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LAND AND RESIDENTIAL PROPERTY TAXATION MODEL. CONCEPT OF TAX ZONING IN MUNICIPALITIES

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ARTICLE INFO

Keywords:

property tax reform, tax zoning, real estate market dynamics

JEL Classification:

E62

ABSTRACT

Analysis of the current property tax structure, which is calculated in proportion to the area of land and buildings, leaves no doubt that this is not an appropriate solution in terms of tax efficiency and equity. Property tax reform is necessary; however, the concept of ad valorem tax is challenging to introduce and implement. An alternative to value-based property tax could be the concept of tax zoning, particularly in heterogeneous urban areas. This would partially expand existing legal regulations, which allow for differentiating tax rates for different types of taxable items, particularly considering their location. The article presents this concept as one that could effectively replace the existing residential property taxation system in a short time. Due to the significant socio-economic diversity of urban units, it is necessary to identify factors reflecting their specificity. The article attempts to quantify the criteria considered significant for residents of Polish cities. A combination of various measures allowed for the indication of the potential effects, both fiscal and non-fiscal. The proposed concepts were validated through empirical analysis based on data from publicly accessible databases. The research results emphasize the importance of the precise design of the property tax system, which can have significant consequences for the dynamics of the real estate market.

Citation: Felis, P., Bernardelli, M., Malinowska-Misiąg, E., Makowska, A. & Olejniczak, J. (2025). Land and residential property taxation model. Concept of tax zoning in municipalities. *Real Estate Management and Valuation*, *33*(2), 39-54. https://doi.org/10.2478/remav-2025-0014

1. Introduction

Real estate taxation in Poland is based on the area approach, although it also includes some elements of the value approach. For this reason, the system – similar to some other countries in Central and Eastern Europe – can be called a mixed system. Analysis of the real estate tax solutions currently in use, which are based on the area of land and buildings, leaves no doubt that this is not an appropriate solution in terms of tax efficiency and fairness. Real estate tax reform is necessary, but the concept of ad valorem tax is difficult to introduce and implement. An alternative solution could be the concept of tax zoning, especially in heterogeneous urban areas. This would partially constitute an extension of existing legal regulations, which allow for the possibility of differentiating tax rates for various types of taxable objects, taking into account a particular location. The article presents a concept that could effectively replace the existing residential property taxation system in Poland in a short time. Due to the significant socio-economic diversity of urban units, it is necessary to determine factors reflecting their specificity. The article attempts to indicate criteria that are considered important for the inhabitants of Polish cities, and which could be used for tax zoning.

The aim of the article is to analyze the current property tax structure and examine the possibility of reforming this system, which, in its present form, is based on the area of land and buildings – a structure

deemed inefficient and unfair by the authors. The article proposes an alternative tax system based on the concept of zoning tax, particularly relevant for diverse urban areas, as a more equitable and effective solution. It also points to the possibility of adapting current regulations, which already allow for differentiating tax rates based on location.

The concept of zoning has been supplemented with a mathematical formula allowing for a universal selection of the number of criteria and zones, as well as a method for measuring each criterion. Based on this formula, examples of zoning are presented for the cities of Olsztyn and Wrocław, including the selection of exemplary criteria and the potential consequences for the municipality's budget resulting from the introduction of zoning. Computer simulations were used to calculate walking distances taken from the Google Maps platform. Replacing the classic Euclidean metric with a more reliable distance covered by pedestrians in urban agglomerations, which considers urban limitations, allows for more precise positioning of zones in relation to the adopted criteria.

The article is organized as follows. The first part includes a literature review to highlight the shortcomings and weaknesses of the Polish real estate taxation system. The next part is devoted to the concept of tax zoning – the justification for its introduction, the fundamental macroeconomic basis for the reform of real estate taxation, actions that the central authorities should take, and the basic competencies of local government units (LGU) in the field of real estate tax rates. Subsequently, the focus is on determining tax rates and the availability of public services, which was indicated as one of the determinants of zoning. The empirical part describes the model and how it can be applied to the two focal cities with county rights. The article concludes by pointing out the problems associated with implementing the zoning concept. The financial consequences and impact of introducing the tax zoning concept are also indicated.

2. Literature review

Real estate tax regulations in European Union countries are very diverse (see e.g. Barrios et al., 2019; Leodolter et al., 2022; Prammer, 2020; Wołowiec, 2018). These differences concern the method of determining the tax base, the level of tax rates, and the scope of applied tax preferences. Clear differences are also visible in the scope of tax-related power exercised by local authorities. Real estate tax remains one of the more stable sources of local own revenues, but in Central and Eastern Europe, is usually of much less importance than in other EU countries.

