

MODELING THE TOURISM MARKET BEHAVIOR BASED ON DISCRETE EQUILIBRIUM MODELS “SUPPLY – PRICE – DEMAND”

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ABSTRACT

The work is devoted to the modeling of the behavior of the tourism market in the conditions of a supply random lag, distributed according to normal and uniform distribution laws. The behavior of dependences on the tourist market of supply and demand on the price is considered. The modeling of the behavior of the tourism market was carried out using a market dynamic model in the plane of variables “supply – price – demand” taking into account the interests of different groups of consumers, primarily from the point of view of pricing. The delay between changes in supply and demand volumes is taken into account using a Cobweb model. To test this method, information was collected on family expenses when traveling abroad (outbound tourism, tourist vacations lasting 7-15 days) by surveying the employees of 38 travel organizations as of 2021. Three segments of the tourism market are identified: low (\$2000 – 4000), medium (\$4000 – 12000), and VIP-segment (\$12,000 – 20,000). The analysis of the modeling results showed that the behavior of tourists of different segments can significantly influence the market dynamics. The use of a Cobweb model allowed for determining the level of stability of tourist behavior and assessing the possibility of consumer migration from one segment to another. Sensitivity to price changes and response to new offers from different segments can be different, which is important for determining pricing strategies, marketing, and the development of new tourism products.

Keywords: *tourism, demand function, supply function, price, market segments, lag, Cobweb model.*

1. INTRODUCTION

The market is an important object of economics research. A market can be described as a place of interaction between buyers and sellers, where they exchange goods and services. The market can be segmented according to various criteria, such as geographical areas, types of goods or services, target audience, etc. Market segmentation helps businesses better understand their customers and adjust their strategy accordingly (Saienko et al., 2020). The research on market supply and demand is important for understanding how the relationship between the number of goods that buyers are willing to buy (demand) and the number of goods that sellers are selling (supply) changes (Jarvis & Tint, 2009). It helps determine the price of goods and services in the market.

The research on the pricing process in the market includes the analysis of how prices are determined depending on changes in demand, supply, production costs, competition, etc. (Shpak et al., 2021). This helps businesses set optimal prices to maximize profits. Studying trends in the tourism market and predicting its future state is an important element of strategic planning for tourism companies and urban communities (Bashynska et al., 2022). This helps them adapt to changes in demand, technology (Bondarenko et al., 2021; Prokopenko et al., 2020), economic environment (Veres et al., 2022), etc.

Tourism is becoming an increasingly popular form of travel as many cities offer diverse cultural, historical, and entertainment opportunities for visitors. Modeling helps to understand the demand and behavior of tourists in these places. Understanding the dynamics of demand and supply in tourism helps governments and businesses plan their economic activities. It allows them to allocate resources efficiently, set pricing strategies, and invest in infrastructure development to meet the needs of tourists (Bonilla-Quijada et al., 2021; Weng et al., 2022). By modeling demand and supply, we can work towards more sustainable tourism (Aydin & Emek-siz, 2018; Brochado et al., 2023). This means balancing the number of tourists with the city's capacity, preventing overcrowding and its associated negative impacts on the environment and local culture.

Tourism market segmentation helps reveal the diversity of needs, preferences, and characteristics of consumers in different market segments. This allows travel companies to better understand their customers and customize travel services according to their needs (Shpak et al., 2023). As the behavior of the segmented tourism market changes over time, the demand and supply of tourism products in the market also change. Over time, they strive for some equilibrium value, taking into account segmented interests. The relevance of this topic dictates the need to consider the behavior of price dependence on supply and demand, demand on price and supply, and supply on price and demand.

At the same time, the volume of demand depends on the prices of the current period, while the volume of supply depends on the price level of previous periods in each segment of the tourism services market. That is, the supply changes with a lag (delay). In the general case, the delay in the change of supply is not a constant value. It can be different in different periods since the time of goods delivery to the market depends on various factors.

Thus, the research is relevant to the current conditions of growing competition and instability in the tourism market. The use of discrete equilibrium models will allow enterprises to optimize marketing strategies, increase competitiveness, better manage risks, and develop personalized services. This will contribute to the more efficient use of resources, increase business profitability, and improve customer satisfaction, which makes the research on this topic important for both practice and research in the field of tourism.

The purpose of this paper is to model the behavior of the tourism market in the plane “supply – price – demand” variables, taking into account the interests of different consumer groups in the context of a supply random lag.

To achieve this goal, the authors (1) consider the behavior of supply and demand dependencies in the tourism market on prices in the context of a random supply lag and (2) model the behavior of the tourism market, taking into account the interests of different consumer groups, primarily in terms of pricing.

These goals create a foundation for a deep understanding and analysis of market processes in the tourism industry and can serve as a basis for elaborating management strategies and business development in this sector.

The authors use a market dynamic model in the plane of variables “supply – price – demand” to

model the behavior of the tourism market under the conditions of random supply lag distributed according to normal and uniform distribution laws. The delay between changes in the volume of demand and supply is taken into account using a cobweb model. As a result of the research, the authors develop a mathematical model that will more accurately reflect the interaction between supply, demand, and price in the tourism market, taking into account the interests of different consumer groups. The scientific novelty of the research lies in the analysis of the dynamics of the tourism market behavior, taking into consideration the time delay between price changes and the response of supply and demand volumes, taking into account different segments in the tourism market, each of which has its interests and characteristics.

This article is divided into six sections. The introduction is followed by a literature review with gap identification and methodology. The fourth section presents the results of the research. After the fifth part with a detailed discussion of the results, the last section presents the conclusions and its limitations and research implications.

2. LITERATURE REVIEW

Research is important for understanding the dynamics and relationships between suppliers and consumers in the tourism market. A lot of research focuses on the study of consumer behavior in the context of the tourism market. They use a variety of models, such as the model of potential and actual value, expectancy theory, and the model of innovation acceptance to understand what factors influence consumers' decisions in choosing tourism services and how they respond to changes in supply.

