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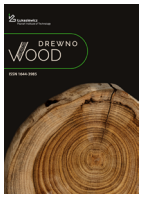

Price Convergence in the Primary Regional Timber Market: Evidence From a Regional Directorate of the State Forests

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This study examines price convergence in the regional primary timber market in Poland. Although timber in the State Forests is sold under a unified institutional framework and standardized assortment classification, persistent spatial price differences remain. Understanding these mechanisms is important for improving the efficiency of the timber sales system and reducing revenue losses associated with spatial price disparities. The aim of the paper is to assess timber price convergence using forest districts of the Regional Directorate of the State Forests in Katowice as a case study. Quarterly nominal timber prices (PLN/m^3, net) for 2005–2024 were analysed, focusing on economically important pine and oak assortments, particularly large-sized timber (WC03) and medium-sized timber (S2A). Three complementary measures of convergence were applied: β (price catching-up), σ (changes in price dispersion), and γ (changes in relative price rankings measured using Spearman's rank correlation coefficient). The results indicate statistically significant β-convergence across all assortments, implying faster price growth in forest districts with lower initial price levels. However, no evidence of σ-convergence was found, as price dispersion did not decrease over time. The γ-convergence analysis revealed limited changes in price rankings, particularly for large-sized oak timber, indicating persistent relative price differences. The findings suggest that a unified sales system contributes to convergence in price dynamics but does not eliminate spatial price differences, which should be considered when formulating sales strategies to avoid pricing and revenue inefficiencies.

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Introduction

Convergence can be defined as a process in which differences in the level of a given economic variable between spatial units decrease over time (Evans et al., 1983; Barro and Sala-i-Martin, 1992). The opposite phenomenon is divergence, which refers to the persistence or deepening of disparities. The concept of convergence originates from development economics and, since the 1990s, has constituted an important stream of empirical research, particularly in the context of market integration and price equalization processes (Nowak, 2006).

The theoretical point of reference for analyses of price convergence is the Law of One Price, according to which, under conditions of perfect competition and frictionless arbitrage, prices of homogeneous goods should equalize, and any remaining differences should result solely from transportation and transaction costs (Balassa, 1964; Samuelson, 1964). In practice, however, the fulfillment of this law is often constrained by market imperfections, spatial barriers, and institutional factors (Wyrzykowski, 2015; Loureiro et al., 2023). As a consequence, price convergence processes are frequently incomplete, and markets may function in segmented

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forms even under conditions of progressing trade globalization (Alfaro et al., 2026).

The issue of price convergence has been extensively developed in the macroeconomic literature, beginning with the classical concepts of β-convergence and σ-convergence proposed by Barro and Sala-i-Martin (1992). Subsequently, Carlino and Mills (1996) as well as Bernard and Durlauf (1995) advanced the concept of stochastic convergence. A further stage in the methodological development was introduced by Phillips and Sul (2007), who proposed an approach allowing for the identification of convergence clubs. The literature employs a wide range of empirical methods to examine convergence, including time-series, cross-sectional, and panel data analyses (Ulucak and Apergis, 2018).

The timber market exhibits characteristics that distinguish it substantially from many other commodity markets (Hetemäki and Mikkola, 2005; Kant, 2010; Alberdi et al., 2016; Gejdoš et al., 2019). It is strongly spatially conditioned and influenced by macroeconomic factors (Hlaváčková et al., 2015), such as inflation, exchange rates (Hänninen, 1998), the pace of economic growth (Lamichhane et al., 2025), as well as opportunities for timber imports and exports.

Research on the integration of global markets for forest products indicates that, despite increasing international trade, prices of timber and wood products do not always converge to a single reference price. Instead of full integration, market heterogeneity, asynchronous price movements, and the existence of convergence clubs are frequently observed (Mäki-Hakola, 2004; Gil et al., 2023). Moreover, industrial demand for specific timber assortments does not always follow the business cycle, which further amplifies price volatility (Adamowicz, 2010; Hasan and Hoffman-MacDonald, 2012).

