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Rental housing affordability and spatial variation in rapidly growing urban areas of Ethiopia: evidence from Debre Markos city

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Abstract

Purpose – Literature indicates that characteristics of private rental housing in Ethiopia include unreasonable rent increases, hostile owner and renter relations, unfair evictions, unaffordable rent, discrimination against certain renters and a lack of basic services. This study aims to investigate the determinants of private rental housing affordability in rapidly growing urban areas of Ethiopia, exemplified by Debre Markos.

Design/methodology/approach – This research is a cross-sectional study, based on data collected during the study period. Data from 385 private rental housing households were collected through a structured questionnaire and analyzed using binary logistic regression as well as global and local spatial analysis.

Findings – Household family size, house area, housing typology and the type of adjacent road are significant determinants of private rental housing affordability. The spatial autocorrelation analysis revealed that there is a cluster (i.e. a grouping of locations with similarly high or low attribute values) of house rent, housing typology, number of families, road type and house area.

Research limitations/implications – These findings have significant implications for policymaking, to address the unaffordability and socio-spatial problems of private rental houses.

Originality/value – The findings of this research contribute to the existing knowledge of housing affordability using econometric and spatial analysis. The determinants of private rental housing were investigated and analyzed, which is an understudied area in the medium cities.

Keywords Housing affordability, Housing, Rental, Spatial autocorrelation, Logistic regression, Ethiopia

Paper type Research paper

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1. Introduction

Housing is a basic human need like food and cloth (Rao and Biswas, 2023). Housing is also a human right enshrined in many international human laws (UN-Habitat, 2019). It normally refers to the quality, the location and access of the house (Aizawa *et al.*, 2020). Urban housing is one of the basic social factors that affect people's well-being, which is interconnected with communities' environmental, social, cultural and economic fabric (Weldetsadik and Hirbaye, 2022). However, cities face the challenge of housing affordability due to rising urbanization rates. The increasing urban population creates a strong demand for urban housing (Rao and Biswas, 2023; Matsumoto and Crook, 2021; Weldetsadik and Hirbaye, 2022).

Areas with larger populations are characterized by greater economic disparity. Differences in housing affordability among residents lead to greater housing inequality among households with different financial statuses (Aizawa *et al.*, 2020). The segregation of housing markets and affordability problems are drivers of urban inequality in neighborhood conditions (Nijman and Wei, 2020).

There are nuanced arguments about the definition of housing affordability (Mulliner and Maliene, 2011). However, it can be defined as the ability of households to acquire appropriate housing for all residents without financial distress (Liu *et al.*, 2021; Suhaida *et al.*, 2011). Housing affordability is a pressing issue worldwide (Tiznado-Aitken *et al.*, 2022) in both developed (Lee *et al.*, 2022) and developing nations (Odunjo, 2021). Unaffordability leads to substandard housing, which affects the well-being of households (Galster and Lee, 2021). For example, unaffordable housing leads to public health crises (McGovern *et al.*, 2023) and rental stress (Debele *et al.*, 2024). It also lowers living standards in particular for lower-income families living in private rental households (Wood and Ong, 2011)

Ethiopia's rapidly increasing population and rapid urbanization are driving the problems mentioned above. It continues to place a substantial influence on housing, particularly among people with low incomes (Alemu, 2021). Approximately 40% housing units in urban areas of Ethiopia are rented from private households while 39% are owner-occupied (Fikire, 2021). There is a massive gap between housing demand and supply in Ethiopian cities (Shitaye, 2022). This gap leads to a housing shortage. The situation is aggravated by substandard conditions and insufficient space, which require immediate action (Tesfaye, 2007). Ethiopia has a lower housing quality than neighboring countries, with overcrowding and poor living conditions posing a significant housing problem in large urban areas (Matsumoto and Crook, 2021).

Research conducted by Debele *et al.* (2024) concludes, that in Ethiopia there are unreasonable rent increases, hostile owner-tenant relations, evictions, unaffordable rents, discrimination, a lack of basic services and restrictions on renters' social interaction (Debele *et al.*, 2024). Several housing affordability studies have been conducted worldwide (e.g. Airgood-Obrycki *et al.*, 2023; Debele *et al.*, 2024; Fikire, 2021; McCord *et al.*, 2011; McGovern *et al.*, 2023; Nwuba *et al.*, 2015; Olanrewaju and Woon, 2017; Yap and Ng, 2018) but also for Ethiopia (e.g. Charitonidou, 2022; Regassa and Regassa, 2015; Wakuma Kitila, 2019). Charitonidou (2022) emphasized housing modalities, development process and participation of communities in housing development but did not discuss private rental housing affordability. Regassa and Regassa (2015) also conducted a study on housing and poverty based on 180 households in Hawassa. However, their research focused on condominium housing affordability and ignores the private rental housing units. Wakuma Kitila (2019) has done housing study in Harar city, however, they emphasize on housing adequacy and accessibility of condominium houses. None of these studies tried to measure

and model the private rental housing affordability. Therefore, there is still a shortage of research on the affordability of private rental housing and land leases for housing.

Housing affordability study was conducted primarily in large cities (like Addis Ababa and Hawassa). Medium cities like Debre Markos were left behind and not discussed so far. Thus there are several reasons to investigate slightly different approaches. First, housing is a context-specific (locational) characteristic and findings may differ between large and medium cities. Second, the focus on private rental housing affordability can lead to new insights. Third, the examination of affordability of land leases for housing will contribute to sustainable development by indicating potential problems. The UN Sustainable Development Goal (SDG) 11 aims at "sustainable cities and communities" by 2030, "ensuring access to adequate, safe, affordable housing and basic services, and upgrading slums" (UN-Habitat, 2019). The terms used for SDG 11 are easy to accept as guiding principles but difficult to assess objectively. Thus, analysis of observable factors affecting housing affordability and their variation across neighborhoods at the micro level is necessary. This then enables the formulation of context-specific policy. The research questions of this study are:

RQ1. Are private rental housing and land leases for housing affordable in Debre Markos?

RQ2. What are the determining factors of rental housing affordability in Debre Markos?

RQ3. Is there a spatial association between private rental house prices, respondents' income and neighborhood affordability in Debre Markos?

RQ4. Are there spatial associations of significant determinants across neighborhoods in Debre Markos?

2. Literature review

It is essential to understand fundamental concepts to address questions posed in a paper. A literature review on housing affordability provides an overview on the concept and its measurement. Figure 1 summarizes the variables included in this paper as a result of this review.

Housing is a bundled good that comprises both the housing unit and local amenities (Acevedo-Garcia *et al.*, 2016). Increasing a neighborhood's access to public facilities may result in higher rents and make housing unaffordable for low-income households (Marwal and Silva, 2023). Housing is more than just a shelter. It comes with the required amenities, such as safety and security, social support, self-esteem and self-actualization (Rao and Biswas, 2023). Housing affordability is generally determined by a person's income and the ability to pay the monthly housing installments (Sani, 2015). Demographic dynamics, income status and the availability and location of housing units differ globally (Fikire, 2021; Molloy *et al.*, 2022).

Because housing affordability is essentially a spatial problem, analytical tools that can accurately capture geographic variation are necessary (Vergara-Perucich, 2025). Affordable housing's spatial distribution can be categorized as either random or clustered (Chen *et al.*, 2015). Affordability outcomes are shaped by spatial differences in housing supply elasticity and amenities (Y. Chen and Li, 2025). According to the theory of spatial justice, the right to the city, urbanization of social justice and physical justice are all embodied in the concept of spatial justice. One of the most crucial city rights is housing, which low-income families might not be able to afford (L. Zhang *et al.*, 2022). The unequal distribution of housing costs, incomes and policy effects among geographical units is known as spatial variation (Chen and Li, 2025).