Changes in supply, price, and demand affect each other in the market through the law of supply and demand, where an increase in price leads to a decrease in demand and an increase in supply, and vice versa. The model of aggregate demand and aggregate supply is used in macroeconomics to depict how the quantity of total output and the level of aggregate price can be determined in equilibrium (Helmold, 2022).

The price is identified in the scientific literature as an important factor affecting tourist arrivals in both the long and short term (Vatsa & Balli, 2023; Imamboccus et al., 2024; Nguyen, 2021). Scientific research focuses on the asymmetric impact of price factors on tourism demand. In particular, it is shown in the study by Sharma (2021), who analyzed the asymmetric impact of economic uncertainty on tourism demand. In his research, Sharma (2021) showed that an increase in uncertainty causes more negative effects than positive ones that arise from a decrease in uncertainty. Chi (2022) substantiated the potential asymmetric impact of tourism prices on the outbound travel demand from the United States for Canada, Mexico, the United Kingdom, France, and Italy using a distributed lag model. The researcher showed that American tourists tend to react strongly to price increases, but remain insensitive to price decreases in the long run. And in the short term, as a rule, tourism demand is more responsive to price cuts than to price increases. The scientists Smeral and Song (2015) confirmed the hypothesis that the response of tourism demand to price changes is asymmetric in different phases of the business cycle having analyzed the demand for international tourism in five source markets using the modified growth rate (MGR) model. As for long-distance travel, tourism demand may be insensitive to price changes in the short run, but sensitive to income in the long run (Vatsa & Balli, 2023).

The price also plays an important role in shaping the tourism offer. The price is one of the key factors, which determines the competitiveness of a tourism product in the market. Different price categories attract customers with different income levels and requirements. For example, high prices can be targeted at customers who value luxury and comfort, while more affordable offers will attract budget travelers. Business travelers tend to spend more than leisure travel-

ers, emphasizing the importance of understanding the factors that influence business travelers' spending (Kumar et al., 2018). The pricing of tourism services is influenced by factors such as corporate objectives, marketing goals, and the level of organizational costs (Camilleri, 2018; Wołowiec et al., 2022). Also, the pricing of tourism services and market competition are affected by the high level of shadow economy. Businesses operating in the shadow sector can offer similar tourism services for lower prices because they avoid paying taxes and do not incur other legal costs. This can drive down prices in the market and force legitimate businesses to lower their prices to compete (Kalaitan et al., 2023). Understanding tourist spending patterns and their underlying determinants is crucial to give practitioners the right guidance to develop effective marketing strategies, as well as for researchers to determine how to structure a spending pattern. The results of the research by Correia, Kozak, and Gonçalves (2018) confirmed that the amount spent by tourists depends on many factors on both the demand and supply sides. Accommodation costs affect the pricing of tourism supply by influencing the total costs of tourism enterprises. High accommodation costs, caused by, for example, high prices for real estate, utilities, or transportation, may force hotels, guest houses, and other accommodation units to raise prices to compensate for these costs. This can lead to an increase in the total cost of travel for tourists, which can affect the competitiveness of a tourist destination and consumer choice (Novakivskyi et al., 2022). Changes in prices for tourism products under the influence of seasonality are quite common in the tourism industry. Many tour operators and hotels adapt their prices to meet changes in demand in different seasons. For example, during the peak season, prices may increase, and during the low season, prices may decrease (Lozano et al., 2021; Duro & Turrión-Prats et al., 2022).

According to the results of the scientific study, the lagged change in tourism supply is caused by various factors and strategies that take into account changes in demand, competition, and other market conditions over time. A lag in tourism supply can have a significant impact on the tourism industry. The research shows that factors such as income, relative price, tourism infrastructure, and exchange rates affect tourist arrivals in both the long and short term (Imamboccus et al., 2024; Nguyen, 2021). Fluctuations in these factors can lead to changes in tourism supply, affecting the overall performance of the tourism industry.

The tourism industry can adapt to changes in the supply of tourists by focusing on strengthening competitiveness through marketing and advertising efforts, attracting more visitors, and increasing investment in tourism (Saleh et al., 2023; Seetanah & Sannassee, 2015). In addition, policymakers should continue to develop and implement measures to attract as many tourists as possible while promoting investment in the tourism industry (Fuinhas et al., 2020). Changes in the tastes and preferences of tourists or changes in the popularity of certain mass vacation destinations require changes in the tourism offer to meet new trends.

In general, research in this area helps to reveal the complex relationships between suppliers and consumers in the tourism market in an unpredictable and dynamic environment. They also contribute to the development of risk management strategies and optimization of business processes in the tourism industry. Based on the results of the scientific literature research, it can be concluded that modeling the tourism market behavior under the conditions of a supply random lag includes taking into account asymmetric responses to price changes, the impact of investment on tourism infrastructure, economic uncertainty, and the relationship between tourism and price factors. The impact of price on tourism supply and demand is a delicate area where various factors operate and market dynamics are shaped. While some markets may be price sensitive, others are not, and modeling tourism supply and demand requires further research to understand the complex interplay of factors and their impact on tourism supply and demand, especially in terms of pricing. This research aims to fill the lack of scientific information on

the analysis of the dynamics of tourism market behavior, especially given the time lag between price changes and the response of supply and demand volumes.

Segmentation of the tourism market plays an important role in taking demand into account while pricing, as it allows travel companies to more accurately determine which consumer groups are willing to pay for their products and services and what factors influence their pricing decisions. Market segmentation has become a very popular marketing strategy for destinations and travel companies (Dolnicar, 2013). Given that price is one of the determining factors in the choice of a tourist, the researchers (Masiero & Nicolau, 2012) identified tourist segments depending on individual price sensitivity to the activity. The research has identified four segments with significant differences in price sensitivity. Tourism market segmentation based on the data of Mexico City, Lima, Buenos Aires, and Bogota, provided by scientists in the source (Carvache-Franco et al., 2023), showed three segments: the first cluster united tourists interested in accommodation and restaurant services; the second included visitors who searched for many attractions, who were most willing to recommend destinations; the third consisted of passive tourists not involved in the sights of these cities.

