be an uncomplicated determinant of housing prices and possesses a positive correlation. GDP generally increases the wealth per capita even if it is not distributed equally. When wealth is more incredible, the opportunities to buy houses also increase, leading to growing housing prices. Further on, housing prices are connected to household income, as introduced in the following chapter.

2.2 Household income

Household income is the amount where all household members' gross income above a specified age is combined. According to the Official Statistics of Finland[1] (2020a), the generally used measurement is disposable cash income, including monetary income

[1] Official Statistics of Finland is a Finnish government agency whose purpose is to serve as an information service and provide statistics and statistical expertise to the needs of society. Statistics Finland is one of the four statistical authorities in Finland. (Ministry of Justice, 2023).

items and fringe benefits related to employment. However, deferred income items such as deferred housing income are excluded. Household income is a standard measurement when the affordability of housing is considered. The general rule used by Finnish commercial banks to determine how much a household should spend on housing is that no more than a third of a household's net income should be spent on housing. For instance, Finland's largest mortgage lending banks, Nordea and OP, use this recommendation (Nordea, 2023; OP, 2023).

Greater income renders more expensive purchases; hence the demand curve moves upwards. Academic researchers have therefore been able to assume causality in the results, and the academic literature on the relationship between housing prices and income is well straightforward. Several studies have identified income as a crucial factor in housing dynamics across most OECD countries. (Fortuna and Kusher, 1986; Holly and Jones, 1997; Hort, 1998; McCarthy and Peach, 2004; Annett, 2005). In the case of Canada, Fortura, and Kusher (1986) investigate the distribution of housing prices and states that the demand factors are essential in determining price development. More particularly, they find that a 1 % increase in the income of households raises the housing prices proportionately more or 1,11 %. Thereafter, Holly and Jones (1997) examined housing prices in the United Kingdom using data from 1939 to 1994. They discovered that real income was the most critical factor in determining real house prices, with their study demonstrating that real house prices have increased in line with income. Like Holly and Jones (1997), Lamontin and Stein (1999) determined that income level was the primary driver of housing price fluctuations. Their research focused on 44 metropolitan areas in the United States between 1984 and 1994 and used economic shocks to capture changes. The researchers also found that the income ratio had the most significant impact on cities where a significant percentage of households were highly leveraged.

Further on, comparable results have been presented by Potepan (1996) and Capozza et al. (2002) in U.S. housing markets, Hort (1998) in Sweden, Hu et al. (2006) in China as well as Li and Chand (2013). In addition, Oikarinen and Engblom (2016) investigated

housing price dynamics in Finland from 1988 to 2012 using panel model specifications, and their findings were consistent with previous research, indicating a cointegration between housing prices and income.

To the best of my knowledge, academic research does not recognize studies where the findings would refer to a negative correlation between housing prices and household income. However, studies do acknowledge that variations exist between regions. For instance, after examining the Finnish market, Oikarinen turned his attention to the United States. Oikarinen et al. (2018) investigated income elasticity in 70 metropolitan areas in the U.S. Their findings indicate that the mean long-term elasticity of house prices with respect to aggregate personal income is 0.81. Although findings are not unequivocally, as there are significant variations between metropolitan areas, and long-term income elasticity is substantial in the more supply-inelastic metropolitans. Therefore, the paper by Oikarinen et al. (2018) raises the question of whether the relationship between income and housing prices should be viewed at a regional unit level due to possibly different impacts.

2.3 Interest rate

In the euro area, European Central Bank (ECB) is responsible for the monetary policy, and the main instrument is to set policy rates. The key interest rate determines the rate at which the ECB lends money to commercial banks. In practice, the key interest rate comprises three rates[2]. Behind the interest rate is to follow the price stability target set at 2 % in the mid-term period. Further, the interest rates set by commercial banks follow mainly the key interest rate. Also, the other essential factor determining the interest rate in a free market is the amount of money in the market. In general, low-interest rates urge to raise loans, consequently creating demand that again increases housing prices. Therefore, increasing housing prices are often associated with market-wide low-interest rates. Likewise, the academic literature has recognized the correlation.

[2] Main refinancing rate, marginal lending rate, and deposit interest rate (ECB, 2023).

Englund and Ioannides (1997) compare the dynamics of housing prices in 15 OECD countries and find the real rate of interest to exhibit significant predictive power to housing prices. Egert and Mihaljek (2007) as for utilized panel DOLS techniques to analyze 19 OECD countries and eight transition economies in Central and Eastern Europe. They establish robust evidence between housing prices and real interest rates in both CEE and OECD countries. Similarly, Giuliodori (2005) investigated the impact of interest rate shocks on house prices in nine European countries, including Finland, using data from 1979Q3-1998Q4 in VAR models identified by Choleski decomposition. The evidence indicates that interest rate shocks significantly affect house prices and are also correlated with consumer spending through housing prices.

Moreover, Himmelberg et al. (2005) find that not only interest level matters. Changes in interest rates have a different impact on the various interest rate environments in the U.S. Specifically, housing prices are more sensitive to changes in interest rates in cities where the housing supply is relatively inelastic. Additionally, in such cities, prices tend to be higher compared to rents. Furthermore, an unexpected rise in real interest rates will increase housing costs, causing demand to settle down and even declining prices. Besides, when it comes to determining a reasonable price for houses, researchers argue that failing to account for changes in real long-term interest rates, expected inflation, expected house price appreciation, and taxes can lead to inaccurate assessments. (Himmelberg et al., 2005).

While a large body of studies focuses on several macroeconomic variables, Nissim (2013) concentrates primarily on expected interest rates in the U.S. between 2007 and 2013. In his paper, he presents a theoretical model for predicting housing prices. In creating the hypothesis, he argues that housing investment can be an alternative to bond investing; hence, it is reasonable to expect a negative correlation between the interest rate and the housing price. It can be explained by rotation from housing investing to bond investing when interest rates increase. Next, he determines the correlation coefficient

of -0,812 between the housing price index and interest rate. As a result, Nissim finds a clearly negative relationship between interest rates and housing prices. Closer to the Finnish market Yang and Wang (2012) analyzed housing prices in Sweden from 1975 to 2009, focusing on identifying permanent and transitory shocks using a common trend model. Results show that interest rates are the dominant explanatory power of housing price swings.

Respectively, Kishor and Marfatia (2017) contribute to the discussion by underlining the gap that literature does not consider the different outcomes of short-run and long-run responses to the relationship between macroeconomy variables and housing prices. In order to account for the dynamic relationship, they apply a long-run cointegration relationship among macroeconomy variables in 15 OECD countries from 1975 to 2013. Results refer to dissimilarities between short- and long-term effects. The short-term housing price movements seem to be independent of interest rates. However, it must be underlined that this does not mean that are no influence on housing prices. Nevertheless, long-term findings show a negative correlation between interest rates and housing prices.

In Finland, the majority of mortgages are tied to a relatively frequently changing interest rate, 12-month Euribor, revised every 12th month. To be exact, at the moment when Russia attacked Ukraine, 95,5 % of mortgage portfolios of financial institutions were tied to the 12-month Euribor (Bank of Finland, 2023a). Thus, the Finnish housing markets are eminently vulnerable to interest rate fluctuations. Simultaneously, when interest rates rise, mortgage payments increase, challenging households to meet mortgage amortizations. Consequently, selling pressure in markets increases. At the same time, demand for housing decreases due to increase lending rates. (Oikarinen, 2005).

Below is presented the development of Finnish household loan stock by interest linkage. According to the graph, the lower the Euribor rate has declined, the more desirable it has become among mortgage lenders. Also, when considering the Finnish market, it is

interesting how small a proportion the fixed rates represent. The graph supports Oikarinen's (2005) argument that the Finnish housing market is exposed to interest rate fluctuations.

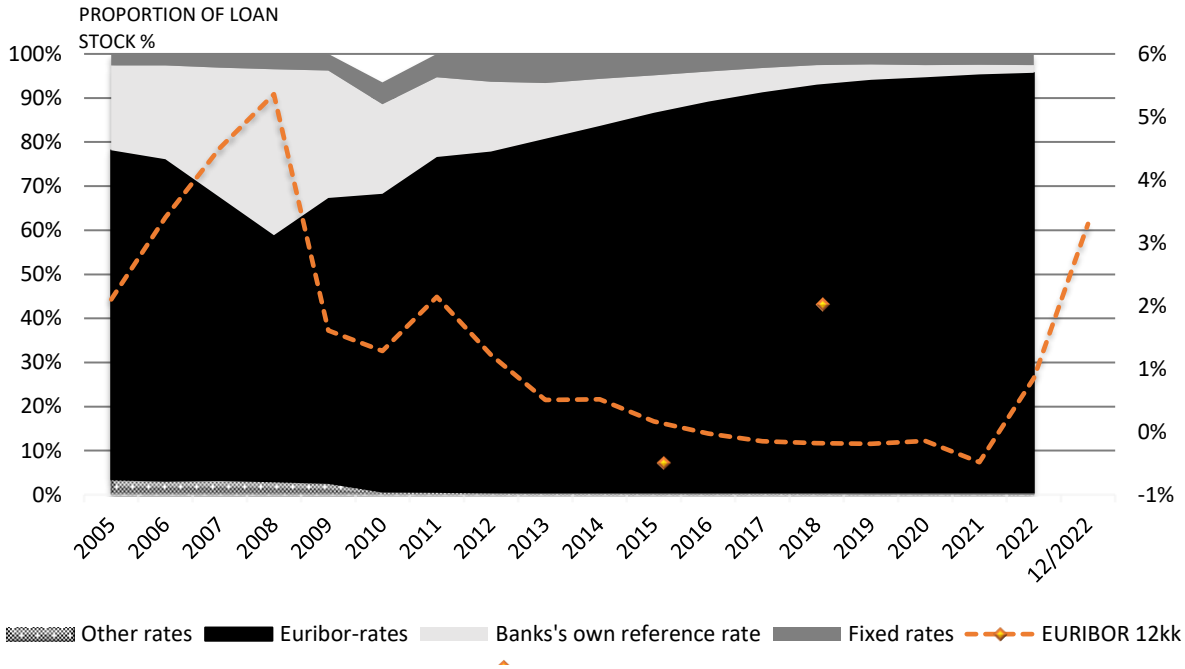

Figure 1. Housing loan stock by interest rate linkage, and Euribor 12-months (Bank of Finland, 2023a; Bank of Finland, 2023b).

2.4 Money supply

Money supply refers to the amount of cash circulating in an economy or, more accurately, all the currency and other liquid instruments in a country's economy on the given date. Academic literature mainly uses the M2 in studies examining money supply and the housing prices, like Kang and Liu (2014) and Su et al. (2018). The M2 describes fixed-term deposits with an agreed maturity of up to two years plus M1, including all physical cash and checkable deposits. In terms of housing prices, M2 is not as broadly studied in the academic literature as GDP, income, or interest rates.

The general interpretation of the correlation between the money supply and housing prices is as follows. Assuming the economic development remains unchanged when the money supply increases, it creates inflationary pressure, which is likely to drop real

interest rates. Therefore, other assets than interest-rate investments become more appropriate. Thereby, a significant portion of the increased money supply flows to the housing market, stimulating demand and thus raising housing prices.

The real estate market and its growth have become an essential part of China's overall economy, leading many studies to examine the correlation between money supply and housing prices in China. Su et al. (2019) apply a dynamic equilibrium model to explain the mechanism between M2 and housing prices, analyzing data from 1998 to 2016. Although they found no causality at first, they applied a bootstrap rolling window and ultimately discovered that fluctuations in M2 have a positive impact on housing prices. Moreover, findings suggest that a stable money supply can maintain a relatively stable price level. Yin et al. (2020) examine not only M2 but also "hot money" that is, speculative capital flows from one country to another, on housing prices in China during the period from 2001 to 2016. Movement in and out of markets is rapid, potentially creating market instability. The study finds that M2 has a significant long-term effect on housing prices, and hot money affects housing prices in both the short and medium term.

Furthermore, Tsai (2013) investigate whether the downward price rigidity result in an asymmetric relationship between housing prices and monetary policy. The study utilizes data from the UK housing market between 1986Q3 and 2011Q4 and replaces M2 with M1 as a proxy variable. The results suggest that housing prices are adjusted asymmetrically to changes in the money supply. Specifically, when monetary policy is loose, housing prices tend to increase, and the modification behavior is evident. In contrast, housing prices do not reflect the same adjustment behavior to tight monetary policy. In other words, housing prices have a tendency to overact in an upturn and, conversely, underreact in a downturn. Zhao et al. (2022) conduct a similar study using data from 2006 to 2021 in China’s housing market using M2 as a proxy for money supply. Evidence shows that monetary supply is asymmetric in both the short and long term.

2.5 Inflation

The determination for inflation lies in a general price increase of goods and services, which consequently affects the value of money and reduces the purchasing power. There are three ways in which inflation occurs. First, prices are forced to increase when the demand for products or services exceeds the supply. As for cost-push inflation, the rise of cost side increases prices. Furthermore, built-in inflation is a consequence of already raised living costs occurring workers to demand higher wages. A traditional utterance states that real estate is a decent inflation hedge because the increase in the value of home prices typically follows inflation. Also, in the case of real estate investing, rents tend to follow inflation as rent contracts usually enables index increments. Several studies (e.g., Tang and Qian, 2018; Frassa and Mésonnier, 2010; Anari and Kolari, 2022) state that inflation is a functioning hedge against inflation, particularly in the long run, and a key driver of house prices. Nonetheless, broader literature has presented mixed findings on the matter.

The inflation target set by central banks is 2 percent over the longer run. Frappa and Mésonnier (2010) study whether the choice of the inflation targeting strategy is correlated with house price booms. The sample comprises 17 developed economies in OECD countries from 1980 to 2007. According to the results, the adoption of inflation targeting has a positive and significant effect on real house price growth and besides, the price-to-rent ratio. In another study, Fortuna and Kusher (1986) examine intercity house price differentials in Canada and focus on anticipated inflation. Their findings suggest that higher anticipated inflation leads to higher house prices due to increased demand for real assets like housing during inflationary periods.