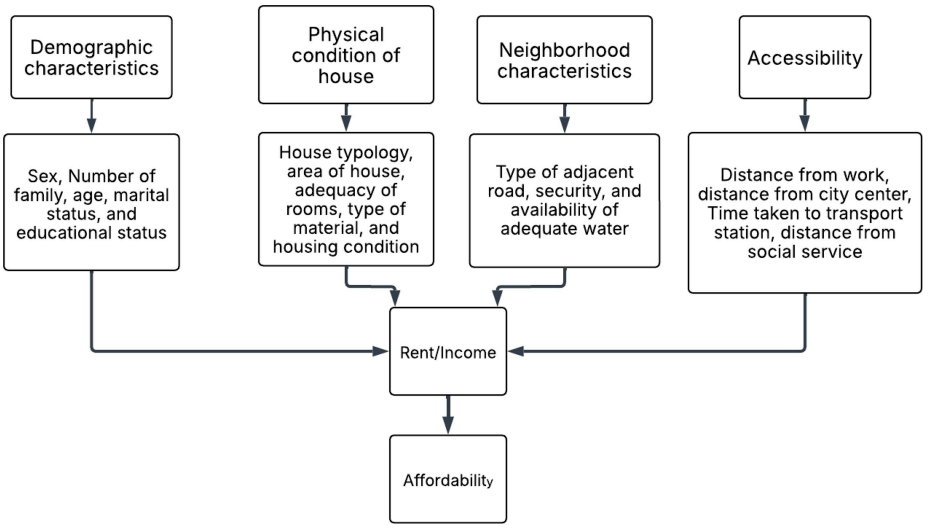

Figure 1. Analytical framework of the research derived from the literature review
Source: Compiled by the authors

Concern over the systematic exclusion of underprivileged and lower-class populations from walkable neighborhoods is growing. Those who could benefit most from walkable, transit-oriented development may find it more challenging to afford them, given the potential displacement of these groups (Bereitschaft, 2019). There are spatial discrepancies between public services like schools, hospitals and public transportation on one side and affordable housing on the other. Policies aimed at affordable housing do not make housing accessible and affordable for qualified households (Yang *et al.*, 2014). Low-income households' well-being is significantly reduced by the spatial mismatch between affordable housing neighborhoods and public services/facilities, a common form of spatial injustice (Zhang *et al.*, 2022).

At the macro level, the following factors have a direct impact on housing affordability: inflation rate, population size, housing costs, loan interest rates, housing construction rates, investment scale, population income levels and overall economic development (Kleshcheva, 2021). Furthermore, spatial heterogeneity and segmentation, as well as other characteristics such as the size of the housing unit, basic amenities and neighborhood conditions, significantly affect housing affordability (Haque *et al.*, 2020). Mulliner and Maliene (2011) identified 17 criteria for assessing sustainable housing. These include, among others, the rental cost, interest rate, mortgage availability, availability of rented accommodation, availability of affordable home ownership products, safety (low crime levels), access to social services, transportation and different amenities, quality of housing and energy efficiency of housing (Mulliner and Maliene, 2011). The level of income and inequality are central determinants of housing unaffordability (Lee *et al.*, 2022). In Ethiopia, age, gender, educational level, housing price, years of residence, household income and access to credit were found to be substantial factors of urban housing choice in Debre Berhan (Fikire, 2021). Other factors identified affecting housing affordability were marital status, number of rooms, transport access and house typology (Shitaye, 2022). The price-to-income ratio is computed by dividing the nominal house price index by the nominal disposable income per head

(https://www.oecd.org/en/data/indicators/housing-prices.html). The price-to-income ratio, housing expenditure-to-income ratio, housing affordability index and residual income approach have all been used to assess housing affordability (Li *et al.*, 2020). However, there is no objective answer, because options have conceptual and operational flaws (Galster and Lee, 2021). Affordability is commonly measured as the ratio of housing expenditure to income (Kutty, 2005). The ratio approach to this relationship could be expressed in terms of housing access, such as the rent-to-income ratio (Galster and Lee, 2021; Nwuba and Kalu, 2018). In Ethiopia, housing affordability is estimated relative to the proportion of household expenses that do not exceed 30% of disposable (Matsumoto and Crook, 2021).

This ratio approach is criticized for its limitations. Despite its widespread use, the ratio-based approach underestimates financial hardship, especially in economically distressed areas, by failing to account for other essential housing expenses like food and transportation (Vergara-Perucich, 2025). Naturally, there is a correlation between economic and social circumstances and a household who have high income pays more, and a person who have less income pays less, and still they can afford (Stone, 2006). The ratio approach does not account for variations in preferences or changes in quality over time. Some households are prepared to spend a significant portion of their income on a larger, better-quality apartment, but this approach may be considered unaffordable. Similarly, it does not account for differences in housing costs resulting from accessibility premiums and neighborhood quality. It does not account for actual financial constraints faced by individual households. Nonetheless, the concept is simple to calculate and understand and can be compared across regions (Bogdon and Can, 1997). Despite the critics, income to expense approach is employed in this research.

The cost burden measure based on 30% of income is used as a standard for affordability status (Airgood-Obrycki *et al.*, 2023). It can be computed for individual households (Galster and Lee, 2021). Thus, the rent should not exceed 30% of the household's gross monthly income (Airgood-Obrycki *et al.*, 2023; Li *et al.*, 2020; McGovern *et al.*, 2023; Weldetsadik and Hirbaye, 2022).

According to UN-Habitat (2019), the World Bank and UN-Habitat established affordability thresholds for owner-occupied and rental housing within the Urban Indicators Program.

> Housing is generally deemed affordable when a household spends less than 30% of their income on housing-related expenses, such as mortgage repayments (owners), rent payments(renters), and direct operational expenses such as taxes, insurance, and service payments. (UN-Habitat, 2019).

The drivers of housing expenditure differ across regions, contexts and periods (Huynh and Truong, 2024). Considering Figure 1, the hypothetical relationships between the variables are explained below.

Demographic-related variables: According to some research, larger families typically spend more on housing. Specific research indicates that household size does not affect housing expenditure. Greater housing consumption is associated with higher educational attainment, but this does not necessarily mean that people with advanced degrees spend more on housing. Some research finds no gender-based differences in the financial burden of housing expenditure or consumption, but it does highlight the importance of age and marital Status in influencing housing expenditure (Huynh and Truong, 2024).

Physical condition of the house**:** Apartment size may contribute to clustering of the poor and the rich in cities, allowing the rich to have larger sized apartments (Marwal and Silva, 2023). A higher number of rooms, a better house material, or a better condition may increase the rental cost. These ultimately affect the household's housing affordability. Housing

typology, as a physical condition of the house, may depend on the household's choice. The house with adequate natural lightning may have a higher rent.

Neighborhood characteristics: For this research, the type of adjacent road, security and adequate water availability were considered neighborhood variables. In general, improved neighborhood quality increases home rents, thereby directly affecting housing affordability.

Accessibility: Accessibility to facilities and amenities improves the quality of life. However, in some studies, evidence indicates that unaffordable households are unable to access various services (Yang *et al.*, 2014). Therefore, this paper tested the effect of access to transportation (as distance from city center and time taken from last transport station to the house), and different services (school, health centers, market, green space and waste disposal).