Typically, the market is divided into premium, mid-market, and economy segments depending on the willingness of consumers to pay for goods or services (Market channels and segments, 2021; How Market Segments, 2024; Lynn, 2007). By studying spending patterns in different segments, researchers determine the characteristics of those visitors (i.e., demand) who have a relatively high level of spending. Studies typically analyze the demographic and psychographic characteristics of those who spend high, medium, and low amounts on a destination or tourist attraction (Petrick, 2005; Craggs & Schofield, 2009; Pratt, 2012). In the research (Valdezetal et al., 2008), the scholars identified the following segments of the San Martin de los Andes in the south of Argentina tourism market, which take into account daily tourist expenditures as a dependent variable, as: “High-income small families”, “Mid-income families”, and “Low-income families”. At the same time, unlike other scientific studies, the authors propose to take into account different segments in the tourism market (low, medium, and VIP-segment), each of which has its own interests and characteristics.

3. METHODOLOGY

The modeling of the development of the multi-segment tourism market is carried out using a dynamic pricing model in the plane “supply – price – demand” variables. This model takes into account the heterogeneity of interests of consumers of tourism products in terms of price indicators. In this case, this market is divided into a set of homogeneous groups of consumers of tourist groups according to their preferences.

The study of the tourism market is proposed to be carried out in three stages:

1. Initial assessment of tourism segments, as well as the determination of their basic parameters based on the analysis of statistical data. When modeling behavior in each segment of the tourism market, it is possible to apply a normal or uniform law of distribution of tourist preferences (Iyer & Thomas, 2020; Ye et al., 2023). Piecewise linear functions are used to represent dependencies between price, demand, and supply.

Piecewise linear functions are mathematical functions that consist of several linear segments, each of which is defined on a certain interval of argument values. These functions are often used to approximate complex relationships between variables such as price, supply and demand in a market (Brijs et al., 2016). In this research, to represent the relationship between price, demand and supply. Piecewise linear functions allow modeling complex relationships between price, supply and demand while ensuring sufficient accuracy in approximating real market conditions.

Since real market processes can be quite complex and heterogeneous, the use of piecewise linear functions allows for avoiding over-simplification or over-complexity in modeling.

2. Building an equilibrium model of the development of a multi-segmented tourism market. To achieve market equilibrium, it is necessary to study the possible dynamics of development. The use of a Cobweb model will allow for determining the level of stability of tourist behavior and assessing the possibility of consumer migration from one segment to another (Chen, 2023; Fadily & Kaddar, 2023).

Since the market of tourism services consists of different segments, each of which has its own interests and characteristics, the article differentiates supply and demand for different segments (low, medium, and VIP-segment):

- The low segment usually consists of budget tourists who are looking for low-cost vacation and tourism services. They may be more price-sensitive and look for cost-effective offers.
- The medium segment covers a wider range of tourists who may have an average income and more diverse leisure and entertainment needs. They may be willing to pay a little more for comfort and the quality of service.
- The VIP-segment includes highly affluent and demanding customers who expect a higher level of service, luxury, and exclusivity. They are willing to pay large sums for premium services and experiences.

Differentiating supply and demand for different segments allows for tailoring offers to the specific needs and requirements of each segment, which contributes to increased customer satisfaction and the effectiveness of market strategies (Zhang & Bell, 2007). The random lag conditions add an element of unpredictability to this, allowing for a variety of scenarios within each segment, reflecting the reality of the tourism market where the supply of services can be affected by various factors such as weather conditions, political stability, economic situation, etc.

The idea of a random lag is that supply volumes depend on the prices of previous periods, and these prices can be random variables with appropriate distributions (normal or uniform) (Li et al., 2021).

3. Analysis of the results. After modeling the market according to these principles, the results are analyzed. The article investigates how average prices, supply and demand volumes change depending on the model parameters, including random distributions.

4. RESULTS

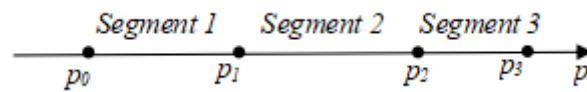
4.1. FORMALIZATION OF THE PROBLEM STATEMENT

Since the market of tourism services consists of different segments, each of which reflects its own interests and price characteristics, it is advisable to take into account the characteristics of supply and demand for different segments. These variables interact in the model, determining the market equilibrium when the quantity of the supply of tourism services corresponds to the quantity of demand at a price that ensures a balance between consumers and producers. Such models allow an understanding of how changes in one variable (e.g., price) affect the others (e.g., quantity demanded or supplied), which helps to make decisions on pricing, production, and consumption.

The range of tourism products is quite wide, each of which is focused on both consumer's certain interests and specific financial costs. Therefore, within the limits of permissible assumptions, the tourism services market can be divided into separate price segments (for example, low, medium, and VIP-segment). It should be noted that the restriction on the number of seg-

ments is not significant, i.e., they can be increased. In practice, the scale of prices for tourism products is divided into three intervals – $[p_0; p_1]$, $[p_1; p_2]$, $[p_2; p_3]$ (Fig. 1).

Figure 1. Scale of price segments of tourism products



Source: Built by the authors

These market segments are in constant interconnection, and potential consumers of tourism products can migrate from one segment to another.

To test this method of researching the development of a multi-segment tourism market, outbound tourism in Ukraine in 2021 was chosen. The results of the research reflect the situation in the Ukrainian tourism market at the pre-war level in 2021. Due to the fact that the war in Ukraine began in 2022 and led to restrictions on free travel abroad, the data of this research reflect the previous state of affairs in the market before these circumstances.

The data were collected through a survey of the employees of travel organizations in Ukraine. The sample size for the research was 38 travel organizations in Ukraine. This number was chosen taking into account the size of the tourism market and its representation in different regions of the country. As for the type of tourism, outbound tourism in Ukraine in 2021 was chosen as the object of research. Outbound tourism includes travel by individuals outside the country for recreation, entertainment, cultural education, or other purposes not related to their permanent place of residence.

