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HOUSING GAP ESTIMATION IN POLAND'S HETEROGENEOUS HOUSING MARKET

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ARTICLE INFO

Keywords:

housing gap, regional heterogeneity, demographic change, housing shortage, conditional forecasting

JEL Classification:

R31, R21, J11, R58

ABSTRACT

National aggregate measures of housing shortages often obscure local disequilibrium, bundling heterogeneous markets and masking the coexistence of severe deficits and excess stock. Furthermore, the housing gap is affected by demographic and cultural changes, which need to be factored into any projection of it. To address these limitations, this article proposes a novel, empirically grounded framework for calculating and projecting the housing gap at the regional level. The model accounts for local demographic projections, immigration trends, and the adaptive responses of real estate developers. We apply this framework to Poland. Our analysis reveals that, as household growth reverses, market adjustment transitions from a return to equilibrium through new supply toward a rapid accumulation of uninhabited dwellings. Consequently, the resolution of the aggregate national housing gap is likely to coincide with widening spatial divergence between local markets. Rather than producing a deterministic forecast, this framework serves as a robust tool for structured conditional forecasting. By identifying where shortages are likely to persist and where oversaturation may emerge, it offers a comprehensive analytical foundation for examining market adjustment, development pressures, vacancy formation, and future house price developments.

Citation:
Ahead of Print

Borowski, J., Olipra, J. & Wałach, A. (2026). Housing gap estimation in Poland's heterogeneous housing market. *Real Estate Management and Valuation*, [Ahead of print]. https://doi.org/10.2478/remav-2026-0038

1. Introduction

Access to adequate housing is a basic condition of social security, household formation, and broader socioeconomic development. When households are unable to secure independent and acceptable housing, whether because dwellings are unaffordable, unavailable, or inadequate in quality, the inability to establish an independent household can become both a source of social tension and a barrier to development (Ermisch, 1999; Zavisca and Gerber, 2018; Rolfe et al., 2020; Hock et al., 2024).

Most existing research has approached this problem through the concept of the housing gap, usually understood as a discrepancy between the number of dwellings and the number of households, or more broadly between housing supply and housing demand at the country level. The aggregate perspective is useful, but it is also analytically limited. Housing supply differs by location, quality, and structure, while demand differs by income, household composition, migration

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

status, and residential preferences. Because housing is immobile, shortages and surpluses may coexist within the same national system. A country may experience shortages in metropolitan labor markets while accumulating excess stock in shrinking regions. National aggregates can therefore obscure local disequilibriums (Phillips & Joseph, 2017; Up For Growth, 2023).

Precise estimation of the housing gap becomes particularly challenging under conditions of demographic change. Even under population decline, the number of households may continue to grow because average household size falls and larger households split into smaller units, a process linked to the broader dynamics of the second demographic transition (Lesthaeghe, 2010; Esteve et al., 2024). At the same time, rising housing expectations tend to increase the effective demand for space and quality over time (Hembre et al., 2024), while internal migration and metropolitan concentration generate persistent geographical mismatches between where housing exists and where it is needed (Paciorek, 2013; Kang et al., 2024). In such conditions, measuring housing shortage through aggregate stock alone becomes increasingly inadequate. It may understate shortage in growing metropolitan and suburban areas, while simultaneously overlooking the emergence of vacant or underused stock in shrinking cities and peripheral regions.

We propose a framework for analyzing the housing gap that addresses these limitations and treats housing disequilibrium as spatially differentiated and structurally heterogeneous. Estimating the gap first at the regional level and only then aggregating it nationally makes it possible to capture the fact that geographically distant surpluses and shortages do not offset one another in any meaningful market sense. The framework links local demographic projections, temporary migration, average household size, residential construction, and the adaptive response of developers. It therefore allows us to examine not only whether a housing gap exists, but where it is likely to persist, where it is likely to close, and where the closing of shortages may be followed by the accumulation of uninhabited dwellings.

Empirically, we apply this framework to Poland, a particularly revealing case for analyzing housing-market adjustment under demographic uncertainty. Poland combines projected population decline, shrinking household size, a recent large-scale inflow of refugees from Ukraine (Czerniak, 2024; Głuszak, 2025), persistent housing shortages, metropolitan concentration, and a dynamic residential construction sector (Bryx, 2023). These features make it possible to observe how adverse demographic trends do not automatically eliminate housing shortages, and how the eventual reversal of household growth may transform the problem from one of insufficient supply into one of spatially uneven excess stock. The Polish case is therefore a setting through which to examine a broader problem: how housing systems adjust when demographic decline, migration shocks, and uneven development interact.

The article makes three contributions. First, it provides a spatially explicit framework for measuring housing disequilibrium in heterogeneous housing markets, avoiding the assumption that shortages and surpluses in different regions can be meaningfully netted out. Second, it integrates demographic and migration dynamics into the projection of local housing demand, distinguishing between permanent and temporary populations. Third, it shows that the closing of an aggregate national housing gap may coincide with growing divergence between local housing markets, as shortages persist in metropolitan areas while uninhabited dwellings accumulate in shrinking regions. In doing so, the article contributes to broader debates on housing market adjustment, forward-looking real estate market analysis under demographic uncertainty, and the spatially uneven consequences of demographic processes.

2. Literature review

The literature on the housing gap is conceptually diverse, with estimates depending heavily on how shortage is defined and at what spatial scale it is measured. One of the most used methods of estimating the housing gap is to calculate the difference between the number of dwellings and the number of households. For example, Phillips and Joseph (2017) examined the difference between housing supply and demand at the regional level in Australia by comparing the number of households with the number of dwellings. They emphasized the importance of disaggregating data at the regional level, as analyzing aggregated data at the national level may lead to significant local shortages being overlooked in the estimates. Similarly, McClure and Schwartz (2025) examined whether there was a housing gap in the metropolitan areas of United States by comparing changes in the number of dwellings and households between censuses. Another vacancy-based framework was introduced in a study by Moody's (2025), which estimated the housing shortage as the deviation of

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local vacancy rates for rental and sale properties from their historical averages.

The approach based on the number of dwellings and households has also been applied in studies of the Polish housing market. Kierzenkowski (2008) assessed the housing shortage in Poland using several complementary indicators, including the difference between the number of households and available dwellings at the aggregate national level. More recently, Kamiński (2019) examined the definitional and measurement problems associated with the housing gap and proposed an adjusted and localized approach to its estimation, which was empirically applied to the housing market of Wrocław. These studies demonstrate the established use of quantitative housing-gap measures in Poland.

Existing estimates also differ because they operationalize shortage in different ways. A study by the Canadian Office of the Parliamentary Budget Officer (OPBO, 2025) estimated and projected the size of the housing gap in Canada up to 2035. In this study, the gap was defined as the deviation of the total vacancy rate from its long-term historical average. Another concept of the gap was proposed by Corinth and Dante (2022), who defined "housing shortage" as the difference between the number of homes that would be built in the absence of supply constraints and the actual number of homes built. Their analysis employed a supply-and-demand framework together with county-level data on the share of land in the final price of housing.

Olaya et al. (2017) proposed a dynamic modeling approach to housing scarcity, focusing on Colombia rather than developed countries, and analyzing both quantitative deficits (fewer dwellings than households) and qualitative deficits (households living in inadequate conditions). Their model considered changes in the number of dwellings resulting from construction, demolition, and modernization.

A significant trend in the literature also examines the spatial mismatch between supply and demand for housing. Glaeser et al. (2006) show that differences in housing-supply elasticity affect whether positive local shocks are accommodated through population and housing-stock growth or instead capitalized into higher housing costs. Hsieh and Moretti (2019) studied the scale of labor misallocation between American cities and the associated total economic costs. According to their research, restrictive limits on the supply of new housing limit the number of workers in high-productivity cities mean that fewer workers can benefit from these labor markets and increased productivity, decreasing overall economic productivity. Tong (2024) examined the relationship between housing construction and housing shortages in American metropolitan areas, focusing on per capita housing production rates. He found significant variability between regions and noted that local markets often overreact to demographic changes. Areas with negative net migration tend to underinvest in new construction, perpetuating persistent housing shortages. Huang (2023) points out that while China's largest metropolitan areas face a significant and persistent housing shortage, many second- and third-tier cities have seen housing production far outstrip population growth, leading to a pronounced local oversupply of housing. Government attempts at alleviating these imbalances have been largely ineffective, and developers' responses to changing demand conditions have been too slow to solve the issue.

Spatial heterogeneity has also been highlighted in the Polish housing market. Łaszek et al. (2017) identified substantial regional differences in housing stock saturation and housing availability in Poland, showing that housing shortages are unevenly distributed across the country. Ciok and Ilnicki (2018) likewise reported pronounced spatial and temporal differentiation in residential construction activity, indicating that the development of the housing stock differs considerably between regions and types of settlement. Using data from Polish metropolitan housing markets, Głuszak and Trojanek (2024) further demonstrated that local housing markets respond differently to demand- and supply-side shocks, with adjustment patterns varying across markets of different sizes. At a more local scale, Blaszke et al. (2024) found considerable differences in demographic potential and housing-stock conditions among large and medium-sized cities in north-western Poland. Taken together, these findings indicate that the Polish housing market is characterized by substantial spatial heterogeneity in both housing demand and supply, reinforcing the need to analyze housing disequilibrium below the national level.

Another strand of research concerns the behavior of residential developers and the adjustment of housing supply to changing market conditions. In the Polish context, Łaszek and Olszewski (2014) model developer behavior under imperfect competition and demand uncertainty, showing that overestimation of demand and increasing competitive pressure may lead to a more elastic ex-post supply response and periods of

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

overproduction. Antczak-Stępniak (2015), examining development activity in major Polish cities, further demonstrates that the intensity of residential development is influenced by local economic and demand-side conditions, resulting in differentiated supply responses across local markets. More broadly, Łaszek and Olszewski (2023) apply an aggregate demand–aggregate supply framework to post-socialist housing markets, emphasizing the usefulness of modeling housing-market adjustment through interactions between changing demand and supply conditions. Most recently, Łaszek and Olszewski (2026) argue that the Polish development market is characterized by relatively flexible supply, partly because large and experienced developers maintain portfolios of construction permits that allow them to adjust the scale of new projects to current demand. Similar adaptive behavior has been examined internationally: developers' expectations affect land-acquisition and investment decisions (Leung, 2019), while differences in optimism under demand uncertainty may influence both the volume of housing construction and the accumulation of unsold inventory (Xu & Lai, 2018). Taken together, this literature indicates that residential construction should be treated as an adaptive process in which supply responds to expected and observed market conditions rather than following a fixed long-run trajectory.

