

EXPLORING THE SPATIAL, TECHNICAL AND ECONOMICAL FEATURES OF AGRICULTURAL LAND MARKET IN ROMANIA IN THE YEAR 2024

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Abstract

This paper examines Romania's agricultural land market by creating a comprehensive database of land sale offers. The database aggregates essential information, including location, pricing, and land characteristics, collected from Ministry of Agriculture and Rural Development for diverse regions of the country, providing a foundation to analyze land market in the year 2024. The study applies statistical methods such as: descriptive statistics, including histogram and scatterplot representation, as well as correlation exploration, to uncover the main aspects in pricing, regional disparities, and market behaviors. These insights illuminate both the challenges and opportunities within Romania's agricultural land sector. To complement the statistical analysis, Geographic Information System (GIS) tools are employed to provide a spatial perspective on land sale distributions. GIS mapping visually represents geographic trends, identifying regions of high and low activity and enhancing the understanding of spatial patterns in land transactions. By integrating statistical and GIS analyses, the paper offers a comprehensive view of the market, delivering valuable insights for policymakers, investors, and stakeholders interested in navigating and optimizing the agricultural land market in Romania. The analysis of Romania's agricultural land market reveals notable regional disparities in both parcel sizes and offer prices. While there is a moderately strong positive correlation between parcel size and total offer price, the results indicate that other factors—such as location, accessibility, and land use—have a greater influence on land value. Spatial and statistical findings emphasize the importance of these factors in shaping market dynamics and highlight the need for region-specific investment strategies and land management policies to support sustainable market development.

Key words: land market, territorial distribution, surfaces, prices, statistical analysis, GIS, Romania

INTRODUCTION

In recent decades, rapid and widespread urbanization has transformed many regions across the globe. (Kwartnik-Pruc & Droj, 2023)[11]. Land, as a finite and valuable resource, requires strategic and sustainable management, particularly in the context of accelerated global population growth. Within this framework, it becomes essential to address the legal evaluation, clear definition, and systematic registration of real estate assets. (Kyalik and Polat, 2023) [10]. The inherent

nature of agricultural activities means that risks and uncertainties are a constant presence in agricultural value chains. Therefore, it is crucial for decision support models in farming to incorporate risk management metrics and strategies. (Chiorean et al., 2024) [5]. Furthermore, the immediate and readily apparent benefits of implementing these solutions in real estate property evaluation include the automation of the evaluation process and the availability of control methods for the obtained results. Discovering methods to seamlessly incorporate data from reliable

sources into contemporary Geographic Information Systems (GIS) would enhance the efficiency of various real estate professionals, including appraisers, brokers, developers and bank analysts (Brožek & Frosik, 2023) [4].

The real estate market encompasses the collective activities related to real estate, comprising investments, transactions, and ancillary services such as brokerage, valuation, consulting and management. This market involves interactions among various stakeholders, including property developers, sales representatives, prospective users, as well as intermediaries like brokers and appraisers. (Pawel et al., 2022) [8].

As specified by G. Liu, in the last few years, real estate prices have risen rapidly and this fact attracted many specialists from various fields (Liu, 2022) [12]. Examining and analyzing the real estate market through forecasting allows for an assessment of its stability. This evaluation serves a dual purpose: firstly, it aids the government in implementing macroeconomic controls on house prices, contributing to overall economic health. Secondly, the prediction of house prices serves as a foundation for real estate investors to develop investment strategies, helping them steer clear of potential losses (Liu, 2022) [12]. Furthermore, urban residents are increasingly prioritizing the quality of their living environments. In cities marked by pollution, environmental quality has emerged as a significant factor influencing residential and location preferences. Consequently, this dynamic plays a pivotal role in shaping land-use patterns, mobility trends, and the economic landscape of the affected areas. This concern is particularly noteworthy in industrial cities where residents confront daily health risks arising from adverse environmental conditions, notably high pollution levels. In an effort to mitigate these risks, individuals often relocate to residential areas with better environmental conditions, even if they may be less accessible in terms of transportation systems and/or urban services (Chiarazzo et al., 2014) [6].

Although there are substantial distinctions between urban and rural spaces, and there are valid methodological reasons to concentrate case studies in either setting, there is

considerable value in establishing connections between the countryside and the city. Analyzing the diverse forms that property ownership assumes across these spaces can offer valuable insights (Van Sant et al., 2023) [17]. Extensive metropolitan areas encompass not only urban centers but also rural outskirts. The connections between these regions are so pronounced that they cannot be studied in isolation. In the rural outskirts, there is a modern coexistence of residential functions, work activities, and traditional agricultural sectors. Consequently, the production of goods and services for the city necessitates a comprehensive analysis, considering the vast territory that comes into play. (Bencardino & Nesticò, 2017) [3]. To delve into the dynamics of rural-urban relations and interactions, it is essential to start with the foundational assumption that certain spaces can be categorized as either "urban" or "rural." While this categorization holds true, it's important to note that urban and rural areas don't exist as isolated and distinct territories. On the contrary, they are intricately interconnected in numerous ways, necessitating a thorough exploration of their associations in terms of identity, causality, and effects, both theoretically and empirically. (Delgado-Viñas & Gómez-Moreno, 2022) [7].

According to some studies, the cities contain 54% of the world's population and this number is expected to increase to 66% by 2050, (Kaluvarachchi, 2022) [9] while other studies shows that by 2030, even faster, megacities or dense metropolitan regions will house almost 60% of the world's population (Vardopoulos et al., 2023) [18]. The distinctive characteristics of urban centers, such as elevated population density, traffic congestion, and intense land development, stem from their high density and central role in hosting urban functions, setting them apart from other regions within cities (Wang & Li, 2019) [19].

The process of managing data related to the market, real estate, and transactions, which is integral to the appraisal procedure, encompasses three key phases: data collection, organization of the collected data, and subsequent analysis. For appraisers, a profound understanding of statistics has become crucial,

particularly with the integration of the valuation methodologies of individual real estate properties into overarching appraisal techniques. In this evolving environment, traditional real estate appraisers play a pivotal role, acting as a bridge between the purely mathematical models employed in valuation, local market conditions, and the analyzed physical attributes of real estate. The incorporation of statistical models and specialized applications of statistical processes offers additional support in formulating an opinion on value or conducting analysis (Zeicu et al., 2017) [20].