The division into segments of the tourism market is usually based on the level of expenditures or income used by tourists. In this case, based on the results of the research of the employees of Ukrainian travel companies, the authors made a division based on the expenditures of a family while traveling abroad. In this case, a family is equated to a tourist unit – a Consumer, which includes either a married couple (a husband and wife) or a married couple with children. Couples have different levels of income and financial capacity to spend on travel. Therefore, they can choose different segments of the tourism market according to their financial capabilities and preferences. It is taken into account that family travel requires more expenses compared to travel by a single tourist. Families may have specific needs that require attention when planning a trip, such as services for children, family rooms in hotels, security, etc. These needs affect the cost of specific types of travel and services.

Long-term vacations were studied – as a rule these are the most popular family trips lasting 7-15 days. According to the purpose of the trip, couples preferred a variety of travel types, but most of all resort vacations, outdoor activities, cultural travel, and family cruises.

Based on the answers received, three segments are identified:

- low segment – from \$2000 to \$4000 for a family vacation package;
- medium – from \$4000 to \$12000 for a family vacation package;
- VIP-segment from \$12,000 to \$20,000 for a family vacation package.

Based on the survey, the size of each of the segments of the tourism market is estimated.

4. 2. DETERMINATION OF BASIC INDICATORS FOR EACH SEGMENT

In general, it can be assumed that the distribution of consumers by price preferences in each tourist segment follows a normal distribution law (Moore & Weatherford, 2001):

$$Q_i(p) = \frac{1}{\sqrt{2\pi}\sigma_i} e^{-\frac{(p-\bar{p}_i)^2}{2\sigma_i^2}} \quad (1)$$

where $Q_i(p)$ is the distribution function of purchased tourism products in the i -segment of the tourism product market;

$\bar{p}_i$ is the average price of the purchased tourism product in the i -segment of the tourism product market;

σ_i^2 is the variance of prices of purchased tourism products in the i -segment of the tourism product market.

Note that the following equality holds for the distribution function (Moore & Weatherford, 2001):

$$\int_{-\infty}^{\infty} Q_i(p) dp = 1 \quad (2)$$

The unknown parameters $\bar{p}_i$, σ_i^2 are determined based on the statistical analysis of the sample in each segment. The consolidated distribution function for the three segments of the tourism market can be represented as follows:

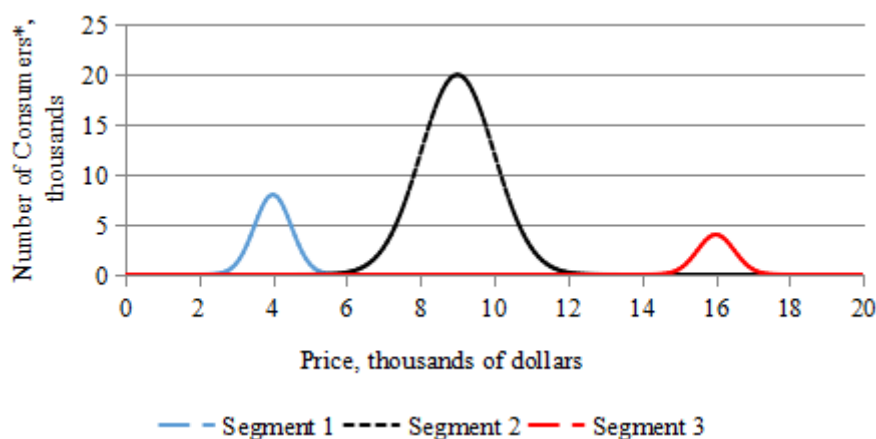
$$Q_{\Sigma}(p) = \sum_{i=1}^3 \lambda_i \cdot Q_i(p) \quad (3)$$

where $Q_{\Sigma}(p)$ is the consolidated distribution function;

λ_i is the size of the i -market segment.

In an economic-mathematical model, this can be represented as a set of functions for the distribution of tourism products in segments. The example of a consolidated distribution function is given in Fig. 2.

Figure 2. Graphical representation of a set of functions for the distribution of tourists by segments



* Consumer – in our case it is a married couple with or without children

Source: Built by the authors

As can be seen from Fig. 2, the segments of tourism products practically do not overlap, which can be explained by the clear differentiation of tourist groups by target interests and their financial capabilities.

However, such ideal conditions are rarely observed in reality. A clear delineation of potential tourists’ interests is rarely an expected scenario in the real market. The market of tourism products is in constant dynamics and there is a flow from one segment to another.

4. 3. BUILDING AN EQUILIBRIUM MODEL OF THE DEVELOPMENT OF A MULTI-SEGMENTED TOURISM MARKET

In each segment of tourism products, the market is in constant dynamics under the influence of socio-economic, political, and other factors. In each segment, it can self-regulate, that is, achieve equilibrium with the help of its internal forces.

The idea of Walras’s supply and demand functions can be used to analyze the interaction between supply and demand in the tourism market, in particular in the context of a general equilibrium model. In general, Walras’s supply and demand functions help analyze how supply and demand interact in the tourism market, based on the equilibrium between them at different prices (Bénassy, 2011; Misaki, 2023; Potier, 2023).

To model the supply and demand functions, a piecewise linear function is used to represent dependencies between price, demand and supply.

The dependence of the demand volume on the price in the conditions of a multi-segment tourism market can be represented in the form of a piecewise linear function (D , Demand) (Bénassy, 2011; Busetto et al., 2008). The authors will conduct modeling with the division of the market of tourism products into three segments: low, medium, and VIP-segment. In this case, the authors will write the demand function as follows:

$$D(p, p_0, p_1, p_2, p_3, d_{10}, d_{20}, d_{30}, d_{11}, d_{21}, d_{31}) = \begin{cases} D_1(p) = d_{10} + d_{11} \cdot p, & p \in [p_0; p_1] \\ D_2(p) = d_{20} + d_{21} \cdot p, & p \in [p_1; p_2] \\ D_3(p) = d_{30} + d_{31} \cdot p, & p \in [p_2; p_3] \end{cases} \quad (4)$$

where $D(p)$ is a complex demand function in the market of tourism products;

$D_i(p)$ is the demand function for the i -segment of the market of tourism products;

d_{i0}, d_{i1} are the parameters of the linear demand function in the i -segment of the market of tourism products;

p_0, p_1, p_2, p_3 are the limit points (prices) of the boundaries of the market segments of tourism products;

p is the price of the tourism product.