The discussion on the need to reform the local public finance system in Central and Eastern Europe indicates that real estate taxation is of the utmost importance. Despite initiatives in some of these countries aimed at bringing property taxation closer to European standards in this respect, mixed models referring primarily to location are still in effect. Among the Visegrad Group countries that use such a solution, an interesting example is Hungary, where the decision to introduce property taxes (land tax and tax on structures) was left to the municipal authorities. Few municipalities use this option – in 2019, land tax was introduced by about 16% of all municipalities, and tax on structures by almost 1/3 (Hulko & Pardavi, 2022). Municipalities also decide whether to apply the area-based or value approach. Due to the difficulties in determining the adjusted fair market value (Hungary. Building and land taxes, 2024), the vast majority of municipalities adopt the area in square meters as the tax base. In Hungary, attempts were made to reform and strengthen the cadastral system, but ended in failure (Hulkó & Fehér, 2021). The Slovak real estate tax is primarily an area-based one, with the exception of the land tax in which the value approach is employed, though value is determined in a statutory manner. In recent years, there have been announcements of a reform of the property taxation system, but, according to Romanov (2021), the introduction of an ad valorem tax in the current conditions would not be advisable, among others, due to the lack of an appropriate database and the high costs of updating the system. A similar opinion was expressed in a document prepared by the Ministry of Finance of the Slovak Republic (2022). In Czechia, the introduction of an ad valorem tax is not considered, and the implemented changes are rather aimed at making the local tax policy more flexible. This is to be facilitated by increasing the scope of the tax-relating power of municipal authorities, due to the possibility of establishing the so-called local coefficient. According to Janouškov and Sobotovičov (2019), this coefficient can be used both to secure long-term tax revenue and when the municipality needs non-recurrent funds for investments. However, municipalities rarely use this instrument, not attaching much importance to real estate taxation, as it is only a very small source of their income (Formanová et al., 2020). Local authorities can also influence the amount

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of property tax revenue by changing the correction coefficient, which depends, among others, on the number of residents of the municipality in which the properties are located. This coefficient is most often used to differentiate parts of the municipality based on infrastructure and the attractiveness of individual locations (Janouškova & Sobotovičova, 2024).

As Hanson claims (2021) it is rare in the literature to find tax studies that examine an outcome that is not directly related to the type of tax being studied, and in the case of property taxes, researchers usually focus on property values. There are few studies that address the area-based real estate taxation system's fairness, efficiency and neutrality. The Polish literature indicates the characteristics of such a method of taxation of real estate, which allows for a comparison of the advantages and disadvantages from the point of view of taxpayers and local governments.

Taxes based on the area of land and buildings are undoubtedly characterized by the simplicity of solutions used at the stage of their implementation (Etel, 2019). They are accepted by taxpayers who understand them and do not feel the need to replace them with an ad valorem tax (Popławski, 2001). Their collection does not require financing costly mechanisms of valuation and valorization of property value, which allows for savings resulting from reduced administrative costs. Costs related to the time required to complete and provide property information/property tax returns, the alternative costs of adopted time units to meet tax obligations, or the costs of tax advisory firms incurred by the average taxpayer are not high (Felis, 2015). However, it is often the case – especially with regard to companies – that the correct determination of the amount of tax due is not so apparent. An important role here is played by knowledge of construction law, the Civil Code and income tax laws, as well as knowledge of the interpretation of law, and the extensive judicature of administrative courts (Felis et al., 2023).

The drawback of the Polish solutions is the significant difference in the burden on individual types of land properties. Disproportions in tax burdens due to different taxes on the owned real estate are characteristic, with agricultural and forest land being taxed on preferential terms. Therefore, one may call into doubt the implementation of the principle of fairness in the real estate taxation system (equality of taxation or ability to pay taxes).

The principle of fairness is inherently linked to the need to determine an appropriate volume of taxation and the proper distribution of the tax burden among various taxed entities (Kopyściańska, 2016). The taxation system is based on a tax that takes into account the size of the property and not its value, which is undoubtedly unfair. A tax based on the area of real estate is certainly not in line with the principle of equal taxation and the ability to pay (Głuszak & Marona, 2015). Separating the amount of real estate tax from the value of property leads to the favoring of much better-off taxpayers with more considerable real estate assets located in favorable locations. For this group of taxpayers, the tax is an imperceptible burden.

Area-based taxes are also characterized by a lack of differences in the taxation of real estate depending on its location and level of development (Etel, 2019), which is a problem not only from the perspective of justice but also from the point of view of efficiency. According to Wójtowicz (2006), the current system of real estate taxation contributes to the financial difficulties experienced by municipalities. Śmiechowicz (2021), in analyzing the fiscal efficiency of local taxes, points out that municipalities' high revenue is ensured only by real estate tax, even if its structure is outdated. The remaining taxes – agricultural and forestry – do not provide revenue that could be assessed as high. The fiscal effect of the real estate tax results from the vast subjective and objective scope of taxation. The relatively large revenue from this tax also results from the higher tax burden on real estate related to business activity. For example, the tax rate on such types of building is about 30 times higher than the rate for residential buildings. As a result, about 85% of property tax revenues are taxes paid on taxable items related to business activity (Felis et al., 2023). From the point of view of municipalities, it is also crucial that it is not possible to adjust the amount of property taxes according to the tasks they perform. The needs of municipalities connected with revenues obtained from local taxes are increasing, while the current taxes related to property ownership are insufficient when it comes to meeting such needs (Gnat, 2021).

