

ANALYZING THE HOUSING MARKET DYNAMICS: MEASURING TEMPORAL TRENDS USING NON- PARAMETRIC METHODS

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ABSTRACT

Rising house prices are increasingly impacting affordability and sustainable urban development in Pakistan, so, understanding the temporal price trends is essential for informed decision making in housing policy and planning. This research study analyzed the monthly house price data of approximately a decade from 28 localities in Lahore City and categorized properties into four size-based groups. The study employed the Mann-Kendall (MK) Test and Sen's Slope Estimator (SSE) for detecting trend direction and magnitude. These non-parametric methods do not require assumptions about data distribution, so, they are well suited techniques for this analysis as the house price data typically follow monotonic patterns. The results revealed statistically significant upward trends in small and medium sized property prices, driven by growing demand and investment activity. In contrast, large sized properties show mixed trends, with some areas experiencing stagnation. Very large sized properties in high demand localities exhibited price increases roughly proportional to their size. The findings point to a segmented housing market, underscoring the need for urban policies that consider size-based market dynamics. To promote equitable access to housing and curb speculative pressures, the study recommends targeted interventions such as incentives for affordable housing development and stronger regulations on speculative real estate investment.

KEY WORDS: Housing Market Dynamics, Spatial Analysis, Urban Planning, Temporal Trends, Mann-Kendall Test, Sen's Slope Estimator

1. INTRODUCTION

Analysis of the urban housing markets has gained growing attention in academic discourse due to its implications for investment decision making, urban planning and economic policy. Dynamics of these markets reflect not only the economic vitality of the cities but also the evolving spatial and social structures (Leishman, 2009; Yunus, 2015; Kobzan & Pomortseva, 2023; Unal et al., 2025). Housing property prices are shaped by a complex interplay of population growth, infrastructural expansions, shifting patterns of land use and investment flows in fast expanding cities (Wu & Zhang, 2012). So, understanding that how property values change over

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time is essential equally for urban planners, policymakers and other market participants because the real estate becomes both a livelihood necessity and a speculative asset in such urban settings (Theurillat et al., 2015).

Temporal aspect of any type of data is of immense importance and the time based inquiry of residential property prices gives a deeper insight into the analysis of housing market dynamics (Chen & Fik, 2018). The trend of a time series data shows the general direction toward which the series moves. A house price index always displays a persistent rising trend over time, much like a money supply or a gross national product time series in a long run because the increasing population number gives rise to the demand while growing land occupancy cuts the supply short, so, prices keep bulging. On the other hand, the house price display a recurring pattern during comparatively short runs and capturing these cyclic booms and busts may be useful for regular investors (Duca et al., 2021). An experimental inquiry into the temporal housing market dynamics can report on the nature of market growth, stability and the price bubble occurrence that could be imperative for various stakeholders (Jones et al., 2003; Coskun et al., 2020). The nature of residential property markets around the world in general, is usually impulsive and opaque. To reach upon a deal, the buyers and sellers greatly depend on the comparisons of transactional prices of proximate houses that possess some similar features. This spatial dependence among housing property prices is more evident in times of a hot market situation but does not show a significant relationship in a cold market situation. This insignificant character of spatial association in dip times can be connected with the seller's tendency of loss avoidance (Hyun & Milcheva, 2018).

In developed countries, various relevant studies have traced well defined housing price cycles that seem often tied to the credit conditions and investor behaviors. An example can be quoted from the U.S. where housing market crash of 2008 remained a case study in price bubble dynamics and systemic risks for years to come (Meng et al., 2014). Similarly, in the UK and Australia, some of the empirical works have revealed a persistent price inflation interspersed with abrupt corrections, mainly influenced by low interest environments and housing as an investment vehicle (M. M. Rahman, 2010; White, 2015). Emerging housing markets display greater volatility and weaker institutional frameworks. These circumstances make them more susceptible to short term price shocks. In developing countries, the house price data is often sparse or informal which complicate the trend analyses, however, the researchers have attempted to model house prices through proxies such as construction material indices, informal rent estimates, and land registry

data (Tiwari & Rao, 2016; Bah et al., 2018; Shimbo, 2019). Some of the major Asian cities exhibit a kind of hybrid dynamics of both developed and developing economies where high demand from urbanization coupled with speculative real estate investments leads to cyclic booms, so, the governments have to impose some kind of cool down measures to trigger the trend reversals (Olanrewaju & Idrus, 2019; Shelby, 2022; Zhu et al., 2022).