Previous studies on the timber market in Poland have focused primarily on analyses of timber supply and prices over time (Paschalis-Jakubowicz et al., 2015; Mandziuk et al., 2021), the identification of seasonal and cyclical price fluctuations (Banaś and Kożuch, 2019), price forecasting (Adamowicz and Górna, 2020; Kożuch et al., 2023), and the examination of linkages with foreign markets, including cointegration analyses (Kożuch, 2021; Wysocki et al., 2025). Considerably less attention has been devoted to regional price differentiation and price equalization processes in the domestic timber market, despite the fact that this issue is of substantial importance for assessing market functioning, particularly under conditions of standardized assortments and relatively small spatial distances between units. In the State Forests National Forest Holding, timber sales are conducted within a unified, centrally regulated system based on standardized assortments and uniform sales rules. Under such conditions, the persistence of price differences between forest districts raises questions regarding the effectiveness of price equalization mechanisms.

Timber prices are an important economic indicator affecting both the revenue performance of forest districts and the raw material costs borne by wood-processing industries. In a system based on standardized assortments and centrally regulated sales procedures, the persistence of regional price differences raises questions about the actual degree of market integration, the efficiency of price transmission, and the allocation of raw material across space. These issues are economically relevant not only for forest management, but also for regional wood-processing industries and broader resource governance. In this study, price convergence analysis is adopted as an appropriate approach for assessing the dynamics of timber price equalization across spatial units, while the analysis does not encompass the examination of long-run equilibrium relationships between price time series. Price convergence processes are analyzed using several complementary approaches, allowing for the assessment of price catching-up mechanisms, changes in price dispersion over time, and the stability of relative positions of units within the market structure (Wolszczak-Derlacz, 2007; Zawojska, 2012; Navarro-Chávez, 2025).

The aim of this study is to assess the regional timber market with respect to price convergence processes, understood as a reduction in price disparities between forest districts. In particular, the analysis examines whether forest districts with lower initial price levels experience faster price growth, whether overall price dispersion decreases over time, and whether relative price positions of units within the market structure remain stable or change.

Research methodology

1. Data sources

The data were obtained from the Information System of the State Forests (SILP). The analysis is based on nominal quarterly timber prices (PLN/m^3) recorded over the period 2005–2024 for forest districts administered by the Katowice Regional Directorate of the State Forests. Quarterly prices represent average transaction prices at the forest district level. The study focuses on pine and oak timber, which are of major economic importance within the Katowice Directorate. Specifically, the analysis covers large-size pine and oak timber (WC0, dimensional class 3) and medium-size pine and oak timber (S2A), sold under the standard sales procedures applied by the State Forests National Forest Holding, excluding submission-based and auction sales.

Due to the twenty-year study period, oak and pine assortments were not harvested in all forest districts

throughout the entire period. Owing to incomplete data records, price convergence analyses were conducted for 35 forest districts in the case of pine timber and for 33 forest districts in the case of oak timber.

Across all organizational units, identical timber assortments were analyzed to isolate purely price-driven market mechanisms and to eliminate the influence of quality or diameter differences on observed prices.

2. Methods

Prices were transformed into natural logarithms, following standard practice in convergence analysis, to stabilize variance and express changes in relative terms. The empirical procedure consisted of the following steps: (1) calculation of average log growth rates and the standard deviation of log prices as a measure of dispersion, and (2) estimation of β-, σ-, and γ-convergence models.

3. Beta convergence

β (beta) convergence refers to the existence of a negative relationship between the initial level of the analyzed variable and its average growth rate over time (Wolszczak-Derlacz, 2007). The presence of β-convergence implies that forest districts characterized by lower initial levels of the variable experience relatively higher growth rates compared to units with higher initial levels.

In this study, β-convergence implies that forest districts with relatively lower initial timber prices exhibit faster price growth in subsequent periods. It is observed that when price increases in units with initially low price levels are sufficiently strong to reduce price differentials between forest districts over time. The dependent variable captures the average growth rate of log prices for each forest district over the study period, and the model is estimated across forest districts. To empirically test for the presence of β-convergence, a linear regression model of the following form is employed (Pukin-Sowul and Włodarczyk, 2024):

$$\frac{1}{T}\sum_{t=1}^{T}(lnY_{ti} - lnY_{0i}) = \alpha + \beta lnY_{0i} + \varepsilon_i, \qquad (1)$$

where:
Y_{0i} - denotes the price in unit i at the initial period of the analysis,
Y_{ti} - denotes the price in unit i in the subsequent period t (quarters),
T - represents the total number of quarters included in the analysis,
α and β - are the model parameters,
ε_i - is the random error term.