The primary approach to forecasting and analyzing the real estate market involves the utilization of the multiple linear regression model, followed by drawing conclusions based on the analysis of real estate data. The multiple linear regression model is a prevalent multivariate statistical method, valued for its convenience and simplicity in application (Liu, 2022) [12]. Using statistical data from the real estate market, this study examines the factors influencing real estate prices. It establishes a multiple linear regression model, employs the least square method to determine the unknown parameters in the model, and ultimately constructs a house price prediction model for forecasting and analyzing the real estate market (Liu, 2022) [12]. Multiple Linear Regression is a statistical method designed to investigate the relationship between two or more variables. The variable to be predicted is known as the dependent variable (or response variable, outcome, or target), while the variables used to predict its value are referred to as independent variables (or predictors, explanatory variables, or regressors). The overarching goal of multiple regression is to gain a deeper understanding of the relationship between multiple independent or predictor variables and a dependent or outcome variable (Abdulhamedh, 2022) [1].

Most input data contain geospatial references, involving geographical location. Managing these geospatial data is becoming increasingly crucial for public institutions such as public administration, environmental organizations, healthcare units, various financial services, etc. GIS applications utilized by these institutions

provide the capability to collect, store, organize, manage, and utilize geospatial information in a graphical form, enabling efficient visualization, searching, planning, and analysis. Through these GIS applications, complex queries and advanced analyses can be performed, leveraging not only geospatial data and information but also technical and economic data and information by integrating with various other information platforms (Badea and Badea, 2013) [2]. In their 2016 study, Sălăgean et al. discuss the development of a Geographic Information System (GIS) tailored for the real estate sector, emphasizing its potential to enhance property evaluation and management through spatial data integration [16]. This approach aligns with contemporary trends in utilizing GIS technologies to improve the accuracy and efficiency of real estate assessments. (Sălăgean et al, 2016) [16].

Currently, the activity of real estate property valuation is regulated by the National Association of Appraisers in Romania, abbreviated as ANEVAR. The association was established in 1992 as a non-governmental professional association, independent, in accordance with the legal provisions in force at that time. In 2011, the regulated profession of authorized appraiser was established through the Government Ordinance of Romania No. 24/2011 regarding certain measures in the field of asset valuation, approved with modifications by Law No. 99/2013. ANEVAR was constituted as a professional public utility organization without patrimonial purposes, and it includes authorized appraisers who acquire this status under the conditions provided by the afore mentioned legal act. (National Association of Appraisers from Romania ANEVAR, ANEVAR.Html) [15]. The purpose of the National Association of Authorized Appraisers in Romania is to organize, coordinate, and authorize the practice of the authorized appraiser profession in the country. It is committed to representing and safeguarding the professional interests of its members, ensuring the independent exercise of the authorized appraiser profession in accordance with the principles of professional ethics and a high level of qualification. Additionally, the association aims to promote

standards, methods, and techniques of appraisal in the activities of authorized appraisers. (National Association of Appraisers from Romania ANEVAR, *ANEVAR.Html*) [15]. As presented in the Property Valuation Standards, 2022 edition, currently in force, more specifically in GEV 630 - Real Estate Valuation, if there are few recently completed sales or when appraisers' access to recent completed sales is restricted by various specific legal provisions or when there is limited information available to the general public, the appraiser may consider prices of identical or similar assets that are published or offered for sale (active listings), provided that the relevance of this information is clearly established, critically analyzed, and substantiated. (National Association of Appraisers from Romania ANEVAR, 2022) [14]. The aim of this study is to conduct a comprehensive analysis of the agricultural land market in Romania by exploring spatial and statistical variations in land offer prices and parcel sizes. Drawing on a robust database of approximately 2,800 land listings aggregated from the Ministry of Agriculture and Rural Development (MADR) [13], the research investigates key indicators such as average offer price per hectare, total parcel area, and

regional disparities. By integrating statistical analysis with geospatial visualization, the study seeks to identify emerging trends, highlight regional imbalances, and provide data-driven insights into the dynamics of agricultural land across Romania.

MATERIALS AND METHODS

To conduct this study, a comprehensive database of agricultural lands available for sale from various counties in Romania was compiled. Approximately 3,300 data points were collected from the official website of the Ministry of Agriculture and Rural Development (MADR) [13], based on the listings available and valid as of December 2024. The database includes several variables, which are detailed in Table 1. This table presents the structure of a geospatial database used for analyzing agricultural land listings in Romania. It comprises eight fields, each with a specific role in identifying and describing land parcels. The first field, "ID-GIS," serves as a unique identifier for representing each land listing within platforms such as ArcGIS Online. This ensures the seamless integration of spatial data with mapping technologies for visual analysis and geolocation purposes.

Table 1. Data base description of study variables

Crt. no.	Fild name	The field category	Description of field	Field type
1	ID-GIS	ID	Unique identifier used for representation in ArcGIS online	Integer
2	Location / County	Spatial features	Name of the county (e.g., Arad) where the land is located	String
3	Name of the Administrative-Territorial Unit (ATU)		Name of the ATU (e.g., municipality or commune)	String
4	Latitude		Geographic coordinates taken from google maps	Double
5	Longitude		Geographic coordinates taken from google maps	Double
6	Area	Technical features	Total surface area of the property in hectares	Double
7	Offer price	Economical features	Total price listed for the land offer on the platform	Integer
8	Unit offer price		The offer price taken from the platform in EURO/hectares	Integer

Source: created by the authors.

The database categorizes the fields into three major types: spatial, technical, and economical.

Spatial features include the name of the county and the Administrative-Territorial Unit (ATU), along with geographic coordinates (latitude and longitude) derived from Google Maps.

These variables enable the spatial localization of each land parcel, allowing researchers to track regional disparities and distribution patterns across Romania.

Technical features are represented by the "Area" field, which indicates the total surface area of the land in hectares—a critical metric for valuation and comparative analysis. *Economical features* are captured through the "Offer price" and "Unit offer price" fields. The total offer price denotes the overall listing value of the land, while the unit price provides

a standardized metric (EUR/hectare), enabling accurate comparison across properties of varying sizes. This structured database not only facilitates descriptive statistical analysis but also serves as a foundation for geospatial and econometric modeling in the context of land market assessments and rural development planning.

The diagram presented in Figure 1 outlines a structured methodology for analyzing agricultural land values at a national level, with a focus on spatial and statistical modeling.

