The analysis of the factors that influence housing affordability in the EU

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THE ANALYSIS OF THE FACTORS THAT INFLUENCE HOUSING AFFORDABILITY IN THE EU

Undergraduate thesis

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Zagreb, 2024

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1. INTRODUCTION

1.1. Subject of the research

The subject of this paper is the analysis of factors affecting housing affordability in the European Union. Housing affordability is a multifaceted concept that refers to the ability of households to pay for housing without compromising their ability to afford other basic needs. It is typically measured by the proportion of household income spent on housing costs, including rent or mortgage payments, utilities, and maintenance. A common threshold is that housing costs should not exceed 40% of a household's income. When costs surpass 40%, households are often considered to be experiencing a housing cost overburden.

It is important to differentiate between "housing affordability" and "affordable housing". Housing affordability pertains to the financial capacity of households to afford housing costs relative to their income. This concept is concerned with the overall economic burden of housing expenses on households. In contrast, affordable housing refers to specific housing units that are priced at levels deemed affordable for low- to moderate-income households, often provided through public policy initiatives, subsidies, or regulations. This research focuses exclusively on housing affordability, examining the extent to which households can afford to purchase or rent housing within the broader market context.

There are various indicators used to measure housing affordability, and no single metric is universally accepted. The most common measure is the housing cost-to-income ratio, which calculates the percentage of household income spent on housing expenses. Other measures include the residual income approach, which considers the amount of income remaining after housing costs are paid, and subjective measures, which assess households' perceptions of their housing affordability. These diverse indicators reflect the complexity of housing affordability and highlight the need for a comprehensive analysis using multiple metrics.

The subject of housing affordability is critically important for several reasons. Firstly, housing is a fundamental human need and a key determinant of individual and societal well-being. Affordable housing ensures that households can meet their basic living needs, such as food, healthcare, and education, without undue financial stress. Secondly, housing affordability is a significant component of economic stability and growth. It influences labor mobility, consumer

spending, and overall economic resilience. When housing costs consume a large portion of household income, it can reduce disposable income and limit economic opportunities.

This research is directly relevant to housing policy and demographic policy. Effective housing policies are essential for addressing housing affordability issues. These policies can include measures to increase the supply of affordable housing, provide financial assistance to low-income households, and implement regulations to stabilize housing markets. Additionally, demographic policies that address population growth, migration, and household formation can significantly impact housing demand and affordability. Understanding the interplay between housing and demographic policies is crucial for designing interventions that improve housing affordability.

In recent decades, many European Union countries have faced a housing affordability crisis, characterized by rising housing costs and insufficient affordable housing supply. This crisis affects not only the low-income population but also middle-income households, leading to broader social and economic challenges. Therefore, analyzing the factors that influence housing affordability is vital for developing effective policies that ensure access to adequate and affordable housing for all citizens. By exploring the socio-economic, demographic, and institutional factors affecting housing affordability in the EU, this research aims to provide a comprehensive understanding of the issue. The findings can inform policymakers and stakeholders, helping to shape interventions that address the housing affordability crisis and promote social and economic prosperity.

1.2. Research objectives

The aim of this paper is to systematically research and explain the economic, demographic and institutional factors influencing housing affordability in the EU, their interrelationships and implications for enhancing existing housing affordability policies.

The key research questions the paper seeks to address are:

1. Which theoretically specified economic, demographic and institutional factors are shaping housing affordability in the EU?

2. Do these factors have significant impact on housing affordability when employing panel data analysis?
3. What implications for improving EU housing affordability policies emerge from the empirical findings?

The theoretical part explains the concept of housing affordability and provides an overview of key economic, demographic and institutional factors and their impacts. This is followed by panel analysis of relevant empirical data on trends in these factors across the EU. Finally, implications for enhancing housing affordability policies are drawn based on the identified factors and their interrelationships.

1.3. Data and Methodology

This research employs a comprehensive methodology to analyze the factors influencing housing affordability in the European Union (EU), utilizing a panel analysis approach to examine the effects of eight independent indicators: housing price index, construction producer prices, average number of persons per household, building permits index, population living in urban areas, net migration, population living in owner-occupied dwellings and employment rate. This section outlines the data sources, analytical strategies, and the rationale behind the chosen methodology.

Data Sources: The study draws on a variety of data sources, including EU statistical databases (like Eurostat), OECD, national housing agencies, financial institutions, and urban planning records. These sources provide a rich dataset covering housing prices, income statistics, interest rate trends, demographic changes, and urbanization patterns across the EU member states over a specified period. The reliability and comprehensiveness of these sources are critical for ensuring the validity of the research findings.

Analytical Strategy: The core of the analysis is conducted through panel analysis, a statistical method that allows for the examination of multiple datasets across different units over time. This approach is particularly suited to assess the dynamic relationship between housing

affordability and the independent indicators, enabling the identification of both temporal and cross-sectional variations within the EU. Panel analysis facilitates a nuanced understanding of how each factor influences housing affordability, controlling for unobserved heterogeneity across countries and over time.

Independent Indicators:

Housing Price Index (HPI): measures changes in residential property prices over time. An increasing HPI indicates rising house prices, which can reduce housing affordability by making it more difficult for households to purchase homes.

Construction Producer Prices: reflect the cost of construction materials and labor. Higher construction costs can lead to higher home prices, impacting the affordability of housing.

Average Number of Persons per Household: provides insights into household size and living arrangements. Smaller household sizes can increase housing demand and prices, while larger household sizes may indicate shared housing expenses, improving affordability.

Building Permits Index: measures the number of permits issued for new residential construction. A higher index suggests an increase in new housing developments, which can improve affordability by alleviating housing shortages.

Population Living in Urban Areas: highlights urbanization trends. High urbanization often leads to higher housing demand and prices in urban areas, affecting affordability.

Net Migration: measures the difference between people entering and leaving a region. High net migration can increase housing demand and prices, reducing affordability, while negative net migration can have the opposite effect.

Population Living in Owner-Occupied Dwellings: indicates the prevalence of homeownership. High levels of homeownership can reflect market stability, while lower rates might indicate barriers to home purchase.

Employment Rate: measures the proportion of the working-age population that is employed. Higher employment rates generally improve household incomes and housing affordability, while lower rates can reduce them.

Rationale for Methodology: The choice of panel analysis and the focus on these eight indicators are predicated on the hypothesis that housing affordability in the EU is a multifaceted issue influenced by a complex interplay of economic, demographic, and institutional factors. By employing a rigorous statistical framework, the study aims to disentangle these effects,

providing a robust basis for understanding and addressing the housing affordability crisis in the EU.

Through this methodological approach, the research aspires to contribute to the body of knowledge on housing affordability, offering insights that can inform both policy and practice in the realm of housing economics and urban planning.

1.4. Thesis Structure

The structure of this thesis is meticulously designed to guide the reader through a comprehensive analysis of housing affordability in the European Union (EU), culminating in actionable insights and recommendations. Following the introduction, the thesis unfolds as follows:

2. Second section: This section delves into the theoretical underpinnings of housing affordability, reviewing housing affordability as a concept, and analyzing economic, institutional and demographic factors. It covers affordability metrics, economic impacts, demographic shifts, and policy implications, providing a foundational overview for the thesis's analytical focus on the dynamics of housing markets and policy effectiveness within the EU context.

3. Third section: The heart of the thesis, this segment presents the empirical analysis conducted to assess the impact of identified factors on housing affordability within the EU.
This section delves into the construction of the statistical model used to explore how housing affordability is influenced by various independent variables, namely housing price index, construction producer prices, average number of persons per household, building permits index, population living in urban areas, net migration, population living in owner-occupied dwellings and employment rate. Following this, the process of model estimation is thoroughly detailed, encompassing data preprocessing, the careful selection of variables, and the employment of panel analysis techniques to ensure robust and accurate findings. Lastly, the interpretation of results section provides a comprehensive discussion on what the empirical analysis reveals, offering insights into the estimated model's implications for comprehending the nuances and dynamics of housing affordability within the European Union.

Through this structured approach, the thesis aims to provide a thorough examination of housing affordability in the EU, combining theoretical insights with empirical evidence to contribute to the ongoing discourse on this critical socio-economic challenge.

2. THEORETICAL INSIGHTS INTO FACTORS AFFECTING HOUSING AFFORDABILITY IN THE EU

2.1. Housing affordability as a theoretical concept

Housing affordability is a complex concept that is defined and measured in various ways in literature and public policies (Bogdon & Can, 1997). Essentially, it refers to the ability of households to afford adequate housing at acceptable costs (Stone, 2006). However, there are different interpretations of this basic concept regarding what is considered "adequate" and "affordable" housing.

The housing cost-to-income ratio is the most commonly used measure of housing affordability in literature and public policies (Bogdon & Can, 1997). It refers to the share of household income that is spent on housing, whether it is rental costs, mortgage payments, or other housing expenses such as utilities and maintenance (Stone, 2006). Although there is no universally accepted consensus, most authors consider ratios below 30% to indicate affordable housing, while ratios above 50% point to excessive housing costs and unaffordability (Jewkes & Delgadillo, 2010). Eurostat regularly publishes statistics on the share of EU households with housing costs above 40% as a measure of "overburden" (Eurostat, 2021). The main advantage of this measure is the simplicity of calculation and interpretation (Bogdon & Can, 1997). However, it is criticized for neglecting the absolute level of housing costs and total household

income (Stone, 2006). For example, a 40% ratio may represent dramatically different absolute costs and material conditions for a poor and a wealthy household (Sunega & Lux, 2020). Despite the disadvantages, due to its simplicity, this remains the dominant housing affordability measure in academic and policy circles (Hsieh & Moretti, 2019).

The concept of residual income represents an alternative approach to defining and measuring housing affordability (Stone, 2006). Unlike the housing cost-to-income ratio, this measure starts from the absolute amounts of income remaining after all housing costs have been paid (Bogdon & Can, 1997). According to this concept, housing is affordable if after paying all housing costs (rent, mortgage installments, utilities) the household is left with enough funds to cover other basic living expenses and maintain a minimally acceptable standard of living (Stone, 2006). Therefore, unlike the cost-to-income ratio which is based on relative figures, absolute amounts and an assessment of the material standard a household can afford are used here, taking into account real housing costs. This is the key advantage of this concept (Jewkes & Delgadillo, 2010). However, it also requires determining that "minimum standard", which carries normative challenges and comparability difficulties (Stone, 2006). This measure also has its critics, but the fact is that it more realistically reflects households' financial situations (Chaplin et al., 1994). Therefore, it contributes to better understanding and monitoring of housing affordability (Hsieh & Moretti, 2019).