4. Sigma convergence

σ (sigma) convergence describes changes in the dispersion of the analyzed variable across units (forest districts) over time. The presence of σ-convergence implies a systematic decline in the dispersion of the variable, indicating a process of equalization of its levels across units. In this study, σ-convergence refers to a reduction in the dispersion of timber prices among forest districts over successive observation periods. To assess σ-convergence, dispersion is measured by the standard deviation of the logarithms of timber prices, calculated separately for each period. Subsequently, a linear time-trend model of the following form is estimated (Próchniak and Rapacki, 2007; Maulana et al., 2020):

$$SD(lnY)_t = \alpha + \beta t + \varepsilon_t, \qquad (2)$$

where:
$SD(lnY)_t$ - denotes the standard deviation of the logarithms of prices at time t (quarter),
t - denotes the index of the time period,
α and β - are the model parameters,
ε_t - is the random error term.

The dependent variable captures the degree of timber price dispersion across forest districts in a given period. The time trend coefficient (β) indicates the direction and magnitude of changes in dispersion over time. σ-convergence is confirmed when the estimated β coefficient is statistically significant and negative, implying that timber price dispersion among forest districts systematically declines over time.

5. Gamma convergence

γ (gamma) convergence refers to changes in the relative positions of units within the distribution of the analyzed variable over time. Unlike σ-convergence, which captures changes in overall dispersion, γ-convergence allows for the assessment of the stability of the ranking of units according to price levels. It examines whether units occupying specific positions in the price distribution in the initial period maintain these positions in subsequent periods or whether mobility in relative price levels occurs.

In the context of the timber market, γ-convergence enables an assessment of the persistence of forest districts with relatively high timber prices. The presence of γ-convergence implies decreasing stability of the price ranking over time, indicating a process of equalization of relative price positions, independent of changes in overall price dispersion. To measure γ-convergence, Spearman's rank correlation coefficient

is applied to price rankings in the initial and final periods across four time horizons (Wolszczak-Derlacz, 2007; Panzera and Postiglione, 2020):

$$\gamma = \rho(R_{i,0},\ R_{i,T}), \tag{3}$$

where:
$R_{i,0}$, - denotes the rank (position in the ranking) of the timber price in unit *i* in the initial period, ranga,
$R_{i,T}$ - denotes the rank of the timber price in the same unit in the final period,
ρ – represents Spearman's rank correlation coefficient,
i =1,…,N – denotes the spatial units (forest districts).

The value of the γ coefficient ranges from −1 to 1. High positive values of γ indicate stability of the ranking of units over time, whereas low values close to zero reflect changes in the ordering of units, providing evidence of γ-convergence. Negative values indicate a reversal of the ranking. Gamma convergence complements the analysis of β- and σ-convergence by enabling an assessment of changes in the relative positions of units within the price structure, independently of changes in overall price dispersion. Confidence intervals for Spearman's rank correlation coefficients were computed using standard asymptotic methods implemented in R.

The results of the convergence model estimations are reported together with the estimated β coefficient, its standard error (SE), the t-statistic, the p-value, the 95% confidence interval (CI), and the coefficient of determination (R^2).

Regression models for β- and σ-convergence were estimated using the ordinary least squares (OLS) method. Statistical significance was assessed at the 5% level (α = 0.05).

All analyses were conducted using R software, version 4.5.2 (R Core Team, 2024).

Study area

The Katowice Regional Directorate of the State Forests, the second largest in Poland, manages approximately 635.6 thousand hectares of forest land. The Directorate comprises 38 forest districts. The study area is characterized by substantial geographical heterogeneity, encompassing lowland, upland, and mountainous habitats, which results in a diverse species composition. Scots pine (*Pinus sylvestris*) is the dominant species, while oak (*Quercus spp.*) and European beech (*Fagus sylvatica*) are the main deciduous species. The forest districts offer a wide range of timber assortments of varying quality. In 2023, total timber harvest within the Directorate amounted to 3,381 thousand cubic meters. Average prices of both large-size and medium-size timber exhibited an upward trend over the study period. The highest prices were recorded for large-size oak timber (WC03), reaching approximately 1 750 PLN/m^3 in 2023, while the lowest prices were observed for medium-size pine timber (S2A), amounting to 91 PLN/m^3 in 2005 (Fig. 1).

Results of the research

It was found that the β coefficient is statistically significant for all analyzed timber assortments ($p<0.05$). The slope of the regression line indicates the presence of negative β price convergence (β<0), reflecting faster price growth in units with lower initial price levels (Fig. 2). Price changes decline as the initial price level increases, which is fully consistent with the concept of beta convergence. In forest districts characterized by relatively low initial prices, the rate of price increase was sufficiently high to allow them to gradually "catch up" with districts exhibiting higher price levels.

