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Local Housing Supply Convergence: A Case Study of Polish Municipalities

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Abstract: *Much remains unknown about whether housing supply converges across regions over time. Therefore, this paper aims to outline the theoretical drivers and barriers of housing supply convergence and to perform an empirical analysis across all municipalities in Poland for 2009–2024. Housing supply was examined from the perspectives of the housing market (new housing for sale/rent) and urban dynamics (total housing stock). Using the Phillips-Sul approach, the study found that housing supply converges across the analysed areas. Specifically, supply from a housing market perspective is characterised by level convergence, meaning it tends towards a stable long-term value. Conversely, supply from the urban dynamics perspective follows a path of growth convergence, with the rates of change in housing supply gradually becoming similar across municipalities over time. These convergence patterns suggest moderate allocative efficiency of housing supply in Poland.*

Keywords: housing supply; convergence; log *t* regression; Polish municipalities; housing economics.

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Introduction

The process of convergence in the housing market has been examined for many years as part of a broader research trend analysing its dynamics. The vast majority of studies focus on identifying price convergence (see Kim and Rous 2012; Apergis and Payne 2012; Blanco et al. 2016; Holmes et al. 2019; André et al. 2024). Recently, the public and policymakers have increasingly recognised housing supply as a key factor in reducing housing prices and improving affordability (Gibb 2021). Aside from a few references in the scientific literature (see Glaeser and Gyourko 2025), this topic appears to be largely overlooked by researchers, both theoretically and empirically. Analysing housing supply convergence is important because it enables us, among other things, to verify housing market equilibrium and, in particular, to assess whether supply in less developed regions is catching up with that in more developed areas. Consequently, this paper aims to explore the theoretical barriers and drivers of housing supply convergence and to empirically evaluate this phenomenon using the example of all Polish municipalities.

Poland was chosen as a case study focusing on Polish municipalities, which are the basic and smallest units of local government. For many years, Poland has faced a housing shortage, with private companies playing a key role in providing housing. Therefore, Poland serves as a good example for evaluating housing supply convergence and for determining whether its model of housing provision, which relies almost entirely on developers, is effective.

This study advances the current literature in several ways. Firstly, it is the first to address the issue of housing supply convergence. Secondly, the empirical analysis will be based on a proven, robust quantitative method that also enables the identification of convergence clubs. Finally, the study will consider two perspectives on the definition of housing supply: the urban dynamics perspective and the housing market perspective.

The article is organised as follows. The next section discusses the theoretical foundations of housing supply convergence and divergence, which is followed by an outline of the research methodology. The results of the empirical analysis are then presented, along with a discussion and an assessment of their strengths and weaknesses. Finally, the article provides policy recommendations and conclusions.

Theoretical background

There is no reason to believe that, in absolute terms, there will be convergence in housing supply, either in the housing market or in urban dynamics. This is because of the substantial differences in housing supply and demand fundamentals between regions.

However, the theory offers evidence for the potential of housing supply convergence in relative terms, that is, in relation to population. Specifically, in urban spatial theory, equilibrium is characterised by the fact that the housing stock always matches the population (DiPasquale 1999), meaning that total housing supply should correspond to population changes on a one-to-one basis. Recent empirical research by Louie et al. (2025) in the United States confirms this relationship.

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Equilibrium in the urban spatial model, meaning the convergence of relative housing supply, can be promoted by many factors, but numerous barriers also exist.[1] The first is population migration between regions, specifically, from low-productivity areas to high-productivity ones. This occurs because workers move from the former to the latter in search of higher incomes (Roback 1982). Migration boosts housing demand, which, if supply is elastic, also encourages its expansion. On the other hand, in regions with declining populations, housing supply depreciates and decreases in the long term. Ultimately, this leads to an equalisation of housing supply across regions; however, if housing supply is highly inelastic, divergence occurs, as increased demand does not result in higher supply but instead causes housing prices to rise (Howard and Liebersohn 2025), consequently weakening migration (Ganong and Shoaq 2017).

Price elasticity of supply, which is essential for convergence, can also be influenced by legal regulations, typically local laws. Looser regulations reduce barriers to entry for new developers and encourage new housing investments. Gyourko and Molloy (2015) conclude that excessive regulation results in higher housing prices, fewer construction projects, and decreased housing supply elasticity.