Further, the effect of inflation does not appear similarly cross-sectionally. For instance, Shiller (2007) and Vincent and Morley (2015) state that the effect of inflation is pronounced in cities where land availability is more limited. Moreover, Hoesli and Hamelink (1997) study the short-run hedge of houses between 1981 and 1992 in Switzerland. They include two cities, namely Zürich and Geneva. The findings of Hoesli

and yield mixed results, with Zurich showing a negative correlation between housing prices and inflation, while Geneva exhibiting a positive correlation. Hence, they suggest that houses are not necessarily a better inflation hedge than other assets.

Furthermore, the most recent studies have not provided a robust correlation between housing prices and inflation. Tang and Qian (2018) studied twenty-nine Chinese cities from 2003 to 2013 with an Autoregressive Distributive Lag (ARDL) model and bounds test. The results are robust for different types of inflation and support the view that there is no long-run cointegration between housing prices and inflation. Additionally, Hoesli et al. (2007) provide quantile findings, suggesting that real estate provides some hedging ability when the inflation rate is low. Nevertheless, when inflation is high, the effect disappears. Moreover, Kuosmanen and Vataja (2002) find a positive correlation between the inflation rate and housing prices in the Finnish market, although the coefficient is statistically insignificant. Additionally, the authors emphasize that house price changes are included in indices that measure inflation as such. Thus, a positive coefficient is assumed.

On the contrary, the findings of Manchester (1987) support the view that inflation has a negative effect on house prices through nominal interest rates. Furthermore, according to several studies, money illusion plays its part in housing prices (e.g., Shafir et al., 1997; Brunnermeier and Julliard, 2008; Tsai, 2020). The money illusion refers to a situation where consumers tend to value their wealth and income at a nominal rate rather than in inflation-adjusted real value. Also, house buyers fail to acknowledge that inflation lowers the real value of debt. Hence home buyers are willing to take larger loans in periods of low inflation and low nominal interest rates. Correspondingly, the loan counter calms down when inflation and nominal interest rates are high. In conclusion, buyers tend to value low nominal mortgage costs. (Shafir et al., 1997). Also, Brunnermeier and Julliard (2008) have a money illusion approach in the hypothesis, and findings support the effect. Decreases in inflation may increase housing prices due to buyers' rising demand during low inflation. The reason lies in mortgages that have lower

nominal terms. Later, Nourrair et al. (2012) too, examine money illusion in experimental asset markets. In laboratory conditions, asset markets are exposed to an exogenous shock that affects the nominal fundamental value but holds the real fundamental value constant. The results suggest that there is an asymmetry, indicating that nominal prices adjust quickly in response to an inflationary shock but do not have a real effect. Conversely, after a deflationary shock, nominal prices exhibit significant inertia, and real prices gradually move back to a level similar to before the shock.

Eventually, Christou (2018) states that the empirical relationship between inflation and house prices should be tested regularly based on updated data. The nature of the housing market is dynamic and has undergone a transformation post the financial crisis. Therefore, cointegration can be expected to vary.

2.6 Uncertainty index

The uncertainty index refers to Economic Policy Uncertainty (EPU) index designed to measure policy-related economic uncertainty, created by SR Baker, N Bloom, and SJ Davis in 2012. The index is based on newspaper coverage frequency. (Baker, S. R., Bloom, N., & Davis, S. J., 2016). Due to the negative effect of uncertainty on consumer confidence, it can also be assumed that index fluctuations impact housing prices. Moreover, there are several possible causalities. For instance, high uncertainty may cause lenders to raise mortgage rates so that increased risk is priced in the mortgages as danger money. Further, higher mortgage rates may result in reduced demand and lower house prices. Also, credit availability can be tightened, leading to the same result.

Nevertheless, causalities are usually intricated. Since its publication, EPU has been a famous topic in academic research, especially in financial market-related studies. However, not all studies find it as the most relevant indicator. Dutta et al. (2021) studied the influence of news-based volatility trackers (EMV) on oil volatility. The study also compared the EMV trackers to other indexes, including VIX, EPU, and geopolitical risk (GPR) indexes. The findings indicate that the EMV trackers have more accurate

forecasting ability. On the contrary, the number of studies related to the real estate sector is very limited, but the existing ones find explanatory power and correlations.

Antonakakis et al. (2015) examined the relationship between EPU and housing market returns using data from January 1987 to November 2014, with house prices and EPU as the primary variables. The results show a negative correlation between the two variables throughout the study period, and the correlations are time-dependent and increase sharply during times of high economic uncertainty. Consequently, the real estate sector possesses a significant tail risk. The spillover effect of housing on the broader economy and the relationship between real housing returns and EPU is also noted by researchers. Additionally, the study controls for macroeconomic variables. Although Antonakakis et al. (2015) examine the U.S. market, Choudhry (2020) focuses on ten regions in England and Wales with quarterly data from 1975Q1 to 2017Q4, using the ARDL approach. The results show significant negative cointegration between house prices and EPU, among other variables, in nine out of the ten regions. Moreover, the relationship is negative, particularly in the long run, while the short term has a positive effect with sample evidence. Although, there is variations between the regions that indicate that aggregated data for countries may not give accurate results, and regions must be considered separately.

Meanwhile, Antonakakis et al. (2015) and Choudhry (2020) studied specific countries, Balcilar et al. (2021) examine 16 countries over the period 2004-2018 with the Granger causality test and panel vector autoregressive approach. Likewise Choudhry (2020) acknowledges the region's dissimilarities, Balcilar et al. (2021) recognize that the country-specific approach must be considered. Further, results imply that EPU strongly predicts real housing prices. The positive shock on EPU will likely lead to a decrease in housing prices, while the vice-versa effect shows only a weak response. Finally, Balcilar et al. (2021) note that EPU is well independent of housing prices, interest rates, and other observables. This indicates rather a direct link of EPU to housing prices than indirect through the other variables.

Su et al. (2019) obtained different findings in their study on Germany, which spanned from January 2005 to December 2018 and used Granger causality tests and GARCH. The takeaway that Su et al. want to state is that “economic policy” should be considered more than “uncertainty”. This is because “statistical mean based” methods do not capture clear policy direction and macroeconomic policy objectives. Moreover, the housing market itself is adequate to cause economic policy changes. Also, similarly to Antonakakis et al. (2015), the effects of mortgage interest rates are controlled.

2.7 Summary of macroeconomy factors

To sum up, there appears to be a strong correlation between macroeconomic factors and housing prices, although there may be some differences across countries and regions. It should also be noted that not all factors have an equally significant impact, and there is a lack of consensus regarding the relationship between inflation and housing prices, with studies showing mixed results. Below is presented a summary of the factors.

Table 1. Summary of macroeconomy factors.

Macroeconomy factor	Concise description	The effect of a variable increase on housing prices
GDP	A significant correlation exists between GDP changes and dwellings development; however, results seem significant in the short term.	
Household income	A robust positive correlation between housing prices and household income.	
Interest rate	A negative correlation between interest rates and housing prices is detected. The correlation seems to be stronger in the long-term.	
Money supply	Increasing M2 positively impacts housing prices.	
Inflation	There is not as consistent a line to be drawn from the studies concerning inflation as from the other variables.	
Uncertainty index	EPU is a strong predictor and has a negative correlation to housing prices. However, regional differences should be considered.	

3 Housing markets from a Finnish perspective

The Finnish housing market has faced some major upturns and downturns. with notable periods including the oil crisis and financial market deregulation. Although the financial crisis did have an impact, it was relatively short-lived. Over the past decade, housing prices have increased in Finland, but prices have diverged regionally. The difference is highlighted in case the metropolitan area is separated from the rest of Finland. This chapter examines not only the historical context but also the current state of the Finnish housing market with a particular focus on Helsinki, which has emerged as a distinct outlier in terms of housing prices. Therefore, Helsinki will be deliberated separately. Moreover, this chapter also includes a housing company standpoint that is well unfamiliar to the rest of the world.

3.1 The history of Finnish housing markets

The Finnish housing market has performed similarly to comparable countries, with real dwelling prices experiencing almost continuous growth from 1960 to 1974. In early 1970, the population of Finland proliferated, causing an increased demand for housing. As a result, house prices ascended exceptionally. Additionally, construction firms recognized the demand and housing construction grew to 70 000 dwellings per year. After the gaily start of 1970, the first oil crisis also touched Finland's economy and induced an extended downturn in real housing prices that sank over a quarter. However, it should be noted that the nominal prices did not fall but real prices because of the high inflation. Turnover took place in 1979, and prices stated to rise again. (Laakso, 2020).

Further to the late 1980s, the Finnish housing market faced a steep increase emerging into a bubble in 1987-1989. The real prices significantly pushed up over 60 %, and nominal prices up to 74 %. The aftermath of the bubble resulted in a near four-year price decline (Kivistö, 2012; Laakso, 2020). Despite this, it is worth noting that the actual role of the housing price bubble was relatively minor (Laakso, 2020). One offered explanatory factor for the bubble has been the deregulated financial markets and a

generally overheated economy. After the deregulation, down payments were reduced, and mortgages' availability increased. Simultaneously, financial systems supervision did not keep up, eventually leading to the housing market boom (Honkapohja, 2009). Furthermore, financial deregulation changed the impact of real interest on dwellings prices according to Oikarinen (2005). In the paper, he used data from 1975 to 2005 in Helsinki Metropolitan Area (HMA). In the longer term, the negative impact of an increase in the real mortgage rate of one percent on the house price level is around 4,6 percent. Moreover, also the United Kingdom liberalized its mortgage markets in the early 1980s. There were similar results than in Finland since real interest rates and the expectation of income growth had notably more influence on housing prices after the liberalization, according to Muellbauer and Murphy (1997).

In the late 1980s, several other industrialized countries, for instance, Sweden, liberalized the financial markets. Jaffee (1994) analyzed the crisis in the Swedish housing market, where prices had overheated from 1985 to 1990 before collapsing between 1991 and 1993. Similarly to Finland, one of the main explanations for the crisis was the liberalization of financial markets.

In Finland, deregulation of the financial market occurred gradually, beginning in 1986. Obtaining household mortgages became much easier, particularly for middle-class households. Although real interest rates increased in the early 1980s, they were still negative in 1985, and between 1987 and 1989, rates yet decreased. Furthermore, the tax deduction right of interest was still in effect. As a result, the change manifested as a dramatic increase in mortgage loans, which in turn fueled the rise of housing prices. (Laakso, 2020). The 90’s recession will be discussed more profoundly in the section 4.1.

Further to the late 1990s, housing prices began to experience a more consistent and long-lasting increase. At that time, Finland joined the European Union, and inflation declined. From then on, house prices grew severely until the financial crisis, including a short downturn in 2001 due to the I.T. bubble. The sub-prime crisis submerged prices

down. However, the downturn lasted also for under a year. Thereafter, housing prices reached the pre-crisis level already in 2011. (Kivistö, 2012). The rise has been relatively stable for the past ten years, yet, starting to differ regionally, with Helsinki as a spearhead.

Following the financial crisis, housing prices increased in also growth centers outside of major urban areas. However, after 2010 prices started to decline again, with differences in prices becoming increasingly apparent. The growing share of the population in urban areas has had a positive impact on housing prices. Also, employment possibilities improved, and interest rates were down. Additionally, despite high demand, the rate of housing supply did not increase enough to meet it. Measured by real prices, Helsinki, Tampere, and Turku started to differ. Towards the end of the decade, there was an increasing disparity between booming towns and other areas, with real estate prices being below the levels seen in autumn 2010 in most parts of the country. Moreover, the number of rooms was another contributing factor to the diverging prices. Smaller dwellings have been more desired. (Putkuri, 2020).

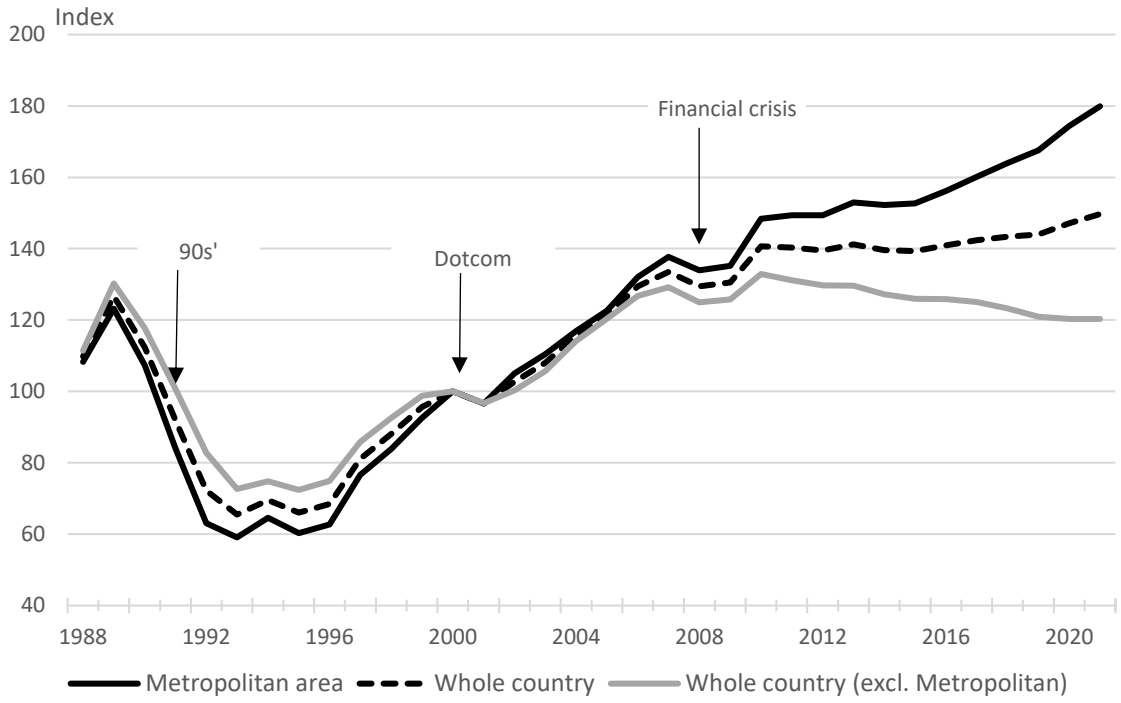

Figure 2. Price development of old blocks of flats in Finland 1988-2021, real index 2000=100. (Official Statistic of Finland, 2023c).