Individual housing construction constitutes a particularly important component of housing supply in Poland and cannot necessarily be assumed to follow the same adjustment mechanism as profit-oriented development. Cesarski (2022) shows the importance of this dual structure, noting that developers and individual investors building single-family houses for their own use jointly accounted for more than 98% of dwellings completed during the COVID-19 pandemic, compared with approximately 96–97% in 2015–2019. Frącz et al. (2023) explicitly distinguish between construction undertaken by individual investors and housing built for sale or rent, identifying different seasonal patterns across building permits, construction starts, and completed dwellings. These differences indicate that the two segments are characterized by distinct investment and adjustment processes and therefore should not automatically be treated as behaviorally homogeneous components of housing supply. Moreover, Mach et al. (2020) demonstrate that residential construction in Poland is a multi-stage and lagged process in which building permits, construction starts, and completions are interrelated over time, further limiting the usefulness of assuming an immediate supply response to changing market conditions. The importance of distinguishing these supply mechanisms is further reinforced by substantial regional differences in housing-stock saturation and availability documented by Łaszek et al. (2017), since the relative role of different forms of construction may vary considerably across local housing markets.

In summary, while many methods were developed to study the housing gap and make projections of it, they have in general not provided a complex and robust framework. Thus, there is a need for a novel framework that would combine the strong points of previously used methods, while providing additional enhancements and increasing the flexibility of use.

3. Material and methods

The housing gap may be defined as the difference between the number of available dwellings and the number of households in each area. Dwellings are individual housing units, while households are defined as groups of people living together and supporting themselves jointly (in line with definitions adopted by Statistics Poland and Eurostat). Thus, the housing gap can be presented as:

$$HG_{t,a} = D_{t,a} - \hat{S}_{t,a} \quad (1)$$

where $HG_{t,a}$ denotes the housing gap in the area a in year t, $\hat{S}_{t,a}$ represents the supply of dwellings adjusted for uninhabited dwellings, and $D_{t,a}$ stands for the demand for housing. This definition assumes that each household occupies a separate dwelling, so a positive housing gap occurs when the number of households exceeds the number of available dwellings. Closing the gap does not imply that all households occupy housing that matches their needs or preferences, only that dwelling supply is not lower than the number of households. The analysis yields most insights when it is performed on both past data and future projections, providing a clear view of the direction in which the housing market is heading.

To improve the precision of housing gap estimation, it should be estimated on a regional level instead of operating on broad national aggregates. Nation-wide estimates may understate the disequilibrium because geographically distant surpluses and shortages do not offset one another. Analysis at the provincial level (first-tier administrative divisions) faces similar problems, as provinces usually contain nearly as much heterogeneity as the national level. The regional level using the middle-tier administrative divisions is usually the first one where regions are homogenous and their size in most cases allows inhabitants to reasonably commute

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between any two points, thus creating a shared housing market. Deeper analysis involving lower-tier administrative divisions (such as municipalities in the United States or communes in France) may be counterproductive, as due to short distances and ease of commute housing in neighboring municipalities can be easily substituted, and estimation on this level would needlessly divide a unified housing market (Jones, 2002; Watkins, 2001).

Furthermore, to enable a joint analysis of counties with similar housing-market characteristics, they can be distinguished and grouped into several segments. Key groups that should be distinguished are the biggest cities, their suburbs, medium cities, and the remaining small towns and the countryside. For some countries, it may also be useful to treat a particular area as a distinct segment due to its unique and impactful characteristics (e.g. Upper Silesian Metropolitan Area in Poland).

3.1. Demand side

Housing demand can be defined as the total number of households, divided into two main groups: households formed by the permanent population (citizens and immigrants with the right of permanent residence) and households formed by the temporary population (immigrants holding various temporary residence permits).

The first component of demand is the number of households formed by the permanent population. Their number is estimated as the quotient of the permanent population of a given area and the average household size in that area:

$$HSP_{t,a} = \frac{PP_{t,a}}{\alpha_{t,a}} \quad (2)$$

where $HSP_{t,a}$ denotes the number of households formed by permanent residents in year t in area a, $PP_{t,a}$ represents the permanent residents and $\alpha_{t,a}$ represents the average household size.

In the empirical application, data on the number of permanent residents in Poland comes from Statistics Poland and the projected population is based directly on the official population forecast for 2023–2060 (Statistics Poland, 2023). Unlike the Polish population described above, the average number of households in individual counties required estimation, as data on this subject are published only as part of the National Censuses (NSP). In addition, the data published by Statistics Poland as part of the 2021 NSP were significantly higher than the national estimates published annually by Statistics Poland, suggesting that there was an increase in the average household size between 2011 and 2021. We therefore concluded that the data from NSP 2021 are likely to be affected by temporary effects related to the COVID-19 pandemic and thus chose the data from NSP 2011 as our starting point.

To obtain estimates for subsequent years, we first used provincial data for 2011–2016 and then the 2016 forecast by Statistics Poland. So far, the forecast has aligned well with data, so despite the passage of time, we believe it remains reasonably accurate and should be sufficient, in absence of newer projections. Although uncertainty increases with the forecast horizon, household structures generally evolve gradually, and structurally based household projections can retain substantial predictive value over long horizons (Zeng et al., 2013; Keilman, 2017). The forecast takes into account separate paths of the projected size of households for cities and rural areas, broken down by voivodship. We assumed that in individual counties, the path of change in the projected size of households (understood as first differences) is the same as for the voivodship in which the county is located. Additionally, in order to take advantage of the availability of separate paths for cities and rural areas, these two paths were combined using a weighted average for each district, where the weight was the urbanization index. This allowed for a better fit of the estimates to the divergent trends within the provinces. Thus, the average household size can be denoted as:

$$\alpha_{t,a} = \alpha_{2011,a} + \left(\alpha_{2016,w} - \alpha_{2011,w}\right) + \Delta\alpha_{t,w}^{urban} * u_a + \Delta\alpha_{t,w}^{rural} * (1 - u_a) \quad (3)$$

where $\alpha_{t,p}$ corresponds to the average household size in year t in county a, $\alpha_{t,w}$ denotes the average household size in year t in voivodship w, $\Delta\alpha_{t,w}^{urban}$ relates to the cumulative change of average household size in urban areas in years 2016-t in voivodship w, $\Delta\alpha_{t,w}^{rural}$ denotes an analogous change in the rural areas of voivodship w, whereas u_p represents the urbanization coefficient in county a.

Households formed by the temporary population (immigrants holding temporary residence permits) constitute the second component of the aggregate housing demand. Their number is estimated as the quotient of the temporary population of a given area and the average household size in that area:

$$HST_{t,a} = \frac{PT_{t,a}}{\alpha_{t,a}} * \beta_a \quad (4)$$

where $HST_{t,a}$ denotes the number of households formed by temporary residents in year t in area a, $PT_{t,a}$ represents the number of temporary residents, $\alpha_{t,a}$

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

corresponds to the average household size (see above) and β_a is a parameter describing the participation of temporary households in the housing market. Parameter β_a is necessary, as a significant portion of temporary residents uses various alternatives to regular dwellings, such as worker barracks and quarters provided by the employer, and as such, not all immigrants participate in the general housing market, and theimpact of migrants on the property prices is limited (d'Albis, 2018).

In the case of Poland, detailed data on the population of temporary residents are only available in the 2021 National Census. They can, however, be scaled forward based on the data on foreigners working in Poland, published monthly by The Social Insurance Institution (ZUS). In absence of more accurate data, assuming a relatively stable spatial distribution of migrants and their labor force participation rate, it can be presumed that their population grew in line with the number of foreigners working in Poland. As there are no official projections for the future size of the temporary population, one has to rely on assumptions. After the fast growth during years 2015-2025, we believe that there is no space for a significant further influx of immigrants to Poland, which is evident from the migration strategy adopted by the government, which assumes a significant tightening of the migration policy (Council of Ministers of the Republic of Poland, 2024). For this reason, we believe that the total immigrant population will show a slight downward trend. According to the Statistics Poland's forecast, the population of immigrants residing permanently in Poland will grow, so the decline in the total immigrant population will mainly manifest itself in a decrease in the number of people with temporary residence permits. Thus, the trajectory of the temporary population in Poland can be described as follows:

$$PT_{a,p} = w_a * \left((1+\varphi) * \sum PT_{t-1,a} - IPS_a\right), for\ t > t_0 \quad (5)$$

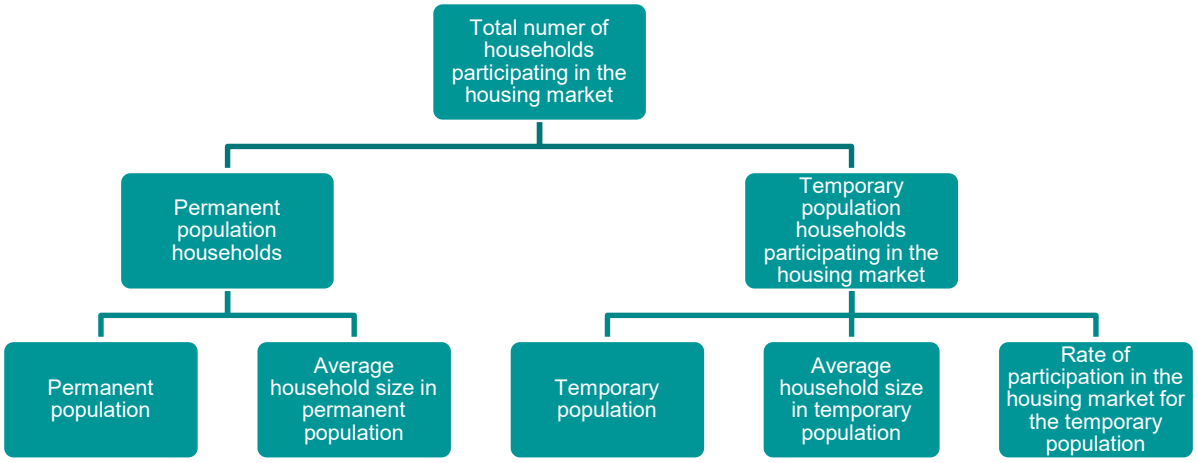
where $PT_{t,a}$ denotes the population of temporary residents in year t in area a, w_a corresponds to the share of area a in the overall population of temporary residents, φ reflects the slight downward trend we have assumed for the total temporary population (a value of -0.5% has been adopted), which we justify by Poland's tightening of its migration policy and the simultaneous outflow of some temporary immigrants), and IPS_t denotes immigration, i.e. the change in the residence status of some immigrants, from temporary to permanent in year t.