Reduced convergence can also arise from differences in housing production costs across regions. These costs depend on factors such as the level of unionisation in the construction sector, local wage rates, and topography (Glaeser and Gyourko 2018). Areas with lower construction costs tend to produce more housing, whereas those with higher costs produce less, potentially sustaining divergence in housing supply.

The geography of the regions mentioned above is another important factor influencing housing supply convergence. Geographical barriers, such as bodies of water or mountains, limit both labour mobility and housing development. Consequently, these regions tend to have a lower supply. Saiz (2010) empirically demonstrated that geographical constraints significantly reduce the elasticity of housing supply. Meen and Nygaard (2011) similarly point out that it is not only geography that restricts supply but also a region's urbanisation history, including building density and land-use patterns. Their empirical findings show that supply elasticity is six times lower in areas most affected by its urbanisation history.

Friction in land assembly may also restrict the convergence of housing supply. In areas where this issue arises, there is tension between landowners and developers, which lengthens construction times and decreases the elasticity of housing supply (Baum-Snow 2023). Developers' profits may also influence the convergence of housing supply. In markets with oversupply and intense competition, profits are nearly zero, prompting developers to explore alternative markets characterised by supply shortages (Gabrovski and Ortego-Marti 2025). This initiates a process of self-regulation of supply across regions.

The above theoretical framework suggests that, from an economic perspective, the key to achieving convergence in housing supply lies in its elasticity, which allows supply to adjust to a changing population in a given area. In particular, the short-term elasticity of housing supply maintained over the years is indirect but strong evidence of its long-term convergence. On the other hand, in the case of a perfectly inelastic housing supply, permanent divergence or the occurrence of so-called convergence clubs can be expected, where supply tends towards a club-specific steady state. On this basis, it can also be concluded that convergence analysis can serve

[1] The remainder of the theoretical framework concerns the convergence of housing supply in relative terms.

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as a test for the existence of cumulative housing supply elasticity over the period under study, offering additional information for direct estimates of short-term elasticity, which often suffer from endogeneity and measurement noise.

The convergence or divergence of housing supply may also result from social and demographic factors. First and foremost, the role of household structure should be emphasised. If there are significant differences in household size between various locations, this may contribute to divergence in housing supply, especially if these disparities increase over time. In particular, areas with similar populations but varying household numbers will require different levels of housing supply. Global empirical studies indicate a widespread decline in household size (Esteve et al. 2024), suggesting that this is becoming less of a problem. However, on a smaller scale, i.e. at the level of urban and rural areas, greater differences are noticeable. For example, in Poland, according to data from the 2021 census, the average household size was 2.83 in urban areas, 3.39 in urban-rural areas, and 3.72 in rural areas. Such differences are a factor that promotes divergence in housing supply.

The convergence of housing supply can also be supported by urban-rural dynamics, in particular by the phenomenon of urban sprawl and suburbanisation. Rural areas near large cities attract new residents due to the areas' transport links, lower property prices, and lower cost of living. Suburbanisation is widespread globally, but is especially pronounced in Central and Eastern European countries since the economic transformation of 1989 (Kryczka et al. 2025).

Finally, as indicated above, the convergence of total housing supply should result from a long-term process of spatial equilibrium across housing markets. However, the dynamics of new housing supply across locations may vary significantly owing to differences in the profitability of new investments. Namely, new housing construction occurs in areas where Housing Tobin's q (HTQ) (Glaeser and Gyourko 2018), the ratio of residential property prices to minimum profitable construction costs, exceeds 1. Empirical studies indicate that HTQ values vary between cities (Barth et al. 2025), leading to a concentration of new housing supply in selected locations and to a short-term divergence of supply between them, regardless of population size. On the other hand, the above studies also indicate that HTQ fluctuates over time, which may even lead to the convergence of new housing supply in the long term. In particular, in areas with a high concentration of housing projects and high HTQ values, competition in the real estate development market becomes so intense over time that it leads to a decline in profits and a fall in HTQ towards 1 or below. As a result, developers are looking for alternative locations, including areas where HTQ values are initially below 1, but where there is significant potential demand for housing due to the areas' proximity to major cities or to changes in housing preferences. Consequently, in these alternative locations, population influx and intensified activity in the housing market cause prices to rise, which, in the long term, translates into an increase in new housing supply and its equalisation across different areas.

Methodology

Data

Data on housing supply at the municipal level were obtained from the Local Data Bank of the Polish Central Statistical Office for the period 2009Q1-2024Q4. A municipality is the smallest unit of local government in Poland, and, as of the end of 2024, there were 2,477 of them.