Area-based taxes encourage the holding of land for speculative purposes. Even if these properties do not generate sufficiently high revenues, maintaining the land in an undeveloped state does not expose their owners to negative consequences. Properties of a similar size are subject to tax of the same amount, regardless of the land value. This is very dangerous, especially in cities where the land supply for new investments is limited.

Summing up the advantages and disadvantages of the current real estate taxation system in Poland, it must be concluded that the applicable taxes on real estate do not bring positive effects, neither fiscal nor non-fiscal. The conclusions drawn from assessing the current real estate taxation system in Poland should result in the implementation of a target model devoid of the dysfunctions and adverse side effects discussed above.

Designing and managing property taxation in an efficient and effective manner is a major challenge. It is often part of an extensive discussion on the intergovernmental fiscal frameworks, land use policy and property rights (OECD, 2021). As Grover et al. state (2017), property taxes tend to be unpopular, and reforms can encounter political resistance. Nevertheless, efforts must not be abandoned to make the property tax system better adapted and ready to face current challenges. A well-designed property tax can be an efficient source of local budget revenue; it can also promote growth, reduce inequalities and contribute to environmental sustainability (Leodolter et al., 2022). An interesting approach to developing a sustainable property tax system, using the concept of antifragility, was presented by Renigier-Bilozor et al. (2024). Since the behavior and attitude of residents towards paying taxes is crucial for fiscal efficiency and the introduction of possible changes to the tax system, it is important for citizens to be aware of the relationship between the taxes they pay and the standard of public services provided by local authorities (Adeosun & Adebowale, 2022), which affects their quality of life and the achievement of sustainable development goals.

3. Justification for the concept of tax zoning

As shown in the literature review, the shortcomings of Poland's current real estate taxation system indicate the need for reform. However, the postulates for a general reconstruction of the system and the replacement of the mixed system with a value-based one have not been implemented for various reasons. Moreover, political and social support for the introduction of a value-based property tax reform in Poland is still insufficient (Grover & Walacik, 2019). We believe an alternative solution to the ad valorem tax should be the zoning of maximum tax rates. Below, we indicate the arguments that justify the concept of location differentiation.

1) Improving the area-based tax is an alternative to the ad valorem reform, which would be costly, unpopular among taxpayers and politically difficult. The implementation of the taxation of the value of real estate is currently impossible due to socio-political, economic and organizational reasons (Gnat, 2016). The disadvantages of the ad valorem tax include a complicated process of determining the value of real estate, the cost of introducing a new real estate tax system, and a potentially significant increase in the tax burden (Piekut, 2014).
2) It is possible to improve the stability and predictability of local government units' revenue systems and increase their financial independence. Municipalities should have real control over their revenues and the possibility to influence the development of the sources of such revenues. The local government financing system requires changes in order to strengthen the revenue side of financial independence.
3) A local tax policy that stimulates local socio-economic development tailored to local preferences should be conducted. The local community expects an effective tax policy from the local government. Creating an effective system of local taxes is an essential factor conducive to using fiscal instruments to affect local socio-economic development.
4) Rationalizing spending and finding sources of savings is possible. The relationship between the tax burden and the level of local services should be considered more thoroughly.
5) Identification of the local community with the local government unit and the decisions made in it can be fostered. An effective system of local taxes favors local autonomy. It increases the responsibility of local authorities towards residents, who are more willing to actively participate in exercising power.
6) The implementation of specific non-fiscal functions of real estate taxes (stimulation of economically effective development and use of real estate, rationalization of the spatial structure of cities and environmental protection). In its current form, property tax encourages the holding of real estate for speculative purposes. A differentiation in the amount of tax burdens would motivate owners to manage such property correctly. The new solution means greater mobility in the real estate market and acceleration of the processes of reallocation of resources in relation to such

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factors as location or type of real estate (Wójtowicz, 2006). Therefore, it would be possible to rationalize the use of housing resources, which is essential, especially for urban areas. There are also no effective pro-ecological regulations in the current legal solutions. Due to their character, property taxes should be used as environmental protection instruments (Etel, 2019).

It should be noted that establishing the boundaries of tax zones on the basis of criteria chosen by local authorities may prove controversial from the point of view of some taxpayers. Therefore, the territorial cohesion of the demarcated areas should also be taken into account when determining the final course of their boundaries. At the same time, some taxpayers may indicate that the adopted criteria do not reflect their preferences related to the availability of public services (e.g. the existence of a school in the case of persons without children). Thus, the selection of zoning criteria by the municipal authorities should be consulted with the residents.

4. The concept of tax zoning within municipalities

The concept of tax zoning should account for the following elements:

1) The macroeconomic foundations of real estate taxation system reform.
2) The role of the central and local authorities.
3) The method of setting tax rates.
4) Accessibility to local public services as one of the determinants of tax zoning.
5) Implementation issues.