In Pakistan, the local housing markets are characterized by chronic supply shortages, informal development practices, and rising unaffordability. These phenomena are particularly pronounced in major urban centers like Lahore, Karachi, and Islamabad. Relevant previous research have noted that the urban population growth continued at a rapid pace and formal housing supply had not kept up, consequently, it lead to an estimated shortfall of over 10 million housing units nationwide (Javed & Naqvi, 2022). The Pakistani housing market is also marked by a dual structure where speculative investments in formal housing sectors inflated the prices and a vast majority of the population have to rely on unregulated and low quality housing options (T. Rahman, 2022). Moreover, some of the other factors such as weak regulatory oversight, limited access to mortgage finance, high construction costs and foreign capital inflow by the overseas have further constrained the housing affordability and deepened the socioeconomic inequality (Ahmed et al., 2021b). House prices in Pakistan often tend to follow the trend patterns of consumer price indices where price bubbles emerge even monthly. This phenomenon reflects an inherently unstable nature of the housing market (Ahmed et al., 2021a).

Several quantitative techniques can be used to analyze the temporal price trends and patterns in housing market studies. For example, Error correction models (ECM) and vector auto-regression (VAR) have been extensively used to detect the long-term equilibrium relationships between housing property prices and macroeconomic indicators such as GDP, inflation and interest rates. These models are also effective in identifying the short run volatilities and lagged effects (Malpezzi, 1999; Kestel & Yilmaz, 2020). Multiple structural break (MSB) tests are widely employed to identify the shifts in market regimes. These tests do not focus the individual structural breaks which often stem out of policy reforms, economic crises, or speculative bubbles that may substantially distort the housing market trends (Barari et al., 2014). Various non-linear approaches are used to distinguish between boom, bust, and stable phases within housing market cycles such as the Markov Switching Regression (MSR) model (Babalos et al., 2015). Real-time house price forecasting can be done using the recently emerged Machine learning techniques and the algorithms such as Random Forests, Gradient Boosting, and Neural

Networks which may provide higher accuracy in short term predictions, especially when combined with non-traditional data like satellite imagery or social media activity (Ho et al., 2021). Mann-Kendall (MK) Test and Sen's Slope Estimator (SSE) are also suitable methods for analyzing the temporal price trends of a housing market. These non-parametric statistics can provide insights into both the direction and magnitude of change over time, and report on an average change per unit time (Sen, 1968; Kolecka, 2021).

This study explored the temporal house price trends across various neighborhoods in Lahore City to offer some useful insights into localized growth patterns and broader market behaviors. MK Test and SSE are carefully chosen for this study due to their methodological robustness and suitability for short, irregular, and non-normally distributed datasets. These techniques offer a statistically sound and interpretable approach for identifying the price trends without the restrictive assumptions which are normally required by more complex econometric or machine learning methods. This study makes three key contributions to the literature on housing market analysis. First, it is the first application of the MK Test and SSE to monthly housing property prices for a robust quantification of local price trends. Second, by comparing four distinct plot sizes across multiple neighborhoods, it reveals size specific dynamics that were previously unexplored in the Pakistani context. Third, it offers a practical tool for planners and regulators to identify emerging bubbles and prioritize infrastructure investments in a volatile market by linking the empirical trends to urban economics theory and policy implications.

2. MATERIAL AND METHODS

This study adopted a quantitative and longitudinal research design to explore the temporal trends in housing property prices across selected localities in Lahore City, Pakistan. The objective was to capture the direction and magnitude of the price changes over time and focusing on four property size categories such as five, ten, twenty and forty Marla, to identify the differentiated trends and submarket behaviors.

2.1. Study Area

Lahore is an ideal setting for this research due to its hasty urbanizing and diverse housing submarkets and being the second largest city of Pakistan. As a growing metropolis with significant economic influence, the city exhibits distinct spatial variations in housing property prices which are largely shaped by factors like transportation networks, commercial hubs, and socioeconomic stratification. This research focuses on the evolving residential real estate landscape of the city to analyze the localized price trends and their drivers because it exhibits a blend of opportunities and

challenges that reflect the broader urban economic trends. Housing demand in the city has intensified due to faster urban population growth and ever increasing in-migration for employment and education from other parts of the country. Numerous infrastructure developments such as the Orange Line Metro, Ring Road, and a number of flyovers have enhanced the connectivity which have derived the house prices up near the transit corridors especially. The middle class of the city prioritizes affordable and secure housing in suburban gated housing colonies, whereas the affluent buyers and overseas Pakistanis fuel demand for luxury housing properties with premium amenities (Rehman et al., 2024). Sustainability trends are also gaining prominence with eco-friendly designs which appeal the environmentally conscious investors. Furthermore, the housing rental market remains robust due to substantial inflows of students and professionals. Despite the challenges like regulatory hurdles, price volatility, and land ownership disputes, prime localities sustain growth owing to their established infrastructure, persistent demand, and strong investor confidence (Rehmani, 2025). In this context, the temporal price trend analysis of this housing market may provide some critical insights for investors and policymakers to make informed decisions at the right time.