The development described above is illustrated in the figure 2. The Statistics Finland provides data on house price indexes from 1988 and forward. Therefore, the proliferated population and oil crisis are not presented in the picture. Nevertheless, the figure indicates how tremendous the 90s recession was for housing prices. During the recession, housing prices began to diverge; however, as the economy recovered, price differentials leveled out somewhat. Nevertheless, during the financial crisis, the differences in prices became more pronounced. Since then, the disparities have continued to increase to unprecedented levels.

Eventually, the underlying reason for instability in the housing market is the short-term inflexibility of the housing supply. Thus, changes in demand often leads to significant price fluctuations, which, in turn, makes the construction sector very cyclical. Both the housing production and construction cost are a roller-coaster following up the house price development. Also, financial markets, and particularly interest rates and availability of mortgages, are essential in housing markets and their fluctuation (Laakso, 2020).

3.2 State of Finnish housing markets

For over a decade, house prices in growth centers have steadily climbed without any significant downturns, driven largely by urbanization and internal migration. Furthermore, the monetary policy has been unconventional. In response to the global financial crisis, the major central banks, including the ECB, lowered the policy rates. In doing so, ECB influenced the money supply, easing liquidity conditions. When policy rates were pushed to zero level bound, ECB also implemented other expansionary monetary policy measures such as large-scale asset purchases and forward guidance. The goal was to reduce long-term bond yields and interest rates, including those on housing loans.

Rosenberg (2020) studied the effect of unconventional monetary policy on housing prices in Finland by using a combination of zero and sign restrictions within the Bayesian SVAR framework. The results indicate that an expansionary policy rate shock has a positive impact on house prices, although a small impact. However, compared to other euro countries, the effect's peak arrives faster and is more persistent in Finland. Further, balance sheet policies on house prices also seem to have an effect, although very small. In the euro area overall, the findings are quite similar, and are also reported by Huber and Punzi (2020), and Rahal (2016).

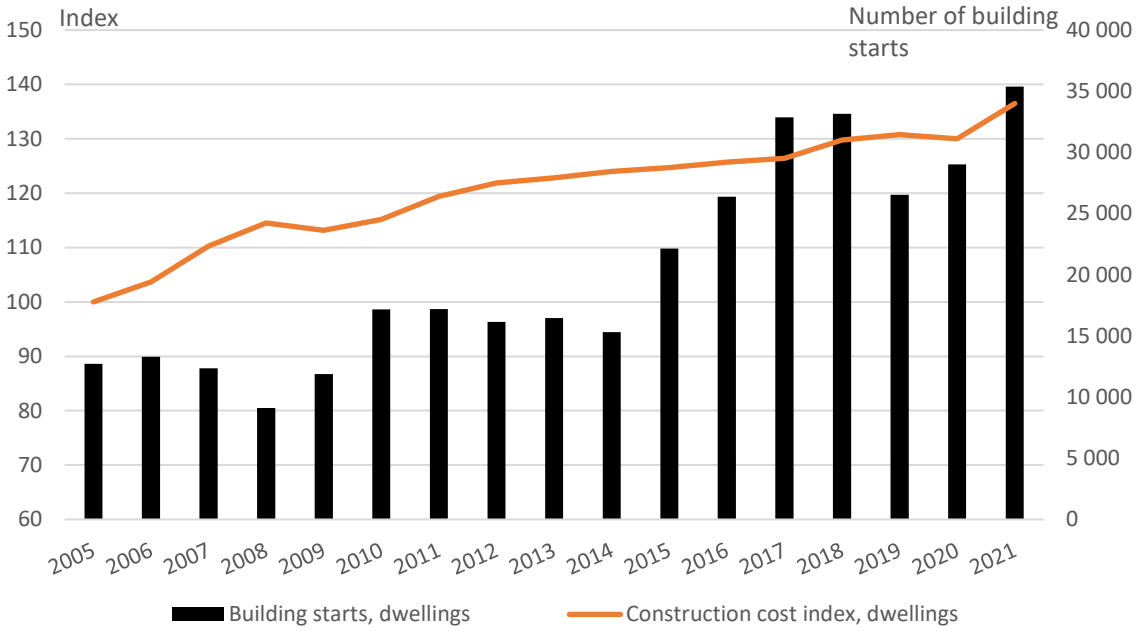

Figure 3. Dwellings building starts and construction cost in Finland 2005-2021, real index 2005=100 (Official Statistics of Finland, 2023e).

The construction industry has experienced a rapid decade, with building starts reaching a notably high level since 2015, as shown in Figure 3. Urbanization has required more houses in growth centres, and construction companies have responded to demand by accelerating construction production. Also, since the dwellings are mainly purchased with debt, it can be assumed that low-interest rates have also contributed to demand, and thus construction companies have dared to start new projects.

The number of starts of a new block of flats and their impact on older surrounding dwellings has been studied by Kurvinen and Vilhola (2016). They used housing sales transaction data from 1999 to 2014, including apartment units built in the 1960s and 1970s. Paper detected a positive 2,3-2,6 % price effect on apartments within a 300-meter radius. Likewise, Herbert and Gibler (2014) studied the effect of new residential construction on housing prices in Louisiana, U.S., with housing transactions completed between October, 1984 and April, 2005. The study analyzed dwellings of various sizes and found that constructing average-sized houses had a minimal effect on existing prices. Conversely, constructing larger-than-average houses had a more pronounced positive

impact, especially in regions where homes are sold at relatively lower prices and the new construction is situated within a 250-meter radius. However, it is important to acknowledge that the housing market is highly localized, with each region having its unique characteristics. Hence, drawing conclusions based solely on existing literature is inadequate, and recent research studies from the Helsinki area are necessary.

However, as of the of writing, the extremely rapid rise in interest rates is driving the debt-driven construction industry into a tightening position. On the contrary, Hypo, a credit institution specializing in housing and housing financing, predicts that construction is not likely to collapse but will inevitably decrease. Conversely, this affects the housing prices elevating with a delay (Hypo, 2022). Additionally, Musarat et al. (2021) examined how inflation, which is closely linked to interest rates and is currently high, affects the construction project budget. According to researchers, inflation is often overlooked, which can result in cost overruns for construction projects due to annual changes in building material prices, labor wages, and machinery rental rates. In February, when Russia attacked Ukraine, Finland's inflation rate was 4,5%. Since then, the consumer price index has continued to rise. Therefore, as stated in Musarat et al.'s (2021) paper, anticipating challenges for construction sites is justified.

Furthermore, figure 3 shows how construction costs have developed. From 2005 to 2021 average annual growth rate (AAGR) has been 1,98 %, which is fairly reasonable and in line with the ECBs' goal. The reason is primarily the moderate inflation over the 2010 decade. All in all, it is essential to follow also the construction cost because it is one of the most critical factors in determining house prices, as Mansur et al. (2016) state.

3.3 Helsinki as a crowd-puller

Before the 90s recession of the 1990s, the Finnish housing market had developed in a relatively parallel territorially. Towards the end of the 80s, however, population growth accelerated in the Helsinki region due to migration, driven by increased employment and

income growth. Moreover, particularly after the recession, development has started to disperse regionally. (Laakso, 2020).

When examining closer on the regional differences, Helsinki stands out, as illustrated in the figure 2. Also, the number of sales in the figure 4, represents how the metropolitan area, particularly Helsinki dominates the housing market. Over the years, Helsinki has accounted for more than one-fifth of the total number of sales, specifically ranging from 21.4% to 23.9%, while the entire metropolitan area makes up a much larger proportion, ranging from 46,1% to 54,5%.

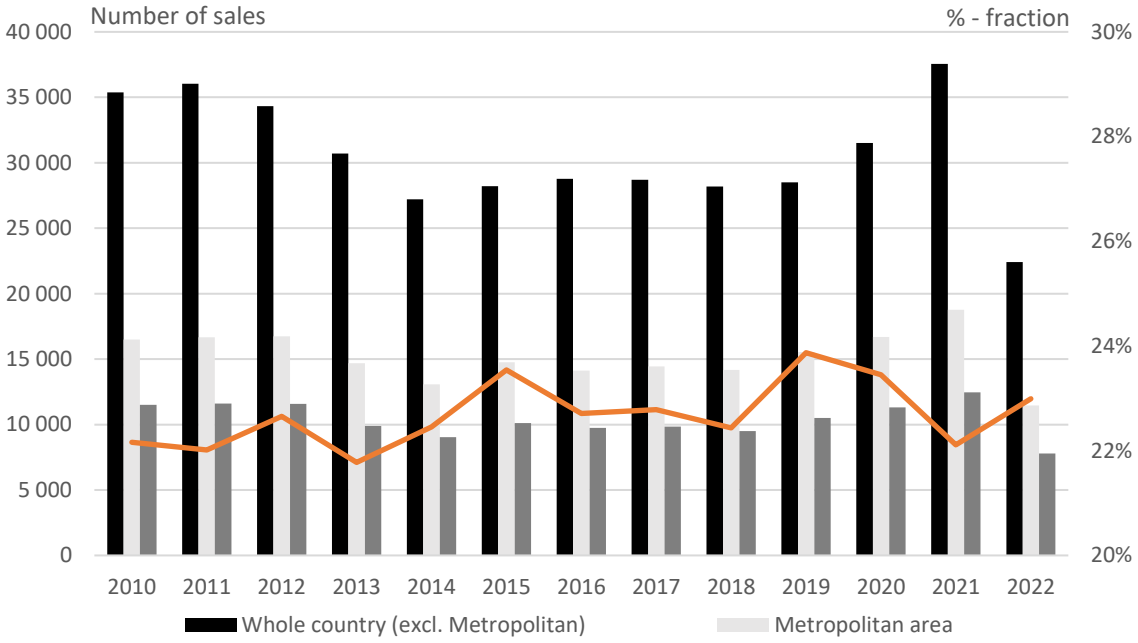

Figure 4. A number of dwellings sales, and percentage portion of Helsinki 2010-2022. The numbers for 2022 are preliminary data, and Q4 data is lacking. (Official Statistics of Finland, 2023f).

To comprehend the root causes of above illustrated distribution of sales, it is crucial to examine and comprehend demographic factors. Furthermore, given the high population growth depicted in Figure 5, it is reasonable to assume that it also influences housing price developments.

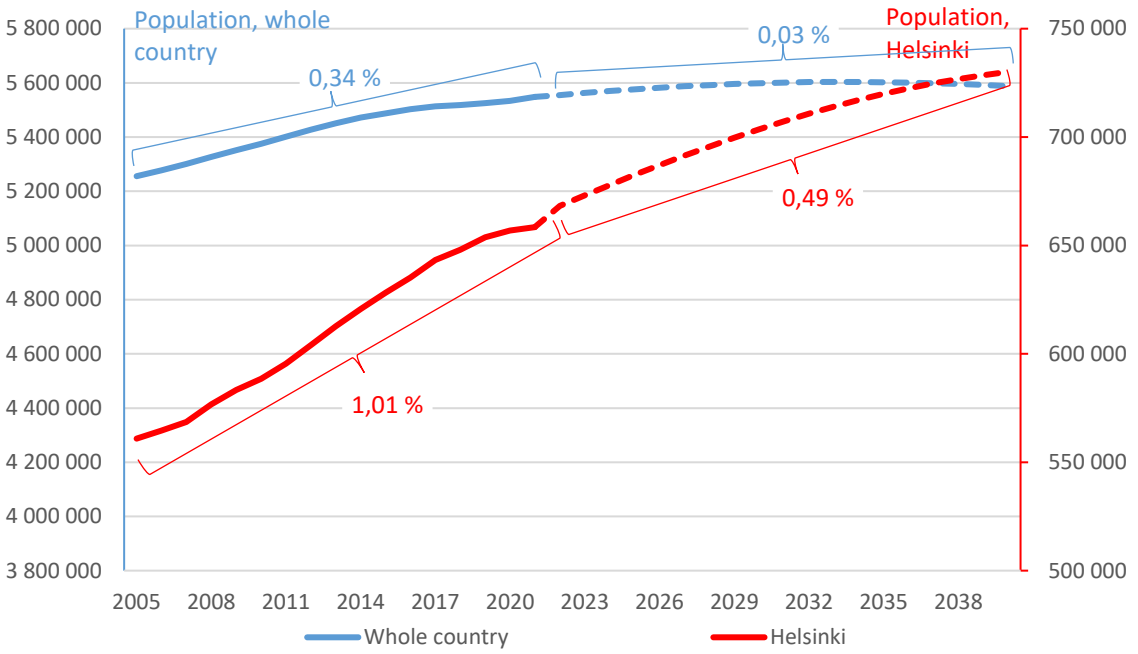

Figure 5. Population trends of whole country and Helsinki from 2005 to 2021. Population projection from 2022 to 2040. AAGR is presented as percentages. Axes are in proportion with each other. (Official Statistics of Finland, 2023g; Official Statistics of Finland, 2023h).

Figure 5 illustrates how population growth has been significantly more substantial in Helsinki than in the whole country from 2005 to 2021. While the entire country experienced an annualized growth rate of 0,34% per year, Helsinki recorded a growth rate of 1,01%, accounting for one-third of Finland's overall growth. As for population projections, the difference between Helsinki and the rest of Finland is only increasing. The estimated increase for the entire country between 2022 and 2040 is around 33,000, whereas Helsinki is expected to grow almost twice as much, at approximately 61 800. Furthermore, if Helsinki is excluded, the rest of the country is projected to experience a negative growth of approximately 28 800.

In conclusion, population growth has created a clear demand for houses in Helsinki. The construction industry has tried to meet the demand, and dwellings completions have been over 4000 every year since 2011. Additionally, in 2020 and 2021, the number was over 7000. (Bayar, 2021). For instance, in 2021 Helsinki was responsible for 19,1 % of all

the dwellings completions in Finland. In the first place, population projection indicates that the trend is likely to continue even more substantially. Thus, it is evident that a substantial amount of new construction is necessary to maintain prices at a somehow affordable level.

Furthermore, even though there has clearly been a demand for housing in Helsinki, the continued price advance in Helsinki has persisted for nearly a decade longer than macroeconomic reasons justify, according to Holappa et al. (2015). The Authorities have tightened their recommendations for self-financing of the mortgages, which again have raised the financial requirements too high for several households. Especially in the metropolitan area, down payments are steep (Lahtinen et al., 2014). However, the demand has been taken by housing investors. Since rental houses have had strong demand, investors have ventured to hold up the new-production activity of blocks of flats. Additionally, foreign investors have increased their portion, and at the end of 2019, they held approximately 15 000 rental apartments. (KTI, 2019). Besides the private investors, major institutional investors such as pension funds have also been active players. Traditionally, pension funds have secured their pension income with government debt securities. However, because of the offered low yields, interest has moved towards housing investments that offer stable returns together with a low price of money. (Holappa et al., 2015).