The concept of tax zoning should consider postulates relating to the local financial economy and the theory of optimal taxation. If the local financial system is to function correctly, it should fulfill the following objectives (Felis, 2012):

- Creation of a long-term capacity for the local finance sector to finance services for local communities.
- Fostering local development in the long term and not limiting it in the short term.
- Implementation of the basic principles of taxation – the principles of universality and equality of taxation.

Among the achievements of the theory of optimal taxation – taking into account the conditions and specificity of local government – the following issues deserve attention:

- Perception of the local tax system in the context of the strategic development goals of the local government.
- Accounting for the equivalence of the exchange of benefits between the local government and the taxpayer (the idea of an equivalent tax at the local level – the principle of the equivalence of benefits as the basis for the volume of tax revenues).
- The principle of minimizing the costs of the fiscal process (the concept of tax zoning would be a much cheaper and easier solution to introduce than the ad valorem tax).

In the case of the central government, the following actions are necessary (Felis et al., 2023):

1) Indication by the legislator of the maximum number of zones that can be determined in the territory of a municipality, where the absence of zones means the application of the base rate for the entire area, and more than two zones means a differentiation in rates.
2) The legislator's proposal of a catalogue of criteria that should/may be followed by the municipality when determining zones. These, first of all, must include measurable criteria and accepted qualitative criteria.
3) Definition of formal rules by the legislator for delimiting zones (procedure, method of calculation, rules for using weights/points for individual features).
4) Determining by the legislator the base value of the rate and the ranges of reference values that municipalities may use when setting rates in zones.
5) Indication that the application of rates lower than the base value in a municipality (i.e. delimitation of zones with a multiplier below 1) will be treated as the application of a tax preference and will not be taken into account, for example, in calculations for compensatory mechanisms (analogous to the current regulations).

The catalogue of basic competencies of local government units in the area of real estate tax rates includes:

1) Differentiation of coefficients for residential and commercial real estate.
2) Use of coefficients (basic, reduced or increased) depending on the degree of criteria satisfaction –access to public services.
3) Introduction of additional conversion rates in a given zone, depending, for example, on the

eISSN: 2300-5289 | Received 2024-08-11 | Revised 2024-12-31 | Accepted 2025-01-16

technical condition of a building, its age and purpose. This will eliminate the weaknesses of the zoning concept (two highly differentiated properties located in the same zone). However, an extensive catalogue of conversion factors may complicate the zoning system.

The concept of dividing the area of a local government unit into property tax zones stems from the diversity of physiographic, technological, functional, service and structural characteristics of individual areas of municipalities. This is because this diversity contributes to the "attractiveness" of particular locations for a given entity (resident, entrepreneur) and undoubtedly affects the value of real estate in individual locations. Consequently, this may provide a rationale for differentiating tax rates in separate zones depending on the scale of the "benefits" and "disadvantages" experienced by taxpayers. Such a solution may indirectly reflect the differences in property values within the municipality and thus make it possible to move away from the previous approach of treating the municipal area as homogeneous and of applying uniform tax rates. Undoubtedly, reference can be made to the concept of the 15-minute city, where the availability of desired services (including public services) is determined by the time it takes for a resident to reach a given place (office, school, public transport stop).

As mentioned above, this differentiation can apply to many areas. Therefore, the catalogue of characteristics that the authorities of individual local government units could consider in determining tax zones should be relatively broad. This would provide municipal authorities with the opportunity to choose the criteria most suited to the municipality's specifics, implement their own tax strategy, or optimize sources of tax revenue.

Some of the basic criteria, especially in terms of the ease of determining the differentiation within a municipality, include the spatial accessibility of public goods and services, the degree of infrastructure provision, the quality of the environment and the planned land use designation. Table 1 proposes a gradation of characteristics for the selected criteria. It should be noted that each local government unit should independently determine not only the criteria but also the "standard" or "target value" for which the highest tax rate will be applied (multiple of the tax base/reference rate). This may mean the need to introduce a points scale for grading each criterion, with the weights assigned to each criterion based on its relevance to taxpayers.

Table 1

Examples of criteria that can be used to identify zones within a municipality

Criterion	Level	Data source (examples)
Infrastructure facilities	Complete (according to the municipality's standard)	GESUT/KIUT
	Substantial (according to the municipality's standard)	
	Limited (according to the municipality's standard)	
	None or not applicable	
Location within the municipality (depending on the spatial structure of the municipality)	Municipal centre or settlement centre (high accessibility)	Isochronous maps of the availability of individual public services (polycentric or monocentric)
	Areas adjacent to the municipal centre (medium accessibility)	
	Transitional areas	
	Areas significantly distant from the municipality's focal points	
Criteria related to the quality of the environment	Areas with low levels of air pollution	Environmental (air, noise) pollution maps
	Areas with a medium level of air pollution	
	Areas with a high level of air pollution	
	Areas with noise pollution	

Source: own study, based on: Felis et al. (2023), Central Statistical Office (2018, 2020).