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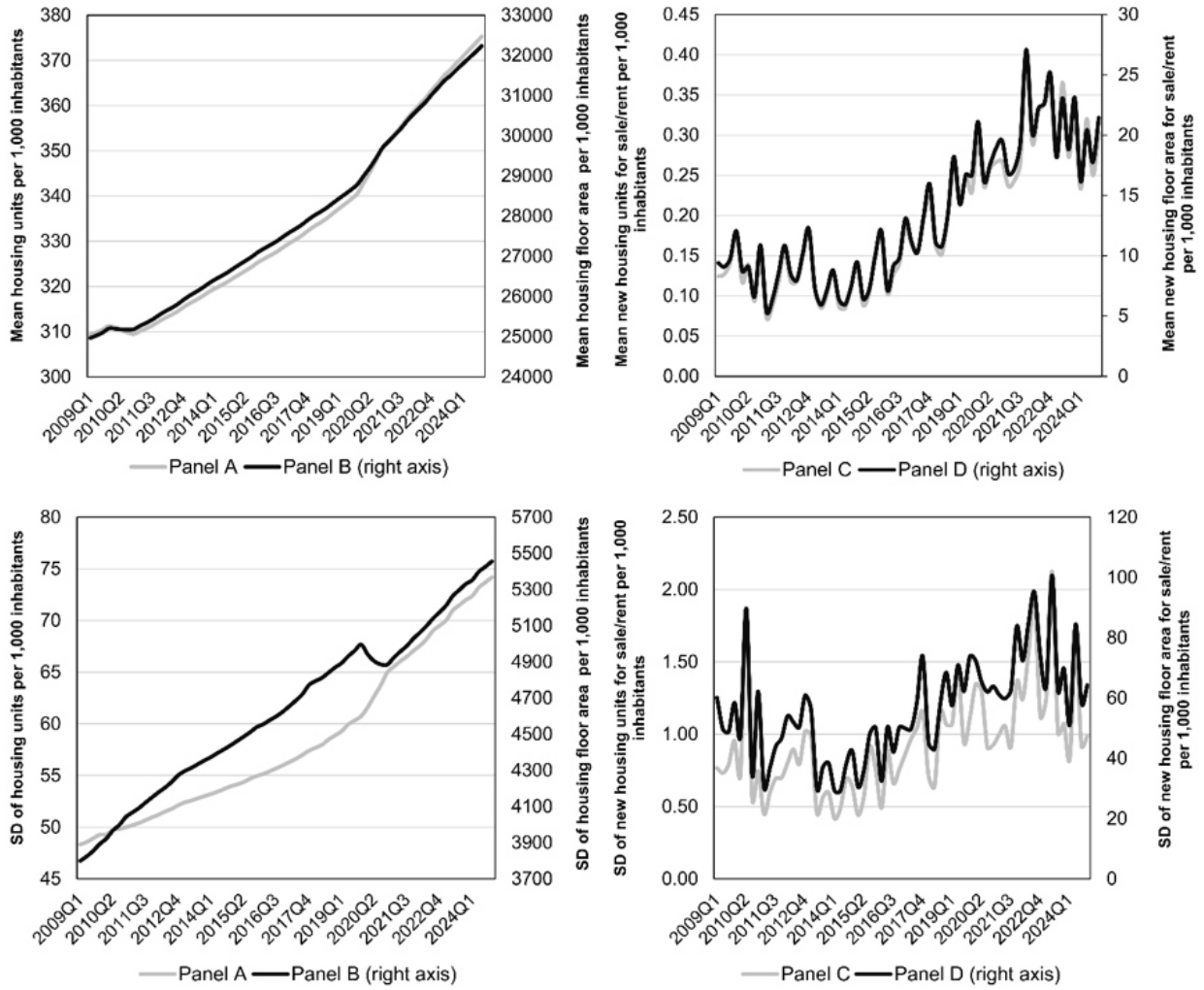
Following Gyourko (2009), housing supply can be described from two perspectives: the total housing stock (the urban dynamics perspective) and the new stock for sale or rent (the housing market perspective). In this approach, both variables are closely related, and convergence results may vary due to the heterogeneous initial conditions of municipalities' housing resources. The analysis of housing market supply is important in Poland because developers are primarily responsible for providing new housing. This share has been growing year on year: in 2005, developers accounted for 33% of all new residential units introduced to the housing stock, and by 2024 this share had already reached 62%.