Subjective measures of housing affordability are based on perceptions, experiences and assessments of households themselves regarding the affordability of housing costs and satisfaction with housing conditions (Morris, 2012). As opposed to objective indicators such as cost-to-income ratios, subjective assessments and self-evaluations of households collected through surveys are used here (Zhen et al., 2022). Examples of subjective measures include: assessments of the affordability of current housing costs, perceived financial strain of housing costs, satisfaction with apartment size, quality and amenities, sense of housing security, and the like (Morris, 2012). The advantage of such measures is that they directly reflect the experiences and situations of the households themselves (Morris, 2012). Validity and reliability may vary depending on how the questions are phrased and the interpretation of the answers (Zhen et al., 2022). Combining subjective and objective measures can provide a more comprehensive picture of housing affordability (Bogdon & Can, 1997). Subjective measures complement

“hard” statistics and provide insight into the affordability experience from the citizens’ perspective.

Availability of minimum housing standards is an approach to defining and measuring housing affordability that starts from setting minimum requirements regarding the quality, size and amenities of housing (Chaplin et al., 1994). Affordability is then defined as the percentage or number of households that can afford a home that meets those minimum standards. For example, a minimum standard may be defined as a dwelling of at least 40m^2, with a bathroom, separate kitchen and heating (Stone et al., 2011). Housing affordability would then equal the share or number of households whose income, minus housing costs, suffices to buy/rent such a dwelling. Such measures give a more realistic picture of the ability to meet basic housing needs (Gabrielli, 2022).
The advantage over other approaches is the explicit definition of a 'decent' minimum housing standard and the measurement of the availability of this standard (Chaplin et al., 1994). Political consensus is required regarding the definition of this minimum (Mulliner et al., 2016). Also, the approach does not take into account regional differences in housing costs (Gabrielli, 2022). Nevertheless, this is a useful approach that complements the usual cost-to-income ratios (Hsieh & Moretti, 2019).

Housing affordability can also be viewed through the prism of access to mortgage lending - i.e. the ability of households to take out housing loans to purchase real estate (Lerman & Reeder, 1987). Since most households finance the purchase of an apartment or house through borrowing, lending terms and creditworthiness crucially affect the affordability of homeownership (Park, 2022). Therefore, affordability measures based on the share or number of households meeting the conditions for obtaining mortgage loans with “reasonable” interest rates and repayment terms can be found in the literature (Bogdon & Can, 1997). The higher the share of “creditworthy” households, the greater the affordability of homeownership. The advantage of this approach is the connection to real mechanisms for financing households' housing needs (Park, 2022). However, “reasonable” lending conditions are relative and hardly comparable between countries (Gabrielli, 2022). Such affordability measures complement traditional cost-to-income ratios and provide insight into another key dimension – the (im)possibility of borrowing to purchase real estate (Hsieh & Moretti, 2019).

Dynamic measures of housing affordability refer to indices and other metrics that allow monitoring changes in affordability levels over a certain period of time (Bogdon & Can, 1997). As opposed to the previously described "static" measures that assess affordability at a given moment, the emphasis here is on identifying trends over time. Examples of dynamic measures include affordability indices calculated for a series of years using an identical methodology (Gabrielli, 2022; Park, 2022), ratios of changes in key variables (e.g. growth/decline of real estate and rental prices versus income growth) (Hsieh & Moretti, 2019), comparisons of share of income needed to purchase/rent a dwelling, and the like (Yates & Gabriel, 2020). Their advantage is monitoring dynamics (Zhen et al., 2022), however, they are sensitive to changes in methodology. Such indices and trends are important for longitudinal analyses, assessing policy effectiveness over time, predicting future developments and early detection of negative trends in housing affordability (Sunega & Lux, 2020). Therefore, they complement "static" cross-section measures.

Different definitions and measures of housing affordability lead to different assessments and policies. Therefore, it is important to analyze them critically.

2.2. Factors affecting housing affordability

Affordable housing is a fundamental human need and a precondition for social well-being. Enabling adequate and affordable living space for all citizens is an important goal of responsible public policy. However, in recent decades, more and more countries have been facing a housing affordability crisis, especially in urban areas. Many households are affected by excessive housing costs and poor housing conditions. Housing affordability is a complex phenomenon conditioned by a number of economic, institutional and demographic factors. A few key economic factors play a crucial role: real estate and rental prices, household incomes and access to mortgage lending. These factors are intertwined and jointly determine the level of housing affordability in an area. The following sections will present in more detail the impact of each of these economic factors on housing affordability, their interdependence, and implications for designing effective policies to address the current housing affordability crisis.

2.2.1. Socio-economic factors

Economic factors are crucial for determining housing affordability (Gabrielli, 2022). The three main economic factors are real estate prices, household incomes and creditworthiness (Hsieh, & Moretti, 2019).

Real estate prices, whether for purchasing or renting housing, have a direct impact on affordability. When prices rise faster than household income growth, affordability decreases (Bogdon & Can, 1997.; Park, 2022). A significant drop in real estate prices can temporarily increase affordability, however, it is unsustainable in the long run without price and income stabilization (Ren & Folmer, 2022). The second important factor is household income.[6] Higher average incomes allow larger housing cost outlays without compromising basic living needs (Chaplin & Freeman, 1999.; Lux, 2003). Lower incomes constrain households' ability to afford housing costs. Households in the lower income deciles are especially vulnerable (Yates, 2008). The third key factor is access to mortgage lending (Lerman & Reeder, 1987).
The inability to obtain housing loans or unfavorable lending conditions negatively impact affordability, especially homeownership (Alves and Da Silva, 2019).

These economic factors are intertwined. Real estate and rental prices affect the share of income needed for housing. Income and creditworthiness determine households' ability to absorb these costs (Hancock, 1993.; Maclennan & Miao, 2017). Therefore, it is imperative to observe them in an integrated manner when designing public policies to improve housing affordability.

2.2.2. Demographic factors

Housing affordability is impacted by various demographic factors pertaining to the size, composition, and lifecycle stage of households. Key determinants include household formation rates, population growth, migration flows, trends in household size and type, and age distribution dynamics.

Rising levels of household formation, due to young adults moving out of family homes or partnership breakdowns, generate substantial demand for affordable starter homes (Yates Gabriel, 2006). High population growth rates through natural increase or immigration also feed into greater housing needs across all segments (Myers & Ryu, 2008). Within many countries, trends of declining household sizes, aging populations, and growth in single-person households

further impact affordability pressures and policy responses required (McLaughlin & Tichenor, 1993).

Rapid growth in the number of households, whether due to young adults setting up homes or immigrant flows, reduces affordable housing availability if construction lags behind. Many countries have witnessed homeownership rates declining among young cohorts over recent decades, linked to housing becoming less affordable for first-time buyers on average incomes. (Gabriel & Jacobs, 2008.; Cigdem & Whelan, 2017). Greater private rental demand similarly squeezes affordability for lower-income households seeking to rent (Yates & Milligan, 2007). Strong population expansion through elevated births, extended longevity, or immigration therefore risks amplifying constraints across multiple tenure options for disadvantaged groups.

Ongoing social shifts towards smaller households on average, through lower fertility rates, partnership breakdowns, aging, and increased lifespans spent living alone, alter aggregate housing needs. A larger number of smaller households increases population-adjusted residential demand and potentially hinders per-capita affordability (Myers & Pitkin, 2009.; Myers & Ryu, 2008). Further, the rise of single-person households, especially elderly solitary living, concentrates affordability risk among more vulnerable groups (McLaughlin & Tichenor, 1993). Older single female households face particularly acute challenges in securing affordable and appropriate housing (Choi, 1996).

Housing affordability barriers vary across age groups and are often most problematic for those entering employment or retiring. High rents and house prices hinder labor market flexibility among young workers when moving jobs involves unaffordable relocation costs (Hulse & Burke, 2020). At later life stages, declining incomes for retirees, coupled with desires to age in place, heighten affordability stresses. Spatial mismatches between the geographical spread of housing versus employment opportunities also dampen affordability, especially for younger and lower-income households (Ong, 2013.; Chapain & Murie, 2008).

2.2.3. Institutional factors

Housing affordability is shaped by various institutional forces, particularly regarding housing supply responses, subsidy programs, and regulatory policies pursued by governments. When

appropriately calibrated, housing policies can improve affordability across ownership, private rental, and social rental market segments. However, inadequately addressing housing and planning system constraints risks compounding affordability pressures over time.

Boosting the housing supply through upzoning land, funding social housing projects, and addressing construction sector barriers can mitigate mounting affordability issues in growing cities (Gurran & Phibbs, 2013). Insufficient market-rate housing development to accommodate household growth and evolving locational preferences lessens affordability by intensifying bidding competition for available properties (Glaeser & Gyourko, 2018). Constraints such as zoning restrictions, infrastructure funding gaps, construction costs, and fledgling build-to-rent sectors commonly hinder supply responses across countries and require policy efforts targeting identified blockages (Barker, 2004).

Government-provided rent assistance payments and home purchase grants help recipient households better afford their existing housing. However, such demand-side subsidies risk being capitalized into higher rents and prices if not coupled with actions countering supply constraints (Fenton, 2010). More construction-linked subsidies can avoid inflationary effects while aiding marginal occupants (Whitehead, 2007). Stamp duty reductions and shared equity schemes supporting prospective buyers also assist affordability at a cohort level alongside economy-wide impacts from stimulating transaction activity (Helderman & Mulder, 2007).

Planning regulations fundamentally shape housing market operations and pricing signals guiding construction. Urban containment boundaries, density controls, approval lags, car parking mandates, and building code obligations variously influence development feasibility and affordability outcomes (Gurran et al., 2018). Reforms streamlining approvals, allowing greater densification, reducing mandatory developer contributions and easing codes provide scope to improve affordability where responsibly implemented (Productivity Commission, 2011). Though regulations aim to enhance amenity and sustainability, an overregulated system hampers responsiveness and affordability (Gyourko & Molloy, 2015). Periodically reviewing regulations and aligning policies across government arms assists in calibrating policy settings.