Accessibility to public services provided by local government units may be one of the elements considered when dividing an area into tax zones. The scope of these services depends on the political and financial conditions of individual countries (see CEMR, 2021), while the division of these services between different levels of local government also varies. In Poland, the basic local government unit (LGU) is the municipality, and municipalities are assigned to perform all local government tasks unless they are reserved for other types of LGU (counties, voivodeships). Municipalities were reactivated in 1990 – one of the critical elements of the Polish political transformation. Municipalities have become entities performing tasks on behalf of the public and under their responsibility. The scope of their activities includes all public matters of local importance not reserved by statute for other entities. Municipalities may also perform tasks in the field of government administration commissioned by statute or based on

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an agreement with government administration bodies.

The wide range and diversity of public services encourage attempts to systematize them. According to the classification often used in the Polish literature (Wańkowicz, 2004; Kożuch & Kożuch, 2011), they can be divided into:

1) Administrative services, i.e. tasks performed by public administration related to performing administrative activities, such as issuing various types of documents, permits, decisions, etc.
2) Social services, which include health care, education and upbringing, culture, physical culture and recreation, social assistance and care, housing and public safety,
3) Technical (municipal) services, such as transport, water supply and sewage, waste management and maintaining cleanliness and order, cemeteries, energy supply (electricity, gas, heating), and public green areas.

The concept of tax zoning presented in the article uses services from two categories: social (education and culture) and technical (transport). Tasks related to public education are undoubtedly among the most critical functions for municipalities. This is due to the role of education itself, which is the basis and condition for social and economic development and their share in municipal budgets. Such expenditures constitute approximately 30% of all municipal spending, of which almost half are on primary education. A much smaller share of the expenditure structure (approx. 3%) is spent on tasks related to culture and the protection of national heritage, but this is an extremely important area due to its impact on the specific sphere of residents' thoughts, emotions and actions (Poprawski, 2016, p. 217). The choice of transport services is related to the role of municipalities as organizers of public collective transport lines or networks in municipal passenger transport in their area.

The way local public services are provided, characterized by such measures as the availability and continuity of services and their quality, measured by the degree of compliance of the services offered with applicable standards, is one of the critical factors shaping the quality of life of residents and the attractiveness of the area where these services are delivered. Such issues are often discussed in the literature; much attention is also devoted to the methods for providing such services. A comprehensive overview of such mechanisms (in-house provision, privatization and inter-municipal cooperation) is presented by Petkovšek, et al. (2021). Scientific research also focuses on the accessibility of public services, which can be understood in a multidimensional way (spatial, economic and social accessibility). Stępniak et al. (2017, pp. 57-67) draw attention to different definitions of spatial accessibility and, consequently, different methods of measuring it. Nevertheless, as Małachowski et al. write (2020), the concept of accessibility is still a central notion in socioeconomic and geographical research, and access to public services can be interpreted either as a measure of the development of social capital or as an indicator (element) of the quality of life.

Since spatial accessibility of primary education facilities is considered to be one of the factors fostering educational equity and sustainable development, it attracts the attention of researchers from all over the world. Among the most recent studies are those from China. Gao et al. (2016) examined spatial accessibility based on the shortest travel distance from places of residence to compulsory education institutions in nearly 3 thousand Chinese counties. The subject of Yuan and Yang's (2023) research was the spatial distribution of urban basic education resources in Shanghai, while Huang et al. (2023) explored spatial distribution and allocation of basic educational facilities (kindergarten, primary school, and middle school) in the main urban area of Lanzhou City. The results of the study on spatial distribution and accessibility of primary schools in Chengdu was published by Jiang at al. in 2024. The issue of the spatial accessibility of primary education was also addressed by researchers from Ethiopia (Abraha, 2019), Brazil (Pizzol et al., 2021), India (Meena et al., 2023), Saudi Arabia (AlQuhtani, 2023) and Jordan (AlFanatseh, 2024).

Implementing the proposed solution will require municipal authorities to analyze the importance of individual zoning criteria for taxpayers. The threat here is considering secondary criteria (from the point of view of the majority of taxpayers), duplicating other criteria and showing no variation within the municipality, or one mainly independent of the municipality's actions. Division into tax zones should consider access to municipal infrastructure and public services provided by the municipality. This is important when it comes to taxpayers understanding and accepting the differentiation of this tax burden. Therefore, the selection of criteria should be conducted with the participation of taxpayers (consultative processes).

eISSN: 2300-5289 | Received 2024-08-11 | Revised 2024-12-31 | Accepted 2025-01-16

Another issue is the number of zones that can be identified based on the adopted criteria. The zones created should reflect significant differences existing between the different urban units of a municipality. Areas of rural municipalities with a dispersed settlement network may prove to be a problem. In such areas, there may be no significant variation in the characteristics of the criteria (e.g., the level of access to municipal infrastructure and public services), making it impossible to distinguish tax zones. Indeed, it should be noted that the location of the tax zones should not depend only on the distance from the city center or town that is the seat of the municipal authorities. By using various criteria and building a synthetic indicator, it should be possible to distinguish several zones/areas within one municipality offering a similar level of "benefits" for residents or entrepreneurs and consequently covered by the same tax rates (polycentric arrangement of zones).