The strongest β-convergence effect was observed for large-size oak timber (WC03), for which the estimated

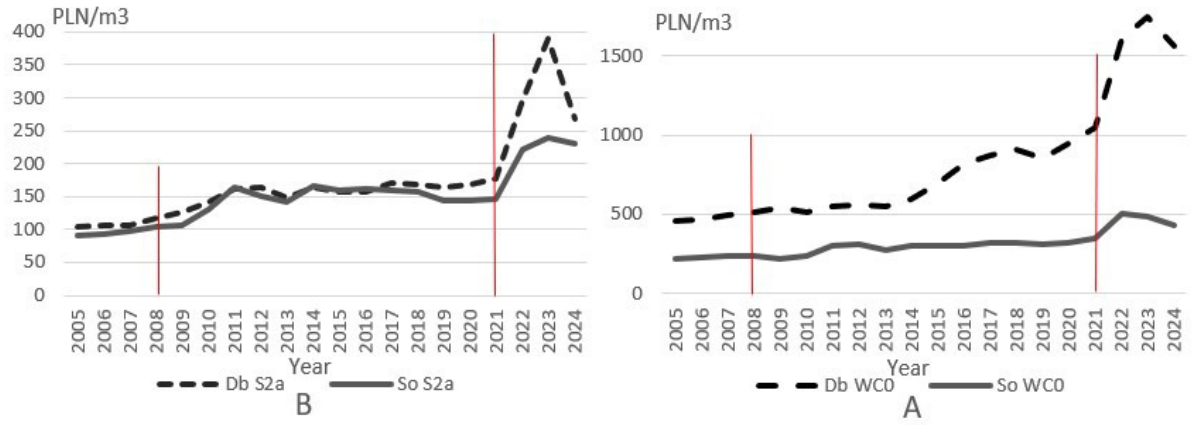

Fig. 1. Prices of Large-Diameter Oak and Pine Timber (WC03) (A) and Medium-Diameter Oak and Pine Timber (S2A) (B) in the RDSF in Katowice, 2005–2024

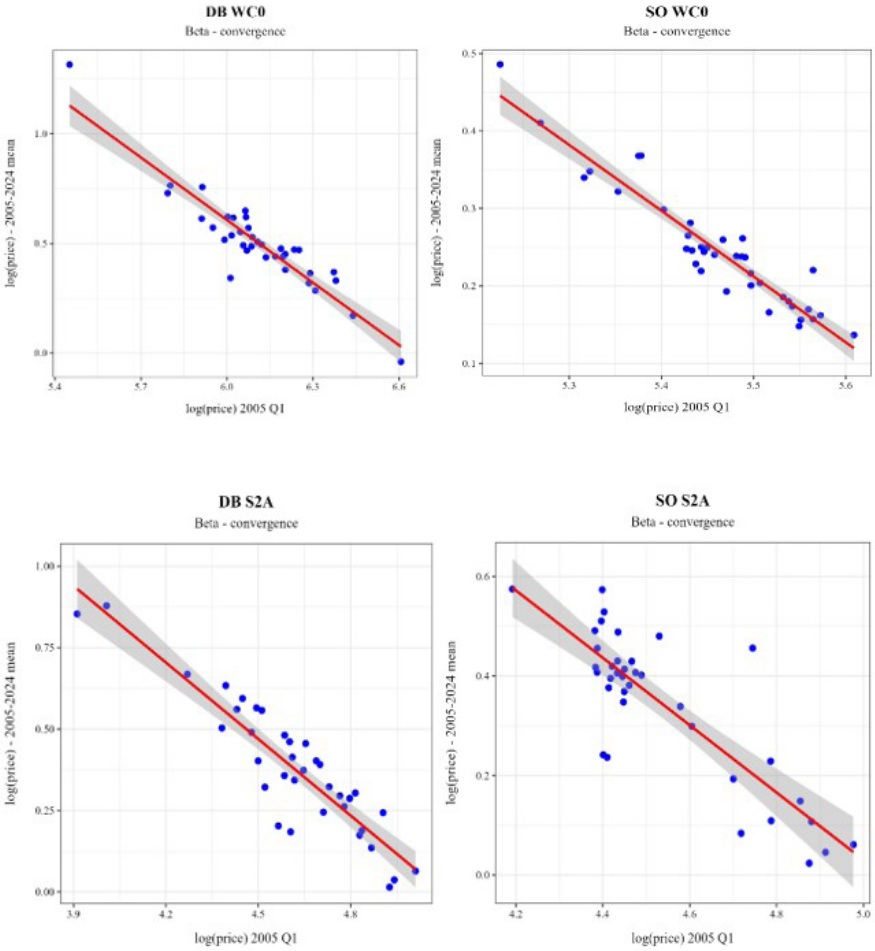

Fig. 2. Relationship between the average price change and the initial price level (β-convergence) of the analysed timber assortments