Farther on, construction costs are among the main variables when considering the schedule and pricing of new construction. An increase in construction costs has an average long-term impact of 0.6% on house prices by reducing housing supply, which leads to an increase in rents and thus increases house prices according to Adam and Fuss (2010). Therefore, while examining the supply and demand in the housing market, particularly the future predictions, construction costs must also be considered.

3.4 Housing company as a Finnish distinctive feature

The Finnish housing market has a unique characteristic that appears only in a few places in the global housing market or housing companies. In Finland, it refers to a particular form of a limited company to administer the residential building owned by parties with interest, that is, apartment owners, to ensure that the housing company's rules and regulations are followed according to its act and articles of association. In practice, shareholders vote for a board that oversees the maintenance, repairs, and finances. However, depart from profit-seeking purposes, a housing company aims to minimize taxable profit. (Heinonen, 2020).

An interesting factor about housing companies is a housing company loan. It can be raised when the housing company must finance a large renovation such as plumbing replacement. In addition, housing company loans are particularly used for financing new construction (Alho et al., 2018). In that event, the buyer pays abbreviations and interest as a financial consideration for the housing company that again amortizes a loan for the commercial banks. The financial consideration can be entered as income or reserved for funds. If accounting treatment is to enter as income, there is a right to deduct the financial consideration in taxation from the rental income. Thus, the accounting treatment has no role for the owner-occupier but for an investor. (Heinonen, 2020).

Considering if the housing company loan and accounting treatment of financial consideration affect housing prices is justified. In the case of new constructions, the lower selling price of a share of stock in a housing company might encourage more buyers because of the lower down payment. Consequently, with more buyers able to afford houses, it can be expected that prices will rise due to higher demand. The same applies to the favorable accounting treatment of financial consideration because it presumably attracts more investors. On the other hand, when interest rates face a steep rise, it also raises the question of whether there is downward pressure on housing prices. Due to housing company loans, households and investors probably has more debt, thus,

the interest rate risk is more substantial. However, the housing company, particularly the housing company loan, lacks exploration and remains unfamiliar in academic literature.

4 Literature review from historical crisis

The father of American literature, Mark Twain, said, "History never repeats itself, but it does often rhyme.". Therefore, being familiar with history is important. The previous paragraph describes Finland's housing market history in general terms, this section delves into crises in more depth, including also other countries than Finland. The development and crisis in the housing market have had a crucial connection to the economy overall. Therefore, examining past crises and learning about their impact is essential. In order to capture the historical effects, this chapter discusses housing prices and the four last significant economic crises. As one might expect, the financial crisis and its causes and consequences have attracted scientists the most. This chapter highlights financial crisis weight, too.

The nature of the world economy has moved towards becoming even more globally networked, even though the recent development has raised a question of whether production should be closer, and supply chains re-considered. Nonetheless, the local crisis has a high probability of spreading even wider. Because the economy is connected virtually everything, the root causes of the crisis might be well various. However, according to According to Agnello and Schuknecht (2011), an economic crisis is often primarily caused by monetary and fiscal policy. As the expansion affects the entire economy through banks, the downturn is likely to begin as a vicious cycle, with a decrease in consumption, a rise in unemployment, and a fall in stock prices. Additionally, the crisis may also be triggered by shocks in supply and demand, such as the ongoing consequences of the Russian invasion of Ukraine.

4.1 90's recession

In the '90s, the global economy was not as connected as in the 21st century. Similarly, the 90's recession did not touch the entire world but the Nordic countries, mainly Finland. The real GDP was reduced by 11 percent from 1991 to 1993, and the unemployment rate

increased from three percent in 1990 to 16 percent in 1993. Moreover, the housing market played a crucial role in overheating and subsequent depression. (Laakso, 2000). The center stage of overheating in the late 80s was the rise of housing prices, which was grounds for the liberalization of financial markets. Because of liberalization, the availability of mortgages increased significantly. The economic cycle of the time and simultaneously removing credit regulation increased the mortgages explosively. No restrictive factors were adopted to crown it all, such as cutting the right to deduct the interest. All this led to rapidly soaring housing prices. Liberalizing financial markets is a considerably faster move than increasing the housing supply. So, the supply was without resource behind. (Laakso, 2000).

Additionally, firms raised a significant amount of foreign currency credit being exposed to the risk of devaluation of the mark. The collapse of the Soviet Union, which had a significant impact on the export industry, as well as the artificial valuation of the mark, are among other explanations presented. As a result, devaluation of the mark was employed as an economic policy instrument to boost exports by enhancing domestic competitiveness, but it also had an unintended consequence of worsening the financial distress of Finnish households who had taken out foreign currency credits. (Kiander, 2001).

Ultimately, the combination of uncertainty and rising interest rates dashed expectations, causing weakening demand and lower asset prices. Stock prices fell, and housing sale times lengthened. Furthermore, the housing market often faced the following factors. The construction produced a significant number of dwellings in an overheated market. So, after a rise in interest rates, the supply exceeded demand, and an overabundance of dwellings arose. The increasing number of empty dwellings increased ever-falling prices. Later, the productional slump drove the unemployment rate up, simultaneously lowering the income level. The harmful vicious circle then enhanced to put money aside, lowering consumption. Eventually, after a steep real rise of 60 percent from 1987 to 1989, real housing prices collapsed more than 60 percent during 1990 and 1993. The largest fall

happened in Helsinki. Prices started to rise in real terms first in 1996. (Kiander, 2001; Official Statistics of Finland, 2020i).

4.2 Dotcom bubble

The dotcom bubble resulted from the accelerating investments from the mid-90s to technology and related innovations. Likewise, the bubble is mainly related to firms focusing on technology and generally to the stock market. Also, to some extent, the bubble touched the housing markets. Although in Finland, housing prices experienced only a slight decrease, as shown in Figure 2.

The universal academic literature related to the dotcom bubble and housing prices remains relatively poor, signaling that significant relation between these variables is not captured. In addition, papers often include the beginning of the early 2000s to investigations on the financial crisis. Moreover, the statistics prove the dotcom bubble's remote effect on housing prices, albeit a small change is noticeable.

An alternative explanation for the housing price drop might lie in changing the housing market structure. Particularly areas where the technology sector played a crucial role possibly experienced a change in housing structure because of changing employment structure and related economic problems.

Even though the dotcom crisis is not as studied as the financial crisis afterward so, during the early 2000s, papers tried to capture the possible housing bubble. Case and Shiller (2003) studied the U.S. with data period from the 1980s to the early 2000s. In addition, they conducted surveys for recent homebuyers in 1988, 1999, and 2002. Combining quantitative and qualitative methods renders a comprehensive picture of the housing market. In the findings, the authors identify that it is difficult to confirm or deny the presence of a housing bubble, although some aspects raise concerns. For instance, a proportion of home buyers and sellers had overly optimistic expectations against future appreciation, making the surge somewhat unstable. Similarly to Case and Shiller,

Himmelberg et al. (2005) do not provide explanation whether a housing bubble exists during the dotcom bubble but explain how to assess whether there is a bubble and on the other hand, which are the underlying factors for supporting housing demand. The authors conclude that economic fundamentals primarily drove house prices during the early 2000s, and a price decline would follow rather after an unexpected rise in real interest rates or a negative shock to the local economy. Moreover, house price dynamics seem to be a local phenomenon according to Himmelberg et al. (2005).

Finally, the fundamental reasons behind the dotcom bubble were different from crises like the '90s recession or financial crisis. Basco (2014) states that the financial crisis resulted from banks' activities and the dotcom bubble from households' activities. Further, Basco (2014) shows that house prices rise along globalization only if the bubble is attached to houses.

4.3 Financial crisis

The financial crisis is the most investigated housing market crisis in the academic literature, and the underlying causes of the crisis are typically attributed to the credit boom and housing bubble. According to Acharya and Richardson (2009), in the U.S., where the housing crisis primarily occurred, house prices grew at an unprecedented rate of 11 percent per year from 2002 to 2007. Simultaneously, the debt to national income ratio grew to 26,7 %. Prior to that, it took an entire decade to reach a similar kind of increase in debt. Nevertheless, the financial crisis was mainly caused by large, complex financial institutions (Acharya and Richardson, 2009). Therefore, also the consequences exceeded the former dotcom crisis. For instance, besides the individuals, also creditworthy institutions faced a reduced supply of capital.

The financial crisis was not just a housing bubble concerning the housing sector but extended to a global financial crisis. For the most part, the reason lies in two methods concerning how banks had evaded the regulatory capital requirements. First, banks hold temporarily placed assets in off-balance-sheet entities to avoid significant capital buffer

requirements. Normally, the purpose of the bank's business model of securitization is to transfer the credit risk to other investors to spread risk. However, between 2003 and 2007, securitization aimed to circumvent capital-adequacy regulations. So, the purpose was not the share risk but to keep risk concentrated in the financial institutions and even on an expanded level due to over-indebtedness by off-balance sheet entities. (Acharya and Richardson, 2009).

Secondly, banks not only increased their off-balance debt but also decreased the amount of capital reserved for the assets that remained on their balance sheets, which was made possible by capital regulations. However, this method was utilized only on AAA-rated asset tranches of securitized mortgages. (Acharya and Richardson, 2009).

So, aiming to decrease capital requirements against loans to multiply the ability to make loans on both on and off-balance sheets, banks repacked the mortgages into mortgage-backed securities. The major consequence of this illegal arbitrage was the concentration of mortgage defaults. On the contrary, the risk would occur only if a large number of mortgages defaulted simultaneously, which, however, would need a systemic shoch that affects all the markets. Eventually, it happened, and the house of cards was ready to collapse. (Acharya and Richardson, 2009). The significant price escalation, reaching up to 50%, within a short period before the crisis was unprecedented. Likewise, the rapid price drop, amounting to 30%, following the housing market's collapse was also a phenomenon never witnessed before.

Brueckner et al. (2012) argue that the cause of house-price escalation cannot be solely attributed to the growth of subprime credit, but rather the growth of subprime credit was a consequence of bubble conditions. The researchers suggest that when there are positive price expectations, concerns about default tend to decrease, and lenders become more willing to lend to risky borrowers. This increase in demand for subprime lending also leads to an increase in demand for houses, which contributes to the formation of a housing bubble. According to the authors, price expectations play a crucial

role in lending, particularly in subprime lending. However, they also note that more research is necessary to strengthen these findings. (Brueckner et al., 2012).

All in all, the following takeaways serve as the main lessons learned from the financial crisis related to the housing market—first, the importance of prudent lending practices. The lenders must have stricter underwriting standards and assess borrowers' ability to repay loans. Related to that, consumer protection and financial literacy are crucial. Secondly, the housing market and overall real estate are the greatest asset class. Thus, systemic risk and macroprudential policies must be considered, and therefore, transparency and disclosure are to be developed. That helps investors and regulators to assess the risks better. Also, when government intervention and support is well targeted and timed, it is essential to stabilize the housing market and mitigate the impact on the overall economy. However, when drawing lessons learned, the housing market's heterogeneity and the bank's activities must be considered. For instance, lending practices in Finland have been more conservative and regulated than in the U.S. Therefore, it is well argued that similar action sequences in Finland are less likely to occur.

4.4 COVID-19 pandemic

Unlike previously handled crises, COVID-19 was not a consequence of particular monetary or fiscal decisions nor bank-driven but a pandemic that became a global health crisis. The economic impact was severe, causing job losses, supply chain disruptions, and business closures. Governments imposed travel restrictions and lockdowns. This particularly affected the tourism, hospitality, and retail industries. Simultaneously, central banks implemented several stimulus packages and still lowered interest rates. The economic impact was not similar around the world and different socioeconomic groups but quite an inequality. The real estate industry ascended from the pandemic as one of the beneficial parties mainly because of low-interest rates and stimulus packages. However, different types of houses, and different locations confronted different varied effects as Hu et al. (2021), Li and Zhang (2021), and D'Lima (2022) indicate.

The offset on studying the pandemic's effect on real estate's overall level was not the aim for Hu et al. (2021), but to capture the correlation between newly confirmed COVID-19 cases and housing returns in Australia. The results show a negative correlation. When newly confirmed cases double, returns fall by 0.35 basis points daily, or 1,26 % annualized. However, the sample period is relatively short, starting on January 1, 2020, and ending on July 30, 2020. (Hu et al., 2021). The swift changes in the housing market, combined with the lagged impact of the pandemic, make it difficult to draw definitive conclusions about pandemics effect on the real estate market. Nevertheless, the study provides evidence of its short-term impact.

At the very beginning of their study, Li and Zhang (2021) acknowledge that it is generally well-known that prices increased in the U.S. during the pandemic. However, the authors remark that studies aiming to understand the spatial patterns and the heterogeneous distribution of housing price changes are not conducted. While studying 2586 U.S. cities with Spatial Autocorrelation Analysis and utilizing Global Moran's I, the authors present two major findings. First, the housing price changes differed across metropolitan areas to rural areas, but also between metropolitans. Secondly, the hot spots for housing prices were typically affordable suburbs, while smaller cities or densely populated urban downtowns were less in demand. Li and Chang (2021) conclude that the real estate market during the pandemic was highly unpredictable, mainly due to factors such as remote working, irrational buying behavior, and millennial buying conjoined with the tense market. This conclusion is supported by the findings of a paper presented by Liu and Su (2021). D'Lima et al. (2022) corroborate these results and expand the study by examining the effects of size and structural density of properties, in addition to population density, on housing prices. The event study results show that in densely populated areas like downtowns, the average price of a three-bedroom property decreased by roughly 1.4%. At the same time, in low-density locations such as suburbs, where shutdowns occurred, it increased by around 1.5%. The impact was more dramatic for properties with fewer bedrooms. The authors conclude that findings suggest a collective change in preferences and behaviors. (D'Lima et al, 2022).

The primary impact of COVID-19 on the housing market seems to be the shift towards remote work, which has influenced the migration patterns from urban to suburban areas. This has also resulted in a desire for an additional room. in the context of Finland during the pandemic, households have accumulated savings due to reduced spending, which has provided potential home buyers with more resources for down payments and mortgage payments. Besides, interest rates were even lower, making mortgage loans attractive. Moreover, the resilience of the Finnish housing market may have encouraged home buyers. For instance, when comparing Denmark, Norway, Sweden, and Finland, the Finnish housing market remained relatively stable, particularly when compared to control countries in Nordics, as seen in Figure 6.