It is also vital to allow municipalities to use a mechanism that corrects established tax zones by being able to apply tax relief for specific situations arising from, among other things, the area's intended use, the willingness to increase the area's investment attractiveness, the actions taken by property owners (e.g., pro-environmental) or taking into account the technical condition of buildings and structures.

However, considering the complexity of the process and the possible shortage of appropriately qualified municipal staff, detailed recommendations on the construction of individual indicators/measurements should be included in an appendix to the law introducing tax zoning in order to facilitate construction and ensure the correctness of the adopted criteria.

5. Model description

It is possible to define the local tax zoning concept using mathematical formulas. Let us assume that there are J zones, and to each of them, a score is assigned using the formula:

$$s_j = w_1 * k_{1,j} + w_2 * k_{2,j} + \cdots + w_K * k_{K,j}, \quad (1)$$

where:
$j = 1, 2, \ldots, J$ is the zone index,
K is the number of considered zoning criteria,
$k_{i,j}$ is the score of the i-th criterion of the $j-th$ zone for $i = 1,2,\ldots,K,\ j = 1,2,\ldots,J,$
w_i is the weight assigned to the i-th criterion for $i = 1,2,\ldots,K.$
It is assumed that criteria scores are on the same scale, and that the sum of the weights is equal to 1, i.e.

$$w_1 + w_2 + \cdots + w_K = 1 \quad (2)$$

Next, the zone with the lowest score is chosen as a reference zone:

$$s_0 = \min_{(j = 1,2,\ldots,J)} s_j \quad (3)$$

Relative to this zone, multipliers are calculated

$$m_j = \frac{s_j}{s_0} \quad (4)$$

for $j = 1,2,\ldots,J$. The multipliers are interpreted as tax rates and are proportional to the score of the reference zone. For example, the tax rate for a zone with twice the score of the reference zone should be twice as high.

This approach allows for any number of criteria, measured in different ways. The only requirement is to provide a transformation function from a specific measure to scores expressed on the same scale. The selection of criteria is left to the discretion of each municipality. Also, the number of zones should be adapted to the municipality's specificity. For smaller municipalities, there could be only two zones, e.g., urban and rural, but for big cities, zones can be equated with districts or even housing estates.

6. Model exemplary implementation for Olsztyn and Wrocław

The empirical analysis consisted of the following steps. First, a grid of points covering the city area was generated. Calculations were carried out only for those points located within the city. After introducing this limitation, the number of points analyzed was 5954 for Wrocław and 1356 for Olsztyn. Then, the closest public transport stops, primary schools and cultural centers were found for each point respectively, based on data from the Spatial Information Systems of Olsztyn and Wrocław and the Database of Topographic Objects (BDOT10k) from geoportal.gov.pl. The measured distance was given in meters. Thus, after completing the measurements, a set of three distances was obtained for each analyzed mesh point, which was analyzed in the next step, grouped into four zones corresponding to the level of accessibility. Properties from zone 0 are located in direct proximity to the location defined by one of the three criteria, while zone 3 is located at a considerable distance from the locations under consideration. The criteria used for the division into zones are given in Table 2.

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Table 2

Zoning criteria for the Wrocław and Olsztyn examples

City	Criterion	Zone 0 [in meters]	Zone 1 [in meters]	Zone 2 [in meters]	Zone 3 [in meters]
Wrocław	public transport stops	< 250	250–500	500–1000	≥ 1000
	educational institutions	< 750	750–1500	1500–2500	≥ 2500
	cultural centers	< 1000	1000–2000	2000–3000	≥ 3000
Olsztyn	public transport stops	< 250	250–500	500–1000	≥ 1000
	educational institutions	< 1000	1000–2000	2000–3000	≥ 3000
	cultural centers	< 1000	1000–1750	1750–2750	≥ 2750

Source: own study.

A detailed description of the method and results for Wrocław is given in Felis et al. (2023).

7. Results

The results of the analysis of the availability of the various public services taken as criteria are summarized in Tables 3 and 4. The visualization of the zoning is shown in Figures 1-3. Due to the different size and number of cadastral districts in the two cities (141 in Olsztyn and 69 in Wroclaw), it is more reasonable to use percentages and area than numbers when making comparisons.

The results of the study indicate that, in the case of Olsztyn, each of the adopted criteria (transportation, culture, education) results in far more of the cadastral districts being qualified as "most favorably located", with more than 40% of the cadastral districts having full access to cultural and educational services. In terms of area, on the other hand, such areas would account for between 9% (transportation) and 24% (education, culture) of the city's area. In the case of Wroclaw, most of the studied units have poorer access to public services. For example, only 1.5% of the surveyed units, or less than 1% of the city's area, would be in the most favorable zone for transportation.