Figure 1: Housing supply dynamics in Polish municipalities



Note: Panel A concerns housing units per 1,000 inhabitants. Panel B concerns housing floor area per 1,000 inhabitants. Panels C and D are defined analogously but refer to new supply for sale/rent.
Source: Polish Central Statistical Office (https://bdl.stat.gov.pl/bdl/start).

Like in Malpezzi and Vandell (2002), in this case study supply was analysed in relative terms – per 1,000 inhabitants of a municipality – to take account of the heterogeneity of municipalities in terms of population. Next, to ensure the robustness of the convergence analysis, housing supply was also defined as total housing area, which, according to Baum-Snow (2023), allows

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for potential increases in supply resulting from renovation and upsizing, which can account for up to 80% of the total increase in supply.

Figure 1 illustrates the dynamics of supply in Polish municipalities during the analysed period. Supply increased steadily over the years, largely influenced by seasonal fluctuations. Regarding new supply, its growth slowed after the pandemic, as many developers paused investments during that time. The standard deviation of the total housing stock has also risen over the years, which may initially suggest a divergence in housing supply.

Methods

Convergence and club convergence will be evaluated using the method developed by Phillips and Sul (PS) (2007; 2009). This method utilises a log *t* regression estimated by the least squares technique, as follows:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = \hat{a} + \hat{b}\log(t) + \hat{u}_t, t = [rT], [rT]+1, \ldots, T \quad (1)$$

where $H_t = N^{-1}\sum_{i=1}^{N}(\frac{\log y_{it}}{N^{-1}\sum_{i=1}^{N}\log y_{it}} - 1)^2$ and y_{it} represents the variable of interest—in this study, a

housing supply indicator, $\mathbf{b}$ is the convergence speed parameter, and r is the time-trimming parameter. The latter is designed to exclude initial observations, focusing the analysis on subsequent values of the variable. Phillips and Sul (2007) recommend setting r based on the length of the time series: $r = 0.3$ for $T \leq 50$, and $r = 0.2$ for $T \geq 100$. Convergence is tested using the log t regression via a one-sided t-test for $\mathbf{b}$, applying a heteroskedasticity- and autocorrelation-consistent (HAC) standard error. If $t_{\hat{b}} < -1.65$, the convergence hypothesis is rejected at the 5% significance level. Otherwise, convergence occurs, with its strength determined by the value of $\mathbf{b}$. Specifically, when $\mathbf{b} \geq 2$, level convergence holds, meaning the variable values across countries converge to a single constant in the long term. When $2 > \mathbf{b} \geq 0$, relative convergence occurs, indicating that the rates of change of the variable across countries converge to a common value in the long term. In the absence of convergence across the entire panel, the PS method enables the identification of convergence clubs. This procedure involves the following steps:

- Step 1. *Data sorting:* The data are sorted in descending order by the final time-period values, assuming that convergence is most evident in the later periods studied.

- Step 2. *Core group formation:* A core group of converging countries is formed. This step begins with testing the two units with the highest values of the variable, as sorted in Step 1. If convergence is detected (via the log *t* regression), additional units are included in the analysis until convergence no longer occurs.

- Step 3. *Club membership:* Units not included in the core group are incrementally added one at a time, and convergence is assessed using the t-statistic from the log t regression. If the t-statistic exceeds 0 for $T \leq 50$ or –1.65 for $T \geq 100$, the unit is included in the core group. Subsequently, convergence for the expanded group is tested using the log *t* regression with a critical value of −1.65. If convergence is confirmed, the group constitutes the first convergence club.

- Step 4. *Recursion and termination:* For units not included in the first club, convergence

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is checked. If convergence is detected, these units form the second convergence club, and the algorithm terminates. If convergence is not detected, Steps 1–3 are repeated for the remaining units to identify additional convergence clubs.

- Step 5. *Club merging:* To assess the potential merging of identified convergence clubs, the log *t* regression is applied to each pair of clubs. If convergence is confirmed, the clubs are merged. Additionally, this study incorporates two corrections proposed by von Lyncker and Thoennessen (2017) at this stage, addressing ambiguity in club merging and the potential inclusion of diverging units within individual clubs.

The PS method provides several advantages over other approaches. First, it handles heterogeneity among units and over time. Second, it can be used with both deterministic and stochastic trend data. Third, it works well with short time series and those with structural breaks.