On the other hand, the steepest rise during COVID happened in Sweden. As pointed out by Asal (2019), this may be due to the country's relaxed lending standards. Although paying amortization of mortgages became mandatory in Sweden in 2016 if the loan exceeds 50 percent of the value of the dwelling. However, this is still quite distinct from Finland, where paying only interest is significantly less common. A rapid increase in prices often leads to concerns about a housing bubble, which refers to a situation where house prices surpass their fundamental values. According to Brunnermeier and Julliard (2008), this occurs because homebuyers strongly believe they can sell the property at an even higher price in the future. In short, the stability of the Finnish housing market may increase the confidence of homebuyers.

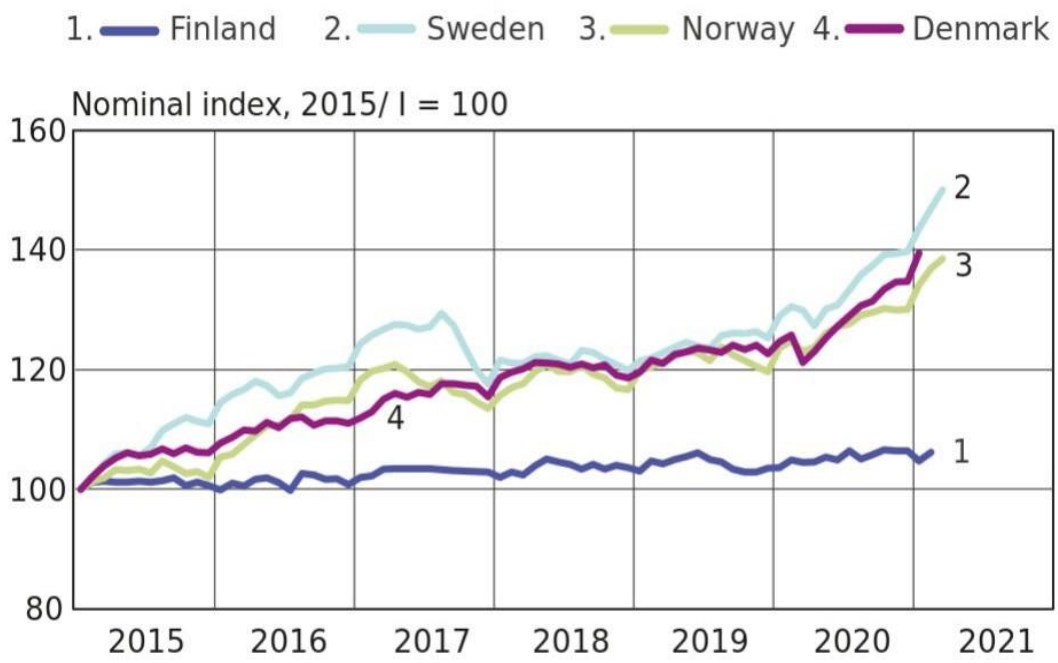

Figure 6. Price development in the Nordic housing market. (Bank of Finland, 2021c).

5 Data, variables, and methodology

5.1 Data

This section presents the data to be used for this study and how the data is gathered and formulated. Also, variable-specific scrutiny is conducted. The regression data consists of debt-free house sales price information and several macro-level time series. The definitions and source of variables are presented in Table 2.

The time series for explanatory variables range from monthly to quarterly, while the dependent variable is based on day-to-day observations. Data is gathered from January 2019 to December 2022. As macroeconomic data may come with lag, not all variables were yet available for January and February 2023 observations[3]. Thus, the empirical part is limited to the period from January 2019 to December 2022.

5.2 Variables

The selection of macroeconomic explanatory variables in this study is based on the approach taken by Kang and Liu (2014). However, there are some differences. Instead of utilizing the House Price Index, data from the Finnish Federation of Real Estate Agency (KVKL) is employed because it provides more accurate and real-time information. Additionally, the interest rate is changed to Euribor 12 months, which is clearly the most used reference rate in Finnish mortgages, according to the Bank of Finland (2023a). Also, the Economic Policy Uncertainty index is included due to the potential impact of uncertain economic policies and the uncertainty associated with events such as war. Besides, Previous studies show a correlation to house prices (e.g., Antonakakis et al., 2020), and Finnish house price studies lack empirical examination for the index in question.

[3] For a longer period would be available housing prices information, Euribor 12-months data, and inflation point figures.

5.2.1 Dwelling transaction data

The Finnish Federation of Real Estate Agency (KVKL) provides the dwelling transaction data, more accurately, KVKL Hintaseuranpalvelu. It is a private data pool intended to serve the real estate and construction companies. The data pool is created by gathering information on the reported transaction by Finnish real estate agents and contractors, and it covers transactions since 1999. The majority of transactions are covered; however, not all transactions are involved real estate agents, and thus, the data pool is not exhaustive. Furthermore, a logical examination of the data has revealed the presence of some human errors. This is due to the fact that the transaction data is entered manually. To address this issue, the data is subjected to the following measures for cleaning and verification.

To begin with, this paper only examines apartment buildings, hence small blocks of flats and maisonettes have been excluded from the housing type. As for municipalities, data also includes municipalities other than Helsinki, even though downloaded data should include only Helsinki transactions. Therefore, other than Helsinki is excluded. Additionally, some distinct errors are found when examining more specific features. All transactions smaller than 15 square metres in area are excluded as well as each transaction with over nine rooms, and transactions where the floor is reported to be under the 1st floor or on top of 33rd floor. Furthermore, during the examination of the price per square meter, distinct errors were detected when the price was reported to be 800 euros or less, or 15 000 euros or above.

Moreover, all new construction is excluded. The new construction and new dwellings differ from older dwellings. To avoid increasing heterogeneity, this paper focuses on dwellings constructed in 2021 at the latest. Likewise, Official Statistics of Finland separately report the prices and price indices for new dwellings and old dwellings. The Official Statistics of Finland defines a new dwelling as a dwelling that is completed in the statistical reference year or the year before it (Official Statistics of Finland, 2022j).

After these measures, the number of transactions decreased from 37 671 to 31 632. Furthermore, after data handling, a winsorization is conducted. It is a method where the effect of possibly spurious outliers is limited. However, since the methodology used in this paper is quantile regression, the aim is to capture the effects of different quantiles. Consequently, the existing outliers are examined carefully to understand if the outliers are human errors or actual transactions with correct debt-free prices and if enough transactions exist at extremely high and low prices. The examination exhibits that the most valuable transactions measured by price seem reasonable and have enough transactions. Respectively, the lowest transactions still include some errors. After examining the lowest percentile, the winsorization is performed by 0,2%. Thus, all transactions under 86 000 euros are converted to 86 000 euros. To sum up, the final distribution of debt-free prices of housing transactions is presented below in the figure 7.

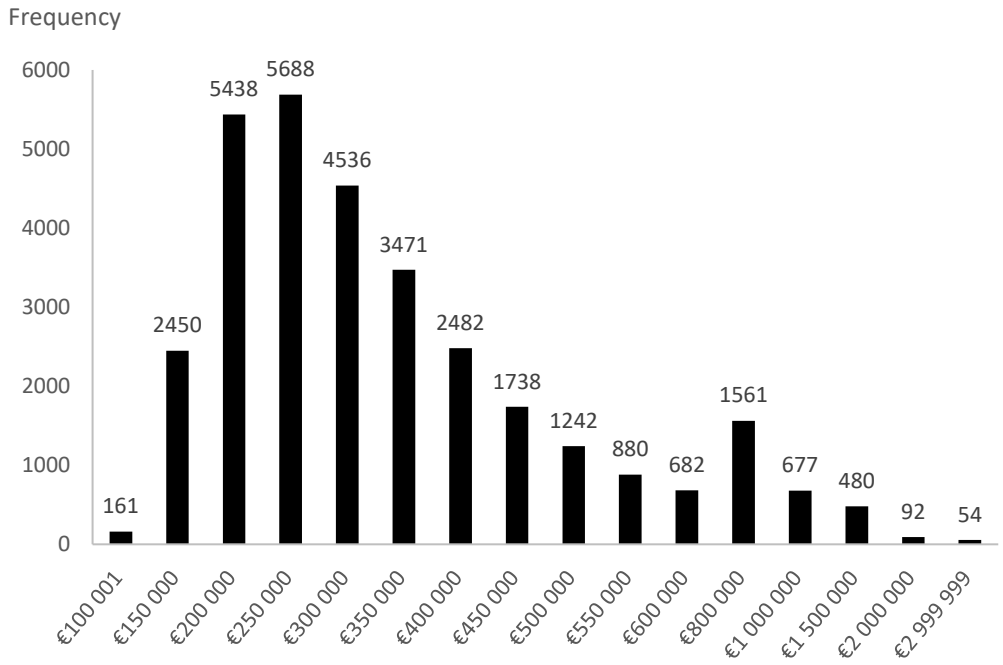

Figure 7. Distribution of debt-free prices of housing transactions.

The distribution indicates that most transactions, 49,5% more accurately, fall within range of 200 000 to 300 000 euros. Nevertheless, it must be noted that the data

concerning housing prices have problems, such as the heterogeneity of housing. Not two dwellings are precisely alike; that is the opposite to financial assets in general. Thus, exact information regarding the dwellings' market value does not exist. Several studies (e.g., Lamont and Stein, 1999; Harter-Dreiman, 2004; Himmelberg et al., 2005) apply quality-adjusted data to solve the heterogeneity challenge. However, according to Oikarinen (2007), quality-adjusted series are generally scarce and relatively short in nature. In addition to the heterogeneity of dwellings, the lack of transactions on particular types of dwellings leads to challenges in measuring price movements as frequently as other financial assets. (Oikarinen, 2007). Furthermore, price series data for dwellings are typically published quarterly, with a lag of several months. However, transaction data from KVKL has largely resolved this issue.

After all, it is reasonable to assume that the methods utilized in this research are sufficiently reliable to offer insights into the relationship between housing prices and macroeconomic variables in the Helsinki area. Below in the figure 8 is illustrated how housing transaction amounts developed both in monetary and measured by the number. The figure reveals a noticeable decline in both measurement methods following the invasion. When transaction amounts decline noticeably it further creates pressure to price decline. In the first place, it strengthens the assumption that 1 hypothesis might be confirmed.

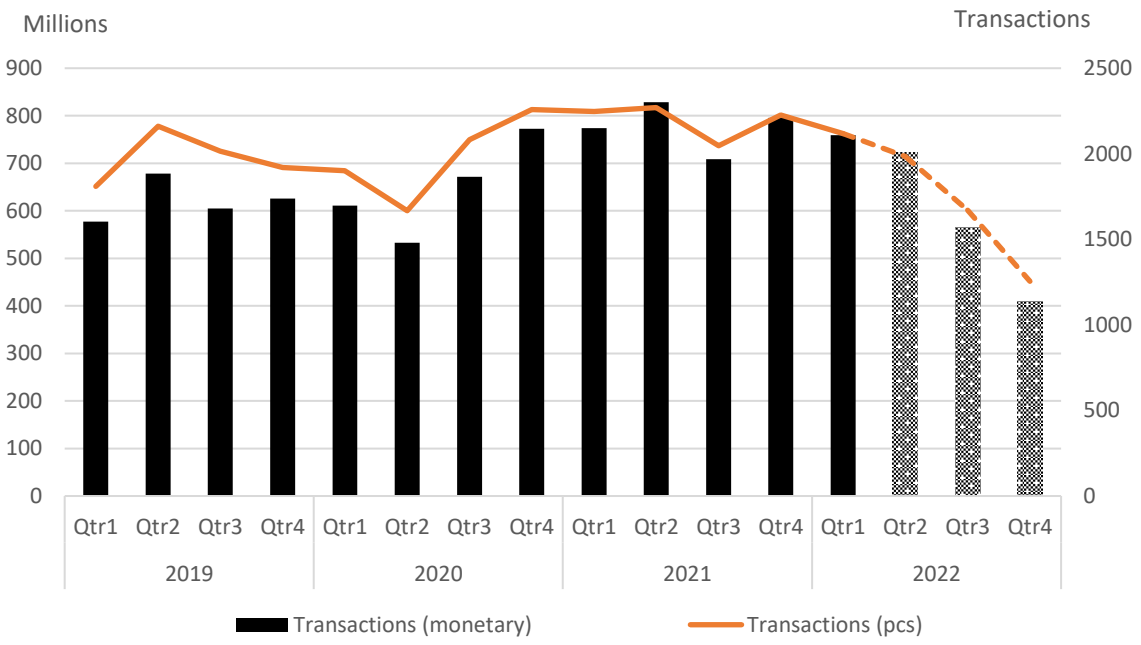

Figure 8. Housing transaction amounts in monetary and measured by the number during the data period. Pattern filled bars deviates the period after invasion.

5.2.2 Macroeconomic variables

As noted, his study follows the approach taken by Kang and Liu (2014), with the variables being mostly the same, except for a few presented exceptions. This chapter presents the variables used in regressions in more detail, while chapter two presents the variables extensively according to previous studies. So, based on the previous studies outlined above, this work includes the following macroeconomic variables as control variables: gross domestic product, household income, Euribor 12-months, money supply M2, inflation, and Economic Policy Uncertainty -index.

McGough et al. (2000) offer evidence of the connection between Helsinki's regional GDP and Finland's national GDP. Helsinki and the metropolitan area are the clear economic centre of Finland and compose over one-fifth of the Finnish population, producing 37 % of the national GDP, according to Urban Research (n.d). Consequently, national GDP data adequately represents Helsinki's economic growth, and it is justified to utilize national-level GDP data in this study. Additionally, addressed linkage and the economic

domination of Helsinki refer that other macroeconomic variables of this study adequately represent Helsinki's state and not only the national state. Furthermore, McGough et al. (2000) findings suggest that the GDP growth in Finland is a key variable for forecasting office property returns in Helsinki, although more in long run.

This study employs quarterly real GDP data from the OECD data pool. This GDP indicator measures growth rates compared to the previous year (OECD, 2023). However, the actual data is available only until the end of 2021 and 2022 values are forecasts and based on an assessment of the economic climate by utilizing a combination of model based-analyses and expert judgement.