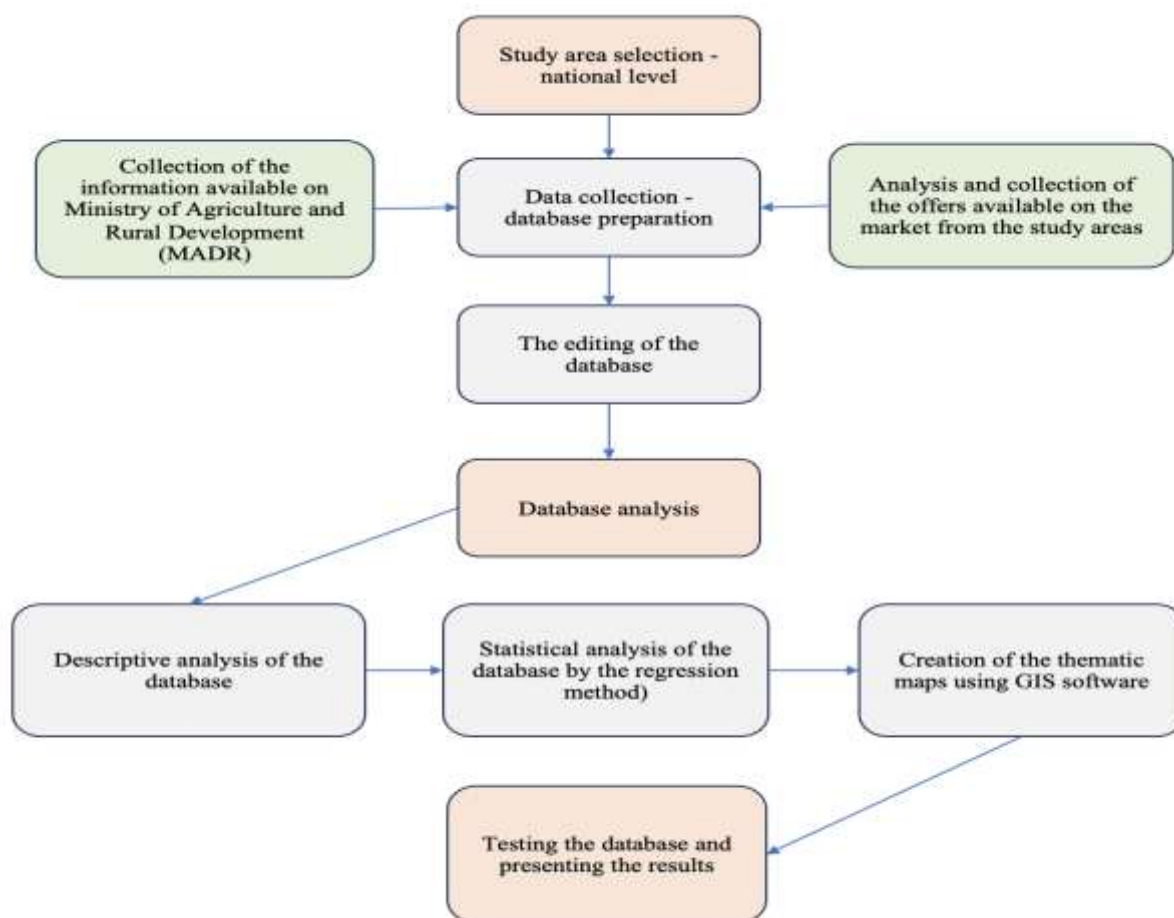


Fig. 1. The stages of running this the case study
 Source: created by the authors.

The process begins with the selection of the study area across Romania, followed by the systematic collection of data from two primary sources: the Ministry of Agriculture and Rural Development (MADR) [13] and public land market listings [21].

These sources provide both official records and real-time market data, which are essential for

ensuring that the database reflects current land values and territorial distribution patterns.

Once data is collected, the next step involves database preparation and editing, which includes verifying, cleaning, and standardizing variables such as geographic coordinates, land surface, and offer prices. Following this step, a comprehensive analysis is conducted through

both descriptive and inferential statistical methods.

Descriptive analysis highlights the key characteristics and trends within the dataset, while regression analysis explores relationships between variables, such as land size and unit price, to identify influential factors affecting land valuation.

The final phase emphasizes spatial representation and validation of the results. Using Geographic Information Systems (GIS), thematic maps are generated to visualize spatial disparities and regional patterns in land pricing.

These maps, along with statistical outputs, are subjected to testing and interpretation, culminating in the presentation of research findings. This integrative workflow ensures a scientifically robust approach to agricultural land market assessment, offering valuable insights.

In the initial phase of the database analysis, a descriptive examination was conducted for both dependent and independent variables. The statistical analysis was performed using the Jamovi software, version 2.6. Subsequently, the authors employed multiple regression to automate the determination of the value of property offers within the examined area. To enhance the visual representation of the analyzed region, GIS software was additionally utilized.

The data input process stands as a crucial step in developing a GIS application. The outcome relies on the existence, accuracy, and uniformity of the data.

Various methods of data input into GIS include the use of maps or plans, aerial photographs, sensors, field measurements, and various other databases, among others. Acquiring these data poses a challenging process, given that information is often not readily available in the market.

RESULTS AND DISCUSSIONS

After the data collection phase, the preparation and editing of the database were carried out,

specifically focusing on the removal of extreme values (outliers).

We've analyzed the uploaded database and identified statistical outliers using the Interquartile Range (IQR) method. Outlier Variables Analyzed: Surface (ha), Offer Price (EUR), Offer Price per Hectare (EUR/ha), Offer Value (RON).

These entries have unusually high or low values, compared to the rest of the dataset. Some plots in Arad county show exceptionally high price per hectare, exceeding 10,000 EUR/ha, indicating potential urban or special-use land.

Thus, the outlier values were removed, resulting in a total of 2,799 records in the database, covering 25 counties and 638 localities analyzed in the year 2024.

Removing outliers: reduces skewness and dispersion, gives more realistic and stable averages and helps avoid misleading interpretations in market analysis, forecasting, or pricing strategy.

The mean value dropped by over 10,000 RON, and the standard deviation almost halved, confirming that outliers had a large effect on the market perception, as shown in Figure 2.

Outliers caused a heavy right-skew; without them, the distribution is more bell-shaped. This helps in building more reliable pricing models and avoiding overestimation.