It follows that the total demand is a sum of the two household populations calculated above:

$$D_{t,a} = HSP_{t,a} + HST_{t,a} \quad (6)$$

where $D_{t,a}$ stands for the aggregate demand for dwellings in year t in area a, $HSP_{t,a}$ represents the number of households formed by permanent residents and $HST_{t,a}$ denotes the number of households formed by temporary residents.

It is necessary to deal with those two segments of population separately, as they possess different characteristics. The permanent population is, in most cases, well documented, and its changes are predictable, allowing for precise demographic projections. The temporary population is often much harder to precisely estimate, especially on a local level. Its changes are also much more unpredictable, as economic and political factors can lead to large changes, with a possibility of large shocks like a refugee crisis or mass deportation. Due to these factors, while numerous long-term projections of the permanent population are available for most countries, they seldom include the future temporary population.



Graph 1. Demand side framework. *Source*: own study.

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3.2. Supply side

The supply side of the housing gap may be defined as the stock of dwellings adjusted for uninhabited units. The main challenge on this side of the framework is that not all dwellings recorded in the housing stock constitute effective housing supply. A certain share of units remains uninhabited for structural or frictional reasons, including search frictions in rental markets, temporary renovation, use for non-residential purposes, unresolved ownership issues, or poor technical condition. For this reason, the observed housing stock should be adjusted by excluding the baseline share of uninhabited dwellings.

The adjusted housing supply for past periods can therefore be written as:

$$\hat{S}_{t,a} = S_{t,a} * (1 - \tau_a), for\ t \leq t_0 \quad (7)$$

where $\hat{S}_{t,a}$ denotes the supply of dwellings adjusted for uninhabited dwellings in area a in year t, $S_{t,a}$ corresponds to the overall stock of dwellings, τ_a depicts the share of uninhabited dwellings in the housing stock, and t_0 is the starting year of the projection. In the empirical analysis, the number of dwellings comes from Statistics Poland local data bank, whereas the share of uninhabited dwellings is based on NSP 2021 data.

The projection of the housing gap relies on a future supply model based on the response of residential construction to changing local housing-market conditions. The projection distinguishes between market-oriented and individual housing construction. Market-oriented construction comprises dwellings built primarily for sale or rent, whereas individual construction refers to dwellings built predominantly for the investor's own use. Other forms of housing construction (cooperative, municipal, social rental, and company housing) have had only a marginal impact in recent years, accounting for just 2.7% of dwellings completed between 2015 and 2024. As such, they can be safely aggregated with market-oriented construction. This distinction is relevant in Poland, where individual construction remains an important component of housing supply and exhibits different dynamics from developer activity (Ciok & Ilnicki, 2018; Frącz et al., 2023). Individual construction is particularly important in the countryside, small towns and suburbs, whereas cities are dominated by construction for sale or lease, particularly the largest ones.

For each area, the historical construction rate is therefore divided into market-oriented and individual construction according to their observed shares in completed dwellings. Until the local housing gap is eliminated, both components increase effective housing supply, so their sum remains equal to the historical construction rate used in the baseline model. This preserves persistent differences in local construction capacity and development patterns while abstracting from short-term cyclical fluctuations.

Once the housing gap has been eliminated, however, the two components are treated differently. Market-oriented construction is assumed to adjust adaptively to subsequent housing demand. If the number of households increases, the housing stock can expand accordingly, whereas a decline in the number of households does not lead to a corresponding reduction in the physical housing stock, reflecting the durability of housing and the absence of costly large-scale demolition (Glaeser & Gyourko, 2005). Owners of vacant houses are also known to retain them despite weak redevelopment potential or a lack of buyers (Kanayama & Sadayuki, 2021), so declining local demand is expected to translate primarily into higher vacancy rates rather than rapid stock reduction.

Individual construction, by contrast, may continue even after the quantitative housing shortage has disappeared. Households may prefer newly constructed dwellings because of their quality, location, size, energy efficiency, or other characteristics even when older dwellings are technically available. Continued individual construction in a saturated market is therefore treated primarily as the replacement, renewal, or qualitative upgrading of the existing housing stock. This does not imply that individual construction ceases; rather, the occupation of a newly built dwelling may be accompanied by the withdrawal or reduced use of an older one. Consequently, individual construction after gap closure is assumed to be neutral with respect to the net effective housing stock used in the housing-gap calculation.

These relationships can be expressed as follows:

$$S_{t,a} = S_{t-1,a} + C_a^{M} * \left(1 - Surplus_{t,a}\right) + C_a^{I} * \left(1 - Surplus_{t,a}\right) + \max(\Delta D_{t,a} * \left(Surplus_{t,a}\right), 0), for\ t > t_0 \quad (8)$$

where $S_{t,a}$ denotes the overall stock of dwellings in year t in area a, C_a^M and C_a^I respectively denote the baseline annual rates of market-oriented and individual construction, $Surplus_{t,a}$ is a binary indicator of a housing surplus, $\Delta D_{t,a}$ denotes the first difference of the demand for housing (see above) and t_0 is the starting year of the projection. The max operator implies that, once surplus emerges, the housing stock

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

responds to increases in the number of households but not to decreases, so excess dwellings are retained in the stock rather than removed. In the empirical analysis, C_a^M and C_a^I are calculated as average number of dwellings constructed by each type of investors over the last 12 years in each area, based on Statistics Poland local data bank data.

The surplus indicator may be defined as a binary variable identifying whether adjusted housing supply exceeds demand in a given area. Once a surplus appears, the indicator remains equal to 1 in all subsequent periods:

$$Surplus_{t,a} = \begin{cases} 1; if\ (\hat{S}_{t-1,a} > D_{t-1,a}) \vee (\exists\, T \in (1, t-1), Surplus_{T<t,a} = 1) \\ 0;\ if(\hat{S}_{t-1,a} \leq D_{t-1,a}) \wedge (\forall\, T \in (1, t-1), Surplus_{T<t,a} = 0\ ) \end{cases} \quad (9)$$

where $Surplus_{t,p}$ denotes the surplus indicator in year t in area a, $\hat{S}_{t,a}$ corresponds to the supply of dwellings adjusted for uninhabited dwellings, and $D_{t,a}$ is the housing demand.

The projection of adjusted housing supply differs from that of total housing stock. Since the baseline share of ordinary uninhabited dwellings is assumed to remain constant, new construction is scaled down accordingly when calculating effective supply. In addition, once the housing gap has been closed, any subsequent decline in the number of households reduces adjusted supply rather than total stock, because some dwellings cease to be occupied and become part of the uninhabited stock. This can be written as:

$$\hat{S}_{t,a} = \hat{S}_{t-1,a} + C_\alpha^M * (1-\tau_a) * \left(1 - Surplus_{t,a}\right) + C_\alpha^I * (1-\tau_a) * \left(1 - Surplus_{t,a}\right) + \Delta D_{t,a} * \left(Surplus_{t,a}\right),$$

$$for\ t > t_0 \quad (10)$$

where $\hat{S}_{t,a}$ corresponds to the supply of dwellings adjusted for uninhabited dwellings in year t in the area a, , C_a^M and C_a^I respectively denote the baseline annual rates of market-oriented and individual construction, τ_a is the baseline share of uninhabited dwellings in the housing stock, $Surplus_{t,a}$ denotes the surplus indicator, and $\Delta D_{t,a}$ is the first difference in housing demand. Unlike the equation for total housing stock, this specification does not truncate negative demand changes once surplus is present. As a result, when the number of households declines in a surplus market, adjusted supply also declines, as a growing share of dwellings becomes uninhabited.

The model assumes that developers' expectations are adaptive (Leung, 2019; Xu, 2018). When local shortages persist, construction continues at its typical pace. Once supply begins to exceed demand, construction activity slows markedly, the absorption period for new units lengthens, and additional dwellings increasingly feed into the stock of uninhabited units rather than into effective housing supply. At the same time, the elimination of the housing gap does not imply a complete cessation of residential investment. New construction may still take place for replacement, renewal, or quality upgrading, but such activity is neutral with respect to the effective dwelling stock as defined in this framework. Detailed assumptions regarding dwelling supply are presented in the diagram below.



Graph 2. Supply side framework. *Source*: own study.

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Given the assumption-heavy character of the framework, sensitivity analysis is a necessary part of its application. In addition to the baseline projection, alternative low and high scenarios for both housing demand and housing supply should be specified. These scenarios ought to focus on the most uncertain components of the forecast, such as future immigration, the size of the temporary-resident population, and the rate of residential construction. Where substantively relevant, they may also incorporate alternative assumptions regarding housing-stock attrition, for example due to accelerated depreciation of ageing dwellings or region-specific exposure to natural disasters. In this way, the framework does not aim to produce a single deterministic forecast, but rather to identify the range of plausible trajectories of housing disequilibrium under different assumptions.