The piecewise linear demand function reflects how the volume of demand changes depending on the price level if the market is divided into different segments with different characteristics and needs. Each segment may have its demand function that reflects its uniqueness.

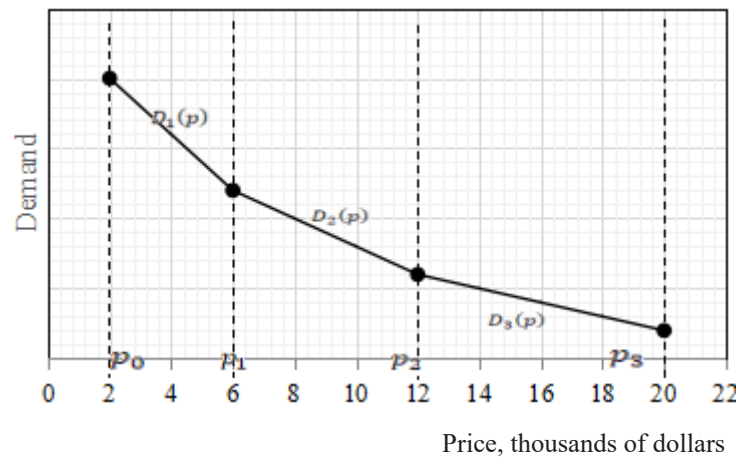
It is important to note that the piecewise linear demand function can reflect different behavioral scenarios of consumers in different market segments. For example, some consumers may be attracted by a low price and their demand may be more sensitive to price changes. In other segments, consumers may be willing to pay a higher price for higher-quality services or unique features (Androniceanu et al., 2022; Cherniaeva et al., 2023).

The usage of piecewise linear demand functions allows businesses to better adapt their pricing and marketing strategies to different market segments, meet their needs, and maximize profits (Blahun et al., 2017).

The unknown parameters of the linear demand function in the i -segment of the tourism product market are determined by applying the method of correlation-regression analysis concerning statistical data by region.

A graphic representation of the piecewise linear demand function in the market of tourism products, divided into three segments, is presented in Fig. 3.

Figure 3. Graphic representation of the piecewise linear demand function in the market of tourism products



Source: Built by the authors

In each of the segments of the tourism market, you can determine the equilibrium point by comparing the functions of supply and demand.

The demand determines the supply of the tourism product. In this case, the supply function (S , Supply) can be presented in a similar form:

$$S(p, p_0, p_1, p_2, p_3, s_{10}, s_{20}, s_{30}, s_{11}, s_{21}, s_{31}) = \begin{cases} S_1(p) = s_{10} + s_{11} \cdot p, & p \in [p_0; p_1] \\ S_2(p) = s_{20} + s_{21} \cdot p, & p \in [p_1; p_2] \\ S_3(p) = s_{30} + s_{31} \cdot p, & p \in [p_2; p_3] \end{cases} \quad (5)$$

where $S(p)$ is a complex supply function in the market of tourism products;

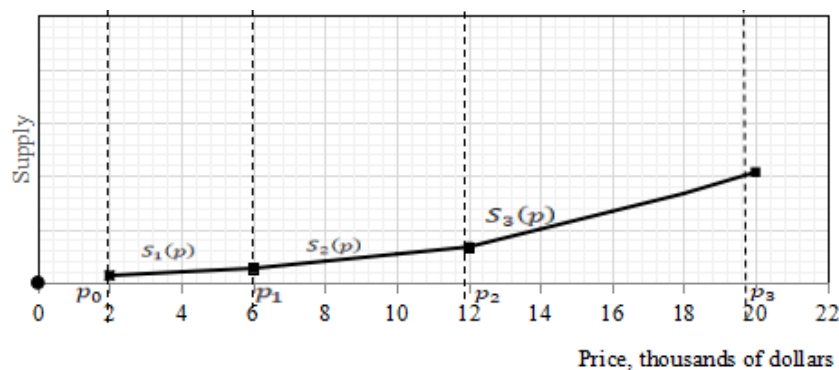
$S_i(p)$ is the supply function in the i -segment of the market of tourism products;

s_{i0}, s_{i1} are the parameters of the linear supply function in the i -segment of the market of tourism products.

The unknown parameters of the linear supply function in the i -segment of the tourism product market are also determined by applying the method of correlation-regression analysis concerning statistical data by region.

A graphic representation of the piecewise linear supply functions in the market of tourism products with a division into three segments is presented in Fig. 4.

Figure 4. Graphic representation of the piecewise linear supply function in the market of tourism products



Source: Built by the authors

These piecewise linear functions reflect the dependence of demand and supply volumes on the prices of tourism products. That is, they show the behavior of tourists depending on the prices of tourism products.

The discrete equilibrium model used is based on the variables “supply – price – demand”.

To study and analyze the dynamics in the market of tourism products, especially taking into account the time lag between price changes and the response of supply and demand, a Cobweb model was chosen.

Walras’s supply and demand functions are conceptual tools in economic theory used to analyze the interaction between supply and demand in a market, particularly in the context of a general equilibrium model. These concepts were developed by the French economist Leon Walras. This function reflects the dependence of the demand volume on the prices of goods or services. That is, it shows how many goods or services consumers will buy at different price levels. Walras’s supply function reflects the dependence of the supply volume on the prices of goods or services (Bénassy, 2011; Busetto et al., 2008; Misaki, 2023; Potier, 2023). In other words, it shows how many goods or services producers will be willing to sell at different price levels.