β coefficient amounted to −0.951. This indicates a very rapid process of price equalization among forest districts, which is further confirmed by the high coefficient of determination (R^2 = 0.859) (Table 1). Such strong convergence may be attributed to the high economic value of large-sized oak timber, its strong market demand, and, simultaneously, limited supply.

A slightly weaker, yet still pronounced, convergence process was identified for large-size pine timber (WC03), with β = −0.849 and R^2 = 0.894. Despite the greater availability of this assortment and its dominant share in total timber supply, prices of large-size pine timber also exhibited a clear tendency to converge over time. The high R^2 value suggests that price dynamics were largely driven by the convergence mechanism, leading to a reduction of initial price differences between forest districts.

In the case of medium-sized timber (S2A), the pace of price convergence was noticeably slower than for large-sized assortments. For medium-sized oak timber (S2A), the β coefficient amounted to −0.783 (R^2 = 0.834), still indicating a process of price equalization, albeit at a slower rate than for large-sized oak timber. This may be related to the stronger influence of local demand conditions. The lowest β coefficient was obtained for medium-sized pine timber (S2A), with β = −0.677 (R^2 = 0.710), indicating the slowest rate of price convergence among the analyzed assortments (Table 1). This suggests that prices of medium-sized pine timber exhibit greater spatial differentiation and respond more slowly to market mechanisms.

The estimation results of the σ-convergence models do not confirm the presence of a process of declining price dispersion over time for the analyzed timber assortments (Fig. 3). In all cases, the β coefficient describing changes in the standard deviation of the logarithms of prices over time was not statistically significant, indicating the absence of a clear downward trend in price differentiation among forest districts. For both large-sized and medium-sized timber, including oak and pine assortments, the estimated β coefficients were close to zero and statistically insignificant ($p>0.05$), pointing to a stable level of price dispersion over the study period (Table 2).

Mixed results were obtained for γ-convergence measured using Spearman's rank correlation coefficient

Table 1. Results of the estimation of the β-convergence model for prices of the analysed timber assortments

β	95% CI	SE	t	p	R^2
Db WC0					
-0,951	-1,086; -0,817	0,066	-14,386	<0,001	0,859
So WC0					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
-0,849	-0,948; -0,75	0,049	-17,392	<0,001	0,894
Db S2A					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
-0,783	-0,905; -0,662	0,06	-13,089	<0,001	0,834
So S2A					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
-0,677	-0,825; -0,528	0,073	-9,249	<0,001	0,71

β – estimated model coefficient; SE – standard error; t – t-statistic; p – significance level (p-value); *CI – 95% confidence interval; R^2 – coefficient of determination*

Table 2. Results of the estimation of the σ-convergence price model for the analysed timber assortments

β	95% CI	SE	t	p	R^2
Db WC0					
0,001	-0,001; 0,004	0,001	0,933	0,354	0,011
So WC0					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
0	-0,002; 0,001	0,001	-0,613	0,541	0,005
Db S2A					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
0	-0,004; 0,003	0,002	-0,23	0,819	0,001
So S2A					
β	**95% CI**	**SE**	**t**	**p**	**R^2**
0,004	0; 0,009	0,002	1,981	0,051	0,048

β – estimated model coefficient; SE – standard error; t – t-statistic; p – significance level (p-value); CI – 95% confidence interval; R^2 – coefficient of determination

(Table 3). Gamma convergence was calculated for prices in the initial and final periods for four different time horizons. Positive and statistically significant values of the γ parameter are interpreted as evidence of persistence in price hierarchies, whereas statistically insignificant values or values close to zero indicate the absence of a systematic process of changes in ranking positions.