Household income is measured as a real wage and salary earning, with the index values presented in 2015 prices. The index covers all sectors and employees. Similar to GDP, actual data is only available until the end of 2021. However, the 2022 values are preliminary data, rather than forecasts. The data is sourced from the Official Statistics of Finland. In more detail, the wage and salary earnings index consists of full-time employees in regular working hours. Deductions from average earning or employee's social security contributions have not been made. The preliminary data are based on the contractual impact and slide estimates. The data pool covers approximately two thirds of full-time employees in Finland[4]. (Official Statistics of Finland, 2017).

Figure 9 below illustrates both quarterly variables, GDP and household income. GDP experienced a significant decline following the quarter when COVID-19 was declared a global pandemic by WHO. However, an extreme increase is also noticeable in 2020Q3 due to the measurement method, which compares values to the previous year. Following the pandemic, both GDP and real income experienced a decline. As per prior research, a decrease in these variables is indicative of a drop in housing prices.

[4] More profoundly description is available in following address https://www.stat.fi/til/ati/kas.html

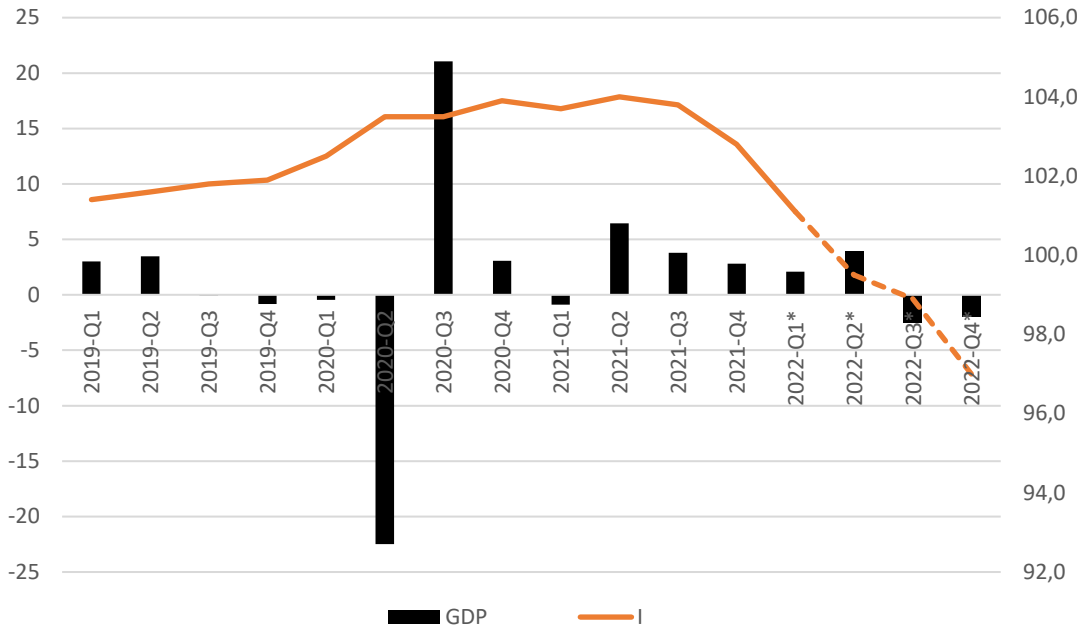

Figure 9. Finnish GDP and household income for the data period (2020 are preliminary data).

In the study by Kang and Liu (2014), prime lending rates were used. However, since Finnish mortgages are tied to Euribor rates, as previously demonstrated, substituting the prime lending rates to correspond to the appropriate interest rate of Euribor 12 months is justified. Euribor, an abbreviation for Euro Interbank Offered Rate, represents the average interest rates at which several European banks borrow funds from each other. There are five different Euribor rates ranging from 1 week to 12 months, and the duration indicates how long the interest rate will remain unchanged (Triami Media, 2023). The Euribor values used are the monthly reported interest rate, and the Bank of Finland publishes data, while the source is Thomson Reuters.

As money supply, the selected measure is the M2 emulating Kang and Liu (2014). Further, the money supply used in the paper is the Finnish contribution to euro area M2, and in more detail, M2 growth is reported in annual percentage change. Values are reported monthly and adjusted for seasonal and calendar effects. Bank of Finland publishes the data while the source is in addition to the Bank of Finland also the European Central Bank.

As depicted below in the figure 10, the M2 measure of money supply in Finland has been on an upward trend since the start of the COVID-19 pandemic and beyond. However, it started declining after the pandemic's peak, and in August 2022, the graph shows a more substantial decrease. Typically, M2 increases during a crisis period, such as COVID-19, but no similar signs are related to the invasion. Although the M2 growth rate indicates an increase in prices rather than a decrease, the 12-month Euribor rate surged after the invasion, and previous studies suggest a clear drop in housing prices.

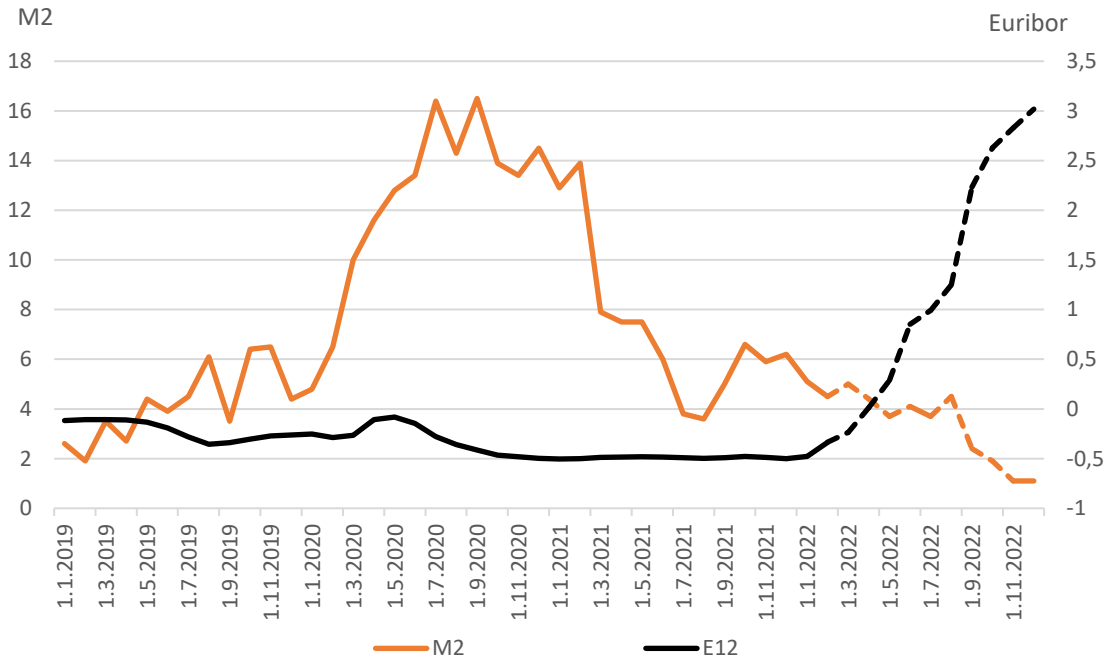

Figure 10. Finnish M2 growth rate (annual) and Euribor 12-month development during the data period.

Consumer Price Index (CPI) is a frequently used measure of inflation, and as in the study by Kang and Liu (2014), this study also employs this variable. The CPI is downloaded from the Official Statistics of Finland for this paper. It describes the development in the prices of products and services purchased by Finnish households covering all citizens in Finland. The CPI is exact and follows EU legislation. Furthermore, the CPI values are calculated by gathering 19 000 prices altogether on nearly 400 commodities from around 2 100 outlets.

(Official Statistics of Finland, 2023k). The utilized data is on a monthly frequency, reported as point figures, and the index values are presented in 2015 prices.

Economic Policy Uncertainty (EPU) is out of the scope of Kang and Liu (2014). Nevertheless, it is an interesting amendment to study, mainly because the war has brought about significant uncertainty. The EPU is based on the frequency of newspaper coverage, and the index value is proportional to the portion of own-country newspaper articles that debate economic policy uncertainty in the respective month. The EPU Index utilized in this paper is based on purchasing power parity (PPP) -adjusted GDP and addresses the global EPU Index consisting of 21 countries. Those countries account for 71 % of global output calculated on a PPP-adjusted basis. (Baker et al., 2016; Davis, 2016). The data pool is available in the official website of Economic Policy Uncertainty[5], and this paper uses monthly frequency.

Figure 11 below illustrates the development of CPI and EPU during the data period. From the beginning of the data period until the invasion, the annual growth rate is 2,5 % while after the invasion it is 7,7 %. Nevertheless, according to previous studies, academic literature on inflations impact on housing prices remains heterogeneous. Therefore, it is challenging to arrive at definitive conclusions. The same applies to EPU, even though academic literature shows evidence of a negative correlation. The figure depicts significant fluctuations in EPU, although the trendline shows a slight downward slope.

[5] https://www.policyuncertainty.com/global_monthly.html

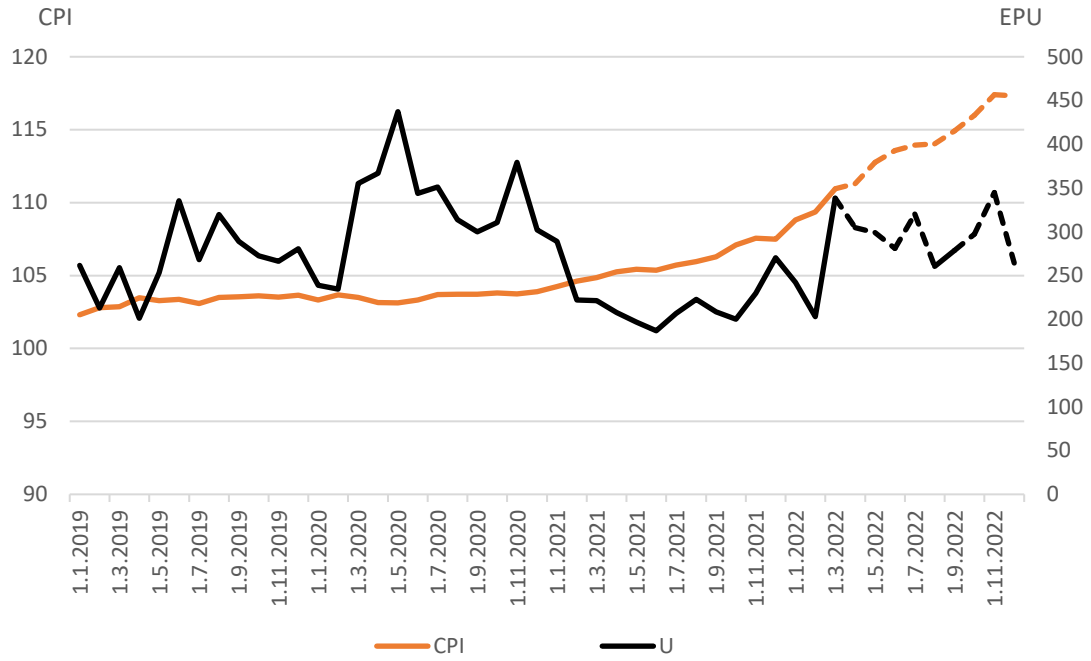

Figure 11. Finnish CPI and Economic Policy Uncertainty-index during the data period.

Table 2 provides an overview of the variables used in the study. The table is divided into two panels; Panel A includes the definition of the dummy variable, while Panel B comprises the definitions, proxies, and sources for macroeconomic variables.

Table 2. Definitions and source of variables.

Variable	Definition
Panel A: Definitions of dummy variables	
crisis22_dummy	The Russian invasion of Ukraine in February 2022 is the demarcation between the pre- and post-Invasion periods. Equal to 1 if the data is from the period February 2022-February 2023, and 0 otherwise.
Panel B: Variable definitions, proxies and sources in Finland	
Variable	Variable definition/proxy/source
HP	House prices/Actual free of debt sales prices of dwellings/Federation of Real Estate Agency (KVKL Hintaseurantapalvelu)
GDP	Output/Finlands' economic situation (Calculated in Real GDP growth)/OECD database
I	Household income/Index of real wage and salary earnings/Official Statistics of Finland
E12	Euribor 12-months/Euribor 12-months/Bank of Finland
M2	Money Supply/Finnish Contribution to euro area M2/Bank of Finland
CPI	Inflation/Consumer price index (point figure)/Official Statistics of Finland
EPU	Economic policy uncertainty/PPP-adjusted GDP-weighted average of national EPU indices for 21 countries /policy uncertainty database

Table 3 provides descriptive statistics for the variables used in the study. Although, this table is only for providing information on initial data. The values are afterwards aggregated for analysis, and summary statistics for aggregated values are presented later.

Table 3. Summary statistics of the main variables for Finland on initial data.

Variable	Obs.	Mean	Median	Std.	Skewness	Kurtosis
HP	31.632	336.232,80	273.000	232.119,61	3,908	30,261
GDP	16	1,281	2,45	8,094	-0,659	5,924
I	16	101,931	102,20	1,957	-1,049	0,942
E12	48	0,020	-0,28	0,885	2,356	5,038
M2	48	6,808	5,05	4,307	0,876	-0,419
CPI	48	106,497	104,07	4,346	1,249	0,359
EPU	48	276,054	271,45	55,763	0,478	-0,020

5.3 Methodology

The methodology of this study emulates the study conducted by Kang and Liu (2014) in terms of quantile regression and the formation of variables. However, as addressed above, variables have been changed to acknowledge closer the special characteristics of Finland. Moreover, unlike the study by Kang and Liu (2014), this study allows for mixed sampling frequency data on macroeconomic variables by exploiting Mixed Data Sampling (MIDAS) technique in the quantile regression framework. The proposed method enables to manage of raw mixed sampling frequency data directly. It is useful for this paper since macroeconomic variables are reported both monthly and quarterly, and in addition, housing transactions are reported on a daily basis. Moreover, the Russian invasion of Ukraine is a relatively recent occurrence. Therefore, the number of observations is limited; thus, including all feasible observations elaborates the method used and given results.