4. Results

To test the framework on empirical data, we have chosen to use it for estimating the housing gap in Poland. Poland was chosen as the empirical test case because it provides a particularly revealing setting for this framework. It combines severe demographic deterioration with a persistent housing shortage that has not disappeared despite periods of strong residential construction. Population decline, ageing, shrinking household size, as well as the large and concentrated inflow of refugees from Ukraine are transforming the regional structure of housing demand rather than merely lowering it. At the same time, the rapid growth of a large temporary-resident population means that standard demographic projections do not fully capture actual housing demand. The application of the model should help determine whether the housing market is likely to reach saturation and, if so, the pace at which this process is expected to occur in each part of the country. The analysis was performed on the level of counties, which are the second-tier administrative divisions in Poland.

In terms of analysis across segments, seven groups of areas were created. The largest cities (more than 500,000 inhabitants), suburbs of the largest cities (typically neighboring counties), large cities (150,000–500,000 inhabitants), suburbs of large cities, medium-sized cities (county-status cities with fewer than 150,000 inhabitants), the Upper Silesian urban area, and lastly, remaining small-town and rural counties. Compared to baseline guidelines, this means that an additional group is created for the six largest cities, which serves to capture their divergence from other large cities.

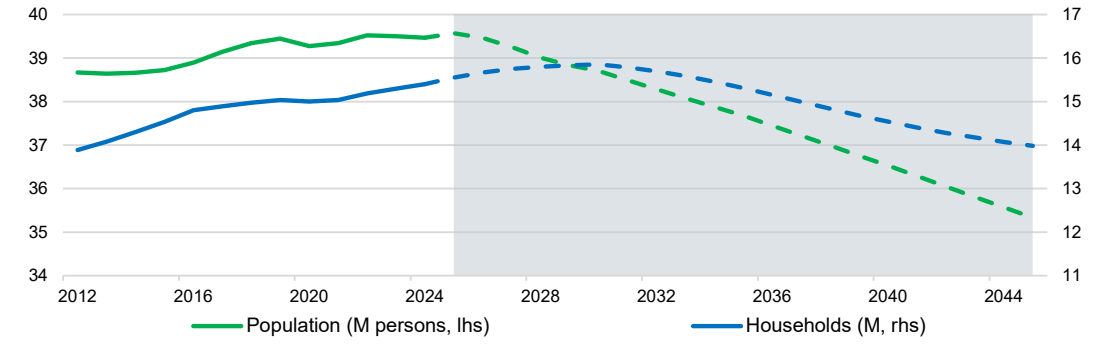


Fig. 1. Demographics of Poland (including temporary immigrants). *Source:* Statistics Poland, own calculations.

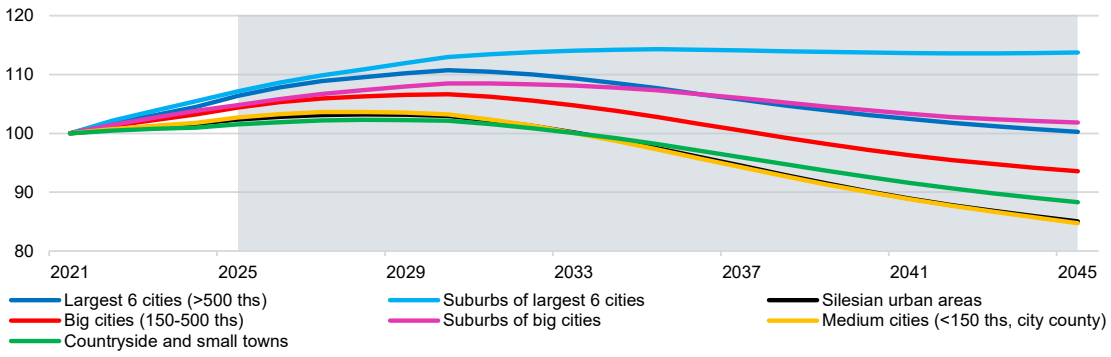


Fig. 2. Household number forecast (2021=100, incl. temporary immigrants) *Source:* Statistics Poland, own calculations.

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

Figure 1 presents the demographic assumptions underpinning the baseline projection. Poland's total population is projected to decline continuously, from 39.5 million in 2024 to 35.2 million in 2045 (including immigrants without the right of permanent residence). The number of households follows a different path: it continues to increase in the short run, peaking at 15.8 million in 2030, before declining to 15.3 million in 2035 and 14.0 million in 2045. When it comes to the estimated housing gap, at the starting point in 2024, it amounts to 1.3 million dwellings, or around 8.5% of households, and covers most of the country. The average household size has been steadily shrinking for many decades at this point, and this trend will enable the number of households to grow even as the population starts to fall. However, as stated in the official household size projection (Statistics Poland, 2016), the room for further decline is limited, as cultural changes and the rise in the number of singles have largely run their course, while a growing number of widowed elderly persons will soon no longer be able to lead an independent one-person household as their health deteriorates with age. Due to these reasons, the projection states that the average household size should stabilize around 2032.

Figure 2 shows that the projected demographic adjustment is highly uneven across county types. The only segment in which the number of households continues to grow throughout the entire horizon to 2045 is the suburban belt of the six largest cities. The six largest cities themselves and the suburbs of large cities also perform relatively well: in both groups, the decline begins late and remains mild, so that by 2045 the number of households stays close to the 2024 level. By contrast, the strongest declines are projected in the Upper Silesian urban area and in medium-sized county-status cities. The category of small-town and rural counties is internally heterogeneous: the sharpest declines are concentrated in the eastern and northern borderland counties, while relatively mild declines are observed in counties adjacent to major agglomerations or benefiting from favorable locations, such as areas with high tourism.

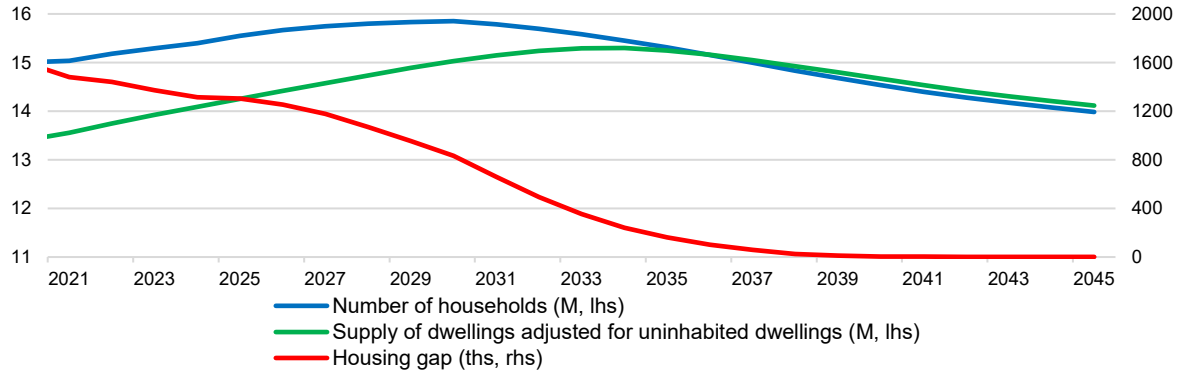


Fig. 3. Housing gap projection. *Source:* Statistics Poland, own calculations.

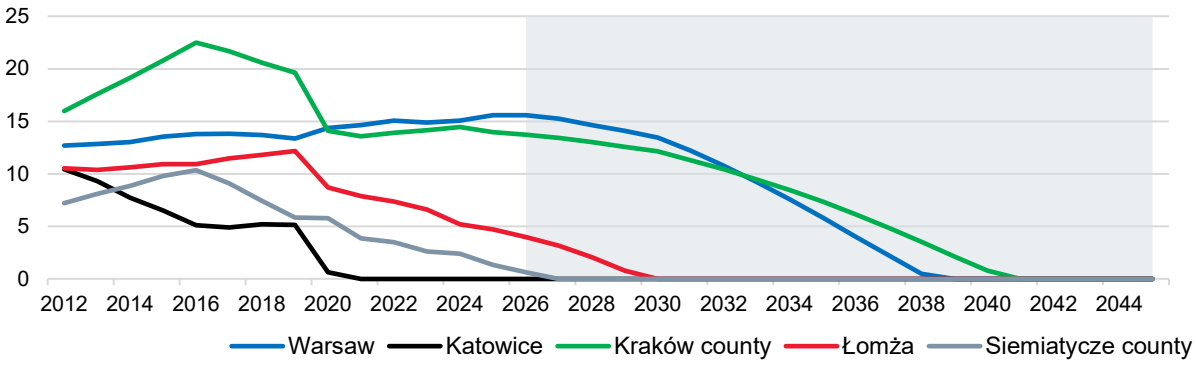


Fig. 4. Household gap (% of households) in selected counties. *Source:* Statistics Poland, own calculations.

Figure 3 indicates that the turning point occurs *around* 2030, when the number of households reaches its local maximum and the adjustment mechanism begins to change. In the first decade of the projection, the housing gap is reduced mainly through new construction. As a result, the shortage falls from 1.31

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million dwellings in 2024 to 153 thousand in 2035. The median county closes its housing gap in 2033, and by 2035 the shortage will have been eliminated in more than three quarters of counties. At the same time, the decline in household numbers has already begun to generate a growing stock of excess uninhabited dwellings, which reaches 484 thousand in 2035.

In the second decade of the projection, a structural shift takes place. Housing shortage falls to near zero around 2039, but this is accompanied by a sharp increase in uninhabited dwellings rather than by a stable equilibrium. Annual housing supply growth slows markedly and falls below 10 thousand dwellings per year by 2040, while the number of excess uninhabited dwellings rises from merely 4 thousand in 2024 to 1.7 million in 2045. As a result, the total stock of uninhabited dwellings increases from 1.9 million to 3.8 million, while the total share of uninhabited dwellings in the housing stock rises from 12% in 2024 to 21% in 2045.