In economic models of general equilibrium, Walras’s supply and demand functions are used to find price levels at which the number of goods that buyers are willing to buy equals the number of goods that producers are willing to sell. This point is called the market equilibrium.

In general, Walras’s supply and demand functions help analyze how supply and demand interact in the market based on the equilibrium between them at different prices.

For this case, Walras’s supply and demand functions take the form (Bénassy, 2011):

$$\begin{cases} D(t) = D(p(t)) \\ S(t) = S(p(t - \tau)) \end{cases} \quad (6)$$

where $p(t)$ is the market price of the product in a certain period $t = 1, \dots, T$, and $p(t - \tau)$ is the market price of the previous period.

For linear supply and demand functions (Bénassy, 2011):

$$\begin{cases} D_i(t) = d_{i0} + d_{i1} \times p(t); \\ S_i(t) = s_{i0} + s_{i1} \times p(t - \tau); \end{cases} \quad i = 1, 2, 3 \quad (7)$$

In general equilibrium economic models, Walras’s supply and demand functions are used to find the price levels at which the quantity of goods that buyers are willing to buy equals the quantity of goods that producers are willing to sell. This point is called the market equilibrium.

In a stable market, each segment is in equilibrium. The distribution of tourists is carried out relative to a certain equilibrium point in each segment. These processes can be seen in the Cobweb model (Chen, 2023; Fadily & Kaddar, 2023). In reality, supply volumes react to price changes with a certain delay. Demand volumes $D(t)$ depend on the price level of the current period t , while supply volumes $S(t)$ depend on the price level of the previous period $t - \tau$, where τ is a time lag. This is because it takes some time to bring additional tourism products to the market (Qin et al., 2023). Taking into account a time lag in the Cobweb model allows us to better reproduce the real dynamics of the tourism market and develop more accurate management strategies in this market.

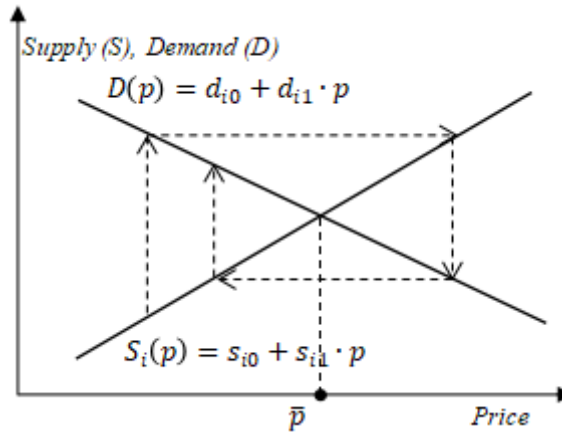
To analyze the behavior of tourists, the analysis can be carried out by predicting the persistence of behavior based on the Cobweb model. The example of sustainable behavior is shown in Fig. 5.

This example confirms the stability of tourists’ preferences for a particular segment. Note that supply volumes depend on the prices of previous periods. However, in practice, these prices are

usually subject to random disturbances that can be simulated by random variables with appropriate distributions (normal or uniform) (Fig. 6).

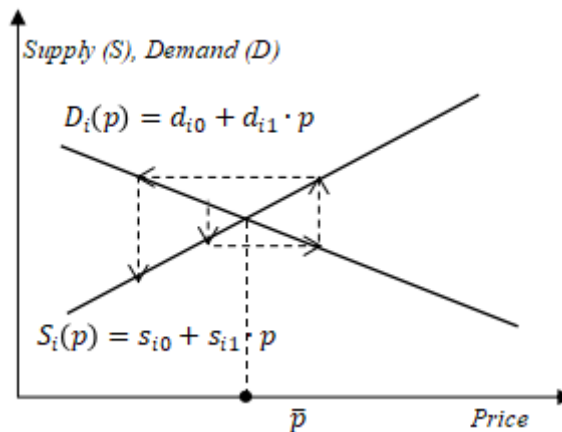
This example shows the unstable behavior of tourists in this segment. This means unstable consumer behavior and possible transitions to neighboring segments. The latter is often related to their socioeconomic status.

Figure 5. The example of a stable equilibrium point in the *i*-segment of the tourism market at time *t*



Source: Built by the authors

Figure 6. The example of an unstable equilibrium point in the *i*-segment of the tourism market at time *t*



Source: Built by the authors

In the discrete version, according to the well-known Walras's approach (Bénassy, 2011) describing the dynamics of the market price in the *i*-segment of the tourism product market; it is represented by the differential equation

$$p_k - \bar{p} = \theta(p_{k-1} - \bar{p}) \quad (8)$$

where $p_k = p(t_k)$, $t_k = t_k + k \cdot \tau$ is discrete time, $k = 1, 2, 3, \dots$ is discrete time index.

$$\theta = \frac{(1 - \tau d_{i1} \cdot s_{i1})}{(1 + \tau d_{i1} \cdot s_{i1})} \quad (9)$$

When $\theta < 1$ (the point $\bar{p}$ is a stable focus), the market price p_k will approach the equilibrium $\bar{p}$ at $k \rightarrow \infty$, if θ , and, conversely, it will increasingly move away from the equilibrium level if $\theta > 1$ (the point is an unstable focus). Finally, at $\theta = 1$, the initial deviation of the market price from the equilibrium level will be constantly reproduced (the point $\bar{p}$ is a center).