For the large-sized oak timber assortment (Db WC03), positive and statistically significant γ coefficients were observed across all analyzed time horizons, indicating the absence of rank convergence and the persistence of price rankings. The γ values ranged from 0.44 for the period 2005–2010 to 0.33 for the period 2005–2024. At the same time, a systematic decline in γ values was observed as the time horizon lengthened, suggesting a weakening of divergence over time.

For large-sized pine timber (So WC03), γ coefficients were low and statistically insignificant (p>0.05) in the

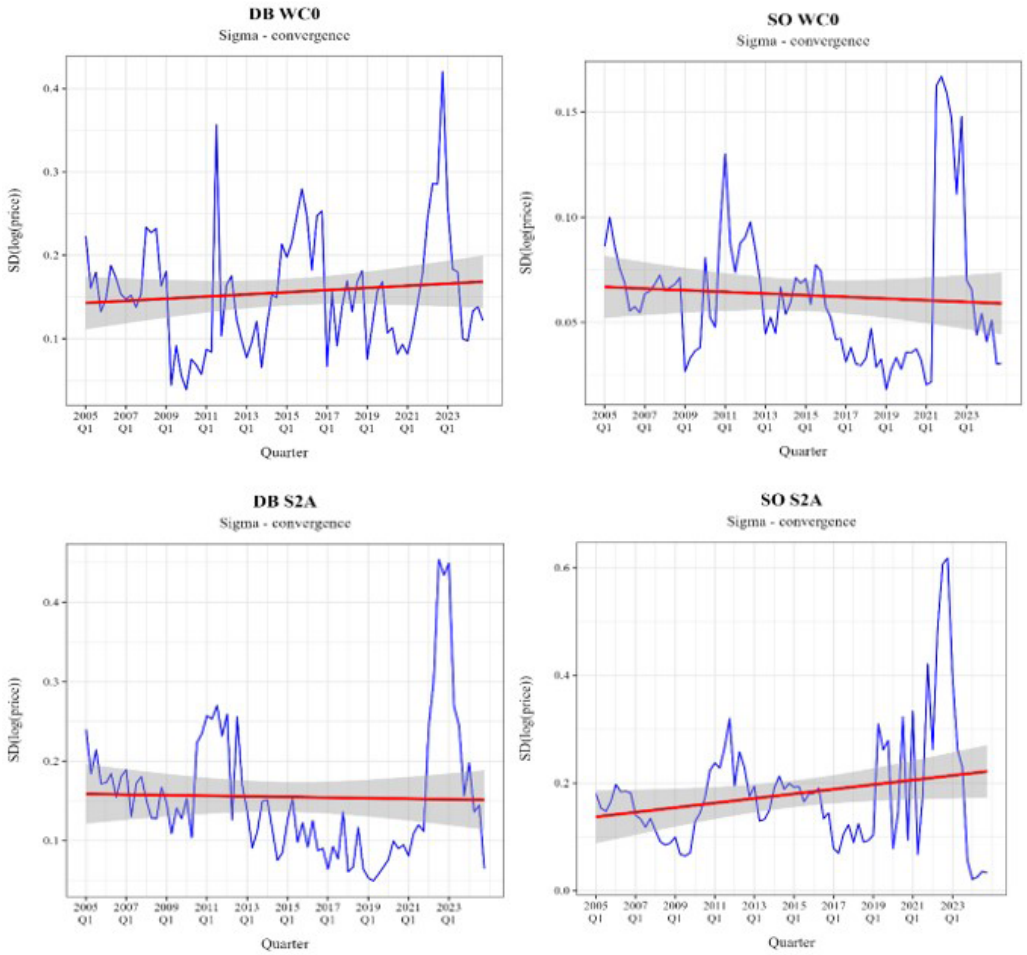

Fig. 3. Changes in the standard deviation of the logarithms of prices over time (σ-price convergence) of the analysed timber assortments

Table 3. Results of γ-price convergence of timber assortments across different time horizons: 2005-2010; 2005-2015; 2005-2020; 2005-2024

γ 2005-2010	p	95% CI	γ 2005-2015	p	95% CI	γ 2005-2020	p	95% CI	γ 2005-2024	p	95% CI
Db WC0											
0,44	0,006	0,14;0,67	0,37	0,022	0,06;0,62	0,35	0,031	0,03;0,60	0,33	0,043	0,01;0,59
So WC0											
0,08	0,633	-0,25;0,39	0,15	0,369	-0,18;0,45	0,58	0,00	0,32;0,76	0,52	0,001	0,24;0,72
Db S2A											
0,48	0,002	0,19;0,69	0,14	0,402	-0,19;0,44	-0,2	0,229	-0,49;0,13	-0,09	0,591	-0,40;0,24
So S2A											
0,18	0,28	-0,15;0,47	0,07	0,676	-0,26;0,38	0,16	0,377	-0,17;0,46	0,08	0,633	-0,25;0,39