The speed of transition varies between different types of regions. The lowest shares of uninhabited dwellings are projected in the suburban counties surrounding the largest metropolitan centers, where continued household growth in most cases prevents the emergence of excess stock (see Kraków county, Figure 4). Large, economically important cities will also see the gap closing relatively late, as seen in Warsaw. At the other end of the distribution are structurally weaker urban and non-metropolitan areas, particularly the Upper Silesian metropolitan area (see Katowice), medium-sized cities (see Łomża), and peripheral rural counties (see Siemiatycze county). In such areas, the share of excess uninhabited dwellings may become very high, reaching over 30% of the total housing stock. The Appendix presents projections for housing demand, housing supply, and the stock of vacant dwellings in selected regions of Poland.

The projected transition depends most strongly on migration and construction assumptions, so the next step is to test how sensitive the results are to alternative demand-side and supply-side paths. As recommended in the methodology, two alternative scenarios were prepared for the demand side and two for the supply side, creating a low and a high variant in both cases, which together give four alternative scenarios (see Table 1).

The demand-side scenarios show an asymmetric effect of migration assumptions. In the low-demand variant, the results of substantially weaker permanent immigration (25% of original forecast) and a fall of the temporary immigrant population to 0.5M compared to 1.0M in the baseline scenario were analyzed. The results were surprisingly mild, accelerating the closing of the housing gap by just one year, with no substantial difference in the shortage of dwellings by the midpoint of the projection. At the same time, the low-demand scenario likely understates the potential downside risk, as it does not consider that many immigrants are employed in the construction sector, and their absence would likely constrain its output, thus deepening the housing gap. By contrast, the high-demand variant produces a much larger divergence: the housing gap remains at 354 thousand dwellings in 2035 and 2 thousand in 2045, and full closure is delayed by four years. This asymmetry reflects the strong spatial concentration of immigration in the largest metropolitan areas, where additional inflows intensify existing shortages.

Table 1

Comparison of scenarios

Scenario	Shortage of dwellings (ths)			Excess uninhabited dwellings (ths)			Closing of the housing gap (year)			
	2024	2035	2045	2024	2035	2045	Q1	median	Q3	full[1]
Baseline scenario	1316	161	0	4	380	1683	2031	2033	2035	2039
Low demand scenario	1316	164	0	4	345	1823	2031	2032	2034	2038
High demand scenario	1316	354	2	4	223	1261	2032	2034	2036	2043
Low supply scenario	1316	443	15	4	275	1481	2033	2035	2038	2043
High supply scenario	1316	39	0	4	707	2073	2029	2031	2033	2037

Source: own study.

[1]Gap's full closing is counted as the gap falling below 1 missing dwelling per 1000 households nationwide, which aims to reduce the impact of individual small outlier areas.

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

The supply-side scenarios show that construction intensity primarily changes the speed at which the housing gap closes. In the low-supply variant, where instead of mean construction the lowest number of finished dwellings of the last 12 years is used, the housing gap remains at 443 thousand dwellings in 2035 and does not fully close until 2043, four years later than in the baseline, while the median county closure year shifts from 2033 to 2035. In the high-supply variant, which accordingly uses the highest number of finished dwellings from the last 12 years, the shortage falls to 39 thousand dwellings by 2035, with full closure brought forward to 2037 and the median closure year to 2031. These differences in construction also affect the eventual stock of excess uninhabited dwellings, which falls to 1.481 million in the low-supply scenario and rises to 2.073 million in the high-supply scenario, compared with 1.683 million in the baseline. The broader pattern nevertheless remains unchanged: construction rates determine how quickly the housing gap closes, but the long-run emergence of excess uninhabited stock is driven mainly by demographic decline and the spatial mismatch between housing demand and supply.

5. Discussion

The results highlight a fundamental tension in housing-market analysis under demographic transition: national convergence in housing supply and demand can occur simultaneously with increasing regional divergence. While the aggregate housing gap in Poland is projected to narrow rapidly and disappear around 2039, this national outcome masks growing disparities between local housing markets. Shortages persist for the longest period in the largest metropolitan areas and their suburban zones, whereas many medium-sized cities, shrinking urban regions, and peripheral rural counties transition from shortage to surplus and accumulate substantial stocks of uninhabited dwellings. This pattern is consistent with Łaszek et al. (2017), who documented substantial regional differences in housing-stock saturation and availability in Poland and identified regions affected by persistent housing shortages. It also complements the findings of Głuszak and Trojanek (2024), whose analysis demonstrates that adjustment to housing demand and supply conditions is heterogeneous across Polish metropolitan markets. Our results extend this literature by showing that spatial differentiation may increase over time even as the aggregate national shortage disappears. Consequently, geographically separated shortages and surpluses should not be treated as mutually offsetting components of a single national housing market.

Another important finding is that demographic decline does not automatically imply declining housing demand. Although Poland's total population is projected to decrease throughout the analyzed period, the number of households continues to grow until approximately 2030. The explanation lies in the continuing reduction of average household size, which partially offsets population losses. Similar mechanisms have been documented by Lauf et al. (2012), who show that changes in household composition can sustain housing demand even under conditions of population stagnation or decline. Evidence from Poland likewise indicates that housing-stock conditions and demographic potential do not necessarily move together. Blaszke et al. (2024), analyzing large and medium-sized cities in the West Pomeranian Voivodeship, found only a weak relationship between their rankings in terms of demographic potential and housing stock. The comparatively favorable trajectory of suburban areas is also consistent with Wysocka et al. (2021), who identify residential construction as an important component of suburban zone development in Poland, reflecting the continuing redistribution of population and housing activity toward areas surrounding major urban centers. Our projections provide a forward-looking counterpart to these findings: population decline alone is an insufficient indicator of the timing and spatial distribution of future housing demand, which depends more directly on the number and structure of households.

The projections further suggest that the housing market undergoes a structural transformation once household growth reaches its peak. During the first phase, market adjustment takes place mainly through new construction, gradually reducing housing shortages. Once household numbers begin to decline, however, additional quantitative supply becomes progressively less important and adjustment increasingly occurs through the accumulation of uninhabited dwellings. This mechanism is consistent with the durable housing framework of Glaeser and Gyourko (2005), in which housing stock adjusts only slowly to negative demand shocks, as well as with research on shrinking regions identifying housing vacancy as a recurring consequence of demographic and economic decline (Döringer et al., 2020). The disappearance of a numerical housing gap should therefore not be interpreted as the arrival of a stable market equilibrium. In shrinking areas, it may instead

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mark the transition from insufficient housing supply to a problem of excess, underused, or obsolete stock.

Our findings also have important implications for residential development. In a market characterized by persistent shortages, a large share of investment activity is oriented towards increasing the quantity of housing. As shortages diminish and competition between sellers intensifies, the relative importance of quality, location, accessibility, and neighborhood characteristics is likely to increase. Frącz et al. (2023) document different patterns of activity in the individual and developer segments of Polish residential construction, while Mach et al. (2020) emphasize the lagged nature of the construction process between investment decisions and completed housing. On the developer side, Łaszek and Olszewski (2026) point to a relatively flexible supply response in the Polish primary market, facilitated in part by the developers' ability to maintain portfolios of projects and permits and adjust activity to demand conditions. Our results are consistent with such an adaptive mechanism: as quantitative shortages disappear, the role of market-oriented net additions to the housing stock diminishes. Individual construction may nevertheless persist because households can prefer newly built dwellings to older available stock. In saturated markets, such construction is therefore more appropriately interpreted as replacement and qualitative upgrading than as a proportional increase in effective housing supply. More generally, as quantitative shortages diminish, the relative importance of housing quality, location, accessibility, and neighborhood characteristics is likely to increase.

The projected regional divergence may also create important consequences for mortgage markets and financial stability. Areas where shortages persist are likely to maintain relatively strong housing demand and continued construction activity. In contrast, shrinking regions may experience weaker mortgage demand, slower transaction activity, and downward pressure on real housing prices. Because housing serves as collateral for mortgage lending, persistent regional oversupply may gradually affect the valuation of residential assets and alter local credit-market conditions. The effects are unlikely to be uniform across the country. Metropolitan areas with strong labor markets may continue attracting households and investment, whereas regions facing demographic decline may experience a gradual erosion of housing-market liquidity and investment attractiveness.

From a public-policy perspective, the emergence of substantial stocks of uninhabited dwellings raises challenges that extend beyond the housing policy itself. In regions undergoing depopulation, housing surplus may interact with broader processes of urban and regional shrinkage. Lower population density can reduce the viability of local services, weaken municipal tax bases, and further encourage outmigration, creating self-reinforcing feedback loops. Under such circumstances, policies focused exclusively on stimulating housing construction may become increasingly ineffective. Instead, policymakers may need to place greater emphasis on managing decline, adapting infrastructure to smaller populations, revitalizing existing housing stock, and supporting economic activity in regions experiencing persistent population losses. The results therefore suggest that future housing policy should become more geographically differentiated and better aligned with local demographic trajectories.

The scenario analysis provides additional insights into the drivers of housing-market adjustment. The results indicate that variation in construction activity mainly affects the timing of housing gap closure, whereas the long-term emergence of surplus stock is driven primarily by demographic factors. Immigration assumptions produce larger long-run differences because migrants are disproportionately concentrated in economically dynamic metropolitan areas where shortages are already the most persistent. This finding suggests that demographic and migration trends may ultimately exert a stronger influence on long-term housing disequilibrium than short-term fluctuations in construction activity. Consequently, forward-looking housing-market assessments should explicitly integrate demographic projections rather than relying solely on housing-supply indicators.