3. Study design

3.1 Description of study area

Debre Markos, shown in Figure 2, the capital of the East Gojjam Administrative Zone, is located 300 kilometers northwest of Ethiopia's capital, Addis Ababa, and 265 kilometers from the capital of Amhara National Regional State, Bahir Dar (Agegnehu and Mansberger, 2020; Biyena and Beyene, 2019). Debre Markos is one of Ethiopia's oldest medium-sized cities. Currently, the city has four (4) sub-city administrations.

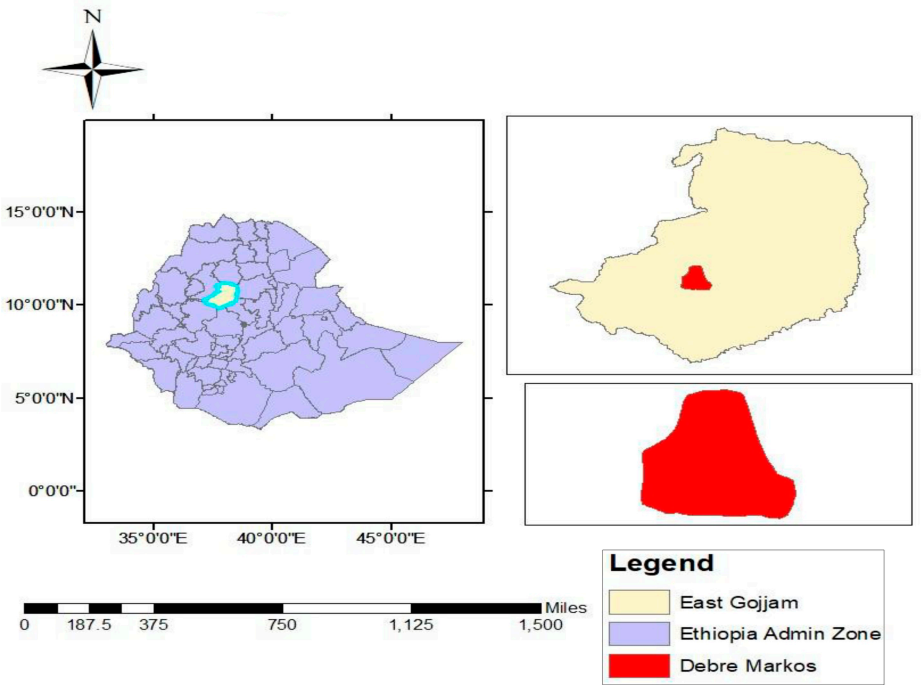

Figure 2. Study area map

Source: Ethiopian boundaries – openAFRICA and Debre Markos city administration boundary map

According to the Debre Markos structural plan report in 2021, the city comprises about 44,120 houses. In total, 39,740 of them are residential houses, and 4,380 are commercial buildings. The primary means of transport for mobility are buses, minibuses and three-wheeled mini cars (Bajaj). However, Bajaj is the dominant means of transportation. The coverage of pure potable water was 67%. Regarding road infrastructure, 16.33 km are covered by asphalt, 136.94 km by pebble, 48.36 km by cobblestone and 6.9 km are mud roads.

There are several educational institutions. The governmental institutions include one university, one polytechnic college, one health science college, one teachers' college and one police college. There are also 32 government schools from kindergarten through secondary school. Furthermore, there are about 11 private colleges and 24 private schools from kindergarten to elementary school. Regarding the health service, there is only one specialized hospital, 32 clinics and health centers, 27 pharmacies and 13 traditional medicine centers.

Figure *3* illustrates that the population of Debre Markos city has been growing significantly in the last years. In 2014, the total population of Debre Markos was 92,470. Ten years later, in 2024, the population had grown to 153,710. The primary cause of this increment next to natural increase is rural-urban migration.

3.2 Current housing modalities in Debre Markos

There are primary housing modalities in Debre Markos. Such are through:

- Private rental housing: This is the agreement between the owner and the tenant for a specified period of time and a specified amount of money. According to officials and local brokerages offers this is the largest share of the housing modality. Cooperative housing: A group of people mostly (14–24) can obtain land from the city through administrative payments, and then construct the house themselves. According to the city administration, about 17,875 households have taken land for housing through this modality from 2014 to 2024. However, a substantial amount of land remains undeveloped due to financial constraints.
- Residential land lease: This is a means of acquiring vacant land for housing through an auction. It is a completion-based system: the highest bidder can take the land and then construct the house themselves in accordance with local building and zoning laws. According to the city administration, 1,131 parcels were transferred from 2016 to 2024.

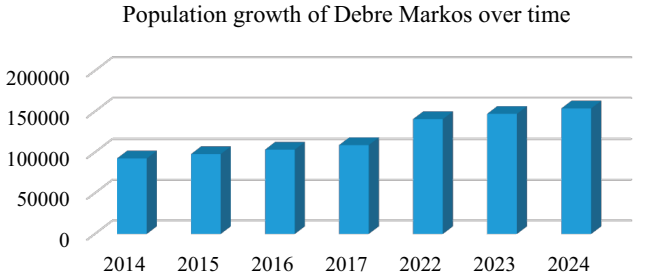

Figure 3. Population growth of Debre Markos
Source: Ethiopian statistical service (https://ess.gov.et/)

Furthermore, mortgages can be used to finance cooperative housing, housing construction and home purchases. A bank can offer customers home financing to buy or construct a new home, based on their eligibility to repay the mortgage.

3.3 Source of data, type and collection mechanisms

Primary data were collected through questionnaires from private rental housing respondents and through interviews with local experts and officials. After preparing the questionnaire, it was tested for its clarity. The questionnaire is provided to 10 people and checked if they understood everything correctly. The questionnaire was revised based on the feedback from the pretest. Finally, the questionnaire was printed and the survey was conducted paper-and-pencil. In addition, the respondents were selected randomly meet in the street.

Households head were asked about their background, income and rental information to estimate their housing affordability status. Furthermore, data for the variables were collected from these respondents. Interviews were conducted with experts and officials in the city. Secondary data (not collected directly from the respondent) includes:

- Geographical maps: The Ethiopian administrative map was used to prepare the location map of the study area. The Debre Markos administrative map was used for the preparation of neighborhood maps of the city and the locational map of the study.
- Coordinate points for the transport stations in the Voronoi tessellation: Due to the absence of a subdivision of the city at a suitable resolution, an artificial neighborhood was created using a Voronoi tessellation based on the locations of transport stations.
- Journal articles, reports and websites for the literature review.

This study is based on cross-sectional research (i.e. one-time data). The primary data were collected directly from respondents; the secondary data are derived from published and unpublished sources.

3.4 Sampling techniques and sample size determination

The target group for the study is private rental house tenants employed in government organizations (i.e. universities, colleges, schools, banks, insurance companies, hospitals and clinics, municipal offices) and private companies to capture accurate financial information. This guarantees that the respondents have a regular income. This avoids some bias in the analysis. During a pretest, families with irregular monthly income did not provide complete income information. Therefore, the scope of respondents was narrowed to employed households with a regular monthly income.

There is no database of rented apartments in the city and therefore the size of the statistical population is not known. Thus, the formula for the necessary sample size in case of an unknown population (Cochran, 1977) was adopted:

$$n_0 = \frac{(t)^2 * (p)(q)}{(d)^2} \tag{1}$$

$$n_0 = \frac{(1.96)^2 * (0.5)(0.5)}{(0.05)^2} = 384 \tag{2}$$

where:

n_0 = the required sample size,
t = value for a selected alpha level of 0.025 in each tail = 1.96,
$(P)(q)$ = estimate of variance = 0.25,
d = acceptable margin of error for proportion being estimated = 0.05.