2.2. Data and Sources

Data of housing property prices was acquired from Zameen.com, a leading online real estate portal in Pakistan, which aggregates property prices based on user submitted listings and platform analytics, providing high frequency, real-time data (Zameen.com, 2025), that makes it suitable for temporal trend analysis in a market where formal transaction data is limited. Listing data is used as a proxy of actual transactions due to the unreliability of official records. Government sources such as the Federal Board of Revenue (FBR) or Provincial Revenue Departments (e.g., Deputy Collector tables) often report under-invoiced values, capturing only 5–50% of market prices (Khalid & Zameer, 2023). Although listings reflect seller asking prices, previous literature suggests that they typically differ by only 3–5% in final negotiations, making them a reasonable approximation of actual transaction values and prior research shows a strong correlation between asking and transaction prices. Moreover, in seller-driven markets where demand exceeds supply, asking prices closely match final sale prices, as sellers act as price setters (Ibeas et al., 2012; Salon et al., 2014; Yang et al., 2020). While not all listed properties are sold, listings still reflect seller expectations and such data can be used in contexts where official transaction records are undependable (Katsalap, 2008; Yang et al., 2020). Only those localities were included in the analysis whose property price records were consistent for the study period to ensure the fair

comparison. The price per square foot in Pakistani Rupees (PKR) was used to enable the standardization across all plot sizes and localities.

2.3. Methods

To analyze the price trends, two non-parametric statistical methods; the Mann-Kendall (MK) Test and Sen's Slope Estimator (SSE), are employed using Real Statistics Resource Pack. MK Test can assess the monotonic trends whether are increasing or decreasing in a time series data without assuming linearity or normal distribution. This ability makes this statistic robust for analyzing the socioeconomic datasets which exhibit fluctuations and outliers. It evaluates pairwise comparisons between data points to calculate 'S' test statistic whose positive values indicate upward trends while negative values suggest downward movement. Statistical significance is evaluated through both the Z-score and its corresponding p-value. At a 99.9% confidence level which is applied throughout the analysis of this study, a ' $|Z| > 3.29$ ' and a corresponding ' $p < 0.001$ ' indicate significance. SSE complements the analysis by quantifying the trend magnitude. SSE also does not require a normality or homoscedasticity assumptions in the dataset which make it resilient to outliers and an ideal tool for analyzing a volatile housing market dataset. It calculates the median rate of change by accommodating irregular or short-term series without stationarity or large sample requirements that offers advantages over parametric alternatives such as regression. It provides a continuous and interpretable measure of trend strength without complex parameterization which is not offered by the alternative techniques such as structural break tests and machine learning approaches (Sen, 1968; Zaiontz, 2015; Alashan, 2020).

3. RESULTS AND DISCUSSION

The results of the analysis are detailed in Tables 1 to 5, which reveal distinct spatial and size-specific patterns in price dynamics. It reflects the underlying economic, infrastructural, and behavioral reasons. This section presents the findings for each property size category separately and then intra locality comparison (Table-5). Tables 1 to 4 present Mann-Kendall test results and Sen's Slope estimates for price trends, while figures 1 to 4 visualize the Sen's Slope estimates by locality for each property size category.

3.1. Price Trend of Five Marla Properties

Table 1 outlines the price trends for five Marla properties across seventeen localities. Most localities exhibited statistically significant upward trends ($p < 0.001$, $|Z| > 3.29$). DHA Phase-5 recording the highest monthly increase at 105.54 PKR per square foot, followed by Johar Town Phase-1 that shows

87.09. Johar Town with 72.57, Wapda Town with 69.44 PKR). Paragon City (59.00) and Bahria Town (57.18) also showed robust growth, while DHA (whole) displayed a modest yet significant rise (8.82). Exceptions were Township and Khayaban-e-Amin, where trends were insignificant, with the latter showing a negative slope of -9.44 ($p > 0.001$).

Table 1: Price Trend Analysis for Five Marla Properties

Locality	MK-Stat	SE	Z-Stat	P-Value	Trend	Slope	Lower Bound	Upper Bound
DHA (Ph-5)	3875	306.16	12.65	0.000	Yes	105.54	92.98	117.44
Johar Town (Ph-1)	6484	424.50	15.27	0.000	Yes	87.09	83.05	90.85
Johar Town (Whole)	2509	218.61	11.47	0.000	Yes	72.57	66.77	79.17
Wapda Town (Whole)	567	102.19	5.54	0.000	Yes	69.44	40.20	98.19
Paragon City	2895	245.19	11.80	0.000	Yes	59.00	50.83	68.15
Bahria Town	2905	245.18	11.84	0.000	Yes	57.18	52.12	62.36
Allama Iqbal Town	2400	218.61	10.97	0.000	Yes	52.41	45.49	58.46
Wapda Town (Ph-1)	1722	193.01	8.92	0.000	Yes	50.15	39.09	62.54
DHA (Ph-6)	1858	193.03	9.62	0.000	Yes	49.28	42.24	56.02
State Life	3370	272.76	12.35	0.000	Yes	49.22	44.31	55.13
Eden	2446	245.19	9.97	0.000	Yes	46.66	37.32	55.85
Al Rehman Garden	1446	145.25	9.95	0.000	Yes	46.07	39.29	49.86
DHA (Ph-3)	619	145.26	4.25	0.000	Yes	27.50	7.04	45.64
DHA (Rahbar)	340	82.47	4.11	0.000	Yes	17.12	4.57	30.75
Township	262	123.12	2.12	0.034	No	10.78	-7.29	27.04
DHA (Whole)	323	82.48	3.90	0.000	Yes	8.82	0.86	19.69
Khayaban-e-Amin	-139	64.50	-2.14	0.032	No	-9.44	-29.70	5.55