Several limitations should nevertheless be acknowledged. First, the framework focuses on the quantitative balance between households and dwellings and does not explicitly account for housing quality, dwelling size, tenure structure, or affordability. As also emphasized by multidimensional assessments of Polish housing conditions (Napiórkowska-Baryła, 2020), numerical housing availability alone does not determine whether the existing stock adequately meets household needs. Second, the projection of average household size out of necessity relies on the Statistics Poland household forecast prepared in 2016, as no newer projection of this kind is available as of 2026. Third, projections of migration and temporary-resident

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06

populations are inherently uncertain and may be influenced by political, economic, or geopolitical shocks. Fourth, the model assumes relatively stable behavioral responses from developers and does not explicitly incorporate changes in planning regulations, housing policy, financing conditions, or technological developments in construction. Finally, the framework assumes limited demolition and attrition of housing stock, an assumption that may require modification in countries with ageing building stocks or different institutional environments. Future research could address these issues by incorporating housing quality measures, endogenous migration dynamics, housing affordability indicators, and alternative developer-response mechanisms.

Overall, the results suggest that in ageing societies, the main housing problem may gradually change. Policymakers and market participants may increasingly need to deal with growing differences between regions. Even if the national housing shortage eventually disappears, this does not mean that housing markets become balanced everywhere. Some areas may continue to face housing shortages, while others may experience large surpluses of vacant homes. Therefore, the most important question is not whether the national housing gap closes, but how housing shortages and surpluses are distributed across different locations and how these patterns affect local housing markets and regional development over time.

6. Conclusions

The main contribution of this article is a novel framework for calculating the housing gap. The framework is analytically tractable and methodologically robust. It captures mechanisms which are often obscured in aggregate approaches, as they bundle heterogeneous local markets into one unified entity, stripping away their underlying characteristics. The results show that housing shortage may persist even under adverse demographic conditions. This is because the number of households can continue to grow for some time despite population decline. Once household growth reverses, adjustment no longer occurs mainly through new supply closing the gap. Instead, it increasingly takes the form of rising stocks of uninhabited dwellings.

The scenario analysis further indicates that the model functions well as a tool for structured conditional forecasting. Across alternative assumptions, it preserves the same basic adjustment logic, which points to a satisfactory degree of internal robustness, while being sufficiently sensitive to distinguish between different types of shocks. This is important, as due to regional heterogeneity impact of each shock will be distributed differently. Empirical application in the case of Poland demonstrates that the framework can be effectively applied, and its application can yield valuable insights. It serves to identify the areas currently most affected by the housing gap, approximate the timing of housing gaps closing in each area, and highlight which parts of the country will be dealing with the highest buildup of uninhabited dwellings.

Taken together, our findings suggest that the framework provides a novel and empirically grounded basis for analyzing housing disequilibrium in settings characterized by demographic change, heterogeneous housing supply, and uneven regional development. Its value lies less in producing a single deterministic forecast than in structuring the analysis of how shortage evolves, how and where it is likely to close, and under what conditions it may be replaced by surplus and rising stocks of uninhabited dwellings. By mapping these trajectories locally, explicitly accounting for future immigration trends and developer responses, the model can provide useful foresight for housing market analysis. In particular, it can help identify where shortages are likely to persist and where excess capacity may accumulate. In doing so, it contributes to broader analytical foundation for forward-looking residential real estate research, including house price forecasting.

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Appendix

Housing demand, housing supply, and the stock of vacant dwellings in selected regions of Poland

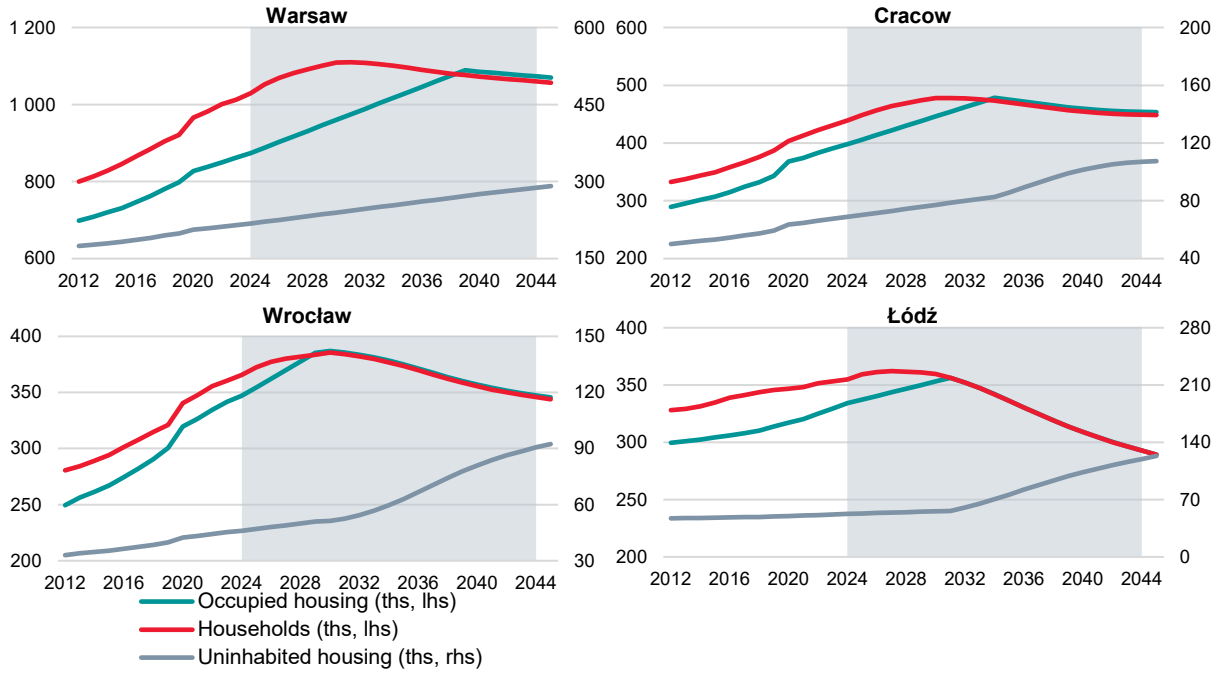


Fig. 5. Top 20 cities in Poland (1-4). *Source*: own study.

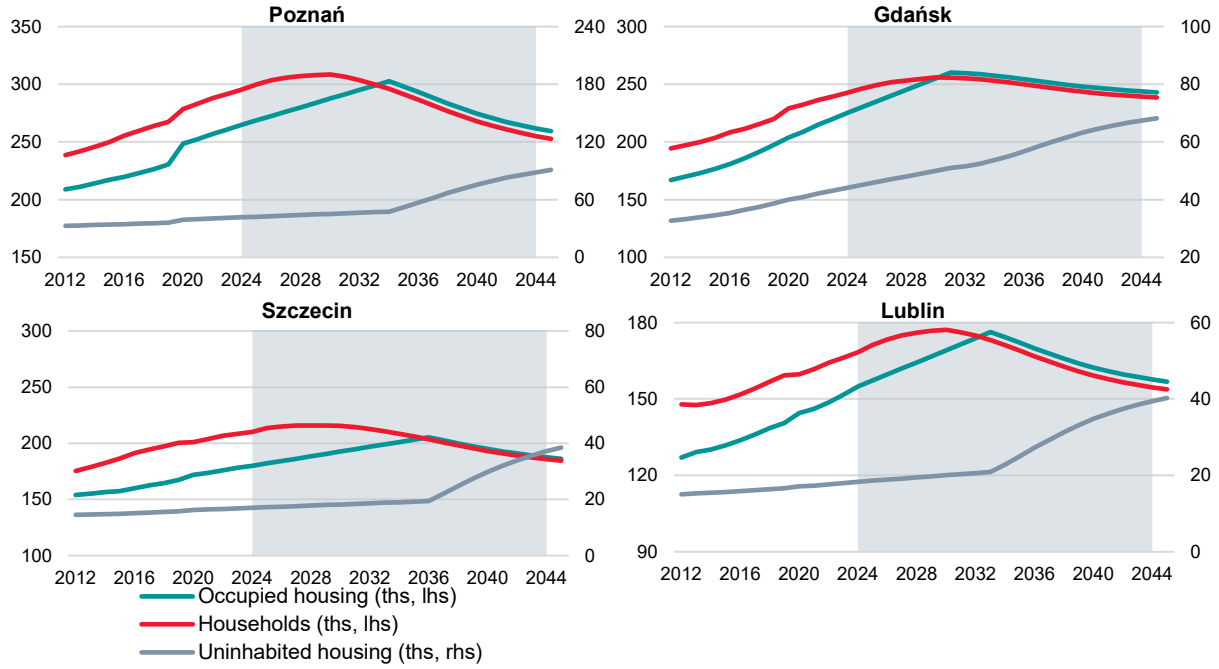


Fig. 6. Top 20 cities in Poland (5-8). *Source*: own study.

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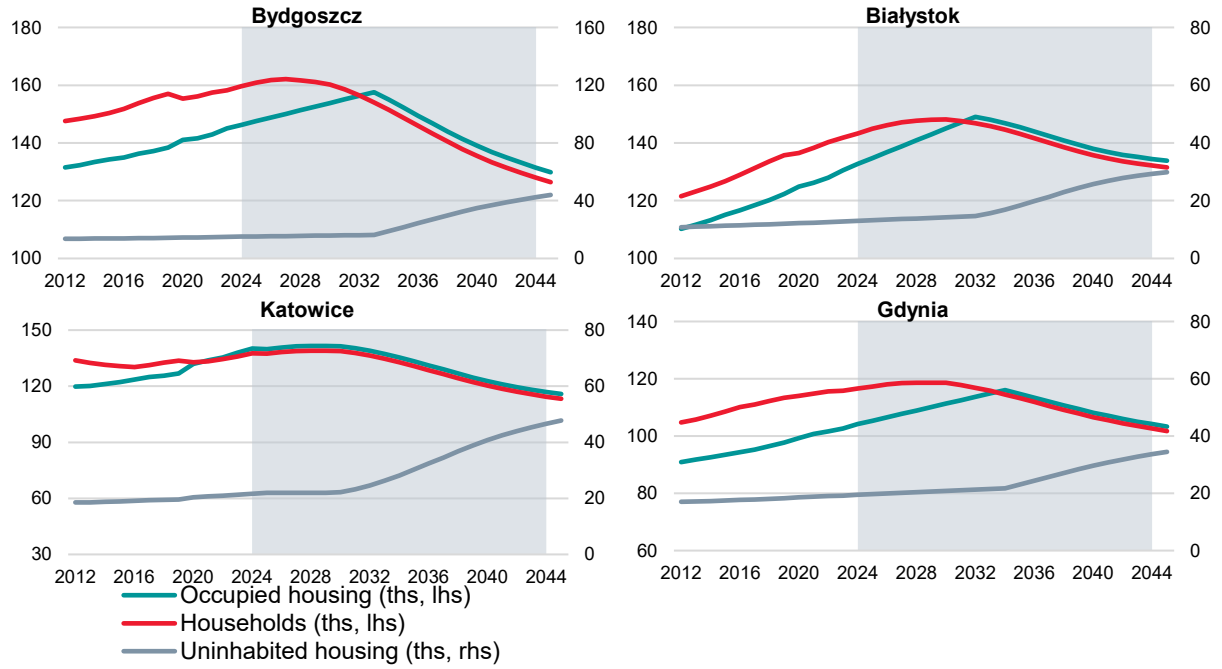


Fig. 7. Top 20 cities in Poland (9-12). *Source*: own study.