Based on the formula, the minimum was 384. However, to compensate for the missing (unreturned) questionnaire, 400 questionnaires were provided to the respondent. Fifteen of these questionnaires were excluded from the analysis. Some of them were not returned, others were removed due to incomplete information (i.e. concerning rent and income).

3.5 Methods of data analysis

Data collected from the 385 respondents included their background, income and expenses for house rent, neighborhood and accessibility information and housing condition. Data coding, encoding and tabulation were done after finishing data collection. Missing data were treated depending on the nature of the variable, continuous variables are using mean value and the ordinal variables and categorical variable were using median value.

The monthly housing rent and monthly household income were used for the estimation of affordability but not directly for the model development. However, affordability status was used as dependent variable. Based on this data, the affordability status of households was estimated using the rental expense-income ratio and categorized as "affordable" or "unaffordable" based on a 30% threshold for private rental housing, land lease and mortgage affordability.

Household demographic characteristics, physical condition of the house, neighborhood characteristics and accessibility variables were regressed on the dependent variable (household housing affordability status) using binary logistic regression. The basic characteristics of the respondents were analyzed using descriptive statistics. A *t*-test was used to examine differences in variables in the affordable and unaffordable households. Finally, spatial autocorrelation was applied to examine the spatial association of variables. This helps to understand socio-spatial inequality. Microsoft Excel, Python and ArcGIS Pro are utilized for this analysis.

To categorize respondents' affordability status, the rent-to-income ratio method of affordability measurement was applied (Galster and Lee, 2021; Nwuba and Kalu, 2018). A 30% threshold was used, i.e. if the household spends less than 30% of its income, then housing is affordable (Airgood-Obrycki *et al.*, 2023; Li *et al.*, 2020; McGovern *et al.*, 2023; Matsumoto and Crook, 2021; Weldetsadik and Hirbaye, 2022).

Therefore, the dependent variable in this research is households' private rental housing affordability status, with 1 indicating affordability and 0 indicating unaffordability. The independent variables derived from the literature are illustrated in Table 1. Given the binary nature of affordability status, a binary logistic regression model was applied to identify the key determinants of private rental housing affordability in the study area. The assumption of multicollinearity was tested using the Variance Inflation Factor (VIF). The result of the VIF test is illustrated in the Table 9. According to the VIF result the variable less than 10 has applied to the model (Cheng *et al.*, 2022).

To assess the model's fitness, Hosmer and Lemeshow, 1989 tests were performed. The Hosmer–Lemeshow test is a statistical measure for the goodness of fit of a binary logistic model. This test is based on the *p*-value, if the *p*-value exceeds a value of 0.05, the model has a good fit (Archer and Lemeshow, 2006). Eventually, the model is tested for spatial autocorrelation. The significant factors in the binary logistic regression were tested for their

Table 1. List of the independent variables and its representation

S.N	Variable	Type	Scale of measurement	Description
1	Sex of the respondent	Category	Nominal	1 = if male, 0 = female
2	Education status of the household	Category	Ordinal	Educational level (illiterate – master's degree and above_
3	Number of families	Continuous	Ratio	Total number member of heads
4	Age of the household head	Continuous	Ratio	Years
5	Number of rooms	Discrete	Ratio	Total unit of rooms owned by the renter
6	Type of building material of the house	Category	Nominal	1 = modern materials, 2 = wood and mud
7	Housing typology	Category	Nominal	1 = condominium and apartment, 2 = detached
8	Availability of adequate water	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
9	Adequacy of rooms	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
10	Area of the house or condominium	Continuous	Ratio	Square meter
11	Reasonably standard of house	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
12	Reasonable distance from health center	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
13	Marital status of the respondent	Category	Nominal	1 = single, 2 = married, 3 = divorced and 4 = widowed
14	Reasonable distance from market	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
15	Type of adjacent road	Category	Ordinal	1 = mud, 2 = stone, 3. Cobble stone and 4. asphalt
16	Reasonable distance from green spaces	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
17	Reasonable distance from the waste disposal area	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
18	Housing condition	Category	Ordinal	1 = very old, 2 = old, 3 = medium, 4 = new and 5 = very new
19	Reasonable distance to work	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
20	Safe and secure	Category	Ordinal	1=strongly disagree, 2= disagree, 3=neutral, 4=agree and 5=Strongly agree
21	Adequate lighting	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree

(*continued*)

Table 1. Continued

S.N	Variable	Type	Scale of measurement	Description
22	Transport cost to the city center	Continuous	Ratio	ETB per trip
23	Reasonable distance from school	Category	Ordinal	1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = Strongly agree
24	Access time nearest transport station	Continuous	Ratio	Minutes

Source(s): Researchers' compilation from the literature

spatial autocorrelation. Spatial autocorrelation along with logistic regression unveils the drivers of socio-spatial inequality in housing affordability. Moran's I was used to assess global spatial autocorrelation and Getis-Ord hotspot analysis for local spatial autocorrelation.

Moran's I indicates if the data are spatially clustered (grouped) or evenly distributed. Moran's I detects and quantifies the strength of spatial patterns using the magnitude of feature values (Mitchell and Griffin, 2021). It does not, however, specify the locations of clusters. This is provided by local indices like the local Getis-Ord (Grekousis, 2020). Incremental spatial autocorrelation was used to establish the threshold distance for these analyses. Incremental spatial autocorrelation is used to estimate the appropriate distance threshold for spatial autocorrelation analyses. It determines the proper analytical scale by indicating the distance at which an object can still significantly affect another object. Local spatial autocorrelation indices and other spatial statistics can be computed more precisely once the proper scale of analysis has been determined (Grekousis, 2020).

3.6 Variables type and measurements

The dependent variable, household housing affordability status, is a binary variable. The independent variables are measured depending on their nature. Sex, marital status, housing typology and type of building material are categorical variables measured on a nominal scale. Educational status, housing condition and type of adjacent road are categorical variables measured on an ordinal scale. The number of rooms and the number of families are discrete variables that are measured on a ratio scale. Age of the household, transport cost to the city center and the time taken from the transport station to home are the continuous variables measured on a ratio scale.

The Likert scale can be used to quantify a variable for which we lack a measure. Since actual measured distances are unavailable because the absolute location of houses is not known, the accessibility variables are measured on a Likert (1–5) scale based on the perceptions of rental households. These variables are classified as categorical variables and measured on an ordinal scale, as shown in Table 1. Some other variables are estimated using a Likert scale (1–5), such as the adequacy of the housing, the reasonableness of the standard of the house, the availability of adequate water and security in the area. Before using the ordinal Likert scaled variables, the linearity assumption was tested and confirmed. Therefore, the Likert scaled variables are treated as continuous variables.

According to the results of the multicollinearity test Table 9, variables with VIF > 10 were dropped from the model. The dropped variables were housing typology, age of the household, educational status, type of materials, house conditions and marital status of the household. The 18 independent variables were retained for the final model to understand the determinants of private rental housing.