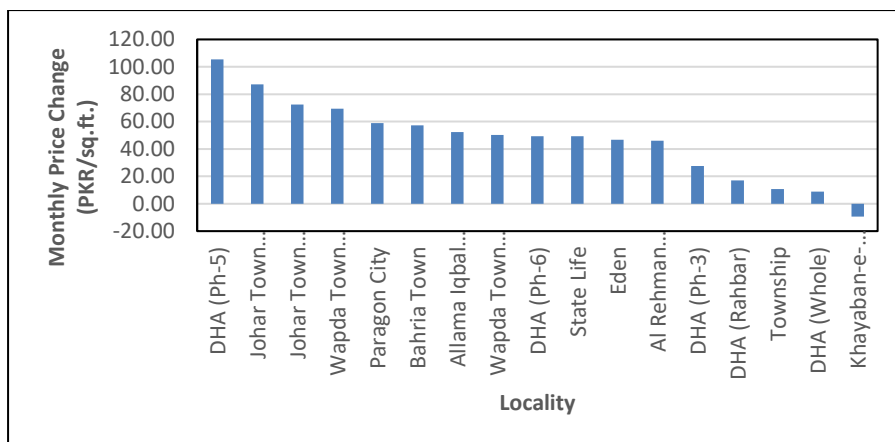


Figure 1: Sen’s Slope Estimates for Five Marla Properties across Localities

The prevalence of upward trends suggests strong demand for smaller plots in well-developed areas, consistent with bid-rent theory, which links property values to proximity to urban amenities (Kopczewska et al., 2021). However, stagnation in Township and decline in Khayaban-e-Amin indicate localized challenges, such as aging infrastructure and delayed development, respectively (Zulfiqar, 2017; Amin et al., 2020).

3.2. Price Trend of Ten Marla Properties

For ten Marla properties, Table 2 indicates statistically significant upward trends across all localities ($p < 0.001$, $|Z| > 3.29$). DHA Phase-5 led once again with a Sen’s Slope of 103.85 PKR per square foot per month, followed by DHA (whole) with 78, Johar Town with 75.57, and DHA Phase-6 with 72.54. Model Town (65), DHA Phase-4 (64.73), and Paragon City (60.42) also exhibited notable increases, while Askari Phase-10 (16.14) and Wapda Town Phase-1 (11.68) recorded the lowest significant slopes.

Table 2: Price Trend Analysis for Ten Marla Properties

Locality	MK-Stat	SE	Z-Stat	P-Value	Trend	Slope	Lower Bound	Upper Bound
DHA (Ph-5)	6260	424.50	14.74	0.000	Yes	103.85	95.41	112.48
DHA (Whole)	6381	424.50	15.03	0.000	Yes	78.00	69.92	88.52
Johar Town	6096	424.50	14.36	0.000	Yes	75.57	67.96	83.54
DHA (Ph-6)	4386	335.78	13.06	0.000	Yes	72.54	62.39	87.26
Model Town	652	102.23	6.37	0.000	Yes	65.00	42.42	84.85
DHA (Ph-4)	5816	424.50	13.70	0.000	Yes	64.73	54.40	72.75
Paragon City	2770	245.19	11.29	0.000	Yes	60.42	50.35	70.73
Bahria Town (Whole)	6544	424.51	15.41	0.000	Yes	57.04	51.60	61.52
DHA (Ph-8)	762	102.16	7.45	0.000	Yes	50.96	39.00	59.00

Valencia	1312	145.27	9.02	0.000	Yes	50.52	39.65	60.52
Askari (Whole)	5203	361.11	14.41	0.000	Yes	42.80	34.10	54.97
Eden	2684	245.19	10.94	0.000	Yes	40.28	33.83	46.73
DHA (Ph-1)	2793	272.76	10.24	0.000	Yes	39.65	33.92	47.11
DHA (Ph-3)	1682	193.06	8.71	0.000	Yes	39.17	29.26	51.67
Township	351	82.67	4.23	0.000	Yes	29.77	8.22	53.60
State Life	2351	218.60	10.75	0.000	Yes	28.61	24.08	32.93
Bahria Town (Sect-C)	1840	193.06	9.53	0.000	Yes	27.34	17.09	36.25
Bahria Town (Sect-B)	1896	245.19	7.73	0.000	Yes	25.33	18.42	34.97
Wapda Town (Whole)	621	102.13	6.07	0.000	Yes	18.16	11.77	25.17
Allama Iqbal Town	1393	218.52	6.37	0.000	Yes	17.80	10.50	23.94
Askari (Ph-10)	2266	218.61	10.36	0.000	Yes	16.14	14.10	18.15
Wapda Town (Ph-1)	882	193.06	4.56	0.000	Yes	11.68	4.56	19.25