3. Empirical research

3.1. Data formulation and description

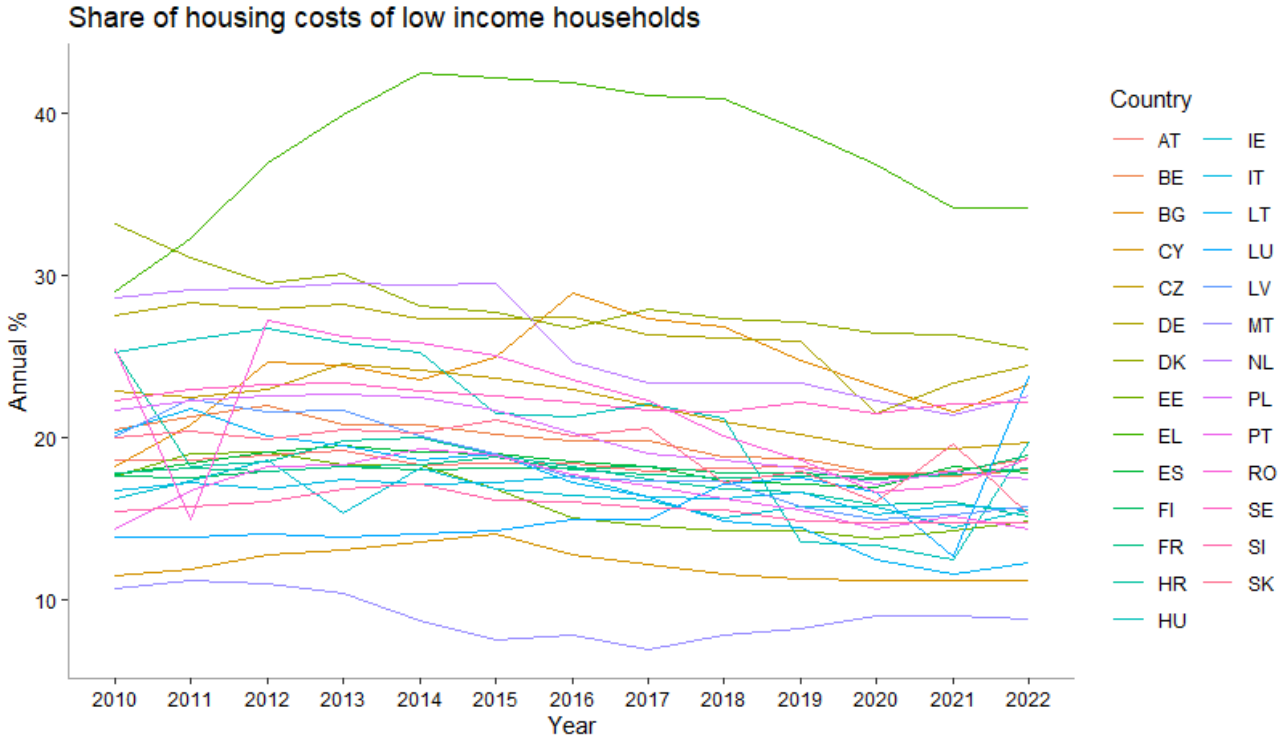
Table 1. Descriptive statistics of three potential affordability proxies over years across EU members (mean, minimum and maximum)

year	Share of housing costs of low inc. households / Mean	Share of housing costs of low inc. households / Min	Share of housing costs of low inc. households / Max	Housing cost overburden rate/ Mean	Housing cost overburden rate / Min	Housing cost overburden rate / Max	Housing cost overburden rate of low income households / Mean	Housing cost overburden rate of low income households / Min	Housing cost overburden rate of low income households / Max
2010	20.30	10.70	33.20	9.04	3.10	21.90	33.68	10.90	71.10
2011	20.36	11.20	32.30	9.51	3.00	24.20	34.59	10.50	78.80
2012	21.24	11.00	37.00	10.30	2.60	33.10	37.07	11.90	90.50
2013	21.32	10.40	39.90	10.49	2.50	36.90	36.99	11.20	93.10
2014	21.15	8.70	42.50	10.55	1.60	44.90	36.86	5.80	93.30
2015	20.75	7.50	42.20	10.17	1.10	45.50	35.61	4.80	94.00
2016	20.15	7.80	41.90	9.67	1.40	40.50	35.36	5.70	91.90
2017	19.63	6.90	41.10	9.24	1.40	39.60	34.94	5.60	89.70
2018	19.12	7.80	40.90	8.60	1.70	39.50	32.92	5.60	90.70
2019	18.54	8.20	38.90	8.25	2.30	36.20	31.98	9.20	88.20
2020	17.59	9.00	36.90	7.24	1.90	33.30	29.09	7.50	83.40

year	Share of housing costs of low inc. households / Mean	Share of housing costs of low inc. households / Min	Share of housing costs of low inc. households / Max	Housing cost overburden rate/ Mean	Housing cost overburden rate / Min	Housing cost overburden rate / Max	Housing cost overburden rate of low income households / Mean	Housing cost overburden rate of low income households / Min	Housing cost overburden rate of low income households / Max
2021	17.57	9.00	34.20	7.15	2.40	28.80	28.67	8.80	76.70
2022	18.37	8.80	34.20	7.89	2.50	26.70	30.98	10.90	84.50

Source: author's calculation in RStudio using data provided by Eurostat

Figure 1:



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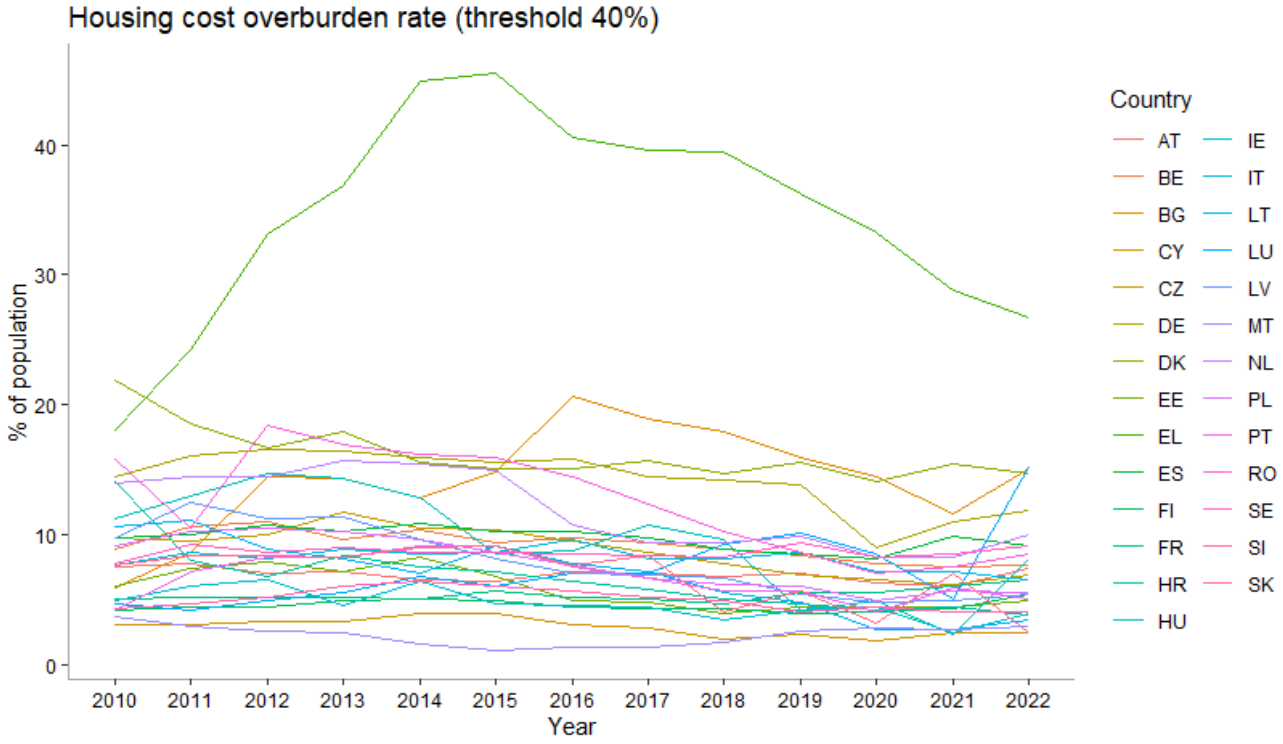

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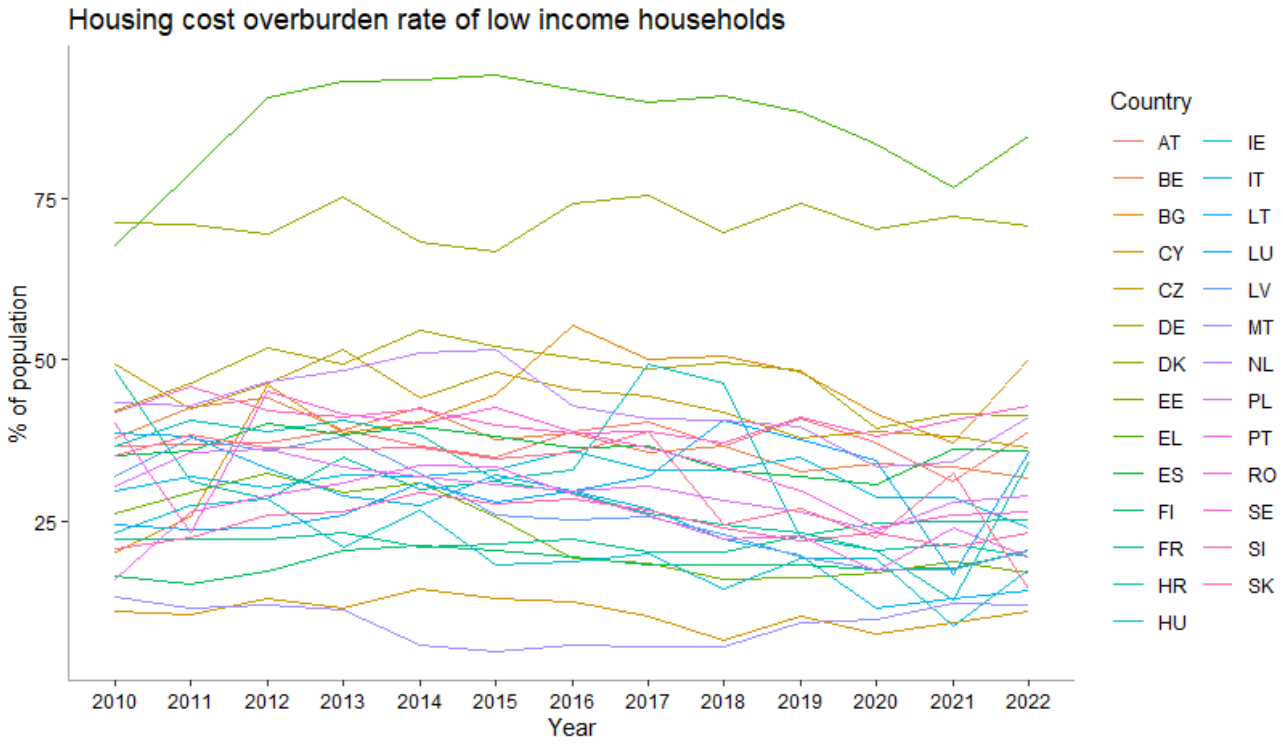
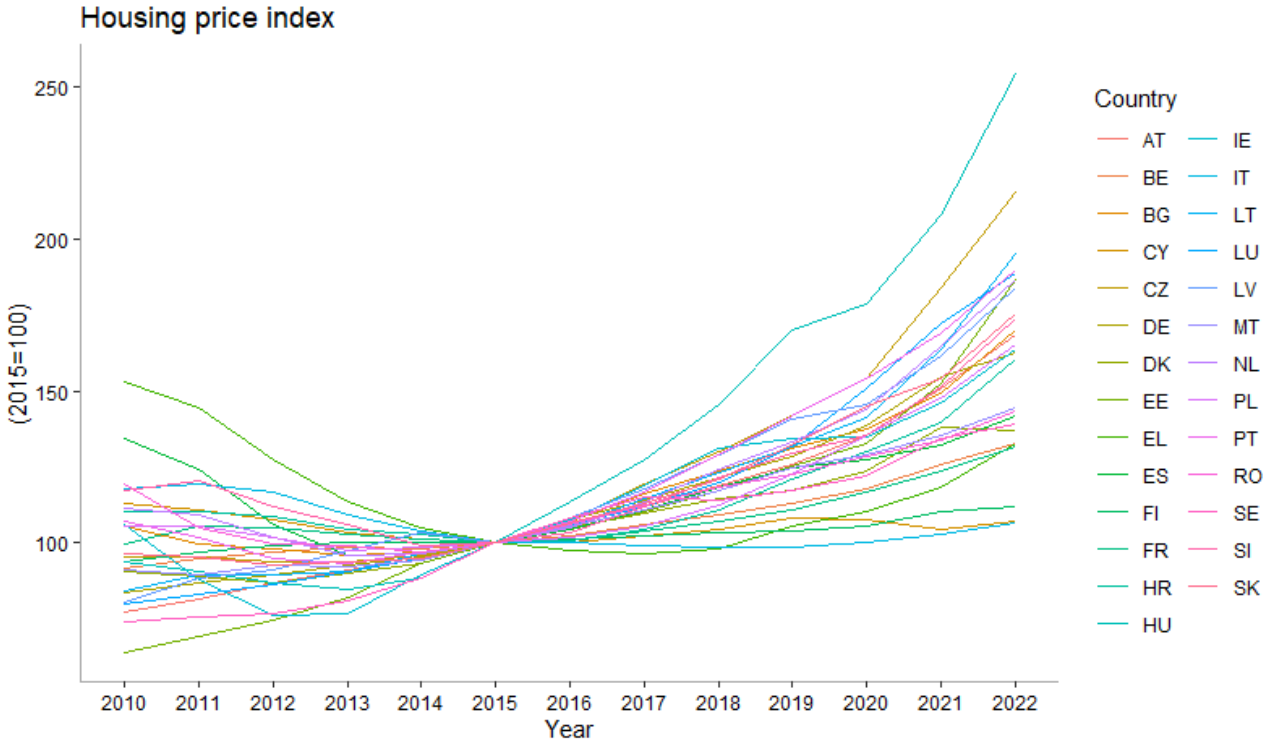