4. Result

4.1 Basic characteristics of the respondents

Table 2 shows that the housing situation of about 46% of respondents was classified as unaffordable and about 54% as affordable based on the 30% threshold. About 28% of the respondents represented female-headed households and 72% male-headed households. Of the respondents, 27% were single, 69% were married, 3% were divorced and 1% widowed. In addition, 9% were at or below the secondary school level, 16% had college diplomas and 75% held university degrees. This disproportional number of respondents with a university degree could reflect the higher chances of people with a university degree to obtain a position in both private and public sector (university, schools, hospitals, banks, different offices of the city).

To guarantee privacy for the interview partners, their apartment location had to be obscured. This was done by creating a partition of the city and allocation each respondent to one cell. As already mentioned, the Voronoi diagram of public transportation stops in the city was used to compensate for the lack of a suitable administrative tessellation. The grouping

Table 2. Basic characteristics of respondents

Characteristics	Frequency	%
Household housing affordability status		
Unaffordable	177	46
Affordable	208	54
Total	385	100
Sex of household head		
Female	108	28
Male	277	72
Total	385	100
Marital status		
Single	106	28
Married	265	68
divorced	10	3
Widowed	4	1
Total	385	100
Educational background of the respondents		
Cannot read and write	6	1
Primary school	26	7
Secondary school	3	1
College diploma	63	16
University first degree	230	60
Master's degree and above	57	15
Total	385	100

Source(s): Computed Survey 2024

guaranteed that a sufficiently large number of respondents were located in each are to prevent identification of the persons. The respondents were asked to identify their nearest transport station to develop the association. As shown in Figure 4, the minimum rent was 500 Ethiopian Birr (ETB), and the maximum rent was 5,000 ETB. Thus the range is between 3.98 US$ and 39.84 US$. The minimum respondents' income was 1,634 ETB (13.02 US$) and the maximum was 20,000 ETB (159.37 US$). Overall, most neighborhoods are affordable.

4.2 Current housing modalities and its affordability in Debre Markos

In Debre Markos, there are different types of housing modalities as described in Section 3.2. However, these modalities are criticized by its unaffordability to the households. In this section each modality is analyzed concerning its affordability.

Table 3 shows that the government of Debre Markos has delivered about 3 million square meters of residential land through cooperative housing. This cooperative housing program, which served about 17,000 households, provided access to land from 2014 to 2022. However, during the field study in winter 2024 / 25, it was observed that a substantial amount of land is still vacant. Cost and shortage of construction materials, inadequate infrastructure (roads, water and electricity) and household income levels appear to be significant challenges to building houses in the cooperatives.

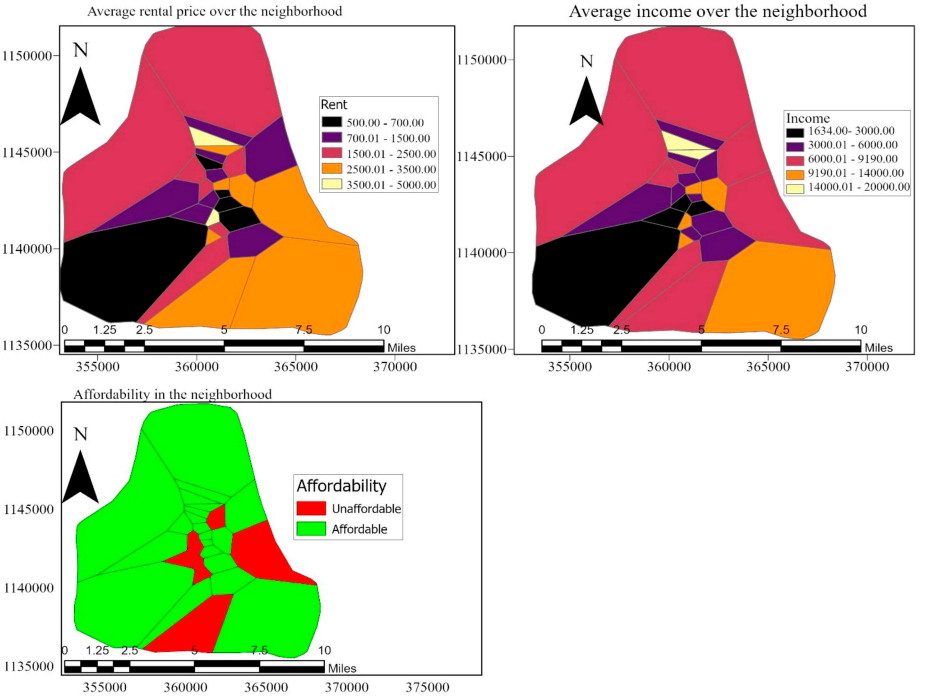

Figure 4. Rent, income and affordability based on the neighborhood using a Voronoi diagram
Source: Respondents' rent and income information. City boundary from the Debre Markos administration

Table 3. Land supply for housing through cooperatives in Debre Markos

Year	Beneficiaries	Sex		Area [sq. m]
		Male	Female	
2014	1,570.00	1,010.00	560.00	314,000
2015	2,202.00	1,530.00	672.00	440,400.00
2017	1,514.00	994.00	520.00	302,800.00
2018	2,547.00	1,689.00	858.00	382,050.00
2022	10,042.00	6,268.00	3,774.00	1,506,300.00
Total	17,875.00	11,491.00	6,384.00	2,945,550

Source(s): Debre Markos Cooperative Office, 2024

In Ethiopia, to construct a house, on average, it costs 35,000 ETB (279 US$) per square meter, regardless of location and other factors (Staff reporter, 2023). The exchange rate between US dollar and ETB, the average exchange rate of 1 US$ was the equivalent of 125.49 ETB during the data collection period on December 2024 [1]. In Debre Markos, the minimum standard for land for cooperative housing is 150 square meters. The minimum standard for the parcel's build-to-suit ratio is 40% to 75%. Table 4 shows the respective periodic payments for a minimum, the average and a maximum buildup ratio based on a parcel size of 150 square meters, average construction cost per square meter and the personal loan interest rate of 12% requested by the Commercial Bank of Ethiopia (for a loan duration of 30 years). As illustrated in Figure 5, none of the respondents could afford any of the three scenarios.

Table 5 shows that the city administration provides about 200,000 square meter of residential land through auction. However, this modality is criticized for excluding people on low and middle incomes. Only high-income people have a chance to win the auction. The winning price per square meter is too high for low- and middle-income people to afford it.

Table 6 shows, how much the respondent should save each month to cover the yearly lease payment. Three scenarios of lease-winning prices are used to understand the affordability levels at the minimum, average and maximum winning prices. The annual payment was estimated based on the lease regulation, which states that the maximum lease periodic payment is 50 years, and an interest rate was calculated from the annual payment based on the Commercial Bank of Ethiopia's interest rate. The annual payment is divided by 12 to estimate the respondent's expected monthly payment. Therefore, at the minimum, the respondent should save 428 ETB (3.41 US$), at the average price 3,767 ETB (30.14 US$) and at the maximum price 9,240 ETB (73.63 US$).