The uniform appreciation reflects growing demand for mid-sized properties in secure, amenity-rich neighborhoods, aligning with hedonic pricing models that emphasize locational and structural attributes (Rosen, 1974; Bourassa et al., 2010; Fotheringham et al., 2015; Yang et al., 2020). The slower growth in areas like Allama Iqbal Town (17.80) suggests shifting preferences away from older and comparatively congested neighborhoods (Geniaux & Napoléone, 2008; Hou, 2016).

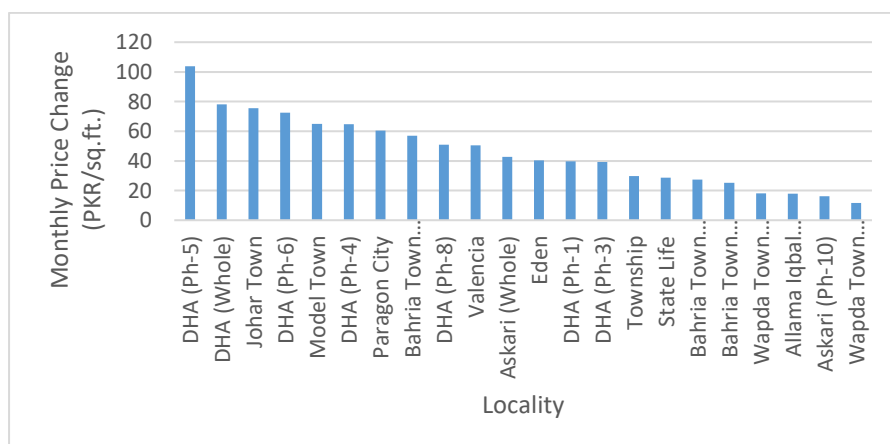


Figure 2: Sen's Slope Estimates for Ten Marla Properties across Localities

3.3. Price Trend of Twenty Marla Properties

Table 3 shows that twenty Marla properties exhibited significant upward trends in all localities except for Model Town ($p > 0.001$).

Table 3: Price Trend Analysis for Twenty Marla Properties

Locality	MK-Stat	SE	Z-Stat	P-Value	Trend	Slope	Lower Bound	Upper Bound
DHA (Ph-5)	844	102.19	8.25	0.000	Yes	71.08	55.00	85.00
DHA (Whole)	6222	429.92	14.47	0.000	Yes	65.95	58.06	71.75
DHA (Ph-6)	5259	366.30	14.35	0.000	Yes	59.85	46.06	68.00
Gulberg	1289	168.58	7.64	0.000	Yes	58.93	45.63	71.48
DHA (Ph-3)	301	82.64	3.63	0.000	Yes	46.16	7.50	90.70
DHA (Ph-4)	637	102.19	6.22	0.000	Yes	45.95	29.64	63.00
Wapda Town	637	102.18	6.22	0.000	Yes	44.97	25.97	61.22
Valencia	2905	245.19	11.84	0.000	Yes	44.39	39.97	48.85
Bahria Town	793	102.17	7.75	0.000	Yes	34.57	27.60	42.20
Johar Town (Ph-1)	1963	245.19	8.00	0.000	Yes	32.09	22.82	40.77
Johar Town (Whole)	491	102.17	4.80	0.000	Yes	25.77	6.56	42.11
DHA (Ph-2)	617	145.26	4.24	0.000	Yes	21.07	6.74	34.71
DHA (Ph-1)	610	145.26	4.19	0.000	Yes	18.53	5.56	32.97
Askari	1775	218.61	8.11	0.000	Yes	16.17	11.25	19.74
Model Town	59	82.65	0.70	0.482	No	7.82	-25.43	57.29

DHA Phase-5 topped the list in this category too, with a Sen's Slope of 71.08 PKR per square foot per month, followed by DHA (whole) (65.95), DHA Phase-6 (59.85), and Gulberg (58.93). Johar Town Phase-1 (32.09) and Bahria Town (34.57) showed moderate growth, while the slope for Model Town (7.82) was insignificant.

The strong performance of DHA and Gulberg highlights their appeal to high-income buyers, whereas the stagnation in Model Town reflects functional obsolescence and restrictive land-use policies (Quigley & Rosenthal, 2005). The overall higher variability underscores the segmented nature of the local housing market (Xiao et al., 2017).