Table 2. Descriptive statistics of potential explanatory variables over years across EU members

year	H price index	Construction producer prices	Size	Building permits index	Urban	netmigration	ownership	Employment rate
2010	99.93	95.09	2.49	156.84	64.13	0.02	76.74	63.10
2011	98.99	97.32	2.47	127.17	64.32	0.12	76.43	63.15
2012	96.33	98.58	2.45	102.21	63.19	0.08	76.57	63.14
2013	95.35	98.81	2.44	88.84	65.19	0.06	76.31	63.24
2014	97.04	99.25	2.41	91.00	65.40	0.14	75.94	64.20
2015	100.00	100.00	2.41	100.00	64.96	0.28	75.68	65.19
2016	104.87	100.89	2.40	124.95	66.10	0.24	75.55	66.21
2017	111.14	103.29	2.39	144.91	67.87	0.32	75.63	67.69
2018	117.99	106.97	2.38	164.20	68.57	0.46	75.50	68.97
2019	125.56	110.78	2.36	174.01	69.07	0.52	75.31	69.83
2020	132.74	113.26	2.36	164.34	69.94	0.31	75.53	68.99
2021	145.60	121.21	2.34	192.19	70.48	0.36	75.85	69.79
2022	161.90	140.62	2.34	192.08	70.52	1.20	75.59	71.50

Source: author's calculation in RStudio using data provided by Eurostat

Figure 4:



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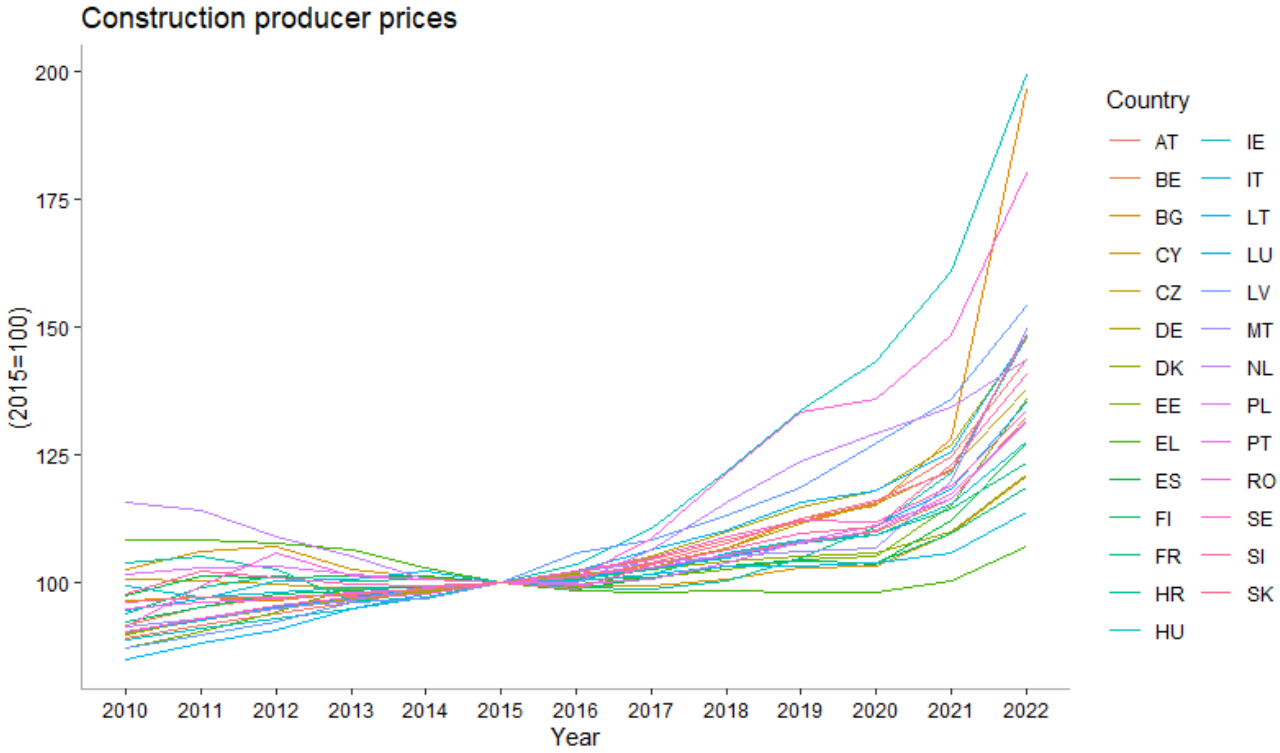

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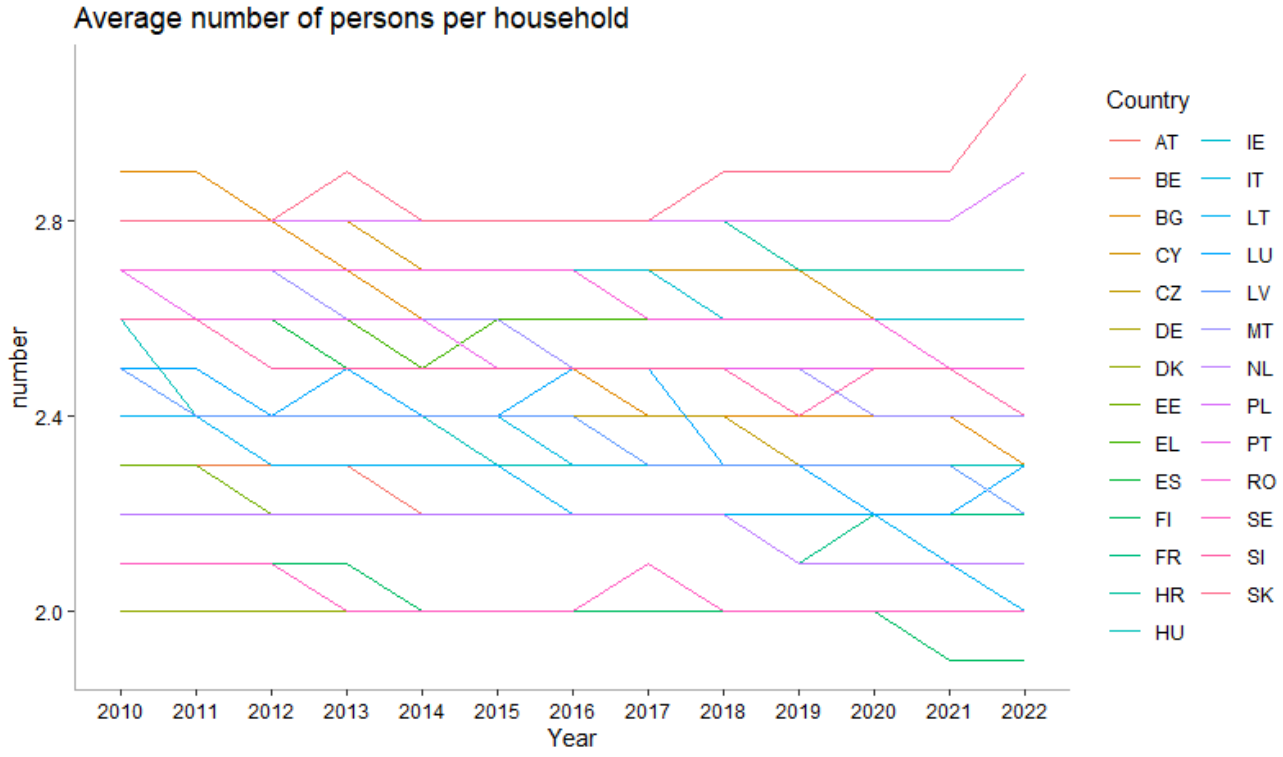