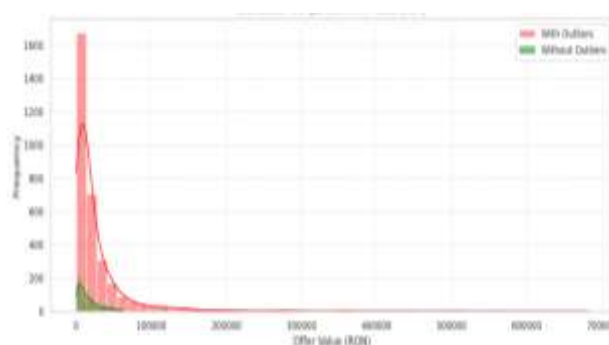


Fig. 2. Distribution comparison: Offer Value in the year 2024 (RON)

Source: created by the authors.

The drop is moderate, suggesting that most EUR/ha values are relatively consistent, but with some extreme peaks, as shown in Figure 3. The shape remains similar, but extreme spikes over 20,000 EUR/ha are removed. The

cleaned data provides a smoother and more interpretable curve.

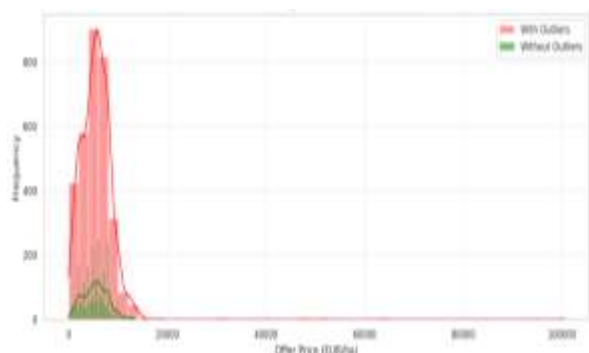


Fig. 3. Distribution comparison: Offer Price in the year 2024 (EUR/ha)

Source: created by the authors.

Figure 4 present a surface distribution comparison in terms of standard deviation, which decreased from 1.29 to 0.44, indicating a more compact distribution.

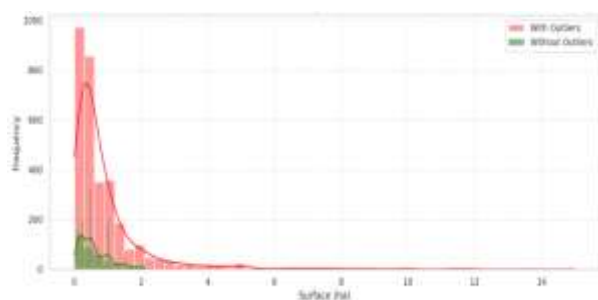


Fig. 4. Distribution comparison: Surface in the year 2024 (ha)

Source: created by the authors.

Smaller plots dominate after removing outlier records with extremely large surface areas. The red distribution (with outliers) has a long right tail → a few extremely large parcels. The red distribution (with outliers) has a long right tail → a few extremely large parcels.

Figure 5 is presenting the standard deviation that dropped from 8,818 EUR to 2,743 EUR. This shows that extreme values were inflating the perceived average significantly. Original data includes listings over 50,000 EUR, which are rare. Cleaned data focuses on offers under 20,000 EUR, better representing the market norm.

Table 2 presents a descriptive statistical summary of four key variables from a dataset comprising 2,799 agricultural land listings in Romania.

These variables include surface area (in

hectares), offer price per hectare (EUR/ha), total offer price (EUR), and offer value in national currency (RON).

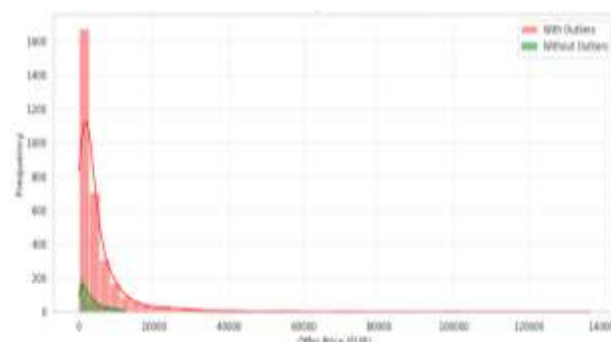


Fig. 5. Distribution comparison: Offer Price in the year 2024 (EUR)

Source: created by the authors.

For each variable, the table provides the number of valid observations, missing values (none in this case), mean, median, standard deviation, and minimum and maximum values. The average land parcel size is approximately 0.58 hectares, with a median of 0.50 ha, indicating a slightly right-skewed distribution. The size ranges from as small as 0.003 ha to 2.13 ha, with a standard deviation of 0.449 ha, showing moderate variability in land size. The average offer price per hectare is EUR 5,382, while the median is slightly higher at EUR 5,483, suggesting a fairly symmetrical distribution, although the wide range from EUR 5.41 to EUR 13,393 and a standard deviation of EUR 2,532 indicate notable dispersion.

Similarly, the total offer price per listing varies significantly, with a mean of EUR 3,032 and a maximum of EUR 12,356, while the offer value in RON has an average of 15,162 and a maximum of 61,780 RON.

These statistics reflect the diversity of land characteristics and market conditions across regions. The absence of missing data further supports the reliability of the dataset for statistical analysis and modeling.

Figure 6 presents a comparative bar chart displaying the top 10 and bottom 10 Romanian counties based on the average offer price for agricultural land, measured in EUR per hectare (EUR/ha). The counties are categorized into two groups: "Top 10" and "Bottom 10," each represented with distinct colors for clarity. The

chart reveals that counties such as Prahova, Călărași, and Suceava lead the national ranking, with average offer prices exceeding EUR 6,500/ha.

Table 2. Data base description of study variables in the year 2024

	Surface (ha)	Offer Price (EUR/ha)	Offer Price (EUR)	Offer Value (RON)
N	2,799	2,799	2,799	2,799
Missing	0	0	0	0
Mean	0.58	5,382	3,032	15,162
Median	0.5	5,483	2,089	10,450
Standard deviation	0.449	2,532	2,744	13,719
Minimum	0.003	5.41	10	50
Maximum	2.13	13,393	12,356	61,780

Source: created by the authors.

These regions may reflect higher land productivity, better infrastructure, or stronger market demand, contributing to elevated land valuations. Other top-performing counties

include Brăila, Constanța, Timiș, and Arad—well-known for fertile soil and commercial agricultural activity.