Before applying the PS method empirically, cyclical fluctuations must be removed from the time series. In this study, the boosted Hodrick-Prescott (HP) filter (Phillips and Shi 2021) was employed to address the challenge of selecting tuning parameters inherent to the standard HP filter. Additionally, to eliminate the endpoint bias in the HP filter, the procedure outlined by Fritsche and Kuzin (2011) was implemented. This bias arises from the excessive influence of the final observation on the trend component. To mitigate it, six additional time-series observations were forecast using an autoregressive integrated moving-average (ARIMA) model, with its specification determined by the Hyndman and Khandakar (2008) algorithm. Subsequently, the boosted HP filter was applied, and the forecasted observations were discarded. The aforementioned data preparation methods enhance the robustness of insights obtained using the PS approach (Tomal 2024).

The PS approach assumes that for all and . The latter condition is not often met in the case of an indicator determining new supply for sale/rent. Therefore, in this case, the approach proposed by Sul (2019) was used: a cross-sectional average multiplied by a constant, in this case 1000, was added to y_{it}.

Results

Convergence analysis

Before proceeding with the convergence analysis, the non-stationarity of all time series was checked using the ADF test. The results revealed that all variables exhibit a clear trend ($p > 0.40$), allowing the use of the PS approach. In the next stage of the study, the cross-sectional variance H_t was calculated, and the results are shown in Figure 2. It can be seen that H_t converges very strongly to zero in each case, indicating that the housing supply convergence process occurs in accordance with the assumptions of the PS approach.

Next, the log *t* regression was estimated. The parameter estimates are presented in Table 1. The results reveal a convergence process in housing supply, except for the total housing stock, expressed as the number of units. For new housing supply, there is level convergence, because $b \geq 2$, which means that in terms of new supply per 1,000 inhabitants, municipalities tend towards a certain constant in the long term. For total supply expressed in terms of area,

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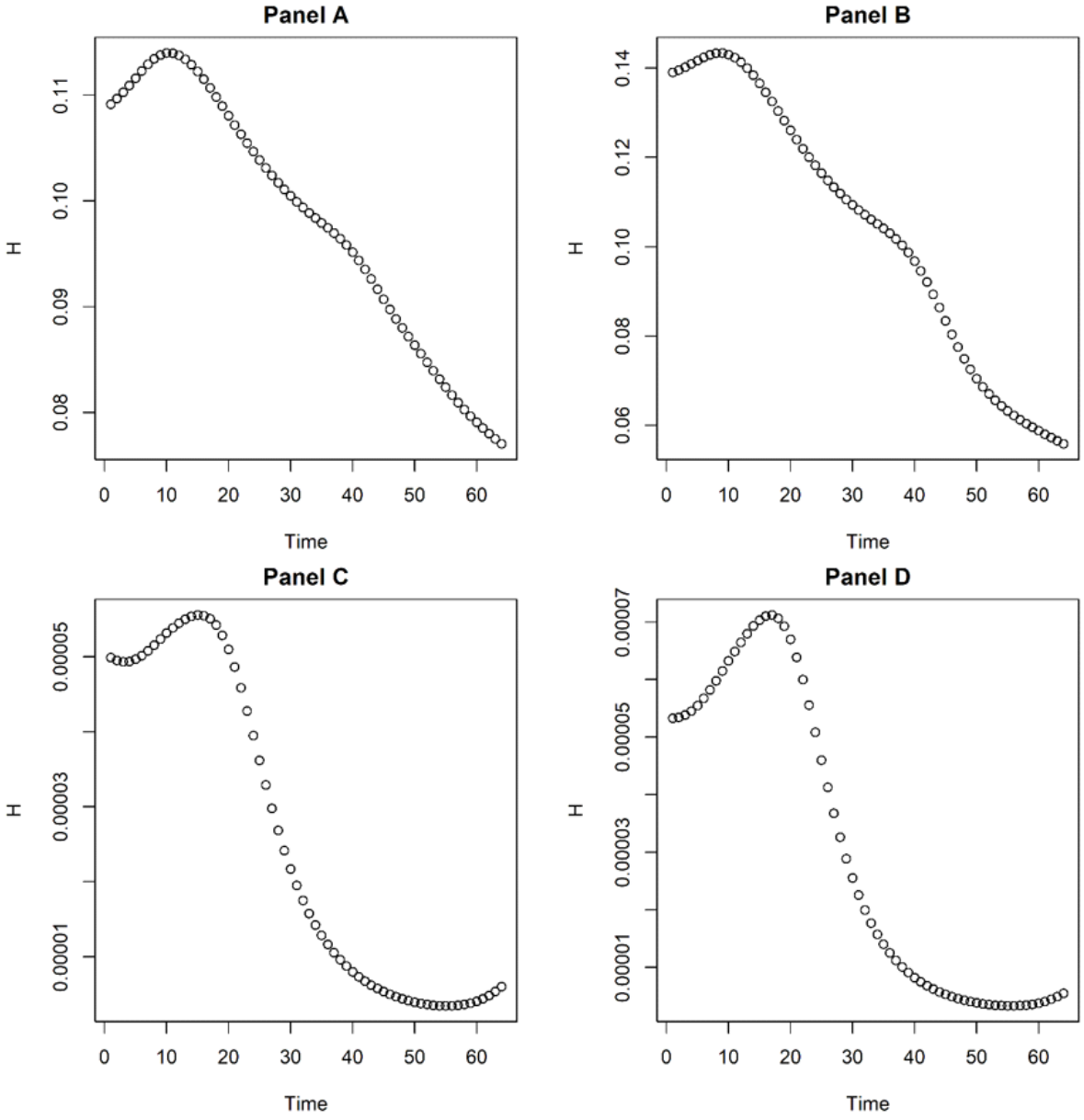
convergence is relative: the rates of change in supply across municipalities converge. Next, for panel A (total supply in units), a procedure for identifying convergence clubs was carried out. The results are presented in Table 2, which shows that the PS method identified two convergence clubs characterised by weak growth convergence.