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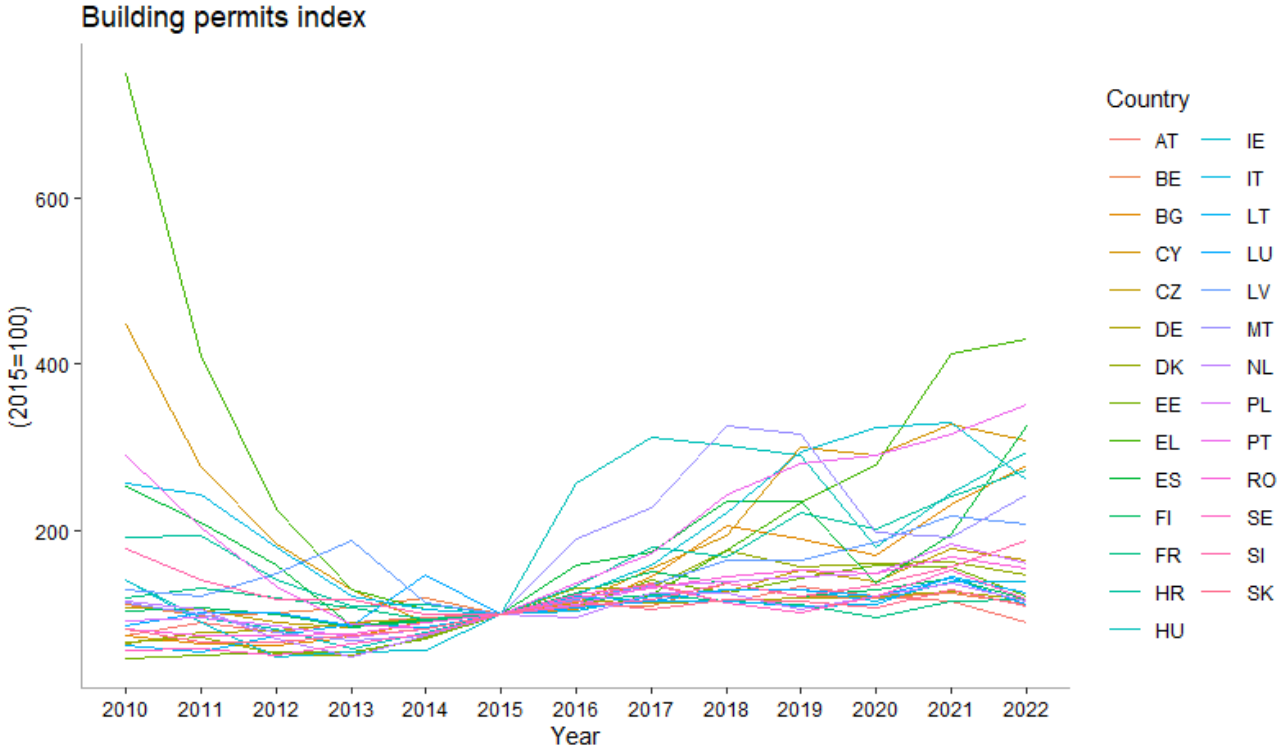

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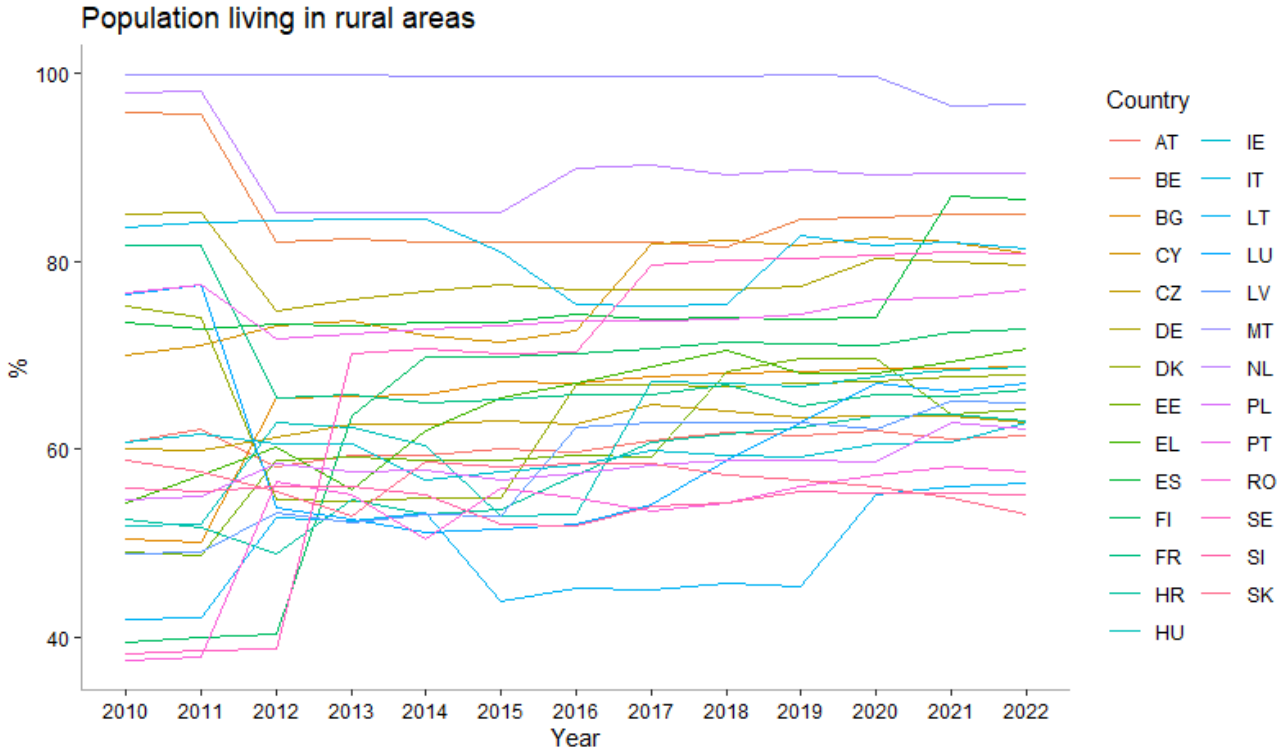

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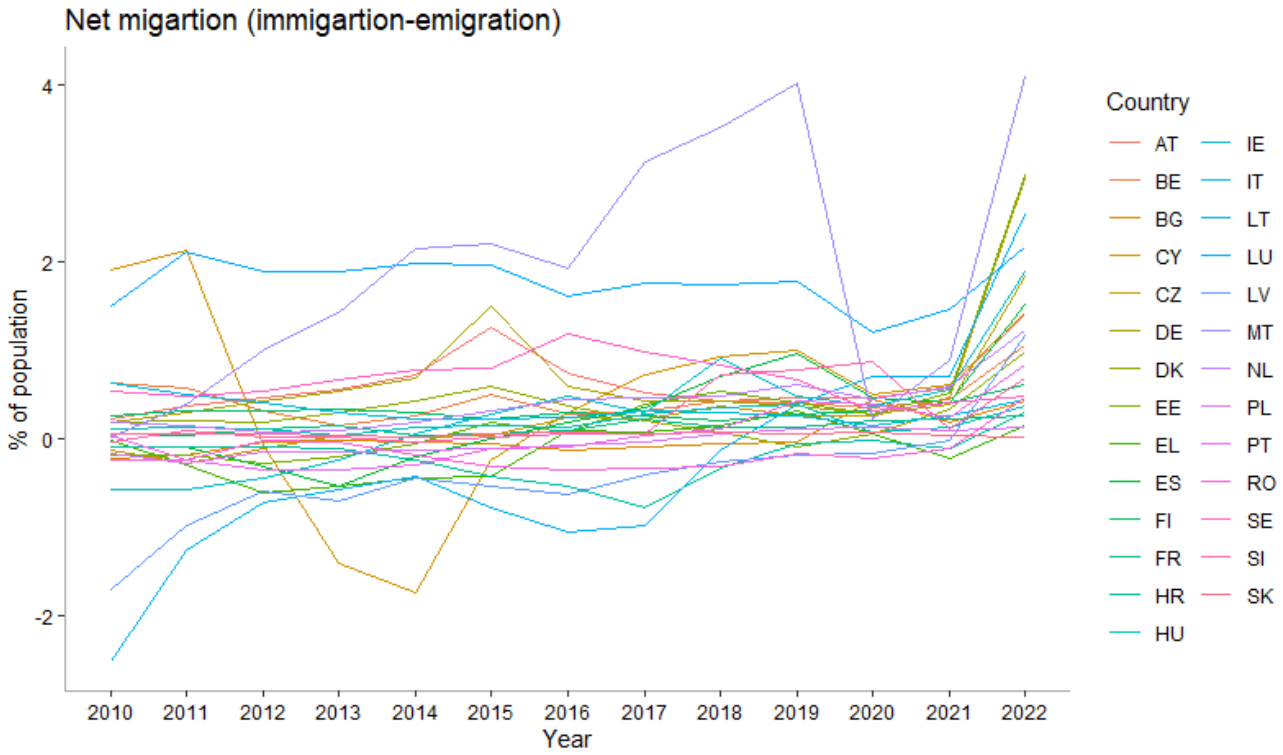

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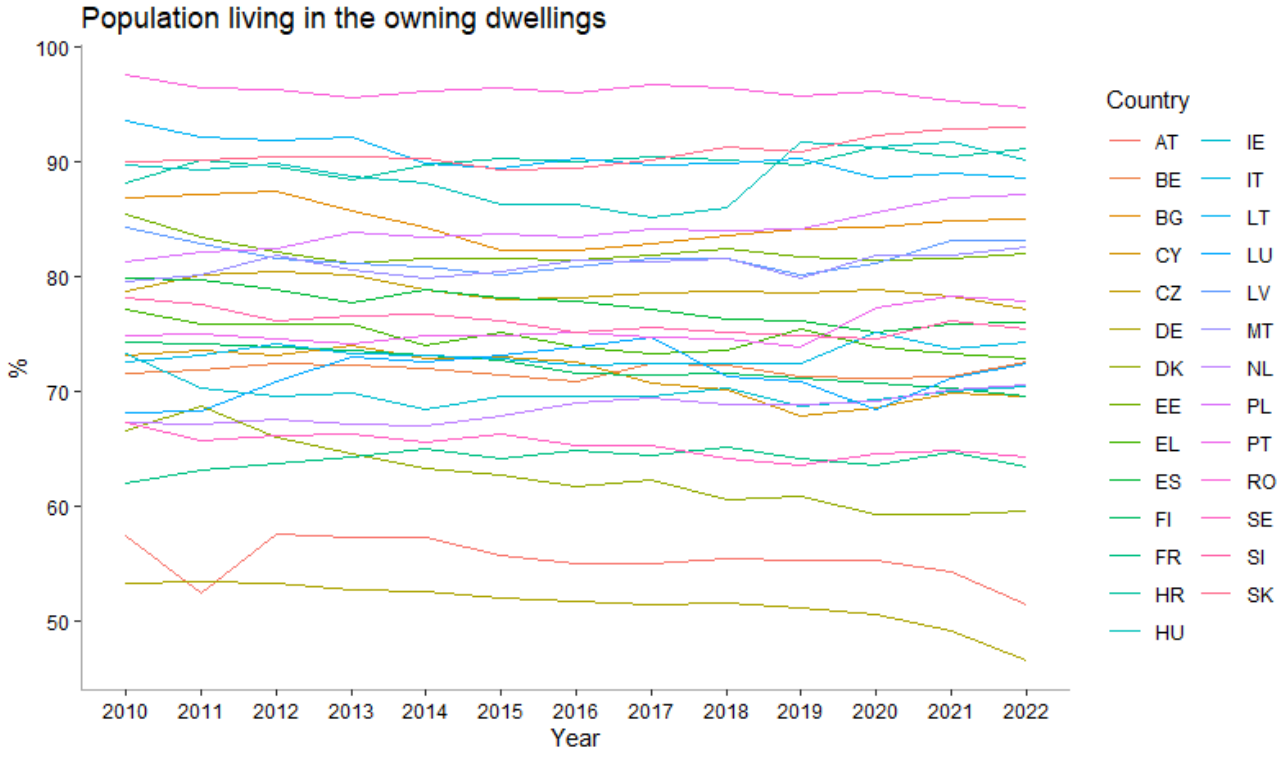