In the case of Olsztyn, the two most favorable zones cover between 65% and 73% of the studied units, while in the case of Wroclaw, this is between 60% and 65% of the studied units. It should be noted, however, that the differences vary from the point of view of the area of the city covered by the two "most favorable" (0 and 1) zones of the availability of public services. This is below 50% in the case of Olsztyn and above 50% in the case of Wroclaw.

The aggregation of the above three criteria made it possible to distinguish tax zones in each city according to the level of the total availability of public services. Figure 4 shows a visualization of the distribution of each tax zone.

Table 3

Percentage of cadastral areas classified by zone (%)

	Access to public schools		Access to public transportation		Access to cultural institutions		Tax zones	
	Olsztyn	Wrocław	Olsztyn	Wrocław	Olsztyn	Wrocław	Olsztyn	Wrocław
Zone 0	44.68	11.59	9.13	0.62	22.53	18.05	36.17	10.14
Zone 1	24.82	49.28	38.07	50.88	26.70	38.49	31.91	53.62
Zone 2	13.48	15.94	43.26	43.11	27.34	22.97	23.40	30.43
Zone 3	17.02	23.19	9.54	5.39	23.43	20.49	8.51	5.80

Source: own study.

Table 4

Percentage of the city's area occupied by registration precincts classified in each zone (%)

	Access to public schools		Access to public transportation		Access to cultural institutions		Tax zones	
	Olsztyn	Wrocław	Olsztyn	Wrocław	Olsztyn	Wrocław	Olsztyn	Wrocław
Zone 0	23.65	11.02	9.13	0.62	22.53	18.05	16.88	10.90

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Zone 1	22.99	42.12	38.07	50.88	26.70	38.49	24.81	45.24
Zone 2	31.67	18.93	43.26	43.11	27.34	22.97	44.95	32.59
Zone 3	21.69	27.93	9.54	5.39	23.43	20.49	13.36	11.26

Source: own study.

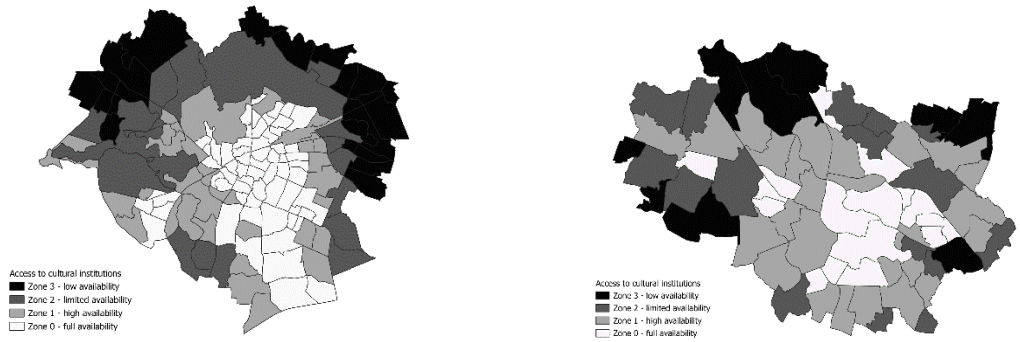


Fig. 1. Access to cultural institutions (zones) – Olsztyn and Wrocław. *Source*: own study.



Fig. 2. Access to public schools (zones) – Olsztyn and Wrocław. *Source*: own study.

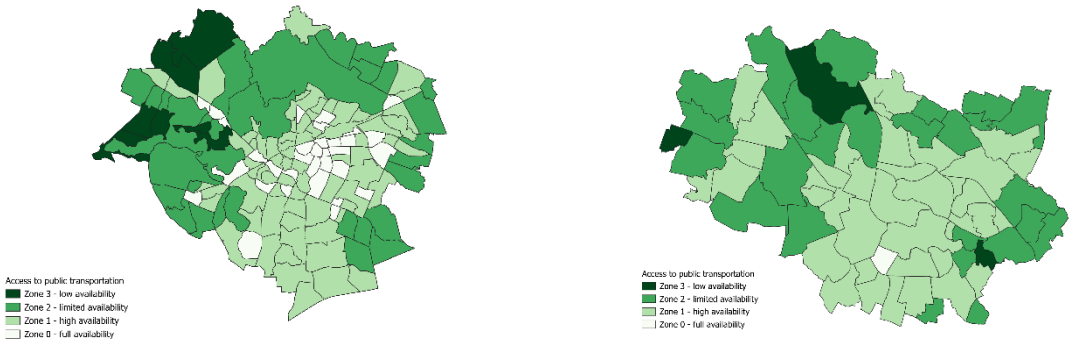


Fig. 3. Access to public transportation (zones) – Olsztyn and Wrocław. *Source*: own study.