γ – Spearman's rank correlation coefficient between timber price rankings in the initial year (2005) and the final year of the given time horizon; p-value – significance level of the Spearman rank correlation; 95% CI – 95% confidence *interval for the γ coefficient*

shorter time horizons (2005–2010 and 2005–2015), indicating a lack of persistent association between price rankings. In contrast, in the longer periods (2005–2020 and 2005–2024), γ assumed high and statistically significant values of 0.58 and 0.52, respectively, pointing to a stabilization of the price hierarchy in the long run.

In the case of medium-sized oak timber (Db S2A), a positive and statistically significant γ value (0.48) was observed in the short term (2005–2010), indicating strong persistence of the price hierarchy. In subsequent horizons, the γ coefficient declined substantially and lost statistical significance, while in the long term, it assumed negative but statistically insignificant values. For medium-sized pine timber (So S2A), γ coefficients were low and statistically insignificant across all analyzed periods, indicating the absence of a persistent relationship between price rankings.

Overall, γ coefficients were positive and predominantly statistically significant, particularly for the Db WC03 assortment, which points to the stability of forest districts' price rankings over time. However, the decline in γ values with increasing time horizons did not lead to the disappearance of ranking heterogeneity, which occurred simultaneously with the presence of β-convergence and the absence of σ-convergence.

Discussion

While some aggregated national and international markets operate relatively close to the conditions of perfect competition, regional and local markets more frequently exhibit features of market imperfections. These imperfections arise, among other factors, from spatial structure and heterogeneous market power among participants. The literature indicates that regional and local differentiation of timber prices may be associated with factors such as the volume and continuity of supply, seasonality of supply and sales, the intensity of competition, local demand conditions, and, in particular, the distance between the place of raw material extraction and processing (Olofsson and Lundmark, 2016; Lamichhane et al., 2025). In this context, the application of β-, σ-, and γ-convergence measures enables a simultaneous assessment of the pace of price equalization, changes in price dispersion, and the stability of relative positions of individual units within the spatial price structure.

The results indicate the coexistence of price β-convergence with the absence of σ-convergence and limited γ-convergence of rankings. This pattern is consistent with previous findings indicating that β-convergence may occur without a simultaneous decline in dispersion (σ-convergence). However, the absence of σ-convergence suggests that price equalization remains incomplete, which deviates from the theoretical expectation of full market integration. The observed β-convergence implies that forest districts within the Regional Directorate of State Forests in Katowice with lower initial price levels experience relatively higher rates of price growth. However, this process is not sufficiently strong to result in a systematic decline in spatial price dispersion. This may indicate the existence of a lower bound for price dispersion, driven by persistent transport costs and localized demand structures (e.g., regional wood-processing clusters), which limit full price equalization despite a unified institutional framework.

This persistence is consistent with the influence of local demand conditions and spatial characteristics, as documented in previous empirical studies (Quah, 1996; Wolszczak-Derlacz, 2007). Similar findings have been reported in studies on regional and commodity markets (Trofimov, 2023; Gil et al., 2023). Recent studies confirm that price convergence processes are often incomplete and shaped by demand-side and spatial factors (Loureiro et al., 2023).

The results of the γ-convergence analysis point to the persistence of price hierarchies among forest districts, particularly for large-sized timber assortments, indicating limited mobility of relative positions within the price distribution. Despite the presence of β-convergence, differences in price growth rates do not lead to substantial changes in ranking positions. Taken together, these findings confirm that price catch-up occurs without a corresponding reduction in dispersion, reinforcing the persistence of spatial price differentiation between forest districts. Differences in results across assortments further highlight the importance of product characteristics in shaping regional price relationships.

