# A Model for Price Assessment of Residential Property in Bulgaria and its Implementation Options as SaaS

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**Abstract.** The paper presents a possible approach to assessment of residential real estate prices. The situation in small Bulgarian regional towns is discussed. The segment of residential real estate market is often underestimated. A spatial regression model of hedonic pricing is used. The model is based on available through the Internet official information. The approach can be used by small businesses operating in the real estate market – real estate agencies, property/ facility management companies, developers, investors, and more. The results are suitable to the modern SaaS systems.

**Keywords:** Real estate, Residential real estate market, Real estate pricing factors, Hedonic pricing, SaaS

## 1. Introduction

The real estate market is an important and specific part of any large territorial-economic system. Its particularly dynamic sector is the residential property. The basic reason for dynamics is the fact that a large amount of relatively small entities are acting independently to form the final demand and supply. One of the most complex problems in studding residential real estate market is the ability to move from studding preferences of individual customers to aggregate market characteristics. Finding appropriate models that allow the collection, processing, storage, and using of such information in contemporary information systems is an ongoing task of managers and entrepreneurs [1].

The aim of the paper is to propose a hedonistic model for price assessment of residential property in Bulgarian district towns. The price is defined as multiplicative function of three variables - average monthly salary, district population, ratio between engaged and population in the district. Some options for implementation of the price model as a SaaS is analyzed.

The main assumption is that the observed final price reflects the combined effect of all relevant market factors. The input data are provided from official government information sources. As real estate prices are background information for different types of analyses, the results are of interest to a wide range of stakeholders. Among them are buyers, sellers, tenants, landlords, investors, consultants, realtors, developers, property and facility managers, banks, insurance organizations, and others.

## 2. A Hedonistic Model for Price Assessment of Residential Property

Theoretical basis of this study is the concept of hedonistic prices. It is widespread in the field of real estate. According to this view each unit of heterogeneous product (e.g. residential property) can be represented as a set of homogeneous components. These components are associated with different aspects of the consumer value of the product. Moreover, each component has its own implicit price (i.e. not directly represented in the market). The inhomogeneity of the product is interpreted as a consequence of different content of components (in this case – in different real estate objects). The observed market price is formed as a combination of contributions to the price of all hedonic (satisfying consumer preferences) characteristics. In the case the task of hedonic analysis is to build a model of property's price where the value is function of property's features as area of individual rooms, presence of balconies or loggias, near downtown, close environments, etc and the econometric indicators as average monthly salary, district population, ratio between engaged and population in the district, etc.

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In this study a basic hedonistic model of multiplicative type is proposed. It is given as follows [2]:

$$P = P_0 X_1^{\beta_1} ... X_n^{\beta_n} e^{\varepsilon},$$

where $P$ is the price of the residential property; $X_i$ – variable, associated with the $i$-th hedonistic characteristic number; $\beta_i$ – structural coefficients; $e^{\varepsilon}$ – residuals; $\varepsilon$ – error term.

The proposed model has clear economic sense. The formula shows that if all variables are equal to zero, then $X_i$=1 and $P$=$P_0$ (multiplied by residuals). Therefore, the variable $P$ is the price of standard product or service $P_0$ (for which all values of the hedonistic characteristics are equal to 1). The correction factors $\{X_i^{\beta_i}\}$, $i = 1,...,n$ reflect the influence of various hedonistic characteristics on the price of the standard good or service. This means that the implicit prices of hedonic characteristics are expressed as a percentage (more correct as a coefficient) of the referent product's (service's) price.

The selected hedonistic pricing model is nonlinear with respect to structural coefficients $\beta_i$, $i = 1,...,n$.

This complicates the procedure for empirical data based determination. Logarithmic function can be use in order to obtain a linear relationship:

$$\ln P = \ln P_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + .... + \beta_n \ln X_n + \varepsilon.$$

Typically the hedonistic pricing model is represented in the following form:

$$\ln P = \ln P_0 + \beta_1 \ln R_1 + ... + \beta_m \ln R_m + \beta_{m+1} K_{m+1} + .... + \beta_n K_n + \varepsilon,$$

where $R_i$, $i = 1,...,m$ are variables with different values depending on product's (service's) characteristics; $K_j$, $j = m+1,...,n$ are Boolean variables that take value 0 or 1 in the cases of absence or presence of the hedonistic feature number $j$.

In order to determine the structural coefficients $\beta_i$, $i = 1,...,n$, it is necessary to apply the least squares method to hedonistic pricing model. The model obtained is linear with respect to its parameters.