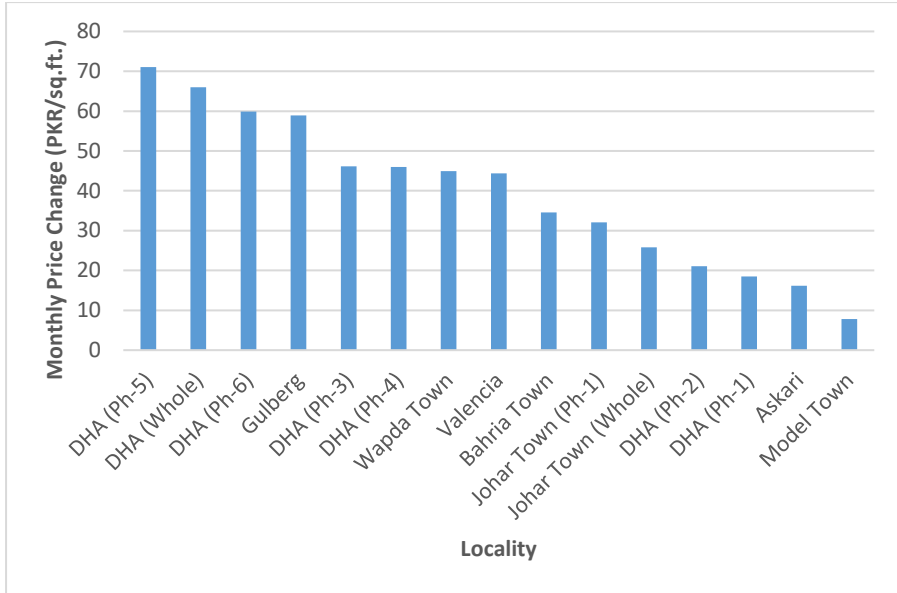


Figure 3: Sen’s Slope Estimates for Twenty Marla Properties across Localities

3.4. Price Trend of Forty Marla Properties

Table 4 reveals significant upward trends for forty Marla properties across all localities ($p < 0.001$, $|Z| > 3.29$). DHA (whole) recorded the highest increase (81.00 PKR per square foot per month), followed by DHA Phase-3 with 77.87, Gulberg with 56.23, and Model Town with 43.38. DHA Phase-5, while significant, showed comparatively a lower slope (33.22). The robust growth in large plots reflects their role as luxury assets in elite areas, driven by capital concentration and mixed-use development (Lauer mann & Mallak, 2023). The relatively modest increase in DHA Phase-5 suggests potential saturation in this segment.

Table 4: Price Trend Analysis for Forty Marla Properties

Locality	MK-Stat	SE	Z-Stat	P-Value	Trend	Slope	Lower Bound	Upper Bound
DHA (Whole)	2075	193.06	10.74	0.000	Yes	81.00	64.75	97.34
DHA (Ph-3)	3825	361.15	10.59	0.000	Yes	77.87	63.67	96.21
Gulberg	672	145.27	4.62	0.000	Yes	56.23	20.56	87.89
Model Town	339	82.67	4.09	0.000	Yes	43.38	10.04	93.27
DHA (Ph-5)	710	145.27	4.88	0.000	Yes	33.22	10.33	52.00

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In Gulberg, mixed-use developments are replacing historical and large-sized residential properties (Majeed & Hosseininasab, 2024). Combined with its central location and expanding commercial hubs, this transformation is attracting professionals and investors, driving increased demand. Model Town also benefits from proximity to the new central business district (located at the old Walton Airport vicinity) and Ferozepur Road, with its established neighborhood charm now drawing luxury interest and high-rise mixed-use developments (Rehmani, 2025).