Table 4. Periodic payment for different scenarios to establish the affordability status; the cost is estimated to be 35000 ETB per square meter

Scenarios (%)	Total area	Total cost	Interest rate	Year	NP per year	PMT
40	60	2,100,000	0.12	30	12	21,600.86
57.50	86.25	3,018,750	0.12	30	12	31,051.24
75	112.5	3,937,500	0.12	30	12	40,501.62

Source(s): Researchers computation; www.thereporterethiopia.com/32758/, [accessed 09 September 2025]

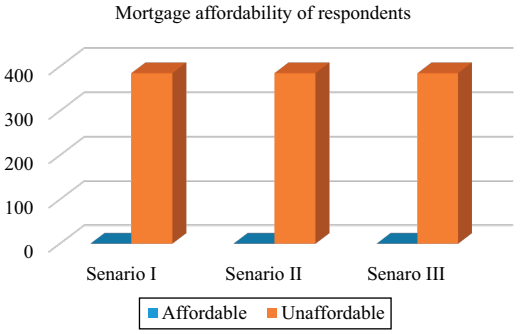

Figure 5. Mortgage affordability of the respondents the three scenarios of construction cost
Source: Researchers computation

Table 5. Land supply for housing through auction in the lease system, in Debre Markos

Year	Parcel	Area(M^2)
2016	112	18,230.3
2017	149	29,376.64
2019	146	26,263.00
2020	91	16,217.21
2021	120	19,763.70
2022	132	22,196.50
2023	241	43,630.00
2024	140	26,321.00
Total	1131	201,998.35

Source(s): Debre Markos data record department, 2024

Table 6. Monthly payment estimation from 2024 land lease data

Scenarios	Winning price per sq. m	Total payment (ETB)	Yearly payment (ETB)	Monthly payment (ETB)
Average	10,747.64	2,018,063.65	45,204.62	3,767.05
Minimum	1,530	229,500	5,140.80	428.40
Maximum	22,000	4,950,000	110,880.00	9,240.00

Source(s): Computed from land lease data of Debre Markos, 2024

According to Table 7, only 1% of the respondents cannot afford at the minimum lease price. However, the average price is unaffordable for about 90% of respondents and no of the respondents can afford the maximum lease price. Figure 6 illustrates the affordability of the lease price under the three scenarios.

Chi-squared tests revealed that there is no significant difference in gender distribution between the two groups (affordable and unaffordable; p-value = 0.546). T-tests for

Table 7. Lease affordability status of respondents at different scenarios

Affordability status	At minimum lease price		At average lease price		At maximum lease price	
	Frequency	%	Frequency	%	Frequency	%
Affordable	382	99.22	38	9.87	0	0
Unaffordable	3	0.78	347	90.13	385	100

Source(s): Computed from survey data. 2024

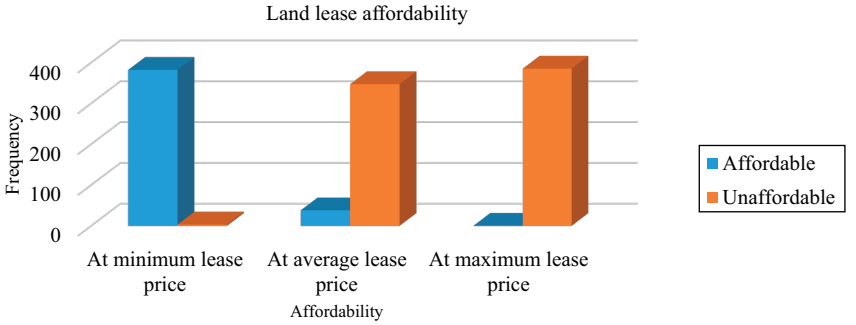

Figure 6. Land lease affordability of respondents at different scenarios
Source(s): Prepared based on the survey data

continuous variables, the number of families, and age of household, rent, area and number of rooms show a statistical significance in categorizing affordable and non-affordable private rental housing (see Table 8). However, household income was not statistically significant.

4.3 Determinate factors of private rental housing affordability status

The logistic regression model was used to identify factors affecting households' affordability for private rental housing. The average marginal effect was used. In the first place, multicollinearity was assessed using VIFs (see Table 9). The model was checked for its goodness-of-fit using the Hosmer–Lemeshow test. The result (Table 10) shows that the model is well fitted since the (p-value > 0.05).

Table 8. T-test of variables between affordable and unaffordable groups

Variable	Unaffordable (n = 177)	Affordable (n = 208)	Total sample (n = 385)	t-value
No. of families	3.446328	2.629808	3.005195	5.4232***
Age of household	34.15254	32.36058	33.18442	2.4982***
Income	6714.982	8153.818	7492.327	−3.9281
Rent	2975.774	1715.529	2294.914	9.7313***
Area	56.5322	29.82212	42.10182	4.8930***
No. of rooms	2.553672	2.0000	2.254545	3.8392***

Note(s): ***, **, * significant at 1, 5 and 10% levels of significance
Source(s): Computed from survey 2024

Table 9. Multicollinearity test result using variance inflation factor (VIF)

Variable	VIF	1/VIF
Sex of the respondent	3.53	0.2831
Number of families	7.80	0.1282
Area of the house or condominium	2.37	0.4211
Number of rooms	7.27	0.1375
Type of adjacent road	4.53	0.2207
Transport cost to the city center	3.86	0.2593
Access time nearest transport station	3.13	0.3200
Reasonable distance from school	5.59	0.1788
Reasonable distance from school	5.69	0.1757
Reasonable distance from market	6.22	0.1609
Reasonable distance from health	6.20	0.1613
Reasonable distance from greenery	4.44	0.2251
Reasonable distance from waste disposal	3.72	0.2689
Safe and secure	4.02	0.2488
Reasonably standard of house	4.88	0.2048
Adequate lighting	5.88	0.1701
Availability of adequate water	3.98	0.2510
Adequacy of rooms	4.48	0.2234

Source(s): Multicollinearity test result from survey data, 2024

Four of 19 variables were significant. These variables (number of families, area of the house, type of adjacent road and availability of adequate water) were significant at ($p < 0.05$). Based on the direction of the coefficients for the independent variables, all of the significant variables are negatively correlated with private rental housing affordability.

The variable family size significantly negatively affects private rental housing affordability ($p < 0.01$). The negative coefficient indicates that having more family members increases the probability of being unaffordable. The marginal effect analysis reveals that an additional person in the family increases the likelihood of unaffordability by 7.30%, holding other factors constant. The area of the house has a significant negative impact on the affordability of private rental housing for households ($p < 0.01$). The negative sign implies that renting more space increases the probability of unaffordability. The marginal effect shows that an increase of 1 square meter will increase the household's exposure to unaffordability by 0.16%, assuming other factors remain constant.

The type of adjacent road also negatively affects private rental housing affordability at ($p < 0.1$). If other things remain constant, the probability of being unaffordable increases by 5.98%. Houses near better roads (asphalt cover) have higher rental prices than those near lower roads (mud cover).

The availability of adequate water has a significant negative affect on the affordability of private rental housing for households ($p < 0.05$). The fulfillment of the amenities including water for the house increases the rental price. This situation made the probability of being affordable decline. The marginal effect shows that an increase of one scale will increase the household's exposure to unaffordability by 3.94%, assuming other factors remain constant.