It can be concluded that the θ value characterizes the stability of tourist behavior in each segment. It was shown that the function of the normal distribution should be associated with the θ value, which affects the value of the variance. We got that:

$$Q_i(p) = \frac{1}{\sigma(\theta)\sqrt{2\pi}} e^{-\frac{(p-p_i)^2}{2\sigma(\theta)^2}} \quad (10)$$

It can be stated that the larger the value of $\sigma(\theta)$ the wider the distribution function is represented. Based on the empirical data, it was

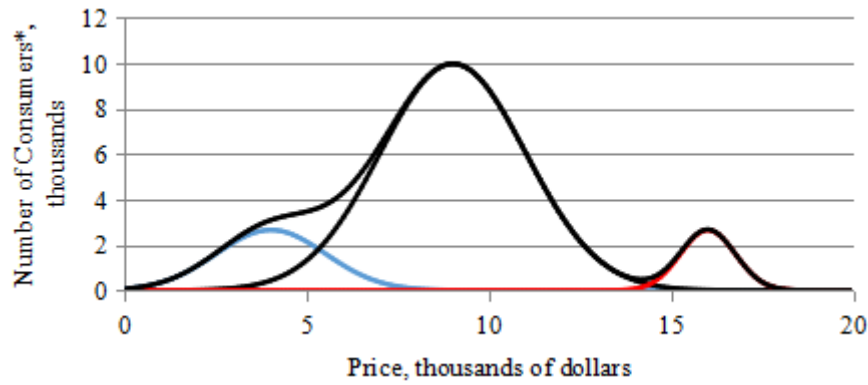
$$\sigma(\theta_i) = \begin{cases} 1, & \theta_i \leq 1; \\ \sigma_{0i} \cdot \alpha \theta_i, & \theta_i > 1 \end{cases} \quad (11)$$

where α is a correction factor calculated based on empirical data.

4. 4. MODELING THE BEHAVIOR OF THE UKRAINIAN TOURISM MARKET ON THE EXAMPLE OF FAMILY TOURS IN THE CONTEXT OF A RANDOM SUPPLY LAG

Based on the received empirical data, depending on the analysis of the Cobweb model for each segment, the results are obtained, the graphic representation of which is presented in Fig. 7.

Figure 7. Graphic representation of the set of functions for the distribution of tourists in segments, taking into account the time delay



* Consumer – in our case it is a married couple with or without children

Source: Built by the authors

As can be seen from Fig. 7, a part of tourists have started to focus on minimum prices. The tourists of the second tourist segment increasingly migrate to neighboring segments. If tourists of one segment focus on minimum prices, this may indicate the high sensitivity of this segment to price changes. This means that even small price changes can significantly affect their decision to buy or not to buy a tourism product.

At the same time, if tourists from the second segment migrate to neighboring segments, this may indicate a change in their preferences, needs, or other factors that convince them to choose other types of tourism products. This may be due to a change in quality, the provision of additional services, pricing policy, or other factors that make other segments more attractive to this segment of tourists (Ilychok et al., 2023; Shpak et al., 2022).

More information and analysis are needed to better understand what is happening in the tourism product market. However, the described situations indicate important changes in the behavior of different segments of tourists and may affect the strategies of travel companies and urban communities in this market environment.

5. DISCUSSION

Changes in supply, price, and demand affect each other through the law of supply and demand, and the model of aggregate demand and aggregate supply is used in macroeconomics to depict

their interaction. Mathematical models, such as demand functions and multivariate additive and nonlinear models are used to analyze their interaction in economic theory. Understanding these variables has practical implications for companies and policymakers, including informing pricing strategies and policy analysis. The practical implications of understanding the variables of supply, price, and demand include the ability of companies and policymakers to make informed decisions on pricing strategies. The price, as a key variable in the marketing mix, is determined by external constraints, internal strategic goals, and market responses, which often requires adjustments based on the company's strategy (Malaval et al., 2014). In addition, the knowledge of demand functions and their parameters is important for policy analysis, as it allows analysts to predict the likely effects of government intervention aimed at influencing markets through programs that include subsidies, price caps, or targeted assistance (Pyles, 2019).

A unique equilibrium in the market exists if and only if some consumers consider equally two prices. Equilibrium exists in symmetric mixed strategies. When no consumer considers equally two prices, there are, in addition, an infinite number of asymmetric equilibriums (Chen et al., 2022). In the price competition model, the shift from simultaneous to sequential pricing dramatically changes equilibrium strategies, leading to both symmetric and asymmetric equilibriums (Heggedal et al., 2023). The asymmetric impact of price factors on tourism demand indicates that price changes can have different effects on different segments of the tourism market. This may be due to different income levels, preferences, travel goals, and other characteristics of different groups of tourists. To study this phenomenon, the segmentation of the tourism market is important for two main reasons:

- Diversity of consumer characteristics – different segments of the tourism market may have different preferences, travel styles, budgetary constraints, and other characteristics. Thus, the reaction to price changes may be different for each segment. For example, for low-budget tourists, a price discount may be a key factor in choosing a trip, while for a higher-end segment, it may have less of an impact on their decision.
- Focus on marketing and strategic planning – a clear understanding of segments allows travel companies to effectively tailor their marketing strategies and pricing policies for each segment. Knowing how each segment responds to price changes allows businesses to optimize their pricing strategies, maximizing profits and meeting customer needs.

In today's world, the tourism market is becoming increasingly complex and dynamic, as consumers have different needs, preferences, and budgetary capabilities. One of the key aspects of managing this market is to understand and take into account different interest segments. Market segmentation is widely used in the tourism industry to focus on specific subgroups of consumers. This allows businesses to develop competitive advantages by serving clearly defined consumer groups (Dolnicar, 2022). Data-driven market segmentation is widely used in tourism research to gain market insights. However, it is important to note that most algorithms used in data-driven market segmentation are exploratory and may not always produce consistent results (Hajibaba et al., 2020).

This paper discusses an approach that takes into account segmented interests and the conditions of a delivery random lag, which aims to achieve more efficient management of the tourism market. First of all, it is important to note that the tourism market consists of different consumer segments, each of which has its own unique needs and requirements. For example, low-budget tourists are looking for economical travel options, the middle class that can afford mid-priced offers, and the VIP-segment that expects a high level of service and exclusivity.