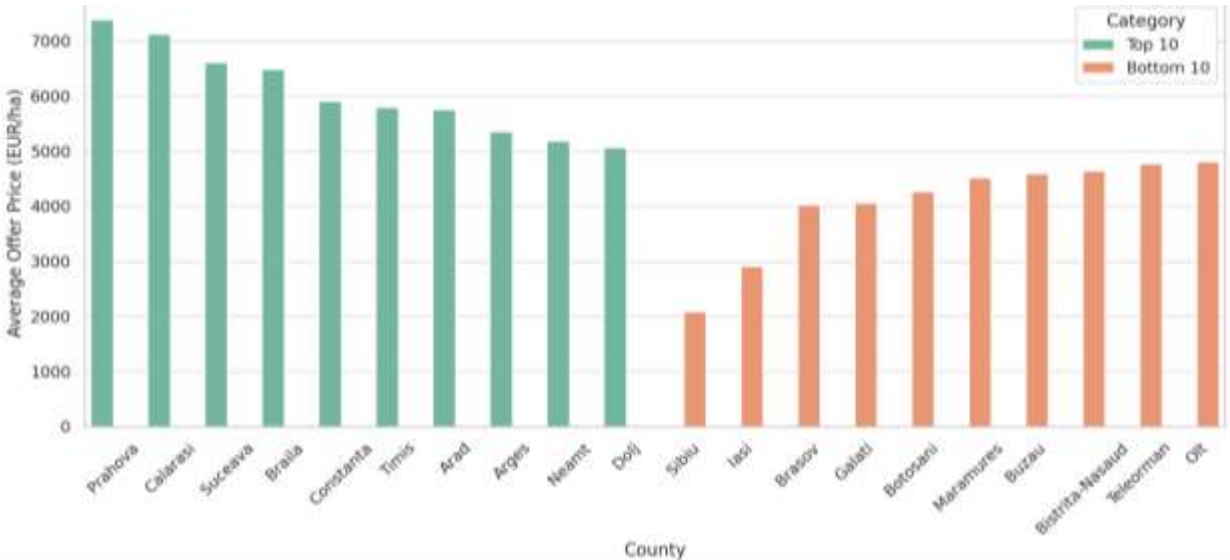


Fig. 6. Top 10 & Bottom 10 Counties in Romania, by average offer price in the year 2024 (EUR/ha)

Source: created by the authors.

Conversely, counties such as Sibiu and Iași exhibit the lowest average offer prices, with values below EUR 3,000/ha, potentially reflecting lower agricultural potential, less accessible locations, or limited market interest. The inclusion of counties like Botoșani, Maramureș, and Bistrița-Năsăud in the bottom tier further suggests regional disparities in land market dynamics.

This visual comparison underscores significant geographic variability in agricultural land values across Romania, offering useful insights for policy-makers, investors, and researchers interested in land use planning and market assessment.

Furthermore, the statistical analysis reveals reveal meaningful regional differences in both land size and pricing, offering insights into local agricultural land markets in Romania.

The plot presented in Figure 7, shows the distribution of land surface areas for each county.

The boxplot presented above illustrates the distribution of land surface areas (in hectares) across various Romanian counties.

Each box represents the interquartile range (IQR), where the middle 50% of values lie, with the median marked as a horizontal line within the box.

Counties such as Brăila and Dâmbovița exhibit relatively lower median land surface areas, indicating a tendency toward smaller land plots being offered in those regions.

On the other hand, counties like Tulcea and Timiș display higher median values and wider interquartile ranges, suggesting greater variability in land plot sizes and the availability of larger parcels.

Additionally, the presence of multiple outliers in counties like Arad, Călărași, and Olt highlights the existence of particularly large land plots that exceed the upper quartile range. These outliers may indicate strategic agricultural investments or less fragmented land ownership in certain areas.

Overall, the data suggests that while most counties maintain median land sizes below 1 hectare, regional variation is significant, reflecting differing patterns of land use, agricultural practices and market structures.

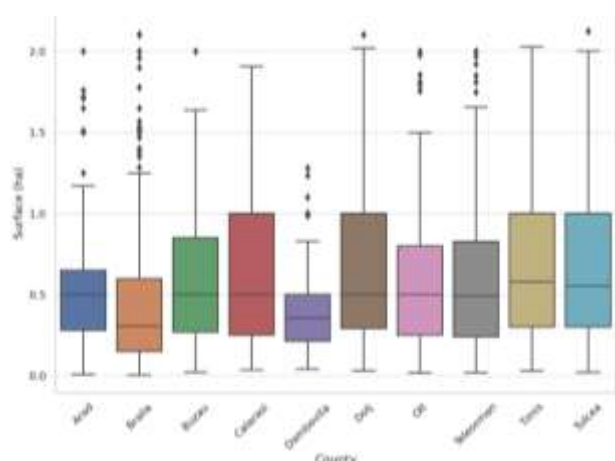


Fig. 7. Surface (ha) by county in the year 2024
Source: created by the authors.

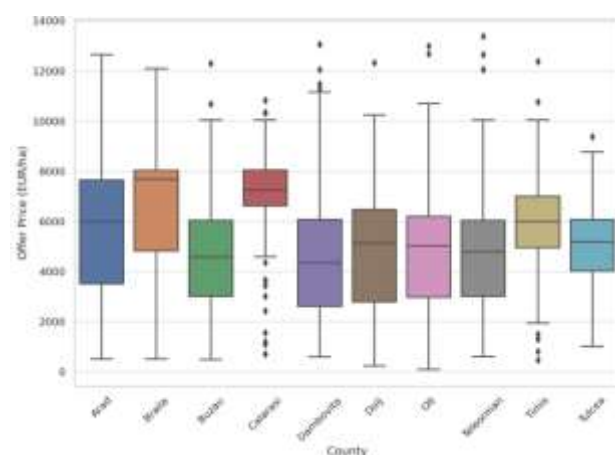


Fig. 8. Offer price by county in the year 2024 (EUR/ha)
Source: created by the authors.

The plot presented in Figure 8, compares the unit offer price (in EUR/ha) across counties. Notably, Brăila, Călărași, and Arad have higher median prices, with Brăila standing out with both high prices and low variability, indicating a more consistent land market.

In contrast, other counties like Dâmbovița and Buzău show a wider price distribution and the presence of significant outliers.

Furthermore, each important variable in the database was individually analyzed.