Moreover, the observed differences in convergence patterns across timber assortments are consistent with studies emphasizing the role of product substitutability and value-to-weight ratios in shaping spatial price relationships (Zhou, 2021; Li et al., 2021; Fuhrmann et al., 2021). Products with higher economic value and lower substitutability tend to exhibit stronger but more persistent spatial price differences, whereas more homogeneous and substitutable assortments are characterized by greater flexibility and faster adjustment of price relationships (Silva et al., 2020; Goodwin et al., 2021). The value-to-weight ratio of timber implies that transportation costs exert a direct influence on the degree of spatial price alignment between geographically separated markets (Engel and Rogers, 1996). Timber is characterized by a relatively low unit value relative to its mass, which makes transportation costs a key factor in the formation of spatial price relationships. In the case of large-size assortments, particularly oak timber (WC03), moderate and persistent rank correlations may stem from the high

economic value of the product, limited supply, and the importance of long-term trading relationships. These factors contribute to the persistence of advantages held by certain forest districts and constrain the mobility of price positions. In contrast, for medium-sized assortments, especially pine timber, low and statistically insignificant γ values may indicate higher product substitutability, a stronger influence of current supply–demand conditions, and greater flexibility of spatial price relationships.

An important interpretative context is provided by the institutional framework of the primary timber market, including a unified and centralized sales system and uniform legal regulations applied nationwide, particularly with respect to price-setting rules. It should be noted that no major changes in the timber sales system of the State Forests occurred during the study period, which suggests that the observed price dynamics are not driven by institutional shifts but rather by persistent market and spatial factors. At the same time, heterogeneity in local conditions—such as geographic location, production characteristics, and the structure of buyers—may foster the presence of β price convergence without leading to full spatial price equalization. Research on natural resource markets indicates that under such conditions, convergence in price dynamics may be partial, while regional price differences may persist over extended periods (Asche et al., 2006). In addition to geographic factors, regional price differentiation may also be influenced by price rigidity, which constrains the speed of adjustment to changing market conditions (Crucini et al., 2010). Moreover, analyses of price convergence in the global softwood lumber market suggest that spatial price relationships are largely driven by demand-side factors, which may further reinforce regional heterogeneity in price dynamics (Gil et al., 2023).

It should also be noted that the degree of competitiveness in timber markets may change significantly over time, particularly during economic downturns or following random events such as natural disasters, which can lead to persistent changes in spatial price relationships. Nevertheless, Yin and Newman (1996) demonstrate that long-term price movements in the U.S. pine lumber market are driven primarily by long-term changes in regional market structures rather than by the direct effects of random shocks. Finally, it should be emphasized that the study focuses on a single region and selected timber assortments and is primarily concerned with the dynamics of price convergence rather than with the direct identification of underlying market determinants, which may limit the generalizability of the results.

The results indicate that price convergence in the timber market is primarily driven by dynamic adjustment mechanisms rather than by full spatial and market equalization, reflecting the presence of persistent spatial frictions. These findings suggest that the regional timber market operates under conditions of partial integration, where price adjustment occurs mainly through growth dynamics rather than through a systematic reduction of spatial disparities. As a result, convergence remains incomplete and dependent on local market conditions.

More broadly, this implies that the timber market functions as a spatially segmented system, in which price convergence is structurally constrained by persistent spatial and market-specific factors rather than driven by full market integration.

A unified timber sales system does not eliminate regional price differences; therefore, these differences should be taken into account by entities responsible for shaping sales policy when designing pricing strategies, in order to avoid inefficiencies in price setting and revenue allocation.

Conclusions

Statistically significant β price convergence is observed in the regional timber market of the Regional Directorate of State Forests in Katowice, indicating faster price growth in forest districts with lower initial price levels.

The absence of σ-convergence indicates that price catching-up does not lead to a lasting reduction in price dispersion, and spatial price differences persist over time.

The γ-convergence results reveal limited changes in price rankings, particularly for large-size oak assortments, pointing to stable relative price positions of forest districts despite declining γ values over longer time horizons.

Variation across timber assortments confirms the role of product-specific characteristics, especially economic value, in shaping price convergence patterns.

From the perspective of timber sales policy within the State Forests, the findings suggest that a unified sales system contributes to convergence in price dynamics but does not eliminate persistent spatial price differentials, which should be taken into account when developing sales strategies to avoid suboptimal pricing decisions and potential revenue inefficiencies.

Although the analysis focuses on a single regional directorate, the results may reflect broader patterns observed in other State Forests units in Poland and similar centrally regulated forest management systems in Central Europe, where institutional uniformity coexists with local market heterogeneity.

Further research should extend the analysis to other regions and explicitly account for spatial and *market-specific factors* underlying timber price differentiation.

Conflict of interest

The author(s) declare(s) that there is no conflict of interest concerning the publication of this article.

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