Researchers have attempted to study customer segments in the hospitality industry using a two-stage cluster analysis to identify market segments and optimize prices based on the price

elasticity of demand (Chalupa & Petricek, 2024). For tourist destinations, cost-based market segmentation was conducted to maximize profits from smaller tourist destinations (Vinniciombe & Sou, 2014). In this regard, differentiating supply and demand for different segments is an important strategic approach to better meet the needs of different customer groups. For example, companies can develop special travel packages aimed at each of the segments, taking into account their requirements in terms of price, the quality of services, and individual preferences. The approach described in this article also takes into account the conditions of a supply random lag, which is a realistic condition in the modern tourism market. Random changes in conditions, such as weather conditions, political instability, or other unpredictable factors, can affect the supply of services at any given time. Scientific research confirms the need to take into account various factors that affect a supply lag, which can cause unpredictability and asymmetry in responses to tourism demand, such as economic uncertainty (Sharma, 2021), geopolitical risk (Shi & Li, 2017), and exchange rate volatility (Parvin, 2022; Sharma & Pal, 2020; Civelek et al., 2019). In addition, investment and innovation in tourism infrastructure (Nguyen, 2021; Pavlov et al., 2023), and marketing efforts (Seetanah & Sannassee, 2015) stand out as important elements for attracting tourists, suggesting that a supply lag may affect the efficiency of these strategies in stimulating demand. Therefore, it is important to develop risk management strategies and flexible adaptation mechanisms that allow companies to respond quickly to such changes and provide reliable customer service in any environment.

In the world of tourism, it is important to understand the diversity of consumer segments and their individual preferences and needs. The trend presented by the research has shown that there are two important dynamics in the tourism market: the growing sensitivity of one segment to prices and the reorientation of the other segment to other types of products.

The first phenomenon indicates the high sensitivity of certain groups of tourists to price changes. In particular, tourists from this segment actively respond to price reductions, which can provoke them to buy. Thus, the Spanish scientists Rondan-Cataluña and Rosa-Díaz (2014), answering the question “Are the variables of pricing and value for money a good basis for segmentation to cluster hotel customers?” concluded that it is necessary to take into account the price perceptions of customers and that pricing decisions should be made by properly informing about changes in prices and the reasons behind them. The researchers confirmed the results of the research by analyzing two segments of hotel customers: “price-elastic” and “price-rigid”. Another group of scientists Masiero and Nicolau (2012) confirmed that price is a persuasive factor in the choice of activity (tourism activity behaves like a regular product), but with a differentiated effect (since this persuasiveness is not common to all individuals). It is this heterogeneous sensitivity to price that supports the use of price sensitivity as a segmentation criterion. Such results allow us to understand which of the segments has a high potential for attracting new customers through offers with reduced prices or attractive offers.

The confirmation of the existence of one segment’s sensitivity to prices compared to others is provided by Kah, Lee, and Kim (2022), who argue that there is a clear difference in the use of information by travelers as a result of this variable. According to the researchers, marketers should use different communication strategies for travelers with different price sensitivities. For example, to attract price-sensitive travelers, the researchers suggest providing travel information more effectively with a clear price difference between products and services, which will reduce their search efforts. The researchers Boto-García and Baños Pino (2024), analyzing the elasticity of foreign tourists’ spending and prices, found changes during the pandemic and emphasize the need for companies to take into account heterogeneous price sensitivity depending on the country of origin when developing pricing strategies.

The second phenomenon, related to the migration of tourists from one segment to another,

indicates instability in demand for specific types of tourism products. This can be caused by a variety of factors, such as changes in the quality of services, the differentiation of offers, changes in pricing policy, etc. The process of globalization creates a territory of flows through human mobility phenomena such as tourism and migration, which reflects unequal socio-economic conditions (Argiroet al., 2022; Kobis & Karyy, 2021). A significant number of scientific studies confirm the fact that price changes can affect the migration of tourists from one segment to another, as price sensitivity affects tourism demand (Nguyen et al., 2023; Vatsa & Balli, 2023). In addition, segmentation criteria and pricing strategies play a crucial role in understanding the differences in spending among tourists, which can potentially lead to migration between segments (Alfarhan et al., 2023). Understanding these dynamics allows tourism service providers to adapt their offers to retain and attract new customers.

Overall, the results emphasize the importance of analyzing market trends and understanding the needs of different consumer segments for effective management in the tourism market. Responding appropriately to changes in demand and adapting offers can help increase competitiveness and success in the tourism market.

6. CONCLUSION

Modeling the behavior of the tourism market under conditions of random supply delays, distributed according to normal and uniform distribution laws, helps to understand market dynamics and inform management strategies.

A dynamic market model taking into account the variables “supply – price – demand” was used in the work where the market is divided into three segments: low, medium, and VIP-segment. The value of prices and their changes affect the distribution of tourists between segments, indicating the sensitivity of consumers to prices for different types of tourism products. The Cobweb model made it possible to better match the real dynamics of the market and take into account a time lag between changes in the volumes of demand and supply. This delay may be due to the time required to bring new tourism products to the market.

The analysis of the modeling results showed that different segments of tourists react differently to changes in prices and market conditions. Some segments are more sensitive to price changes, responding strongly even to small adjustments. Additionally, tourists may move between segments due to changes in their preferences, needs, or other factors.

Therefore, this work highlights the importance of considering consumer dynamics and diversity when creating management strategies for the tourism market. The model presented in this paper can help predict changes and adapt strategies to achieve better results in the tourism industry.

The limitations of this research are as follows: (1) to create a mathematical model some assumptions were simplified, (2) all possible factors affecting tourists' behavior and market dynamics are not taken into account, (3) the assumption of a clear differentiation of tourist groups in three different segments may not always reflect the real diversity and change of consumer preferences.

The practical significance of this research is that it provides tools and approaches for better understanding and management of the urban tourism market under changing conditions and dynamics. This research not only reveals the fundamental aspects of tourism market behavior but also provides practical tools and guidelines for effective segmentation of the tourism market, which can contribute to increasing the profitability of travel companies.

In the future, it is advisable to conduct a detailed analysis for a better understanding of the causes and consequences of market movements. It is recommended to focus on developing flexible strategies that can adapt to changes in the requirements and behavior of different segments of tourists.

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