Figure 11:

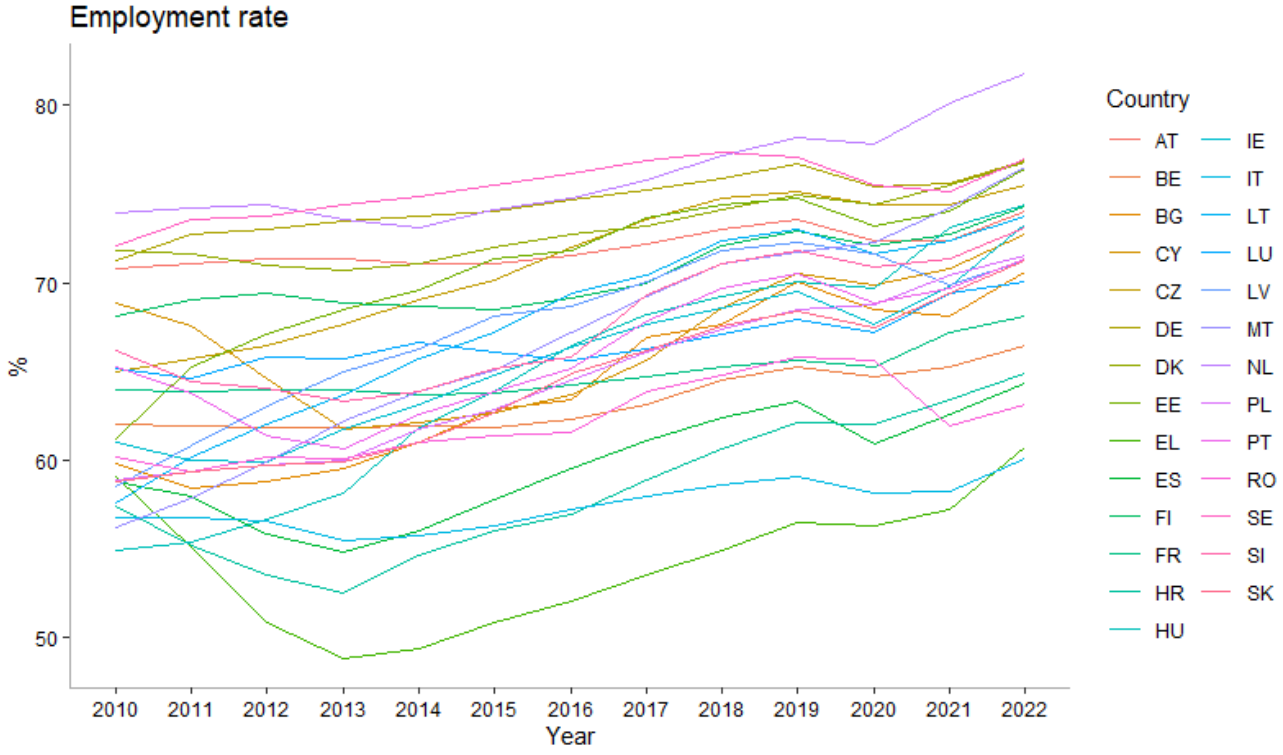


Table 3. Correlation matrix between housing affordability proxies and potential explanatory variables

	overburden	overburden 2	housing	H price index	construction	size	permits	urban	netmigration	ownership	Employment rate
overburden	1	.	.	.	.	.	.	.	.	.	.
overburden2	.91	1	.	.	.	.	.	.	.	.	.
housing	.92	.93	1	.	.	.	.	.	.	.	.
H price index	-.14	-.13	-.18	1	.	.	.	.	.	.	.
construction	-.13	-.13	-.15	.85	1	.	.	.	.	.	.
size	-.04	-.18	-.16	-.05	-.10	1	.	.	.	.	.
permits	-.01	-.04	-.12	.49	.33	.20	1	.	.	.	.
urban	-.04	-.08	-.11	.08	.10	-.20	.17	1	.	.	.
netmigration	-.23	-.22	-.32	.29	.27	-.20	.20	.38	1	.	.
ownership	-.08	-.23	-.17	.11	.11	.58	.08	-.36	-.27	1	.
Employment rate	-.32	-.14	-.15	.39	.38	-.61	.01	.15	.39	-.41	1

Source: author's calculation in RStudio using data provided by Eurostat

The highest and positive correlation (0.85) is noticed between house price index (2015 = 100) with respect of purchasing existing or newly built dwellings and construction producer price index of new residential buildings (2015=100), which was expected. For the same reason both variables will be omitted from panel analysis due to multicollinearity issue and because these prices are already embedded, although indirectly, in housing affordability indicators through mortgage payments. Variable “size” which measures the average household size, will be also omitted as it is almost time-invariant according to Table 3. Therefore, five variables will be used in explaining housing affordability when dealing with panel data analysis (building permits,

degree of urbanization, net migration, ownership and employment rate), while three housing affordability proxies will be swapped in the new panel model specification. All three potential indicators of housing affordability are extremely and positively correlated (0.91, 0.92 and 0.93) which gives as the reason to alternate with those indicators as dependent variables. In theoretical part of the paper is already explained why price-to-income ratio will not be used in this research due to its many drawbacks and cons, although it is mostly used in previous empirical studies. There is a lack of studies dealing with housing affordability indicators different than price-to-income ratio and hence this paper will contribute in filling this gap. Moreover, this research offers a comprehensive panel analysis with detailed explanations of all possible diagnostic checks in post-estimation phase, which many existing papers ignore. Finding the best fit panel model is not straightforward as well as concluding about variables which are most relevant in reducing the housing overburden or improving affordability.

3.2. Model specification

The observation units are typically spatial units denoted by i=1, 2, ..., N (countries, cities, households, companies, respondents, etc.).

Time units are equidistant time points or intervals represented by t=1, 2, ..., T (years, quarters, days, etc.).

There may be one or more independent variables indicated by j=1, 2, ..., k.

Each variable (whether dependent or independent) is represented by a column, and each observation unit i is repeated t times in chronological order.

Each observation unit (cross-sectional unit) is assigned an ID identifier, for example, numbers 1, 2, ..., N.

The identifier is necessary for the software to recognize that these are repeated measurements of the same observation units, i.e., panel data.

Advantages of panel data:

- Larger sample size of observations (NT) because historical data for multiple observational units are analyzed simultaneously
- Reduces the problem of multicollinearity, which is common in cross-sectional regression analysis
- Addresses the problem of biased estimated parameters due to omitted variables that should have been included in the model but were not (omitted variable bias)
- Parameter estimates are somewhat more precise than when limited to just spatial analysis or time series analysis, and interpretation can be generalized

Disadvantages of panel data:

- Missing values in certain years for at least one spatial unit make the panel data unbalanced
- Heterogeneity among observational units due to their specific characteristics
- Problem of endogeneity when the assumption of exogeneity is violated (independent variables are correlated with the errors of the relation, i.e., residuals, and they should not be)

When we use conventional OLS parameter estimates based on panel data, the model is called a **pooled panel model**, and the estimator is called pooled OLS.

The pooled OLS estimator provides biased parameter estimates because it ignores differences among countries due to their specific characteristics.

Although the specific characteristics of the observed countries are unobserved, they should be controlled for and included in the model using time-invariant factors.

In standard application, it is desirable to have balanced panel data with the condition $N > T$, and it is assumed that the parameters β_j do not change across countries i or years t.

Such a panel model with k independent variables is written as follows:

$$y_{it} = \beta_1 x_{1,it} + \beta_2 x_{2,it} + \cdots + \beta_k x_{k,it} + \alpha_i + u_{it} \quad (4)$$

Panel model (4) has parameters β_1, ..., β_k which are common to all observational units over multiple periods.

Factors that are unobserved α_i, and specific to each country individually, are not time-varying, hence they are called fixed factors or fixed effects.

Each α_i is a constant associated with an individual country, therefore the term β_0 is omitted from equation (4).

The model presented by equation (4) is called a **fixed effect panel model**.

Pooled Model vs. Fixed Effect Panel Model

If $\alpha_i = 0$ for each i, then panel model (4) becomes a pooled panel model:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \cdots + \beta_k x_{k,it} + u_{it}$$

In most cases, the use of a pooled OLS estimator provides biased and inconsistent parameter estimates due to problems of heterogeneity and endogeneity.

These problems can be partially resolved by including constants α_i.

A pooled panel model would be appropriate under the following assumptions:

- The error terms u_{it} are equally distributed with a mean of zero (assumption of normality).
- The variance of the error terms σ^2_u is constant both in time t and in space i (assumption of homoscedasticity).
- The error terms u_{it} are independently distributed across time units t and observation units i (assumption of independence).
- The error terms u_{it} are independent of Xs for every j, i, and t (assumption of exogeneity).
- Due to the heterogeneity of the observation units, we cannot expect the variance of the error terms to be constant.
- Due to repeated measurements of the same observation units, we cannot expect the error terms to be mutually independent.
- If the error terms u_{it} are indeed independent of $x_{j,it}$, the OLS method provides biased and inconsistent estimates if α_i are correlated with $x_{j,it}$.

3.3. Model estimation and findings

For each dependent variable 5 static panel models are estimated: (1) pooled model, (2) fixed model with individual effects, (3) random model with individual effects, (4) fixed two way model with individual and time effects, and (5) random two way model with individual and time effects. The first part of the table presents parameter estimates with standard errors in parenthesis, while the second part provides commonly used goodness of fit measures (coefficient of determination, Adjusted coefficient of determination, Akaike Information Criterion, Bayes Information Criterion, Root Mean Squared Error, etc.).