4.4 Spatial association of variables in the neighborhoods

According to Grekousis (2020, P.216), interpretation depends on statistical significance; however, the strength of the association is measured by Moran's index. A Morn's index score

Table 10. Determinates of rental housing affordability with fitness of binary logistic regression model fitness

Variable	Coefficient	Odds ratio	dy/dx	Std. err.	*z*	Pr(>|z|)	[0.025	0.975]
Const	1.9676	7.1536		0.6930	2.8400	0.0050	0.6100	3.3260
Sex of the respondent	0.1860	1.2044	0.0399	0.0546	0.7316	0.4644	−0.0671	0.1470
Number of families	−0.3401	0.7117	−0.0730	0.0194	−3.7620	0.0002	−0.1111	−0.0350
Area of the house or condominium	−0.0076	0.9925	−0.0016	0.0006	−2.8642	0.0042	−0.0027	−0.0005
Number of rooms	0.0328	1.0333	0.0070	0.0243	0.2901	0.7717	−0.0405	0.0546
Type of adjacent road	−0.2786	0.7568	−0.0598	0.0225	−2.6628	0.0077	−0.1039	−0.0158
Transport cost to the city center	0.0088	1.0089	0.0019	0.0024	0.7792	0.4359	−0.0029	0.0067
Access time nearest transport station	−0.0202	0.9800	−0.0043	0.0030	−1.4383	0.1503	−0.0102	0.0016
Reasonable distance from school	0.0066	1.0066	0.0014	0.0176	0.0807	0.9357	−0.0331	0.0359
Reasonable distance from school	−0.0664	0.9358	−0.0143	0.0172	−0.8301	0.4065	−0.0479	0.0194
Reasonable distance from market	0.0253	1.0256	0.0054	0.0186	0.2915	0.7707	−0.0311	0.0419
Reasonable distance from health	0.0892	1.0933	0.0192	0.0183	1.0474	0.2949	−0.0167	0.0550
Reasonable distance from greenery	0.0331	1.0337	0.0071	0.0164	0.4333	0.6648	−0.0251	0.0393
Reasonable distance from waste disposal	−0.0174	0.9828	−0.0037	0.0164	−0.2274	0.8201	−0.0359	0.0285
Safe and secure	0.0828	1.0863	0.0178	0.0167	1.0630	0.2878	−0.0150	0.0506
Reasonably standard of house	0.1161	1.1231	0.0249	0.0188	1.3256	0.1850	−0.0119	0.0618
Adequate lighting	−0.1135	0.8927	−0.0244	0.0161	−1.5104	0.1309	−0.0560	0.0073
Availability of adequate water	−0.1833	0.8325	−0.0394	0.0198	−1.9883	0.0468	−0.0782	−0.0006
Adequacy of rooms	0.0267	1.0270	0.0057	0.0187	0.3059	0.7597	−0.0310	0.0424
Dependent variable affordability status of private housing renters households					No. Observations	385		
					Df residuals	366		
					Df model	18		
					Log-Likelihood	−237.92		
Model	Logit	Pseudo R^2			0.1043			
Method	MLE	LLR *p*-value			0.00			
logistic model for the affordability status of respondents, goodness-of-fit with Hosmer–Lemeshow test, *p*-value = 0.4568								

Source(s): Computed from survey 2024

higher than 0.3 indicates relatively strong positive autocorrelation, while a score lower than −0.3 indicates relatively strong negative autocorrelation.

According to Table 11, the spatial autocorrelation (Global Moran's I index) indicates that household income and affordability status are not significantly spatially correlated. However, rental price, number of families, house area and type of adjacent roads are significantly correlated. The Moran's I index for all critical variables is positive.

However, being insignificant in the global Moran's I does not guarantee there is no local associations in the specific neighborhoods (Grekousis, 2020, pp. 207–237). According to Figure 7, showing the local autocorrelation results for Getis-Org, there are cold-spot and hotspot areas at different significance levels.

Hotspots of rent and affordability are found in the northern part of the city. However, income hot spot are found in the northern and eastern parts. Income cold spots are found in the center of the city. This implies that lower income people are living in the city center in small apartments. In addition, high income people are living in the outer parts demanding larger spaces.

5. Discussion

The private rental housing, residential land lease price and mortgage affordability status of 385 households were estimated based on their income. 46% of private house rental households were classified as unaffordable. This is due to the respondents' low economic status and the unregulated rental market in the area. There is no specific law governing private rental housing. Everything is at the discretion of the house owner. The finding also shows that about 90% of respondents are unable to afford a residential land lease at the average price. Because the land lease is based on bidding, the highest bidder takes the land. Therefore, a majority of the respondents are unable to obtain land for housing due to their financial constraints. Low- and middle-income people are left behind.

Almost all respondents were unable to afford the mortgage at the current construction cost. Due to rising construction costs, buying a house or constructing a new one is very expensive in the study area. These respondents were not eligible for mortgage repayment. Therefore, financial institutions are not willing to offer finance to the respondents. The government provided vacant land to residents through cooperative housing, but a significant number of houses were not yet constructed. The substantial challenges include financial

Table 11. Spatial autocorrelation of variables using global Moran's I index

Variable	Threshold distance	Global Moran's index	Variance	*Z*-score	*p*-value
Income of household	1,569.33	0.022720	0.000399	1.267170	0.205095
Rental price of the house	1,569.33	0.036021	0.000398	1.935956	0.052873
Affordability	2,096.66	−0.012905	0.000403	−0.513031	0.60793
Number of families	1,569.33	0.057314	0.000402	2.989906	0.00279
Availability of adequate water	1,644	0.006219	0.000384	0.450528	0.65230
Area of the house	1,644.67	0.070834	0.000395	3.694086	0.000221
Type of adjacent road	1,644.67	0.063625	0.000403	3.300989	0.000963

Source(s): Computed from survey data 2024

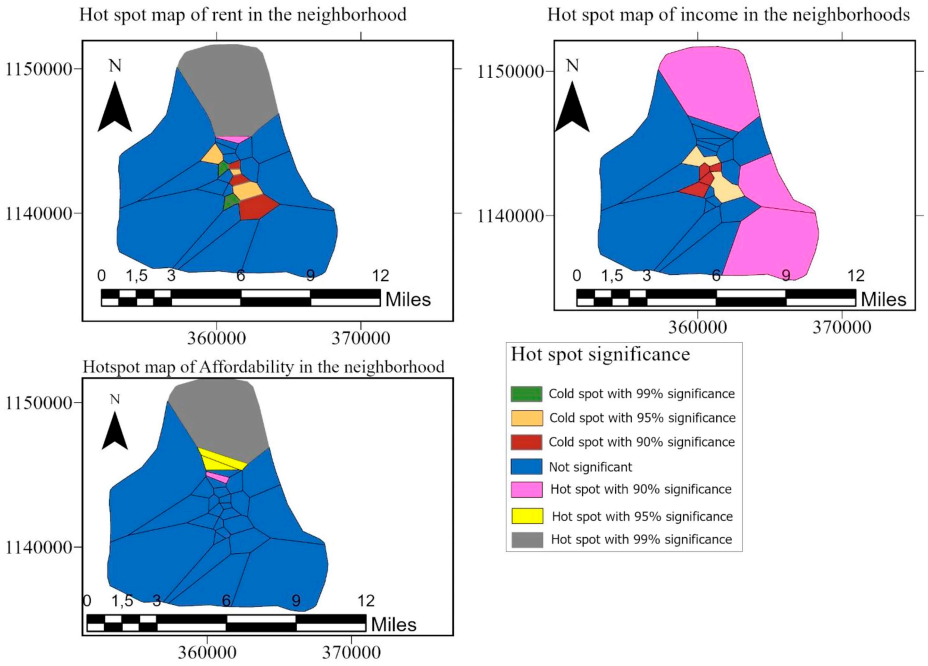

Figure 7. Hotspot map of rent, income and affordability in the neighborhood
Source: Prepared from survey data

limitations, ever-increasing inflation, shortages of construction materials, high construction material costs and a lack of infrastructure.