Figure 2: The cross-sectional variance H_t



Note: Panel A concerns housing units per 1,000 inhabitants. Panel B concerns housing floor area per 1,000 inhabitants. Panels C and D are defined analogously but refer to new supply for sale/rent.
Source: Author's study.

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Table 1: Log *t* regression estimates

Panel	$\hat{b}$	$t_{\hat{b}}$
A	-0.24	-18.88
B	0.26	6.08
C	2.04	8.32
D	2.38	9.36

Note: Panel A concerns housing units per 1,000 inhabitants. Panel B concerns housing floor area per 1,000 inhabitants. Panels C and D are defined analogously but refer to new supply for sale/rent.
Source: Author's study.

Table 2: Convergence club analysis for panel A

Club	$\hat{b}$	$t_{\hat{b}}$	η
1	-0.03	-1.15	1763
2	-0.04	-1.31	714

Source: Author's study.

Discussion

The results show a process of supply convergence across all Polish municipalities over time. For total supply, convergence is characterised by a tendency towards the same rate of change in the long term, and for new supply, towards a constant value. These findings generally align with the research by Glaeser and Gyourko (2025), who noted strong convergence in the rate of change in housing units over time across six metropolitan areas in the United States.

Although the study indicates the existence of two convergence clubs in housing supply when measured by the number of housing units, a more robust indicator – the total floor space of dwellings – suggests convergence across all municipalities. This could imply that measuring supply by the total number of dwellings may not accurately reflect its actual size, as Baum-Snow and Han (2024) point out.

The results show strong convergence in housing supply across Polish municipalities during the review period. There may be several explanations for this. Firstly, the number of dwellings per capita in Poland remains relatively low, which is driving significant growth in new supply, mainly from private developers. In Poland, as indicated by the latest OECD (2025) research, supply is elastic, which leads to convergence.

Furthermore, there have been no excessive legal regulations in Polish municipalities to date that would significantly hinder new investments. This may change in the coming years due to a new law requiring each municipality to establish an absorption rate that limits new residential development. On the other hand, the 2026 planning reform requires each municipality to create a general zoning plan across the municipality's entire area, which may facilitate the implementation of new housing projects.

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Population changes in Polish municipalities are heterogeneous. Increases are observed in large cities and their agglomerations, while decreases occur mainly in rural areas (Krzysztofik et al. 2019). In the short term, population migration to highly developed regions directly increases the total housing supply in less developed areas. In the long term, housing supply depreciates and adjusts to a smaller population. On the other hand, supply growth can also be expected in highly developed regions as a result of supply elasticity to demand shocks, including demographic ones.