As illustrated in Figure 9, the distribution is right-skewed, meaning most plots have smaller areas (predominantly between 0.2 and 0.7 hectares). The majority of land parcels in the dataset are small to mid-sized, which is common in peri-urban and rural real estate markets.

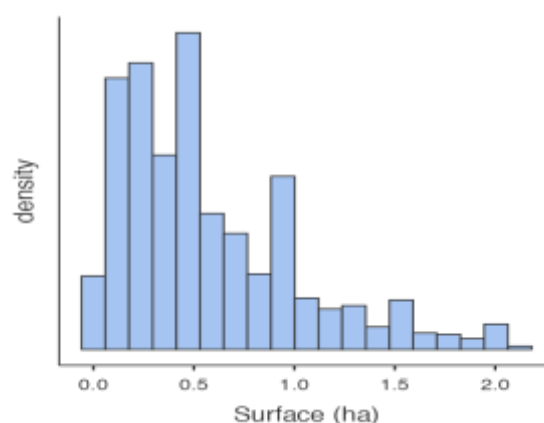


Fig. 9. Histogram for Variable Surface in the year 2024 (ha)
Source: created by the authors.

This skewness should be considered when applying statistical models that assume normality.

As evidenced in Figure 10, while most land parcels are small, the presence of outliers suggests the existence of significantly larger plots. These outliers may distort mean-based analyses and require careful treatment in statistical modeling.

According to Figure 11, the distribution is slightly right-skewed, indicating a concentration of prices around the 4,000–7,000 EUR/ha range.

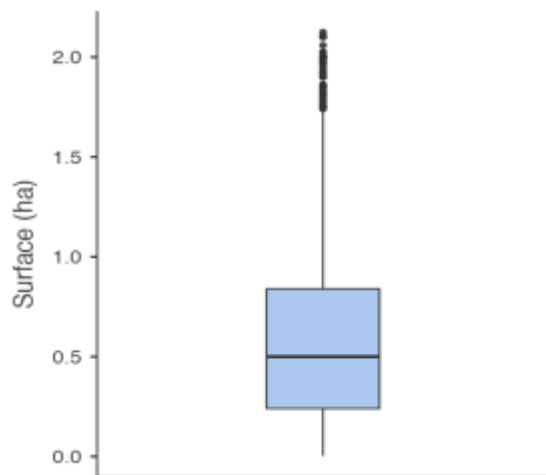


Fig. 10. Boxplot for Variable Surface in the year 2024 (ha)
Source: created by the authors.

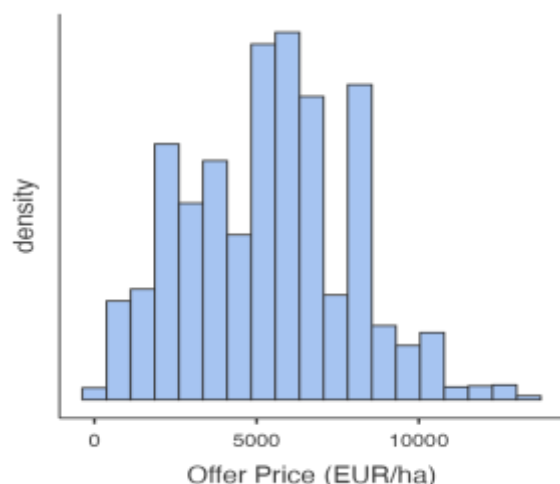


Fig. 11. Histogram for Offer Price in the year 2024 (EUR/ha)
Source: created by the authors.

Most land listings cluster within a mid-range price bracket, although a number of high-priced listings are still visible. This mix implies market heterogeneity possibly due to differences in location, land quality, or infrastructure.

As evidenced in Figure 12, the real estate offer prices exhibit moderate spread with a concentration in mid-range values and a few extreme values that may warrant exclusion or separate analysis, depending on the study's goal.

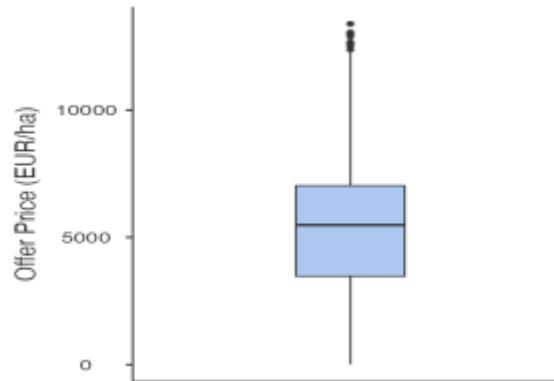


Fig. 12. Boxplot for Offer Price in the year 2024 (EUR/ha)
Source: created by the authors.

Histograms are commonly used in statistics to visualize the shape, center, and spread of a dataset. They provide a quick and effective way to understand the underlying distribution and identify patterns, such as the presence of peaks, gaps, or outliers in the data. Histograms are particularly useful for exploring the characteristics of numerical data and making informed decisions based on data patterns.

This histogram, presented in Figure 13 helps us understand how price per hectare affects the type and size of land on the market.

Most properties fall into the 1k–3k and 3k–5k EUR/ha categories, especially for small plots (under 1 ha).

Plots with prices below 1,000 EUR/ha are fewer and generally smaller. Higher-priced categories (5k–10k and 10k+) appear much less frequently, and typically involve small-sized land parcels — often peri-urban or special-use land.

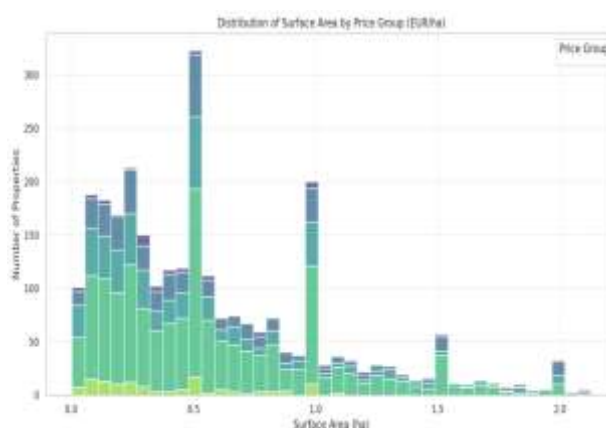


Fig. 13. Distribution of Surface Area by Price Grup in the year 2024 (Eur/ha)
Source: created by the authors.