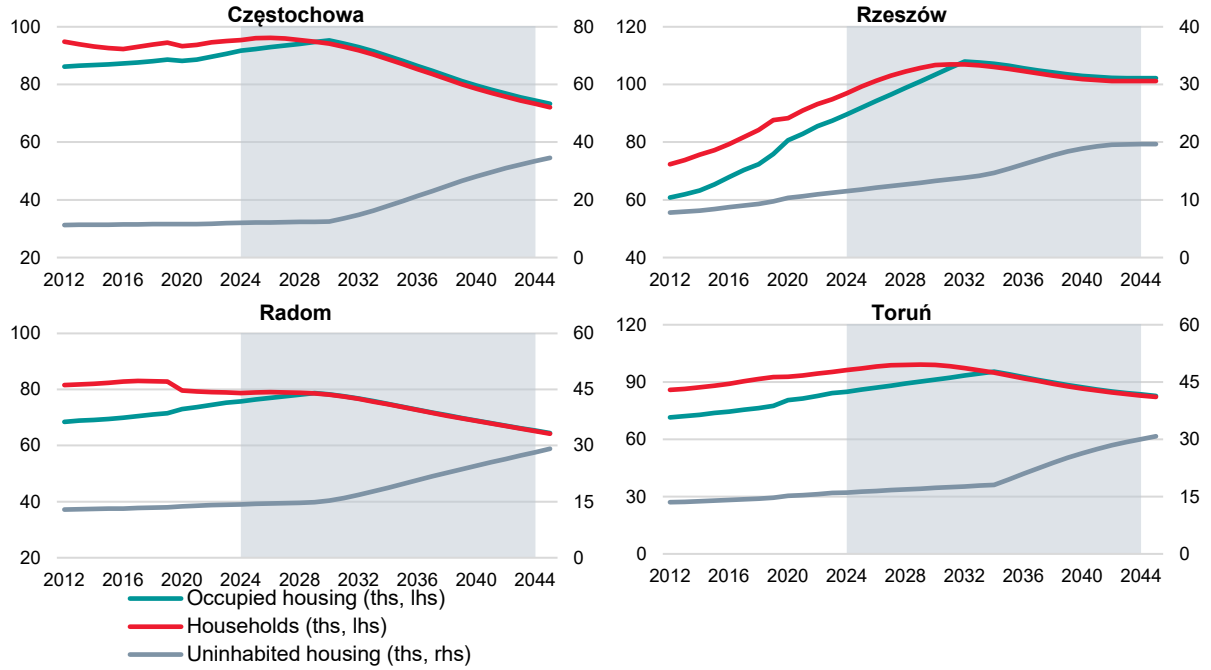


Fig. 8. Top 20 cities in Poland (13-16). *Source*: own study.

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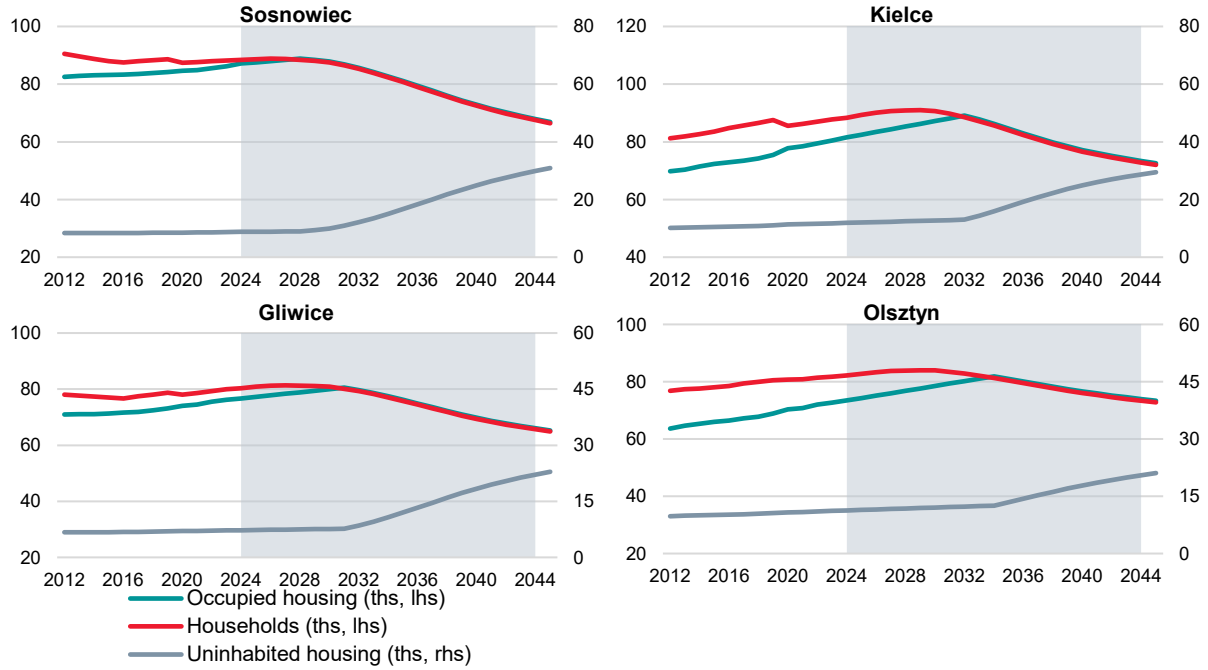


Fig. 9. Top 20 cities in Poland (17-20). *Source*: own study.

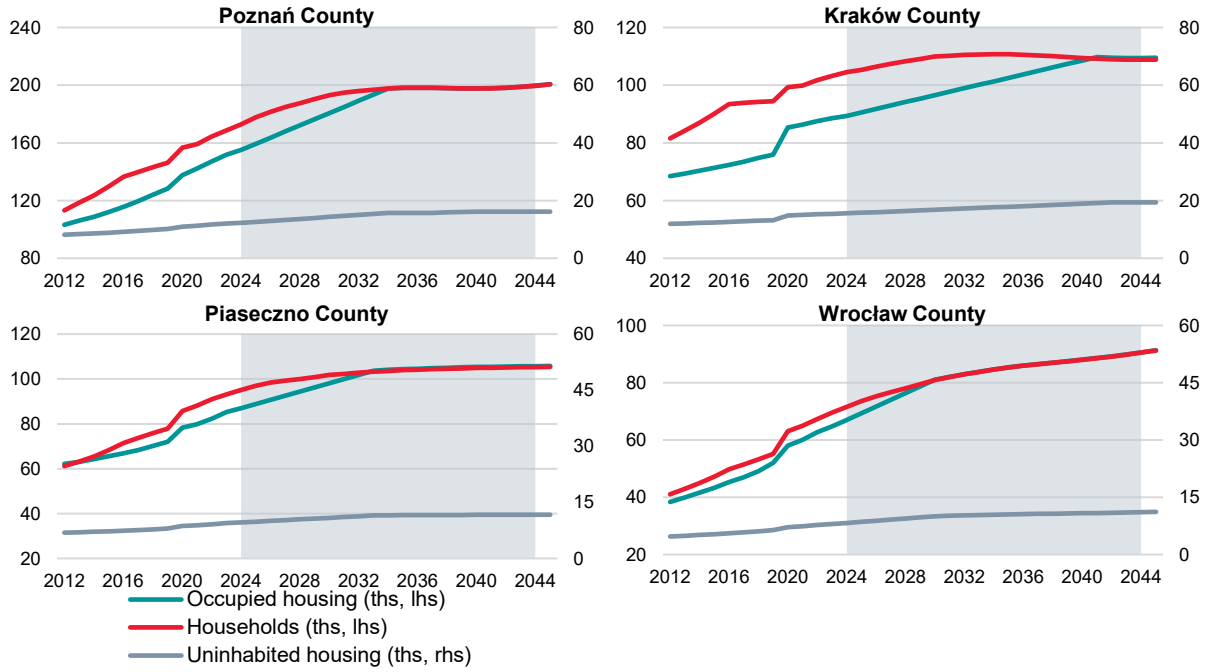


Fig. 10. Selected suburban counties. *Source*: own study.