Based on the previous studies outlined above in chapter two and presented above in table 2, the following equation is the basic model used in the empirical study:

$$HP = \alpha_0 + \beta_1 E12_t + \beta_2 CPI_t + \beta_3 GDP_t + \beta_4 I_t + \beta_5 M2_t + \beta_6 U_t + \beta_7 Invasion\_Dummy_t + \varepsilon_t \quad (2)$$

5.3.1 Quantile regression

Quantile regression, first introduced by Koenker and Bassett (1978), is an extension and advanced application of the classical least squares estimation. The classical methods, such as ordinary least-square (OLS) regression models, mainly approximate the conditional mean and median located at the center of distribution. By doing so, the conditional distribution is not fully described because of the focus on the conditional mean (Mosteller and Tukey, 1977). Moreover, OLS may lack the ability to capture the relationship between variables in extreme economic conditions, as invasion can cause, for instance. In short, the limitations of traditional linear regression are as follows, 1) assumption of linearity, which may lead situation where non-linear dependence remains concealed, 2) outliner may unnecessarily distort the results, 3) heteroscedasticity may reduce the value of statistical significance, and 4) time dependence of observations, that may cause challenges in time series data because basic assumptions for regressions are the independency of the error terms of observations.

According to Waldmann (2018), quantile regression is particularly suitable when there exists outliers and heteroscedasticity**.** So, the estimated coefficient vector is not sensitive to outliers, because the quantile regression estimator minimizes the weighted sum of squared residuals rather than the sum of squared residuals (Kang and Liu, 2014). The quantile regression offers also a more comprehensive view concerning the conditional distribution of the predicted variable. According to Konker and Bassett (1978), any quantile can be examined as quantile regression does not set any strong requirements for sample distribution. In fact, the variable distribution may be divided into any number of quantiles. Furthermore, conditional distribution does not have any standard shape. In conclusion, quantile regression enables understanding more comprehensively and detailed how the explanatory variables affect the dependent variable. The basic quantile regression model delineates conditional quantile as a linear function of the explanatory variables, and is structured as follows:

$$y_i = \beta_0 + u_{\theta i}, 0 < \theta < 1 \quad \textbf{(3)}$$

$$Quant_\theta(\gamma_i|x_i) = x_i\beta_{0^1}, \quad \textbf{(4)}$$

where y is the dependent variable, x is a matrix of explanatory variables, u is the error term whose conditional quantile distribution equals zero, and $Quant_\theta(\gamma_i|x_i)$ signify the θth quantile of y conditional on x. The distribution of the error term is left unspecified. An individual coefficient $\beta_{\theta k}$ associated with the *k*th independent variable in the vector x_i, called x_{ik}, could be construed as 'how y_i in its θth quantile is affected by a marginal change in x_{ik}, otherwise ceteris paribus. Thus, the quantile regression method enables identifying the covariates' effects at different locations in the conditional distribution of the dependent variable.

The θth regression quantile estimate, $\hat{\beta}_\theta$ may be defined as a solution to the following minimization problem:

$$\min_{\beta} \sum_{y_i \geq x_i'\beta} |y_i - x_i'\beta| + \sum_{y_i < x_i'\beta} (1-0)|y_i - x_i'\beta| \quad \textbf{(5)}$$

which is solved via linear programming. The special case of the quantile regression, that is the median regression, is obtained by setting θ = 0,5. To obtain other quantiles of the conditional distribution we can change the θ for desired quantile. This study obtains the relationship among selected variables across the conditional housing prices distribution by setting the quantiles and reporting results for the 10th, 25th, 50th, 75th, and 90th quantiles. With the presented distribution, capturing movements across the whole distribution is possible.

Furthermore, it is also important to note that quantile regression can address the following concern: all sample data points are utilized in conducting a quantile-fitting regression for each quantile. This method differs from traditional piecewise regressions,

which divide the dependent variable (unconditional distribution) and then perform ordinary least squares (OLS) on the resulting subsets. Piecewise regressions are an unsuitable alternative to quantile regression due to significant sample selection issues, as Koenker and Hallock (2001) highlighted. Additionally, since piecewise regressions are based on least squares, they may be sensitive to Gaussian assumption or the presence of outliers. (Kang and Liu, 2014).

5.3.2 MIDAS regression

MIDAS (Mixed Data Sampling) regression, first introduced by Ghysels et al. (2004; 2006) is a statistical technique that allows for the estimation of a model where the dependent variable and predictor variables have different sampling frequencies. This method is particularly useful for analyzing relationships between time series data with mixed frequencies, such as monthly and quarterly observations. Usually, MIDAS incorporates lags of the higher-frequency predictors to capture their time-varying effects on the lower-frequency dependent variable. However, it also can be used and vice versa. The coefficients for these lags are estimated using the appropriate weighting scheme. To sum up, the resulting model provides insights into the dynamic relationships between the variables, accounting for their different data frequencies and time-varying effects. (Ghysels et al., 2004; 2006).

6 Empirical results

6.1 Basis to analysis

To begin with, below is presented the summary table used for the analysis where the data has been converted to monthly in order to conduct OLS and quantile regressions where data must be at the same frequency. Thus, there are 48 observations per variable.

Table 4. Summary statistics of the main variables for Finland used in the analysis.

Variable	Mean	Maximum	Minimum	Std.	Skewness	Kurtosis
HP	221.557.412	312.885.725	121.983.527	42.974.891	-0,117	2,660
GDP	1,281	21,049	-22,469	8,180	-0,659	6,875
I	101,931	104,000	97,000	1,978	-1,049	3,319
E12	0,020	3,018	-0,504	0,895	2,357	7,407
M2	6,811	16,496	1,063	4,350	0,875	2,497
CPI	106,497	117,400	102,310	4,392	1,249	3,200
EPU	276,054	437,247	186,930	56,353	0,478	2,859

The mean value for the dependent variable “HP” is 221.557.412, and the skewness is -0,117, indicating that the distribution is slightly negatively skewed. That is, the tail of the distribution is slightly longer on the negative side, indicating that there are slightly more extreme values in the negative direction. Also, a kurtosis of 2,660 indicates that the distribution is moderately leptokurtic, meaning it has heavy tails and a higher and sharper peak than the normal distribution. For these reasons, the normal distribution assumption for error terms in OLS may not be guaranteed, potentially leading to inaccurate results. Quantile regression can address these issues while offering a more versatile and comprehensive analysis, especially when examining the effects of the Russian invasion of Ukraine on housing prices at both upper and lower levels. Additionally, none of the variables show negative values on kurtosis indicating a flatter and more spread-out distribution with fewer outliers. Moreover, all variables show positive values on kurtosis, indicating either moderate or highly leptokurtic values indicating a more peaked and heavier-tailed distribution with more outliers. Skewness

and kurtosis strengthen the changes seen in figures regarding variables. Below in Table 5 is presented the correlations among the variables, which are consolidated into monthly values.

Table 5. Correlations among the variables during the data period.

Variable	HP	GDP	I	E12	M2	CPI	EPU
HP	1,000	0,361*	0,527***	-0,580***	0,252*	-0,231**	-0,356
GDP	-	1,000	0,112	-0,190	0,082	-0,047	-0,316**
I	-	-	1,000	-0,865***	0,661***	-0,817***	-0,116
E12	-	-	-	1,000	-0,450***	0,819***	0,185
M2	-	-	-	-	1,000	-0,479***	0,407***
CPI	-	-	-	-	-	1,000	0,022
EPU	-	-	-	-	-	-	1,000

*** Indicates significance at the 1% level.
** Indicates significance at the 5% level
* Indicates significance at the 10% level

Housing prices positively correlate with strong significance to household income, and with 10% significance to GDP and M2, while negatively and with strong significance to Euribor 12-month rate, and on a moderate level to CPI. However, even though p-values indicate significant correlation, values are not close to 1 or -1, which would indicate multicollinearity. Furthermore to other correlation among other variables, notable correlations exist between household income and the Euribor 12-month rate. Euribor correlates significantly also with inflation, and inflation also correlates with household income. On whole, the correlations among housing prices and explanatories are consistent with previous studies, although CPI shows unanimous results in previous studies. Nonetheless, these correlations only indicate linear relationships and further analysis is needed to determine causation.

6.2 Ordinary Least Squares regressions

In the first place is conducted an OLS regression, which allows a comparison of traditional OLS and quantile regression. Housing prices function as a dependent variable, while macroeconomic factors act as explanatories. Since debt-free housing transactions have large values, a logarithmic transformation is applied to reduce the scale and address potential heteroscedasticity.

Table 6. OLS regressions result for the data period 2019–2022.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4,771	1,508	3,163	0,003***
GDP	0,002	0,001	1,727	0,092*
I	0,028	0,014	1,944	0,059*
E12	-0,068	0,023	-2,909	0,006***
M2	-0,0004	0,0038	-0,1128	0,911
CPI	0,007	0,006	1,265	0,213
EPU	-0,0002	0,0002	-1,0978	0,279
Invasion_dummy	0,094	0,057	1,647	0,107
F-statistic				*11.516****
Adjusted R-squared				*.610*
Durbin-Watson stat				*1.657*
Obs.				*48*

*** Indicates significance at the 1% level.
** Indicates significance at the 5% level
* Indicates significance at the 10% level

According to OLS results presented in Table 6 above, the Russian invasion of Ukraine seems not to impact negatively on housing prices. In fact, the impact seems to be positive; however, not significant. Secondly, the debt-free housing price transactions in Helsinki show significant, if marginal, and positive co-movements with GDP and Household income. This direction is in accordance with previous studies (Adam and Füss, 2010; Annett, 2005, for instance). Further, Euribor 12-months has a negative coefficient and is statistically significant, and thus is in accordance with previous studies (Oikarinen, 2005, for instance). Moreover, even if other variables show significant movement during the data period, coefficients are not statistically significant according to the OLS method possessing a high p-values.

Furthermore, the F-statistic (11,516) is statistically significant, indicating that at least one independent variable is related to the dependent variable. Next, the adjusted R-squared is 0,610, reflecting that 61 % of the variation in the dependent variable is explained by the independent variables included in the regressions. Further, Durbin-Watson statistics, which is 1,657, suggest that the regression model satisfies the independence assumption, although a slightly positive autocorrelation may exist in the residuals.

Utilizing only the OLS method, the result interpretation remains slightly poor. Moreover, the assumption of the normal distribution is unmet, so the above-interpreted results may be misleading. Thus, the method is extended to quantile regression.

6.3 Quantile results

The empirical analysis is carried out by estimating Equation (2) at five distinct quantiles, namely the 10th, 25th, 50th, 75th, and 90th quantiles, utilizing an identical set of explanatory variables for each. This enables the investigation of how the explanatory variables influence housing prices at various points within the distribution.

Table 7 reports the results where housing prices remain the dependent variable and macroeconomic factors are the explanatories. The output shows the coefficients for a quantile regression at different quantiles (10th, 25th, 50th, 75th, and 90th). The coefficients for each predictor variable represent the change in the response variable associated with a one-unit increase in that response variable at the specified quantile. For instance, at the 25th quantile, a one-unit increase in E12 is associated with a decrease in the response variable by 0,086, holding all other predictors constant. Moreover, for comparison purposes, the last column of Table 7 also presents the OLS estimates, enabling a side-by-side assessment. Besides, Table 7 includes pseudo-R-squared values that indicate the goodness of fit for the quantile regression at each quantile. They represent the proportion of the variance in the response variable that is explained by the predictor variables at the specified quantile. The pseudo-R-square values show decent goodness. So, below is presented the main table of this paper.

Table 7. Quantile and OLS regressions result for the data period 2019–2022.

	Quantile regression					OLS
	10th quant	25th quant	50th quant	75th quant	90th quant	
The empirical results are obtained by estimating the following equation:						
$HP = \alpha_0 + \beta_1 E12_t + \beta_2 CPI_t + \beta_3 GDP_t + \beta_4 I_t + \beta_5 M2_t + \beta_6 U_t + \beta_7 Invasion\_Dummy_t + \varepsilon_t$						
GDP	0,001	0,001	0,003	0,002	0,003	0,002*
I	0,005	0,008	0,027	0,045	0,094**	0,028*
E12	-0,066	-0,086***	-0,079	-0,076	-0,004	-0,068***
M2	0,007	0,004	-0,003	-0,007	-0,019**	-0,0004
CPI	0,008	0,003	0,013	0,017	0,003	0,007
EPU	-0,001*	0,000	0,000	0,000	0,000	-0,0002
Invasion_Dummy	0,004	0,109*	0,039	0,023	0,166**	0,094
Pseudo R^2	0,554	0,478	0,410	0,457	0,443	*Adj* R^2 *= 0,61*

*** Indicates significance at the 1% level.
** Indicates significance at the 5% level
* Indicates significance at the 10% level

Starting from the first hypothesis and focusing on Invasion_Dummy, as stated above, OLS yielded a positive but non-significant result. Quantile regression, which distinguishes the effects on different quantiles, namely the 25th and 90th percentiles, reveals a positive and significant correlation. In this instance, quantile regression provides added value as OLS regression does not capture the significance.

Nevertheless, the positive impact is not the expected outcome. According to the estimates, the Russian invasion of Ukraine positively affected Helsinki housing prices, and the first hypothesis does not hold. Besides, no linear conclusion can be drawn on the impact on low or high prices since a significant effect is observed in both ends (25th and 90th). Although, the strongest price movement is observed at the highest quantile. Therefore, the impact varied at different housing price levels, and the second hypothesis holds water.

Despite the positive effects observed in the examination of Invasion_Dummy, housing prices experienced a decline towards the end of 2022 as illustrated in Figure 8. Therefore, a more in-depth analysis of macroeconomic variables is warranted.

The coefficients for GDP are positive across all quantiles but are not statistically significant. This implies that an increase in GDP has a positive but insignificant impact on housing prices across the distribution. However, OLS shows a significant impact, although weakly significant, and thus is more in accordance with the previous studies (e.g., Égert and Mihaljek, 2007; Valadez, 2010; Vogiazas and Alexiou, 2017). The coefficient is expected considering the great impact of the real estate sector on GDP, as Acolin et al. (2022) found.