The Figure 14 displays a correlation matrix examining the relationships between key variables associated with agricultural land offers: surface area (ha), offer price (EUR), unit offer price (EUR/ha), and offer value (RON). Correlation coefficients range from -1 to 1, with values closer to 1 indicating strong positive associations and values near -1 indicating strong negative associations. The matrix reveals a strong positive correlation (0.76) between surface area and total offer price (EUR), as well as between surface area and offer value (RON), suggesting that larger plots of land are generally associated with higher overall offer prices.

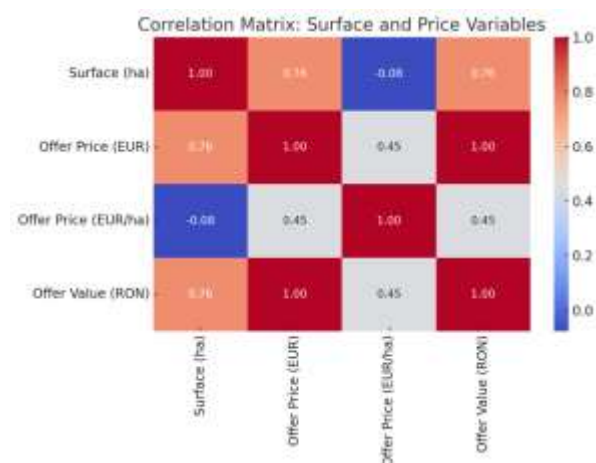


Fig. 14. Correlation matrix: surface and price variables in the year 2024

Source: created by the authors.

Interestingly, the correlation between surface area and unit offer price (EUR/ha) is slightly negative (-0.08), indicating that as the surface area increases, the price per hectare may slightly decrease. This inverse relationship suggests a potential volume discount effect or a market preference for smaller, more accessible plots at a higher rate per unit area. The unit offer price shows a moderate positive correlation (0.45) with both total offer price (EUR) and offer value (RON), indicating that it plays a notable, albeit less dominant, role in determining the total value compared to surface size. These findings provide valuable insight into how land size and pricing components interact in the agricultural land market.

The size of a land parcel significantly affects the total offer price, but not the unit price per

hectare. This suggests that economies of scale or location differences may be affecting unit pricing.

The scatterplot matrix, shown in Figure 15, provides a comprehensive visual overview of the relationships between key variables in the agricultural land offer dataset: surface area (ha), offer price (EUR), unit offer price (EUR/ha), and offer value (RON).

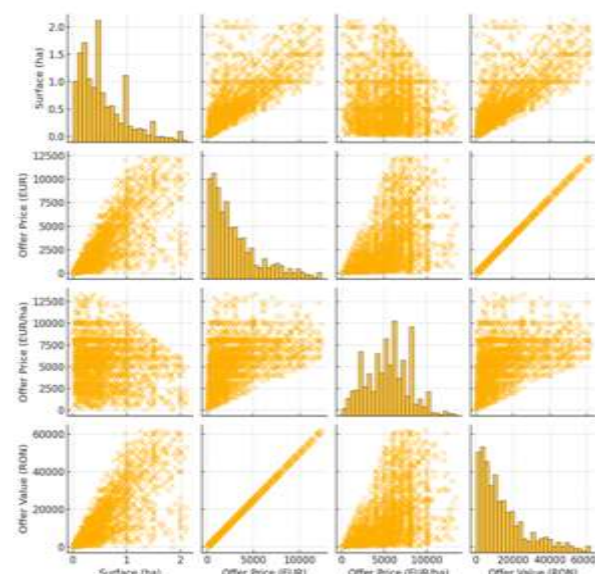


Fig. 15. Scatterplot Matrix. Surface and Price variables in the year 2024

Source: created by the authors.

Each diagonal panel presents the distribution of individual variables through histograms, revealing a right-skewed distribution for surface area and total offer price, indicating a higher frequency of small to mid-sized land parcels and lower total prices. In contrast, the unit offer price (EUR/ha) appears more evenly distributed but still displays variation across a wide range. A strong linear relationship exists between Surface (ha) and Offer Price (EUR). Offer Price (EUR/ha) shows no strong linear relationship with surface size, which is expected since it represents a normalized price. Offer Value (RON) is almost perfectly correlated with Offer Price (EUR) (due to currency conversion).

The plot shown in Figure 16 shows a positive linear relationship between the size of land (in hectares) and the total offer price. As the surface increases, the offer price tends to increase as well, which is expected.

The distribution of variables like Surface and Offer Price shows positive skewness (long tail to the right), indicating the presence of a few very large values.

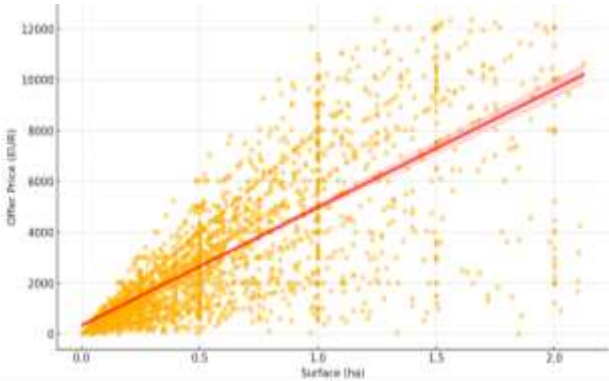


Fig. 16. Regression Plot: Surface (ha) vs. Offer Price (EUR) in the year 2024

Source: created by the authors.

The map (Figure 17) illustrates the average offer prices for agricultural land across various counties in Romania, measured in EUR per hectare. The data is visualized using proportional circles, where the size of each circle corresponds to the average offer price in that region—larger circles indicate higher land prices. Counties such as Brăila, Buzău, and

Mureș display notably larger circles, suggesting elevated market values for farmland.

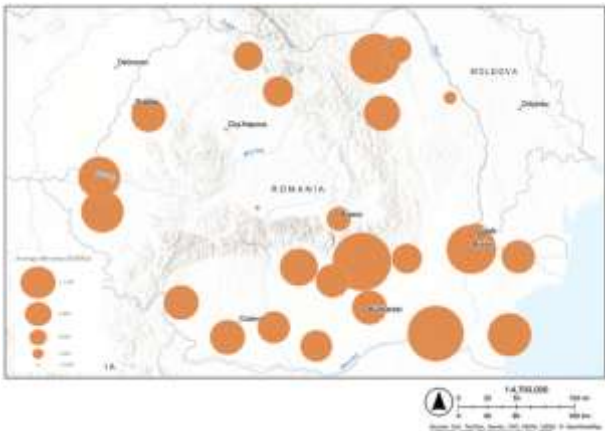


Fig. 17. Average offer price for agriculture land in Romania in the year 2024 (EUR/ha)

Source: created by the authors.