The task is to minimize the square of the random error $\varepsilon^2$. The solution of the problem starts with the conversion of the hedonistic pricing model to a general form of multiple regression model:

$$Y = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + .... + \beta_n Z_n + \varepsilon,$$

where the following substitution are defined: $Y = \ln P$; $\beta_0 = \ln P_0$; $Z_i = \ln X_i$, $i = 1,...,n$.

During the analysis of the multiple regression model by Least Squares Method, it is assumed that for each set of random variables $Z_1, Z_2, ..., Z_n$ the random errors are mutually independent and random variable $\varepsilon$ is normally distributed with mathematical expectation E($\varepsilon$)=0 and variance $\sigma^2$.

Under these assumptions, the mathematical expectation of $Y$ is given by the relationship:

$$E(Y) = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + .... + \beta_n Z_n.$$

The estimates $\hat{\beta}_0$, $\hat{\beta}_1$, ..., $\hat{\beta}_n$ of the coefficients $\beta_i$, $i = 1,...,n$ are determined by Least Squares Method.

For this purpose, it is established n+1 equations system. The equations are solved using a suitable computer program (for example, Excel).

## 3. The Hedonistic Price Model Application to Residential Property in Bulgaria

The proposed hedonistic model is applied to the price assessment of the residential property in Bulgarian district towns. Here, the real estate price is defined as multiplicative function of three variables - average monthly salary, district population, ratio between engaged and population in the district.

In this case, the hedonistic model for price assessment of residential property is given as follows:

$$P = P_0 . X_1^{\beta_1} . X_2^{\beta_2} . X_3^{\beta_3},$$

where $P$ is the residential property price per square meter of living space in the district town; $P_0$ – the basic residential property price; $X_1$ - the average monthly salary; $X_2$ - the ratio between engaged and population in the district; $X_3$ – the district population; $\beta_i$, $i$=1,2,3 are unknown parameters.

The unknown parameters $\beta_i$, $i$=1,2,3 are estimated on the basis of data from the National Statistical Institute - Bulgaria [3], which are presented in Table 1. The following result is obtained:

$$P = 445.X_1^{-0,34}.X_2^{0,16}.X_3^{0,24}.$$

Table 1. Statistical data

| District | Salary | Engaged/Population | Population | Price |
|---|---|---|---|---|
| | $X_1$ | $X_2$ | $X_3$ | $P$ |
| Blagoevgrad | 525 | 0.42 | 192374 | 784 |
| Veliko Tarnovo | 563 | 0.37 | 185019 | 707 |
| Vidin | 464 | 0.27 | 65371 | 577 |
| Vratsa | 722 | 0.37 | 111638 | 619 |
| Gabrovo | 603 | 0.38 | 102407 | 524 |
| Kardzhali | 489 | 0.43 | 64519 | 684 |
| Kyustendil | 530 | 0.33 | 97537 | 554 |
| Lovech | 522 | 0.41 | 91857 | 623 |
| Montana | 517 | 0.30 | 97024 | 676 |
| Pazardzhik | 541 | 0.32 | 179050 | 654 |
| Pernik | 553 | 0.26 | 102265 | 705 |
| Pleven | 539 | 0.32 | 188486 | 797 |
| Razgrad | 528 | 0.42 | 60343 | 663 |
| Ruse | 575 | 0.36 | 188053 | 866 |
| Silistra | 502 | 0.35 | 56830 | 654 |
| Sliven | 530 | 0.30 | 133174 | 713 |
| Smolyan | 522 | 0.45 | 67415 | 697 |
| Stara Zagora | 718 | 0.43 | 239891 | 861 |
| Dobrich | 551 | 0.31 | 132664 | 707 |
| Targovishte | 519 | 0.41 | 65281 | 628 |
| Haskovo | 512 | 0.28 | 177883 | 856 |
| Shumen | 545 | 0.35 | 121047 | 685 |
| Yambol | 529 | 0.30 | 93350 | 657 |

# 4. Implementation Options as a SaaS

Software-as-a-Service (SaaS) is a model of software deployment over the Internet. With SaaS a provider licenses an application to customers as a service on demand, through a subscription or a “pay-as-you-go” model. SaaS is also called “software on demand.” The use of SaaS can be extremely beneficial to any organization’s corporate real estate management efforts. SaaS can provide several major benefits when it comes to managing the corporate real estate [4, 5]:

- SaaS can assist an organization in efficiently managing its corporate real estate.
- SaaS can reduce the corporate real estate while maintaining or growing the organizational size.
- SaaS enables small businesses to deploy enterprise-wide applications such as enterprise resource planning and customer relationship management at a fraction of on-premise application costs. Instead of investing in expensive IT infrastructure and support teams, the organization can rely on flexible cloud-based IT support and infrastructure.