Household income expresses positive coefficients across all quantiles, indicating that higher household income is associated with higher housing prices. However, the relationship is only statistically significant at the 90th quantile, suggesting that the

impact of household income on housing prices is more pronounced at the higher end of the distribution. A closer examination of Figure 7 reveals that house prices at the highest quantile climb relatively high, making them affordable for only a small and limited group of people. That is, income must be extremely high to lower the bank's risk and obtain a loan. Nevertheless, looking at the distribution as a whole, the results are consistent with prior research (e.g., Fortuna and Kusher, 1986; Holly and Jones, 1997; Hort, 1998; McCarthy and Peach, 2004; Annett, 2005), with the OLS regression also revealing a statistically significant impact, albeit a relatively weak one.

Similarly, the evidence from the interest rate aligns with previous studies (e.g., Englund and Ioannides, 1997; Himmelberg et al., 2005; Egert and Mihaljek, 2007). The coefficients for the Euribor 12-month rate are mostly negative across the quantiles, with a significant negative impact at the 25th quantile. This indicates that a rise in the Euribor 12-month rate is linked to lower housing prices, especially for the lower-middle part of the distribution, which could be attributed to income and affordability. When interest rates rise, it may affect overall housing expenses more at lower levels due to moderate disposable income. Nevertheless, at the same time, OLS exhibits a highly significant impact. This supports Oikarinen's (2005) argument that the Finnish housing market is exposed to interest rate fluctuations. As stated, 95,5 % of mortgage portfolios were tied to the 12-month Euribor at the moment of invasion. Thus, the linkage is highly expected.

As for the money supply, the coefficients are mixed, with positive coefficients at the lower quantiles and negative coefficients at the higher quantiles. The relationship is statistically significant at the 90th quantile, suggesting that an increase in the money supply is associated with lower housing prices at the higher end of the distribution. But this is not entirely in accordance with previous studies (e.g., Tsai, 2013; Su et al., (2019). However, neither Su et al. (2019) found any impact with the equilibrium model but first with the bootstrap rolling window. As for Tsai (2012), evidence shows asymmetric impact indicating that loose monetary policy increases housing prices, but the tighter monetary policy does not reflect vice versa similarly. In Table 7, the results are asymmetric,

although in a different sense. This could be because lower-income households are more sensitive to changes in interest rates and are more likely to purchase houses when there is an increase in money supply. However, at the higher quantiles, the negative coefficients suggest that an increase in money supply is associated with lower housing prices for higher-priced houses. This could be because higher-income households have a higher ability to obtain loans and are more likely to purchase houses regardless of changes in money supply. Nevertheless, further research is needed to determine the exact reasons for these mixed coefficients.

Throughout all quantiles, the coefficients for inflation are positive but lack statistical significance, suggesting that the relationship between inflation and housing prices is not significant in this study. These findings are in line with the study conducted by Kuosmanen and Vataja (2002) in the Finnish market, who also found a positive but insignificant relationship. However, previous studies on the impact of inflation on housing prices do not provide a consistent agreement, which could partly explain the insignificant results.

To the best of my knowledge, the impact of Economic Policy Uncertainty (EPU) on housing prices has not been studied in Finland before. The coefficient for EPU in this study is negative and to a small degree significant at the 10th quantile, implying that an increase in economic policy uncertainty is associated with a decline in housing prices at the lower end of the distribution. This finding may suggest that growing uncertainty affects the buying intentions of households with lower incomes more than those with higher incomes, as people tend to purchase homes that they can afford. Therefore, negative global news may create more uncertainty among lower-income households. On the other hand, the coefficients at other quantiles are not significant, and the coefficients are zero. This deviates from previous results (e.g., Choudhry, 2020; Antonakakis et al., 2015; Balcilar et al., 2021). Nevertheless, this might indicate some similarities to the conclusion of the Dummy variable. Contrary to expectations, housing prices were not affected negatively by the invasion. Neither is housing prices affected

negatively, although on lower quantile and OLS, so some indications exist that the Finnish housing market is not strongly linked to global events and news. However, further investigations are needed to draw conclusions.

In summary, results suggest that the first hypothesis can be rejected, while the second is confirmed. The impact of the Russian invasion of Ukraine on the Helsinki housing market is found to be very small overall. Moreover, that household income, the Euribor 12-month rate, money supply, and the Russian invasion of Ukraine have significant impacts on housing prices at different points in the distribution. Economic policy uncertainty shows moderate significance, while the effects of GDP and inflation are not statistically significant across the quantiles analyzed.

6.4 MIDAS results

As stated above, data is on different frequencies and must be converted to the same frequency to run Quantile regression. However, according to Ghysels et al. (2005, 2006, 2007), variables sampled at different frequencies can yield better forecast performance, which is the case in MIDAS. The data used in the study is relatively new and on mixed frequency, and the number of observations becomes noticeably less when using methods where data must be aggregated. Thus, the comparable results of MIDAS create a more comprehensive framework for analysis as it allows for modeling the relationships between high-frequency and low-frequency data. Moreover, it is more common that MIDAS regression is used with a lower-frequency dependent variable and higher-frequency predictor variables. In the case of this paper, the dependent variables, namely house prices, are high-frequency variables. Thus, the paper employs a variation of MIDAS, which is inverse MIDAS. The following MIDAS regression is used in the analysis:

$$HP_t = \beta_0 + \beta_1 B(L^{\frac{1}{m}}; \theta)\, x_{t-h}^{(m)} + \epsilon_t, \qquad (6)$$

where HP is the dependent variable, that is, debt-free housing transactions, t refers to the time unit of the dependent variable, and m refers to unit of higher frequency variable. Below in Table 8 is presented the results of MIDAS estimation.

Table 8. MIDAS regression result for the data period 2019–2022.

Variable	Coefficient	Std. Error	t-Statistic
C	10,179***	2,501	4,071
LOGDFP (-1)	-0,172	0,163	-1,059
QUARTERLY Series: GDP			
PDL01	-0,001	0,003	-0,446
PDL02	0,002	0,001	1,311
QUARTERLY Series: I			
PDL01	0,102*	0,051	2,000
PDL02	-0,045*	0,023	-1,949
MONTHLY2 Series: E12			
PDL01	0,529*	0,207	2,555
PDL02	-0,424**	0,153	-2,766
MONTHLY2 Series: M2			
PDL01	0,007	0,009	0,723
PDL02	-0,002	0,004	-0,345
MONTHLY2 Series: CPI			
PDL01	0,190**	0,069	2,766
PDL02	-0,088**	0,031	-2,817
MONTHLY2 Series: U			
PDL01	-0,001	0,001	-1,035
PDL02	0,000	0,000	0,167
MONTHLY2 Series: Invasion_Dummy			
PDL01	-0,107	0,178	-0,604
PDL02	0,083	0,115	0,720
Adjusted R-squared		*0,846*	
Durbin-Watson stat		*1,92*	

*** Indicates significance at the 1% level.
** Indicates significance at the 5% level
* Indicates significance at the 10% level

The R2 statistic suggests that 84,6% of the variation in the debt-free housing prices can be explained by the predictor variables, which is a good predictive fit. Besides, Durbin-Watson test is close to 2, indicating little to no autocorrelation in the residuals. The

constant term (C) is statistically significant at 1% level, with a coefficient of 10,179. This means that even when all other variables are zero, the expected value of the dependent variable is 10,179. The LOGDFP (-1) is negative but insignificant, suggesting no significant relationship between the lagged and current debt-free prices. Nonetheless, evaluating the predictor variables is more appropriate and informative. Farther on, quarterly series include GDP, I, while monthly series include E12, M2, CPI, U, and Invasion_Dummy.

The results indicate that there is no significant relationship between either the current or previous quarter's GDP and housing prices. PDL02 is consistent with Quantile regression, while OLS only shows moderate significance. Household income shows mixed effects, or PDL01 and PDL02 indicate that the relationship between past household income and the current debt-free price varies depending on the time lag. The positive relationship in the first lag period and the negative relationship in the second lag period reveal a mixed effect of household income on debt-free prices over time. That is, PDL01 is positive at a 10% significance level, implying that there is a positive relationship between the lagged value of the quarterly household income variable and the housing prices, which is in accordance with OLS, and the 90th quantile in Quantile regression.

Similarly, the mixed effect applies to other variables that show significance, namely Euribor-12 month and CPI. However, for Euribor-12 month, only PDL2 is in accordance with OLS, and the 25th quantile in Quantile regression. With regard to CPI, it demonstrates significance at the 5% level, and the mixed findings correspond with the diverse outcomes found in academic literature. Furthermore, Christou (2018) asserts that the empirical relationship ought to be examined routinely. In line with this, the impact of inflation on housing prices is variable and requires ongoing analysis with up-to-date data. This underscores the fact that the effect can differ, and as new data is incorporated, inflation continues to exhibit mixed outcomes.

The Invasion_Dummy variable yields insignificant results, indicating that the Russian invasion had no significant effect on housing prices in Helsinki, neither in the current or previous months. The insignificant results are in accordance with OLS; however, Quantile regression has positive values at the 25th and 90th quantiles. On the contrary, MIDAS is the only method that shows a negative value. This could be due to a variety of reasons, such as the fact that the Helsinki housing market is relatively insulated from geopolitical events according to the results of EPU variable in Quantile regression, or that the market is slow to react to global events. Nevertheless, results are not significant so no conclusion can me made.

Furthermore, the analysis does not find a significant relationship between the money supply and housing prices. Similarly, Economic Policy Uncertainty (EPU) shows results similar to those of the Quantile regression, with the coefficients being very close to zero or zero.

All in all, the mixed results on predictive variables vary depending on the time lag being considered. These mixed results might reflect the complexity of the housing market, where the effect of certain economic factors may change over time. The lagged values capture the delayed or persistent effects of the predictor variables on the dependent variable, allowing the model to account for potential time-varying relationships. To sum up analysis, the MIDAS regression results reinforce the rejection of the first hypothesis by indicating no significant impact of the Russian invasion on housing prices in Helsinki.

Furthermore, analysis finds no significant relationship between GDP and housing prices in Helsinki. The variable for household income displays a mixture of positive and negative effects, as it produces positive outcomes for the first lag period and negative outcomes for the second. Similarly, the variables for Euribor-12 month and CPI exhibit comparable mixed effects, where the impact in the current month is positive while it is negative in the previous month. Moreover, the assessment does not identify any substantial connection between money supply and housing prices, whereas Economic Policy

Uncertainty shows results similar to those of Quantile regression. Thus, the study indicates that the impact of key variables such as E12, CPI, and household income on housing prices is not straightforward and should be considered with respect to the specific time lags.

7 Conclusions

This study analyzed how the Russian invasion of Ukraine impacted housing prices in Helsinki in the short term. It examined the effects of the crisis on the real estate market across various price levels, utilizing quantile regression to investigate how housing prices responded to the effect of war at different points in the housing price distribution. The use of a conditional quantile regression estimator extended the traditional OLS and allowed for the assessment of how the impact of the crisis varied at different levels of the dependent variable distribution, thereby enabling a comprehensive analysis of the relationship between the Russian invasion of Ukraine and housing prices at various price levels.

Housing assets represent the largest share of household wealth, and changes in housing prices have a wealth effect that impacts consumption and, in turn, the national economy. Therefore, it is essential to identify the factors driving housing price development, as they serve as an indicator of macroeconomic growth. This paper examines the price movements across different quantiles and uses macroeconomic variables as explanatory factors, which account for nearly 60% of the variation in real estate returns (McCue and Kling, 1994). In addition to studying price movements, this paper employs also a MIDAS regression to closely examine the critical factors that determine housing prices. The analysis covers the period from January 2019 to December 2022 and utilizes precise transaction data from Hintaseurapalvelu (KVKL), along with explanatory macroeconomic variables measured on either a monthly or quarterly basis.

In conclusion of findings, the empirical analysis conducted in this thesis does not support the first hypothesis that the Russian invasion of Ukraine had a negative impact on housing prices in Helsinki. Both the OLS and MIDAS methods fail to report any statistically significant results, whereas quantile regression results reveal a positive and moderately significant correlation at both lower (25th) and higher (90th) quantiles. Thus, the impact of the invasion seems to vary at different housing price levels, supporting the second hypothesis. Furthermore, these findings suggest that global events and news

may not strongly influence the Finnish housing market, although further investigation is required to draw definitive conclusions.

The analysis also shows that some macroeconomic factors, namely household income and the Euribor 12-month rate, have significant impacts on housing prices in Helsinki. However, the effects are not straightforward and should be considered with respect to the specific time lag. When comparing the findings to prior literature presented in chapter two, findings in OLS are similar. However, as stated, MIDAS show mixed results implicating that further research is needed. Although, results also implicate the complex effects on the housing market, at least in the short term. Further on, macroeconomic factors are unlikely to have an immediate impact on housing prices, a more extended time frame could potentially enhance the consistency of the findings. However, in the context of examining the effects of a significant short-term event such as a neighboring country engaging in war, the short-term impact on housing prices through macroeconomic variables appears to be relatively weak, with the exception of interest rates and household income. When considering the entire data period, the only variable to exhibit significant explanatory power at a 1% level for housing prices is the Euribor 12-month.

Finally, incorporating Quantile regression into the analysis adds value to the thesis by capturing significant effects that traditional OLS may miss. The primary finding of the study is that the recent drop in Helsinki's housing prices cannot be attributed to the Russian invasion of Ukraine. Instead, the increase in the Euribor 12-month rate is the most significant factor that explains the decrease in prices.

My research on the subject presents intriguing opportunities for future investigations. Firstly, the use of Quantile regression in the study of the Finnish housing market is a relatively unexplored area that can be applied to various types of studies. Combining the hedonic pricing model with Quantile regression, for instance, could potentially provide more precise information on certain types of dwellings that offer better returns.

Secondly, the susceptibility of the Finnish housing market to global events could be studied further to strengthen the findings of this research. Thirdly, if exploring the same topic, the focus could be shifted to a region along the eastern border, such as Joensuu. Additionally, the explanatory variables that did not exhibit a significant difference could be replaced with factors such as stock market performance, unemployment rates, credit constraints, or construction costs to improve the accuracy of the findings.

Also, afterward, it would be valuable to conduct further research to determine if the Russian invasion had a negative long-term impact on housing prices and compare the findings to this thesis. Nevertheless, the recent announcement of Finland's full membership in NATO on April 4, 2023, eliminates significant uncertainty related to country risk, and the long-term impact of the invasion may not be evident. On the contrary, the impact of Finland joining NATO on the housing market could be studied. Beyond, while discussing the Finnish housing market, it became clear that research on housing companies is limited and requires attention.

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