The existing literature documented the challenges of housing affordability. For example, according to Regassa and Regassa (2015), about 62% of condominium-tenant households in Hawassa were unaffordable, and Shitaye (2022) concluded that about 32% of households in Hawassa spent more than the income threshold. This problem occurs throughout the world. 55.4% of households in 145 countries suffer from unaffordable housing (UN-Habitat, 2019). A recent study in Shaggar City found that unreasonable rent increases lead to unaffordability for renters (Debele *et al.*, 2024). Those studies are consistent with our studies. Saiz (2023) underscored that the housing affordability challenge is everywhere. However, housing affordability is context-specific. The magnitude may differ across contexts, such as between developed and developing countries, cities and neighborhoods within the same city.

Housing affordability is affected by several factors, including increased construction costs, inadequate regulation, natural population growth, income inequality, agglomeration and induced migration (Galster and Lee, 2021). Housing supply is not perfectly elastic (Galster and Lee, 2021), as the demand for housing rent has been increasing. House and rental prices have been as a consequence of rising population. The cost of constructing new houses, and inflation, which are the primary reasons explained by local brokers and experts. The income of the respondent was stagnated as rents increased. However, the city administration provides land for housing for over 17,000 households through cooperatives.

The binary logistic model estimation results reveal that the following variables significantly affected private rental housing affordability: number of families, housing

typology, house area and type of adjacent road. The number of families is critical to determining household affordability. Increasing the household size requires more space to accommodate the whole family. An increase in household size creates an additional financial burden. According to the results, respondents from larger families were more likely to be exposed to unaffordable private rental housing compared to those from smaller family-size households. These results were supported by Iqbal *et al.* (2023); Nwuba *et al.* (2015) and Regassa and Regassa (2015).

Housing typology is a significant factor in determining households' housing affordability. The probability of being unable to afford a condominium is higher than that of renters in detached houses. This result is substantiated by Regassa and Regassa (2015) and Shitaye (2022). Condominium sites in the study area are near infrastructure and accessible to public transportation, which may raise rental prices and make renting unaffordable for some. In the study area, compared with other housing typologies, condominiums offer greater freedom and security at this stage, according to local brokers.

Our findings indicate that the type of adjacent road to the private rental house negatively affected respondents' housing affordability. As the area has improved, there is a tendency to raise rental prices for homes. The probability of private rental households near asphalt roads being unaffordable. This scenario suggests that infrastructure can shape the neighborhood and enhance property values; however, this appreciation will ultimately be reflected in rents. Ultimately, it leaves renters unable to afford rent.

The area of the house is another significant factor in determining private rental affordability. An increase in the house's area will raise the rent, making it unaffordable (Iqbal *et al.*, 2023; Rao and Biswas, 2023) confirm that house size is identified as one of the affordability factors.

The global spatial autocorrelation results reveals that weak but significant variation across neighborhoods in rental prices, number of families, house area and types of adjacent roads. This variation implies that these variables are spatially clustered rather than randomly distributed. However, income and housing affordability were not clustered geographically across the city's neighborhoods. Housing affordability is computed from, rent and income, there is a probability that high rent is occupied by high income respondent and low rent house is occupied by low rent, in this case the affordability leads to random rather than clustering. On the other hand, income and affordability were tested for local autocorrelation, and there are signals that some areas are clustered as hot and cold spots. The variables' global and local spatial correlations demonstrate that housing and infrastructure policymakers and implementers should consider before it leads to severe and diverse segregation. We argued that determinants of rental housing affordability variables are not strongly autocorrelated in medium sized emerging cities. However, due attention should be given to control future socio-spatial inequalities. Shi and Dorling (2020) found that spatial clustering in fast developing Beijing is lower than in the highly developed London.

6. Conclusion

This study assesses the housing affordability status of households and the determinants of private rental housing affordability, and their variation in the neighborhood of Debre Markos. Using established rent-to-income ratio methods, the respondents were categorized as affordable and non-affordable of private rental housing. The finding sends a message that a significant number of respondents were unable to afford. This result implies that a substantial portion of families are struggling with affordability problems backed by high inflation-induced increases in food and nonfood costs.

The *t*-test results identified differences in the determinants among respondents in affordable and unaffordable housing. These determinants include the number of families, the household's age, the home's rental price and the home's total area. These factors should also be considered to address housing affordability.

The logistic models identified key determinants of private rental housing affordability. These key factors include the number of families, housing typology, house area and the type of road adjacent to the house. The implication of the logistic regression result in addressing the housing affordability problem is that it should consider different contexts, such as family planning, infrastructure allocation and planning, to inform future building decisions.

The spatial analysis also manifests that a cluster of variables in the city might lead to different types of segregation. These variables include rental house price, number of families, housing typology, house area and the kind of adjacent road. This result is crucial for formulating housing policy and allocating and developing infrastructure. The local spatial analyses also revealed cold and hot spots in respondents' affordability status, rental prices and income. Chen *et al.* (2022) explained that infrastructure development tends to create spatial autocorrelation, because infrastructure increases the vitality of adjacent houses (Chen *et al.*, 2022). These infrastructure and different amenities have a marked effect on urban structure and house prices (Liao *et al.*, 2024). Zhang and Buyuklieva (2025) pointed out that this unequal access to resources creates socio-spatial segregation.

The findings of this study have significant implications for policymakers and stakeholders involved in sustainable urban management and planning, urban housing development and the well-being of urban residents. This considerable level of housing affordability for middle-income people allows policymakers to see how lower-income people are affected by the growing private rental market. Despite the government's efforts to improve housing supply through a cooperative housing strategy, housing demand remains a pressing issue in Debre Markos.

There are different housing modalities of housing in the study area such as, rental housing, mortgage financing, residential land leasing and cooperative housing. However according to this research a significant amount of the respondents were unaffordable in these modalities. Therefore, the following reactions seem appropriate:

- The government invests in public housing/social housing to ensure the well-being of the city residents.
- The local government considers the significant determinants of housing affordability in its policy.
- The government intervenes on both the supply and demand sides through rent regulation, as done in some countries facing serious challenges with affordable rental housing (Galster and Lee, 2021).
- Infrastructure, services and accessibility should be distributed more equally to avoid segregation.

This study has its own limitations to be considered in the future works:

- This data collection is limited to rental affordability of employed respondents who have regular income. It ignores irregular income respondents including low-income respondents. Future research is recommended with respondents who have irregular income.
- There might be possible biases in the affordability determinants housing affordability from the measurement of variables and excluding of important

variables like neighborhood quality index, irregular income, the quality of house, etc.

- Due to the absence of neighborhood subdivisions, neighborhood is created using nearest public transportation stations for the respondents. Each respondent was associated with the corresponding neighborhood. Better results might be obtained if the house's absolute location is included in the analysis rather than categorized by neighborhood. This might pose privacy issues but future work might be recommended in this regard.
- The discussion of mortgage affordability is based on theoretical scenarios. The conclusions should be compared to real data.
- The result is based on the rent-income-ratio. Future works could use other approaches like the transport and rent income ratio or the residual income method and compare the results to the results presented here.

Ethics and survey

All data were collected according to the relevant guidelines and regulations. The trial protocol, including recruitment, informed consent and data processing procedures, was reviewed by the Research Ethics Committee of TU Wien. There was no objection to conduct the survey. Written informed consent was obtained from all participants prior to participation. Participation was voluntary and could be discontinued at any time without consequences. No minors were recruited, and no identifiable personal data or images were reported. All persons involved in the study participated voluntarily and agreed to the publication of the results derived from their responses.

Note

[1.] www.exchange-rates.org/exchange-rate-history/usd-etb-2024 accessed at January 13, 2026.

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