This spatial distribution highlights regional disparities in land value, influenced by factors such as land quality, accessibility, and proximity to urban centers. The map provides a clear overview of the geographical trends in Romania's agricultural land market.

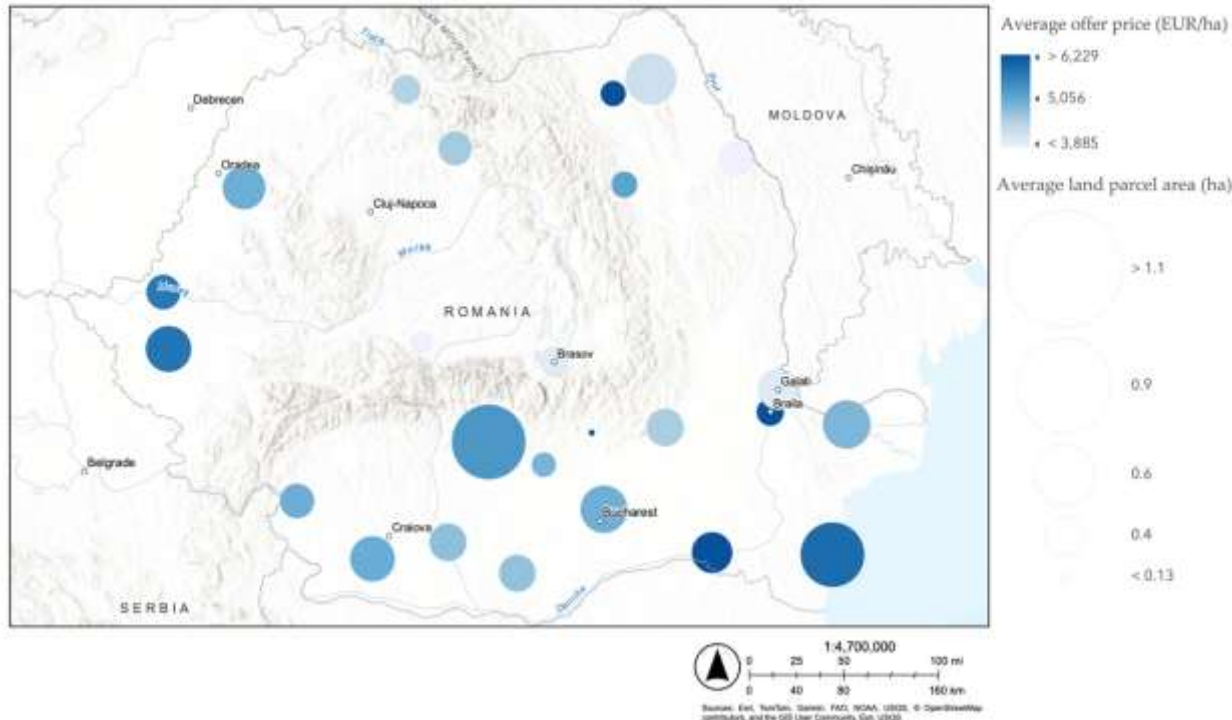


Fig. 18. Average offer price (EUR/ha) and average area for agriculture land (ha) in Romania in the year 2024

Source: created by the authors.

The map (Figure 18) shown above offers a bivariate representation of the average offer price per hectare (EUR/ha) and the average land surface area (ha) across Romanian counties. The intensity of the blue color represents the average offer price: darker shades indicate higher prices, while lighter tones correspond to lower values. Concurrently, the size of the circles reflects the average land surface area within each county — larger circles denote counties with more extensive average plot sizes, while smaller ones suggest smaller average parcels.

This visual approach enables a simultaneous examination of two critical agricultural land market dimensions: price and size. For instance, certain counties in southern and South-Eastern Romania (e.g., near Brăila and along the Danube) exhibit both high offer prices and large average surface areas, indicating regions with strong agricultural value and demand. In contrast, central or North-Eastern counties may display smaller circle sizes with varying price levels, suggesting either fragmented land ownership or less economic activity in agricultural land transactions. This map supports spatial decision-making by highlighting geographic disparities and market potential across the country.

CONCLUSIONS

There is a moderately strong and statistically significant positive correlation between the surface area and total offer price. However, additional factors (e.g., location, accessibility, land use) would likely improve model accuracy. The analysis supports the use of regression modeling for estimating land value based on parcel size.

This visualization (Figure 17 and Figure 18) reinforces the spatial disparities observed in the first map, where counties in central, southern, and eastern Romania exhibit significantly higher offer prices. The visual contrast between the maps provides valuable insights into the spatial dynamics of the Romanian agricultural land market, where high land value does not always correlate with larger surface areas. These findings can inform

policymakers and investors regarding land-use strategies and investment decisions tailored to regional characteristics.

This study has provided a comprehensive exploration of Romania's agricultural land market, highlighting notable disparities in both offer prices and land parcel sizes across counties. Through statistical and spatial analyses, significant regional differences emerged—counties such as Prahova, Călărași, and Brăila consistently displayed higher average offer prices per hectare, suggesting strong market demand and perceived land value. Conversely, counties like Sibiu and Iași recorded lower price levels, which may reflect reduced market pressure or lower land productivity. The correlation analysis further emphasized a positive relationship between surface area and total offer price (EUR), while revealing a weak correlation between unit price (EUR/ha) and land size, suggesting other factors—such as location, accessibility, or land quality—may play a more decisive role in value determination.

The spatial visualizations reinforced the statistical findings, providing an intuitive understanding of market dynamics at the regional level. Maps illustrating mean prices and parcel sizes revealed clusters of high-value zones concentrated in the southern and southeastern parts of the country, aligning with areas of economic activity and infrastructure accessibility. These insights underline the complexity of Romania's agricultural land market and point to the need for regionally tailored land management and investment strategies.

Future research should delve deeper into socioeconomic and environmental factors that shape these patterns, with the goal of supporting sustainable land-use policies and informed investment decisions.

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