- SaaS can play a major role in minimazing the corporate real estate expenses since it converts fixed costs into variable costs. The pricing innovations in SaaS enable to pay per seat. Thus, the organization can scale back or increase its demands based on customer demand and business growth.
- SaaS enables more employees to join the mobile workforce and become remote workers. Any data or software that is accessed in the office can be accessed just as easily from home, or even on the go through cell phones and other mobile devices. As SaaS offerings continue to grow and more software is deployed in such manner, organization's will begin to see more employees join the mobile workforce and the large amounts of corporate real estate that has been necessary in the past will no longer be necessary.
- SaaS enables data security - Data security for most small businesses consists of anti-virus software installation because it is expensive and involves additional resources. Usually enterprise-level solutions involves physical security, data storage and backup. Since SaaS is cloud-based, data resides in a server cloud, managed by a third party company which is responsible for the security of the company's data. It is important for them to protect the data of their customers and provide for its availablity on constant basis.

Software as a Service (SaaS) is connected with on-demand software service, provided by the vendors to consumers. It enables to hire any software application only when there is a requirement of such a utility. The licensing for using this kind of application may be with a single user or it can be shared with multiple users and offers a simple and economic way to have proper software facili-ties with a minimum of expenses.

The SaaS methodology became more popular in crisis period, because of its high services and less maintenance and costs. The availability on demand makes is highly flexible when the maintenance of the tool is taken into account. SaaS avoids the complexity of meeting different hardware and software requirements set and it enables a centralized control of the business by the service provider. The network operations are distributed amongst many users from a single server and offers sharing in the license. SaaS also eliminates software reinstalling within an organization.

The developed model is envisaged to be implemented as a SaaS application through the Windows Azure platform. Windows Azure is an open cloud platform that enables you to quickly build, deploy and manage applications across a global network of Microsoft-managed datacenters. SaaS applications can be built using any language, tool or framework [6].

The primary goal of the Windows Azure platform is to be a foundation on which ISVs can create SaaS applications. Customers are increasingly interested in having a SaaS option for the software they buy. To satisfy this demand and to keep pace with the competition, many ISVs will choose to offer a SaaS version of their current or future products. Creating a SaaS application requires building a highly scalable, highly available cloud-based service that can be used simultaneously by many customer organizations. Building your own foundation for this makes no more sense than would writing your own operating system for an on-premises application. Just as Windows provides a platform for traditional on-premises applications, the Windows Azure platform can support SaaS applications [7].

The Windows Azure platform has three components:

- Windows Azure, providing compute and storage services in the cloud.
- SQL Azure, providing a cloud-based relational database.
- Windows Azure AppFabric, providing cloud-based infrastructure services.

This proposed SaaS application will be implemented using C# and the .NET Framework in the Visual Studio environment. The tool provides templates for creating cloud applications. Windows Azure also provides a Development Fabric which is an image of Windows Azure that runs on a local machine. Developers can use this to create their code and do initial testing, then upload the application in Windows Azure when it is ready. Windows Azure provides its own cloud-based mechanisms for storing and retrieving data.

## 5. Conclusions

The pointed out illustrative example clearly shows the possibilities of applying hedonistic pricing models in business practice. The analysis uses public available data. The results are easy to interpret and suitable for use in CRM systems of different types through SaaS implementation of the model.

The pointed out values might be interpreted as an input to a hedonic pricing model only under certain conditions. The model contains a cognitive sense only if the general location of the property (in one town or another) is interpreted as hedonistic variable. In the context of New Economic Geography (NEG) this is the point. Acquiring a property with certain location, the buyer receives a full range of products and services that are connected with the location. One of the most important characteristics of the location is the possibility to find out good job. In other words, the results of the specific features of the model in this case can be reversed: not how much are going to increase the prices of certain property location, but what the buyer loses by selecting a cheap location in one of the small Bulgarian towns. In this case the buyer has to accept low wage for his work. At the end it comes to the same effect, but seen through the different perspectives. This is another illustration of the positive features of the hedonic pricing model.

All model variables have clear economic sense. The variable $X_2$ indicates how the increasing of the employment rate of a certain Bulgarian town increases the attractiveness of the town. The variable $X_3$ indicates the increasing attractiveness of a town as consequences of the town's growth. In terms of the variable $A_1$ the situation is more complicated. The variable indicates that the increasing of the salary leads to price reduction. The reasons probably are: the largest volume of housing demand leads to attracting of more developers and more competition between them.

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