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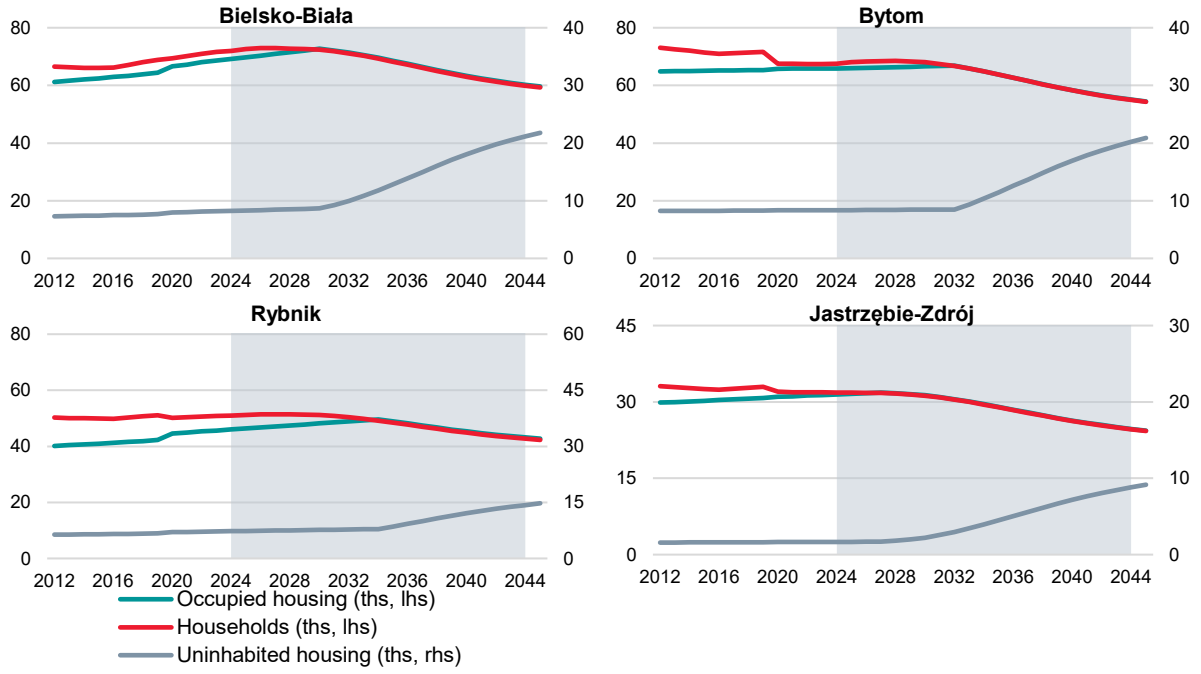


Fig. 11. Selected cities in Silesia. *Source*: own study.

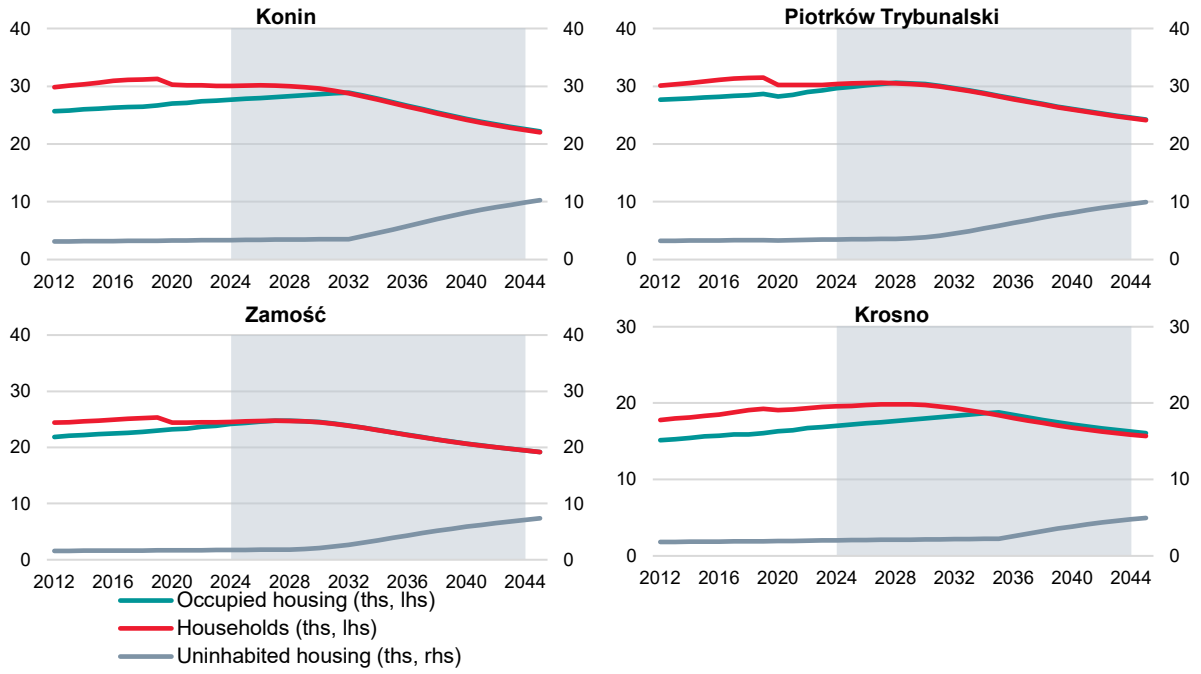


Fig. 12. Selected medium cities. *Source*: own study.

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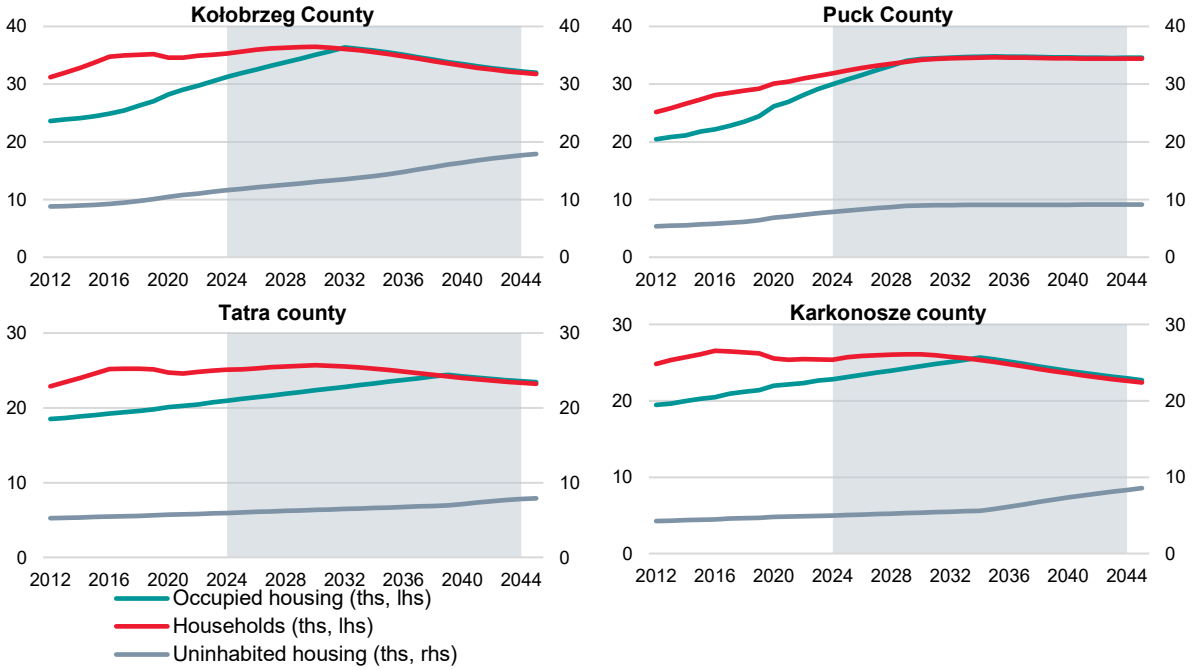


Fig. 13. Selected counties with strong influence of tourism. *Source*: own study.

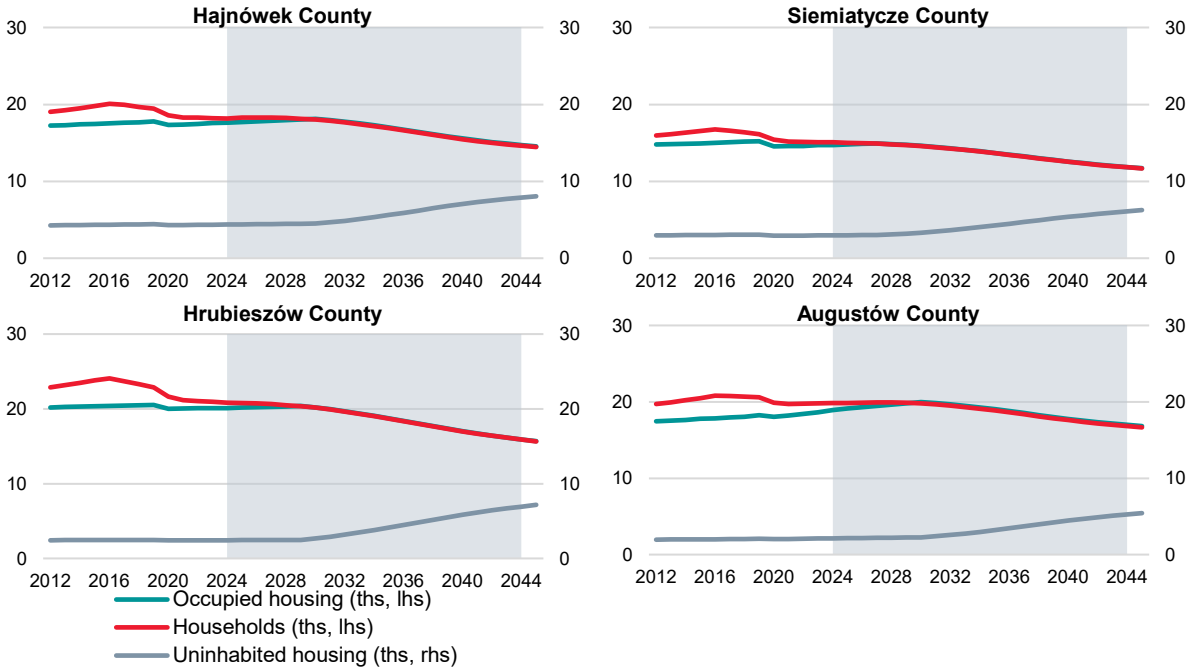


Fig. 14. Selected counties on the eastern border of Poland. *Source*: own study.

eISSN: 2300-5289 | Received 2026-06-11 | Revised 2026-09-03 | Accepted 2026-10-06