Table 4. Panel models results with share of housing costs in disposable income of low income households as housing affordability proxy

	(1)	(2)	(3)	(4)	(5)
(Intercept)	51.184***		57.424***		57.024***
	(5.796)		(5.353)		(5.389)
urban	-0.034	0.028	0.024	0.038*	0.025
	(0.025)	(0.018)	(0.018)	(0.018)	(0.017)
log(permits)	-0.999	-1.738***	-1.734***	-1.268**	-1.683***
	(0.674)	(0.397)	(0.389)	(0.431)	(0.392)
netmigration	-2.361***	0.034	-0.021	-0.255	-0.050
	(0.445)	(0.220)	(0.219)	(0.232)	(0.219)
employment	-0.145**	-0.272***	-0.265***	-0.212***	-0.264***
	(0.052)	(0.046)	(0.044)	(0.063)	(0.045)
ownership	-0.184***	-0.188**	-0.176**	-0.197**	-0.175**
	(0.031)	(0.072)	(0.058)	(0.074)	(0.059)
Num.Obs.	351	351	351	351	351

	(1)	(2)	(3)	(4)	(5)
R2	0.200	0.397	0.378	0.189	0.358
R2 Adj.	0.188	0.338	0.369	0.075	0.349
AIC	2174.3	1408.6	1439.8	1376.5	1435.1
BIC	2201.3	1431.8	1466.9	1399.7	1462.1
RMSE	5.25	1.77	1.84	1.69	1.83

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: author's calculation in RStudio using data provided by Eurostat

According to the information criterion's AIC and BIC fixed model with two-way effects is most appropriate indicating that building permits, employment and ownership reduce housing costs (and hence improves housing affordability), while degree of urbanization increases housing cost and consequently diminishes housing affordability. For example, a 1% increase of employment improves housing affordability on average by 0.197%. Likewise, a 1% increase of building permits improves housing affordability on average for 0.01268% (1.268/100) assuming all other variables are constant.

Contrary, housing affordability worsens by 0.038% if population living in urban areas increases by 1%.

Although negative, net migration is not statistically significant variable.

It should be noted that only building permits are taken into logs as variable which is not expressed in percentages, while other variables are.

A best fit model (4) is validated through diagnostic checking when comparing to other models.

In the context of panel data analysis, the F-test can be used to test the joint significance of individual effects (e.g., individual-specific effects, time effects or both) in a fixed effects model. It helps to determine whether including individual effects in the model significantly improves the model's fit compared to a model without individual effects (pooled panel model). Under the

null hypothesis it is assumed that all individual effects are equal to zero. If the null hypothesis is rejected, then the fixed effects model is preferable to the pooled model.

Two F-tests are conducted in this empirical research: a) to compare model (2) against model (1), and b) to compare model (4) against model (1).

Table 5. Testing the significance of individual and two ways effects

Effects	F statistic	df_1	df_2	p-value
Individual	95.789	26	319	<0.001
Two way	69.894	38	307	<0.001

Interpretation: The results show that both individual and two-way effects are statistically significant, suggesting that these models, which account for both individual and time effects, provide a better fit compared to models that do not include these effects.

Breusch-Pagan test (Lagrange Multiplier test) is used to check for constant variance assumption. Moreover, it can be employed to check if variance of individual effects is zero (the null hypothesis). If assumption of zero variance of individual effects is rejected it implies that random panel model is more adequate than the pooled model. Therefore two Breusch-Pagan tests are conducted, i.e. one for random model with individual effects and second for random two way model with individual and time effects, respectively.

Table 6. Testing the variance of individual effects as well as two ways effects

Effects	BP statistic	df	p-value
Individual	1431.3	1	<0.001
Two way	1432.4	2	<0.001

Interpretation: The results indicate that the null hypothesis (zero variance of individual effects) was rejected in both the random model with individual effects and the random two-way model. This suggests that a random panel model is more adequate than a pooled model because there are significant individual and time effects that vary.

Hausman test helps to decide between fixed effects and random effects models by testing the correlation between the individual effects and explanatory (independent) variables. The null hypothesis of the Hausman test assumes there is no difference between the random effects and the fixed effects, meaning that the random effects model is consistent and efficient. Rejection of the null hypothesis typically leads to the preference of the fixed effects model over the random effects model. Therefore two Hausman tests are conducted, i.e. one for comparing fixed and random models with individual effects and second for comparing fixed and random two way models.

Table 7. Comparing fixed and random effects estimates

Effects	Hausman statistic	df	p-value
Individual	12.34	5	0.0304
Two way	116.29	5	<0.001

Interpretation: The null hypothesis was rejected for both the individual effects and the two-way effects, suggesting that fixed effects models are more suitable.

Wooldridge test for serial correlation (Breusch-Godfrey) examines the existence of autocorrelation in the error terms, which violates the assumption of their independence. This assumption is tested for all models except the pooled model as it serves to determine the adequacy of other models.

Table 8. Testing the serial correlation of the error terms

Model	Effects	Wooldridge statistic	df	p-value
Fixed	Individual	97.472	13	<0.001
Random	Individual	112.07	13	<0.001
Fixed	Two way	107.11	13	<0.001

Random	Two way	112.33	13	<0.001

Interpretation: The results indicate significant serial correlation in all models except the pooled model. This means that the error terms are not independent across time, which could potentially bias the estimations if not addressed properly.

Test for cross-sectional dependence checks for correlation between the cross-sectional units in the panel data. One common approach is the Pesaran CD test.

Table 9. Testing for cross-sectional dependence in panels

Model	Effects	Pesaran CD statistic	*p*-value
Fixed	Individual	4.753	<0.001
Random	Individual	4.905	<0.001
Fixed	Two way	-0.149	0.8816
Random	Two way	3.959	<0.001

Interpretation: There is significant cross-sectional dependence in the random and fixed models with individual effects, and in the random two-way model, but not in the fixed two-way model. This suggests that for the fixed two-way model, the cross-sectional units behave independently of each other, making it a potentially more robust model in terms of dealing with cross-sectional independence.

Table 10. Panel models results for overburden rate of low income households as housing affordability proxy

	(1)	(2)	(3)	(4)	(5)
(Intercept)	47.515***		42.682***		42.702***
	(6.488)		(6.300)		(6.309)
urban	-0.018	0.044*	0.044*	0.051*	0.044*
	(0.028)	(0.021)	(0.021)	(0.022)	(0.021)
log(permits)	0.392	-2.480***	-2.296***	-1.997***	-2.298***
	(0.755)	(0.475)	(0.464)	(0.526)	(0.464)
netmigration	-1.389**	0.177	0.169	0.009	0.169
	(0.498)	(0.263)	(0.261)	(0.283)	(0.261)
employment	-0.378***	-0.193***	-0.212***	-0.206**	-0.211***
	(0.058)	(0.055)	(0.053)	(0.077)	(0.053)
ownership	-0.178***	-0.195*	-0.150*	-0.163+	-0.150*
	(0.035)	(0.087)	(0.069)	(0.090)	(0.069)
Num.Obs.	351	351	351	351	351
R2	0.180	0.299	0.283	0.164	0.283
R2 Adj.	0.168	0.231	0.272	0.047	0.273
AIC	2253.4	1534.0	1564.3	1516.1	1564.0
BIC	2280.4	1557.2	1591.4	1539.2	1591.0
RMSE	5.88	2.12	2.20	2.06	2.20

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: author's calculation in RStudio using data provided by Eurostat

Table 11. Testing the significance of individual and two ways effects

Effects	F statistic	df_1	df_2	p-value
Individual	82.452	26	319	<0.001
Two way	57.564	38	307	<0.001

Interpretation: The results indicate that both individual effects and two-way effects are highly significant, suggesting that these effects are crucial for explaining the variation in the dependent variable and should be included in the model.

Table 12. Testing the variance of individual effects as well as two ways effects

Effects	BP statistic	df	p-value
Individual	1415.3	1	<0.001
Two way	1416.3	2	<0.001

Interpretation: Both individual and two-way effects tests show extremely significant results, indicating the presence of substantial heterogeneity across individuals and time that a random effects model can capture.

Table 13. Comparing fixed and random effects estimates

Effects	Hausman statistic	df	p-value
Individual	6.142	5	0.2927
Two way	6.073	5	0.2991

Interpretation: Unlike the results from the first proxy, the Hausman test results here do not reject the null hypothesis, indicating no significant difference between the fixed and random effects estimates. This suggests that the random effects model is consistent and efficient for this data set, making it a suitable choice.

Table 14. Testing the serial correlation of the error terms

Model	Effects	Wooldridge statistic	df	p-value
Fixed	Individual	129.80	13	<0.001
Random	Individual	144.39	13	<0.001
Fixed	Two way	136.06	13	<0.001
Random	Two way	144.25	13	<0.001

Interpretation: Significant results across all models indicate that there is autocorrelation present, which can affect the reliability of standard errors and test statistics. This suggests that corrections for serial correlation might be necessary to ensure valid inference.

Table 15. Testing for cross-sectional dependence in panels

Model	Effects	Pesaran CD statistic	p-value
Fixed	Individual	2.152	0.0314
Random	Individual	2.304	0.2124
Fixed	Two way	0.889	0.3738
Random	Two way	2.301	0.0214

Interpretation: The results are mixed; the fixed effects model with individual effects shows significant cross-sectional dependence, while the fixed two-way model does not, suggesting that when both individual and time effects are modeled, the cross-sectional independence assumption might hold better.

Table 16. Panel models results with respect to overburden rate as housing affordability proxy

	(1)	(2)	(3)	(4)	(5)
(Intercept)	129.772***		134.709***		130.209***
	(16.869)		(14.752)		(14.831)
urban	-0.143*	-0.024	-0.025	-0.002	-0.018
	(0.072)	(0.048)	(0.047)	(0.047)	(0.046)
log(permits)	0.231	-1.435	-1.325	0.676	-0.488
	(1.963)	(1.062)	(1.040)	(1.127)	(1.058)
netmigration	-4.606***	-1.231*	-1.259*	-2.092***	-1.602**
	(1.294)	(0.590)	(0.583)	(0.607)	(0.586)
employment	-0.564***	-0.552***	-0.558***	-0.522**	-0.575***
	(0.150)	(0.122)	(0.118)	(0.165)	(0.126)
ownership	-0.640***	-0.813***	-0.729***	-0.764***	-0.713***
	(0.090)	(0.194)	(0.162)	(0.193)	(0.161)
Num.Obs.	351	351	351	351	351
R2	0.176	0.270	0.260	0.156	0.214
R2 Adj.	0.164	0.199	0.249	0.038	0.203
AIC	2924.2	2099.5	2126.8	2051.1	2105.9
BIC	2951.2	2122.7	2153.9	2074.3	2132.9
RMSE	15.28	4.73	4.91	4.42	4.76

	(1)	(2)	(3)	(4)	(5)

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Source: author's calculation in RStudio using data provided by Eurostat

Table 17. Testing the significance of individual and two ways effects

Effects	F statistic	df_1	df_2	p-value
Individual	115.58	26	319	<0.001
Two way	88.55	38	307	<0.001

Interpretation: The results show highly significant F statistics for both individual and two-way effects. This indicates that including these effects provides a significantly better fit for the model, highlighting their importance in explaining variations in housing cost burdens.