Among the demographic phenomena promoting convergence in housing supply, suburbanisation around large Polish cities should also be noted. Mantey (2025) points out that, in recent decades, suburbanisation in the municipalities neighbouring Warsaw has intensified, but its intensity varies across them. Other examples of suburbanisation can be seen in Poznan (Tanaś and Trojanek 2015) and Krakow (Kurek et al. 2017).

The convergence of supply among Polish municipalities may also stem from capital transfers to less developed regions, particularly through European Union programmes. This enhances the appeal of these areas as places to live, consequently boosting demand for housing.

Finally, the convergence of housing supply in Poland is driven by the equalisation of average household size between rural and urban areas. As shown in Table 3, the average household size decreased significantly across Polish provinces between 1999 and 2024. In turn, the standard deviation values indicate sigma convergence in household size between provinces. The latter may have resulted from migration from rural areas to cities. To rule this out, the share of the urban population in the provinces was examined. The results showed that there was almost no change in this aspect between 2010 and 2024.[2]

Table 3: Household size and urban population in Polish provinces

Year	Household size				Urban population			
	Mean	*Standard deviation*	*Min.*	*Max.*	*Mean*	*Standard deviation*	*Min.*	*Max.*
1999	3.22	0.21	2.94	3.63	No data	No data	No data	No data
2010	2.91	0.19	2.70	3.31	0.59	0.10	0.41	0.78
2024	2.41	0.14	2.15	2.67	0.58	0.10	0.41	0.76

Source: Polish Central Statistical Office (https://bdl.stat.gov.pl/bdl/start).

It can be concluded that supply in the Polish housing market is allocated with moderate efficiency. New supply for sale/rent is distributed to municipalities in proportion to their populations. In terms of total supply, a trend of growth convergence is apparent. This means that, although the market for new investments effectively allocates new housing supply to changing population levels, the initial differences in total stock are so large that they do not lead to equalisation of total supply between municipalities, only to similar rates of change.

[2] Apart from data from the 2021 National Census, there are no data on this subject at the municipal level in Poland.

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Strengths and limitations

The main strength of this study is that it addresses, for the first time in the literature, the issue of housing supply convergence. However, this empirical study also has its limitations. Firstly, the data were collected at the municipal level, and although it offers relatively detailed information, fluctuations in housing supply might be more evident at even smaller spatial scales. Currently, however, there is a lack of data for areas smaller than municipalities in Poland, such as cadastral units or statistical localities. Secondly, the barriers and drivers of housing supply convergence may change over time. Therefore, to gain a complete understanding of the phenomenon and the varying pace of convergence in housing supply, a local linear log t regression can be employed (Johnson 2020). Third, future research could analyse the spatial spillovers of housing supply to better understand the flow of housing supply between locations and, consequently, the drivers and barriers to convergence. Fourth, due to upcoming changes in spatial planning in Polish municipalities from 2026 and possible new restrictions on residential development, it would be worthwhile to repeat this study in a few years to account for these regulations. Finally, the limitations of this study are also related to the housing supply indicator used and particularly to the reliability of data on the actual population in individual municipalities. The amount of housing supply per 1,000 inhabitants in major agglomerations is likely overestimated due to errors in population registration. This is due to the presence of short-term migrants, short-term tenants, managers, and students, among others, in the population, who are not included in the population count. In Poland, one example (of such a gap between estimates and reality) is in Krakow, whose official population is just over 800,000, while the actual population is well over 1 million (Tymczak 2023). If a significant number of municipalities are characterised by such discrepancies, the results of the housing supply convergence analysis may be biased.

Policy implications

Research results indicate that the market for new housing investments is functioning effectively; therefore, policymakers should not significantly restrict its activity through new regulations. In this context, the newly introduced municipal absorption rate in Polish law, which restricts new housing projects, is alarming. Detailed research should be conducted to determine whether it will artificially limit the private housing investment market, potentially leading to increased regional supply inequality. On the other hand, research has shown that the private market alone does not ensure level convergence in total housing supply, indicating that the state should also take active measures in this regard, especially targeting areas unattractive to the private sector. This includes not only the construction of new flats, but also planning facilitations and financial redistribution schemes.

Conclusion

This study investigated the convergence of housing supply across all Polish municipalities from 2009 to 2024. The findings show that, in relative terms, total housing supply demonstrates growth convergence, whereas new supply exhibits level convergence. The results suggest moderate allocative efficiency in housing supply in Poland and provide a foundation for further theoretical and empirical research in this field.

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