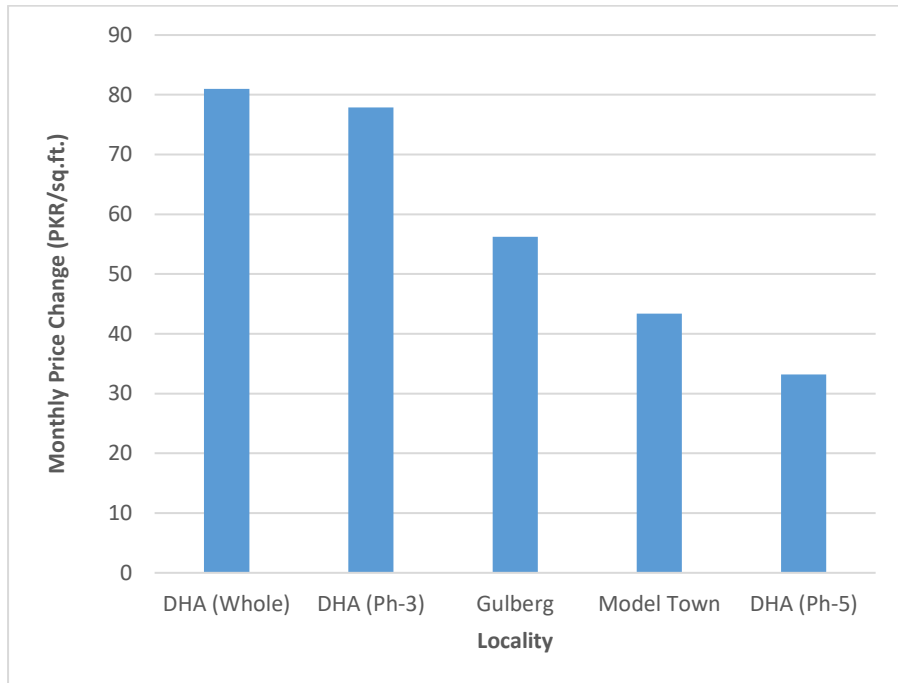


Figure 4: Sen’s Slope Estimates for forty Marla Properties across Localities

3.5. Intra-Locality Price Trends across All Four Property Sizes

Table 5 consolidates Sen’s Slope estimates for all four size property categories across all the 28 surveyed localities, presenting intra-locality variations in price trends. ‘Nil’ entries indicate ‘no data’ for specific plot sizes in certain localities. Figure 5 visualizes these trends, with localities arranged alphabetically on the x-axis and monthly price changes (PKR per square foot) on the y-axis, using distinct colors for each plot size. DHA Phase-5 exhibits the highest appreciation for smaller plots, with slopes of 106 for five Marla and 104 for ten Marla, decreasing to 71 for twenty Marla and 33 for forty Marla, suggesting a preference for smaller plots in this area.

Table 5: Sen’s Slope Estimates for all Categories by Locality

Locality	5 Marla	10 Marla	20 Marla	40 Marla
Al Rehman Garden	46	Nil	Nil	Nil
Allama Iqbal Town	52	18	Nil	Nil
Askari (Ph-10)	Nil	16	Nil	Nil
Askari (Whole)	Nil	43	16	Nil
Bahria Town (Sect-B)	Nil	25	Nil	Nil
Bahria Town (Sect-C)	Nil	27	Nil	Nil
Bahria Town (Whole)	57	57	35	Nil
DHA (Ph-1)	Nil	40	19	Nil
DHA (Ph-2)	Nil	Nil	21	Nil
DHA (Ph-3)	28	39	46	78
DHA (Ph-4)	Nil	65	46	Nil
DHA (Ph-5)	106	104	71	33
DHA (Ph-6)	49	73	60	Nil
DHA (Ph-8)	Nil	51	Nil	Nil
DHA (Rahbar)	17	Nil	Nil	Nil
DHA (Whole)	9	78	66	81
Eden	47	40	Nil	Nil
Gulberg	Nil	Nil	59	56
Johar Town (Ph-1)	87	Nil	32	Nil
Johar Town (Whole)	73	76	26	Nil
Khayaban-e-Amin	-9	Nil	Nil	Nil
Model Town	Nil	65	8	43
Paragon City	59	60	Nil	Nil
State Life	49	29	Nil	Nil
Township	11	30	Nil	Nil
Valencia	Nil	51	44	Nil
Wapda Town (Ph-1)	50	12	Nil	Nil
Wapda Town (Whole)	69	18	45	Nil

In contrast, DHA shows a different pattern, with slopes of 9 for five Marla, 78 for ten Marla, 66 for twenty Marla, and 81 for forty Marla, indicating comparatively stronger growth for mid and large-sized properties across rest of the phases in DHA, especially the Phase-3 where price appreciation improved with the increase in property size. Bahria Town as a whole display's consistent growth for smaller plots at 57 for both five and ten Marla, dropping to 35 for twenty Marla, with no forty Marla data. Model Town reflects significant disparity, with 65 for ten Marla, a stagnant 8 for twenty Marla ($p > 0.001$), and 43 for forty Marla. Khayaban-e-Amin stands out with a negative slope of -9 for five Marla, suggesting declining prices, while Township shows very slow growth at 11 for five Marla and a modest appreciation at 30 for ten Marla. Localities like DHA Phase 3 (28 for five

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Marla, 39 for ten Marla, 46 for twenty Marla, 78 for forty Marla) provide data across multiple plot sizes, whereas others, like Gulberg (59 for twenty Marla, 56 for forty Marla) and Al Rehman Garden (46 for five Marla only), are limited to one or two categories.

Nil values, particularly for forty Marla plots (absent in 24 localities), reflect that larger plots are less common or less transacted in many areas. These variations underscore a stratified housing market, where smaller plots appreciate faster in high-demand areas like DHA Phase-5, Johar Town and Wapda Town while larger plots dominate in others like Gulberg, Model Town and DHA Phase-3. These dynamics reflect the influence of urban development patterns and evolving buyer preferences, underscoring the need for targeted interventions such as regulatory measures to mitigate the potential speculative bubbles in areas like DHA Phase-5, or zoning reforms to enhance affordability in stagnant localities such as Township.