Table 18. Testing the variance of individual effects as well as two ways effects

Effects	BP statistic	df	p-value
Individual	1624.0	1	<0.001
Two way	1625.6	2	<0.001

Interpretation: The results are extremely significant for both individual and two-way effects, suggesting significant heterogeneity across both individuals and time that a random effects model can appropriately account for.

Table 19. Comparing fixed and random effects estimates

Effects	Hausman statistic	df	p-value
Individual	1.832	5	0.8718
Two way	130.1	5	<0.001

Interpretation: The test does not reject the null hypothesis for individual effects but rejects it for two-way effects. This suggests that the random effects model may be appropriate when considering individual effects alone, but the fixed effects model is preferable when considering both individual and time effects.

Table 20. Testing the serial correlation of the error terms

Model	Effects	Wooldridge statistic	df	p-value
Fixed	Individual	67.18	13	<0.001
Random	Individual	75.21	13	<0.001
Fixed	Two way	71.82	13	<0.001
Random	Two way	74.38	13	<0.001

Interpretation: Significant results for all models indicate the presence of serial correlation, suggesting that this issue needs to be addressed, possibly through model adjustments or using robust standard errors.

Table 21. Testing for cross-sectional dependence in panels

Model	Effects	Pesaran CD statistic	p-value
Fixed	Individual	6.221	<0.001
Random	Individual	6.310	<0.001
Fixed	Two way	-1.637	0.1017
Random	Two way	2.560	0.0105

Interpretation: Significant results for the fixed and random models with individual effects indicate the presence of cross-sectional dependence, which means that the error terms are correlated across entities. This can affect the independence of observations and should be considered when interpreting the model results. The fixed two-way model shows no significant cross-sectional dependence, suggesting more independence among entities in this model configuration.

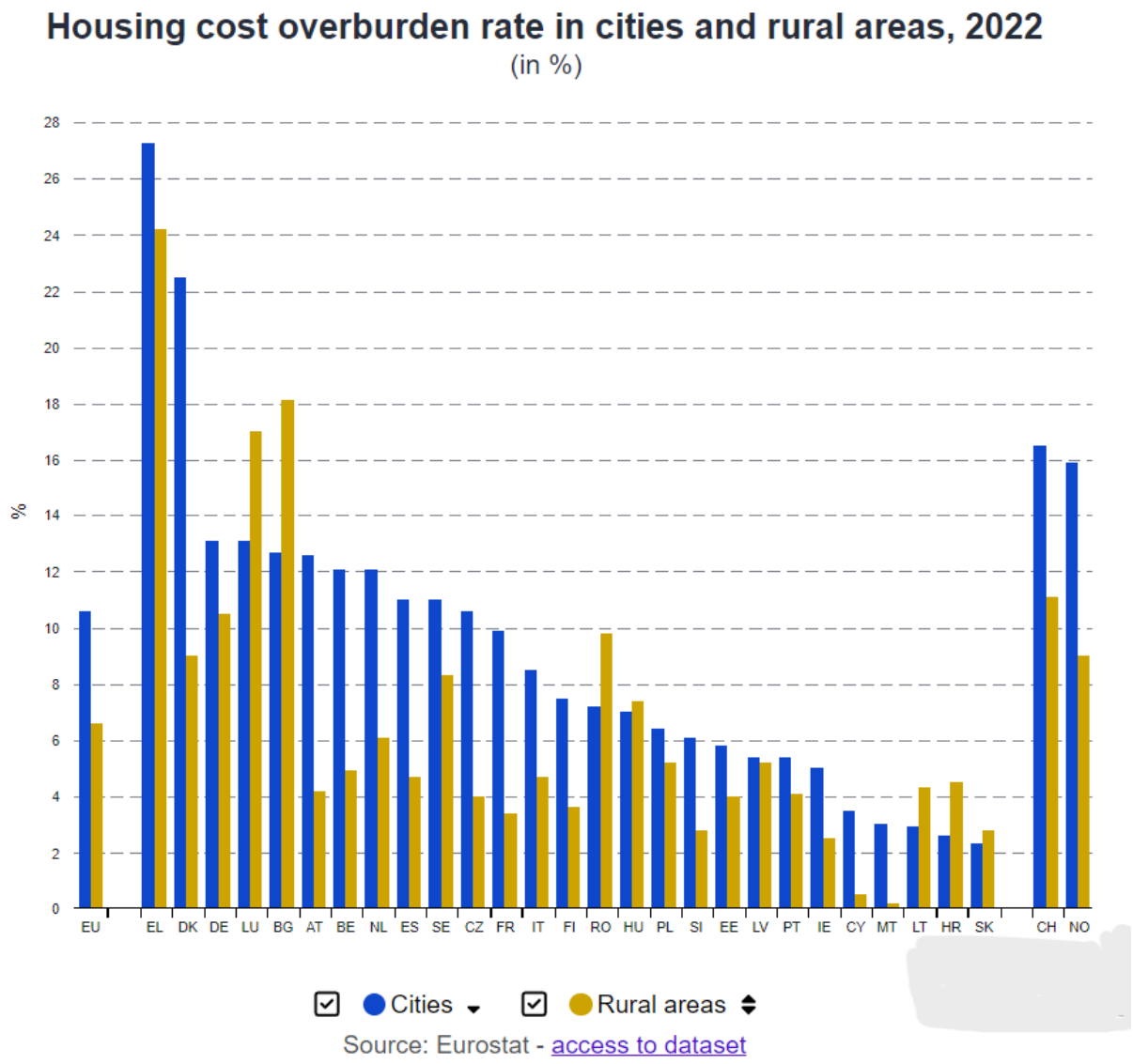
Table 22. Two way fixed effects models with robust standard errors (Driscoll and Kraay standard errors) considering three measures of affordability

	(1)	(2)	(3)
urban	0.038*	0.051*	-0.002
	(0.015)	(0.014)	(0.036)
log(permits)	-1.268**	-1.997***	0.676
	(0.302)	(0.463)	(0.635)
netmigration	-0.255	0.009	-2.092***
	(0.229)	(0.256)	(0.414)
employment	-0.212***	-0.206**	-0.522**
	(0.059)	(0.074)	(0.168)
ownership	-0.197**	-0.163+	-0.764***
	(0.109)	(0.101)	(0.220)
Num.Obs.	351	351	351
R2	0.189	0.164	0.156
R2 Adj.	0.075	0.047	0.038
AIC	1376.5	1516.1	2051.1
BIC	1399.7	1539.2	2074.3
RMSE	1.69	2.06	4.42

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: author's calculation in RStudio using data provided by Eurostat

According to the Eurostat interactive publication on housing in Europe (2023 edition), housing costs have shown significant variation across different EU countries. Below is a graphical representation of the housing cost overburden rate across different EU countries in 2022:



As depicted in this graph, the housing cost overburden rate varies significantly across the EU. Countries like Greece, Denmark, and Bulgaria have some of the highest rates, indicating that a substantial proportion of the population spends more than 40% of their disposable income on housing. Greece has the highest housing cost overburden rates in the EU. This can be attributed to the economic challenges the country has faced over the past decade, leading to reduced household incomes while housing costs remain high. Denmark's high housing costs are partly due to a strong demand for urban living, coupled with a limited supply of affordable

housing options. Bulgaria also shows a high overburden rate, which reflects a disparity between relatively low incomes and the rising costs of housing.

4. CONCLUSION

First, some limitations should be addressed. Limitation of this thesis is not using other explanatory variables, such as mortgage rate, because such data are not available for all EU members and all years of observation. Although standard requirements are fulfilled, having the number of cross-sections (N=27) greater than the number of time periods (T=13), this thesis deals with small panel (351 observations in total) and therefore panel data should be balanced and complete, at least to compensate for that deficiency. Another limitation is regarding the use of static panels, while the use of dynamic panels (accommodating not only serial correlation but also cross-sectional dependence) will be considered in future research. Of course, dynamic panel analysis requires another estimators which brings a new issues into the focus of research.

In conclusion, this thesis has comprehensively examined the multifaceted issue of housing affordability within the European Union. By analyzing the socio-economic, demographic, and institutional factors, the research has shed light on the intricate dynamics that influence housing affordability across different member states.

The empirical analysis revealed significant insights into how variables such as the housing price index, construction producer prices, average household size, building permits, urbanization, net migration, homeownership rates, and employment rates interact to shape housing affordability. However, the findings also indicate that housing affordability is not significantly influenced by any single factor. Instead, it appears to fluctuate independently, rising and falling in a manner that suggests other, perhaps more complex, underlying mechanisms are at play.

These results underscore the complexity of the housing market and suggest that housing affordability cannot be fully explained by traditional economic or demographic variables alone. This unpredictability highlights the necessity for a nuanced approach to policy-making. Effective housing policies should not only address the supply side by encouraging new construction and reducing regulatory barriers but also consider demand-side measures such as financial assistance for low-income households. However, demand-side interventions must be

carefully designed to avoid unintended consequences, such as inflationary pressures on housing prices.

Furthermore, the thesis highlighted the role of demographic trends, particularly urbanization and migration, in influencing housing markets. Policymakers need to account for these trends when designing strategies to ensure that housing supply meets the evolving needs of the population.

The study also pointed out the necessity for continuous monitoring and adaptation of housing policies to respond to changing economic and demographic conditions. Regular reviews and adjustments can help maintain a balance between housing supply and demand, ultimately enhancing affordability.

Overall, this thesis contributes to the body of knowledge on housing economics and provides valuable insights for policymakers, urban planners, and stakeholders involved in addressing the housing affordability crisis in the EU. By integrating theoretical concepts with empirical evidence, the research offers a robust framework for understanding the complexities of housing affordability and developing effective interventions to promote accessible and affordable housing for all.

This conclusion reaffirms the critical importance of addressing housing affordability through comprehensive, evidence-based policies that consider the diverse factors at play. Ensuring that all households have access to affordable housing is not only a matter of economic stability but also a fundamental aspect of social well-being and equity. Despite the unpredictable nature of housing affordability, continuous efforts in policy-making and strategic planning are essential to mitigate its impacts and promote long-term stability in the housing market.

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