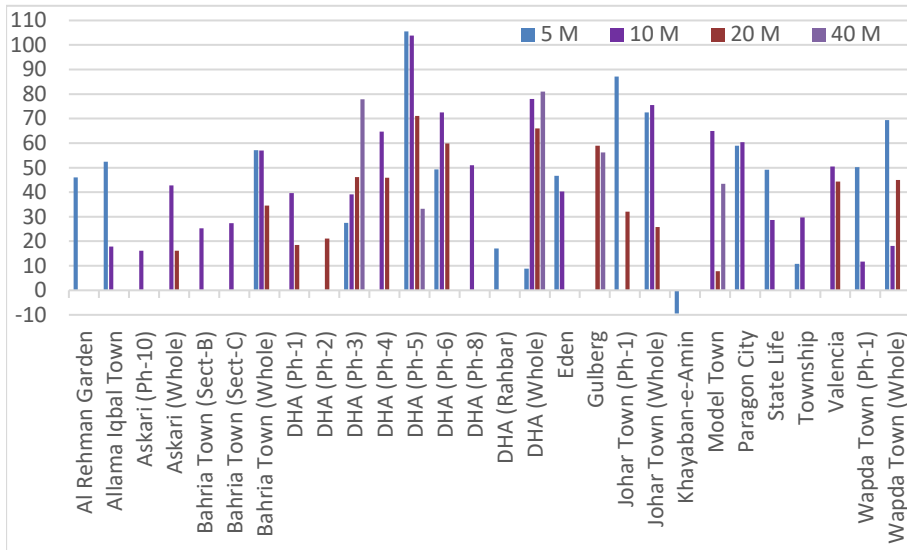


Figure 5: Intra-Locality Comparison of SSE Estimates (Monthly Price Change (PKR/sq.ft.))

The results further reveal that housing market stratification is shaped by factors including accessibility, security, infrastructure quality, and the availability of amenities. These findings align with bid-rent and hedonic pricing theories, as proximity to amenities and modern facilities boosts property values (Hess & Almeida, 2007; Redfearn, 2009; Munshi, 2020; Hussan et al., 2023). However, rapid price increases in certain areas, particularly for smaller plots, raise concerns about speculative bubbles, necessitating regulatory oversight (Gaffney, 2009; Ahmed et al., 2021a). The concentration of wealth in elite enclaves can exacerbate affordability

issues, with implications for urban equity (Myers, 2021). Data limitations, such as the use of listing-based prices from Zameen.com, may inflate the trends a bit, as asking prices often exceed transaction values. Future studies may incorporate transaction data and spatial econometric models to refine these insights. The observed trends underscore the need for targeted urban planning and policy interventions, such as infrastructure upgrades in lagging areas and measures to curb speculation, to ensure a balanced and sustainable housing market in Lahore.

4. CONCLUSION

This study analyzed the temporal trends of housing property prices across four size categories in various localities of Lahore, Pakistan, using the Mann-Kendall (MK) Test and the Sen's Slope Estimator (SSE). It was aimed at revealing the distinct spatial and size specific dynamics in the local housing submarkets by identifying the direction and quantifying the magnitude of price change. For five Marla properties, most of the localities exhibited significant upward trends. DHA Phase-5 showed the highest price appreciation in this category. Township and Khayaban-e-Amin displayed insignificant trends with a negative slope for the latter which reflects some localized challenges such as aging infrastructure and delayed developments. In the ten Marla category, all localities showed significant price increases led by DHA Phase-5 once again. For twenty Marla properties, significant upward trends were observed in all localities except for Model Town where growth was negligible. The forty Marla segment demonstrated a uniform appreciation with DHA (whole) recording the steepest slope. These findings underscore a stratified housing market in Lahore City. Property size and location appear to influence the price trajectories critically. Small sized housing properties in premium areas exhibited robust growth which seems to be driven by accessibility and security mainly. Large sized properties in some older neighborhoods appeared facing stagnation that can be attributed to the infrastructural decline and shifting buyer demands. The rapid price increase in selected areas particularly for smaller properties suggest some potential speculative bubbles. This situation necessitates regulatory oversight by the government to ensure market stability. The study also highlights the need for targeted urban planning interventions such as infrastructure upgrades in underperforming localities and policies to enhance housing affordability. The concentration of wealth in elite enclaves raises equity concerns. This phenomenon emphasizes the importance of inclusive development strategies. Future research may address the data limitations by incorporating transaction-based prices and spatial econometric models that may refine the trend accuracy further and capture the inter locality dependencies. Extending the analysis to other cities and utilizing longer

timeframes may further enhance the understanding of the evolving housing landscape in Pakistan.

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