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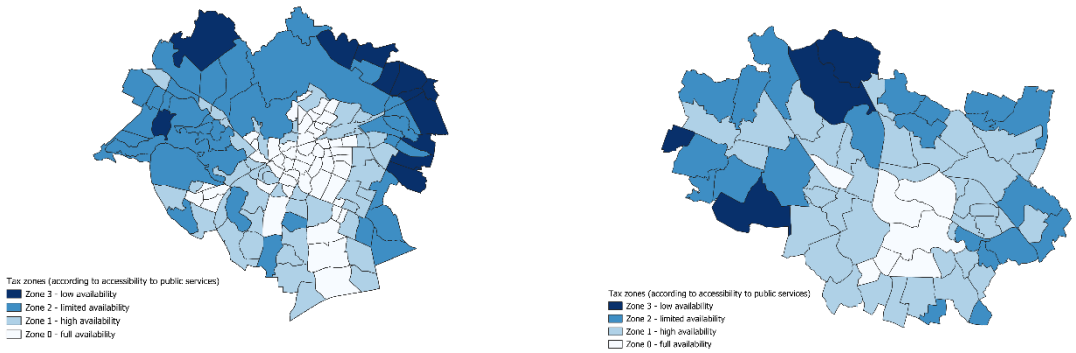


Fig. 4.Tax zones – Olsztyn and Wrocław. *Source*: own study.

As seen in both cities, there is primarily a concentration of zones with high availability of all public services in the city center. However, in the case of Olsztyn, the occurrence of such zones outside the centre (polycentric distribution) should be noted. This is due, on the one hand, to topographical conditions and, on the other hand, to urbanization processes (including the emergence of large, complete settlements - e.g. Jaroty, Dajtki). A similar phenomenon was not observed for Wroclaw, despite the existence of similar types of settlements (e.g. Nowy Dwór, Kozanów). In addition, a strong fragmentation of cadastral districts is visible, which may have influenced the assessment of the availability of the various public services considered in the survey. This highlights the need to adapt zoning methods/criteria to local specifics.

In the case of Wroclaw, only 10% of the precincts qualified as Zone 0, where the highest tax rates could be applied. In the case of Olsztyn, on the other hand, this share was as much as 36%. According to the simulation, the zone of highest taxation could cover about 17% of the city area in Olsztyn, while in Wroclaw, it could cover approximately 11%. In the case of Zone 1, on the other hand, more than half of Wrocław's cadastral districts would meet the eligibility criteria, as opposed to only about one third of Olsztyn's. In total, the first two zones in both Olsztyn and Wrocław would include between 63% and 68% of the studied cadastral districts. This would constitute about 41% of the city area in Olsztyn and more than 56% in Wroclaw.

It is also noticeable that in the case of both cities, there are clear peripheral areas due to topographic conditions and their use. This may lead to the adopted method of determining tax zones not being appropriate in such areas because the criteria mentioned will not be adequate to the expected/received benefits by taxpayers who own real estate in a given area (e.g. persons conducting business activities related to sports and recreation, entrepreneurs with logistics bases in a given area). This is another rationale for differentiating the criteria for determining tax zones according to land use.

8. The impact of zone tax on the municipality's income

According to the proposed approach, there is no need to aggregate areas into a predefined number of zones. Each area can be its own zone. However, to simplify the calculations and improve the readability of the visualization, the areas were clustered into four zones. In the case of Wrocław, the areas were districts (Fig. 4, left), and in the case of Olsztyn, precincts (Fig. 4, right). The issue that remains is the selection of multipliers that increase or decrease property tax rates. In the original formula, these multipliers are determined in relation to the zone that meets the adopted criteria to the lowest degree. No additional action is needed. However, with the simplified aggregation to four zones used in the presented examples, it is necessary to define tax rates for each zone. Quantifying the differences in tax rates between zones is crucial for the amount of municipality income. A simulation of the change in the municipality's income from real estate tax (excluding buildings) was conducted to demonstrate this relationship. An additional assumption was made that the total taxes within each zone are proportional to the number of inhabitants living there. Data on the number of inhabitants came from Bulletin of Public Information Wroclaw City Hall in the case of Wrocław and from Bulletin of Public Information Olsztyn City Hall in the case of Olsztyn. The tax amount was taken from the SP-1 report for 2023. Of course, each municipality has

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detailed data on the real estate tax paid and does not need the simplifications adopted for the described simulation.

Four scenarios were considered in which the current property tax rate was taken as the base and linked to each of the four zones in turn. Zones with better access to public services than the base zone were assigned higher multipliers using a 25% incrementation. Zones with worse conditions in relation to the adopted criteria were assigned 25% lower multiplier values for each subsequent zone from the list of zones, arranged in order from the best to the worst access to public services. The simulation results for each scenario are summarized in tabular form in Tab. 5. For each set of multipliers, the change in the amount of budget income from real estate tax (excluding tax from buildings) was estimated in relation to the actual income of the municipality in 2023. The characteristics of the city determine the distribution of zones and the associated estimated amount of income. Scenario 1 is the most financially favorable out of the four scenarios considered for the municipality. It would increase the income of the city of Wrocław by 52%, but in the case of Olsztyn, it would mean a decrease in income by over 17%. All the scenarios for Olsztyn would generate less property tax income than that actually obtained in 2023. This is due to the relatively small number of people living in the parts of the city with full access to public services. Unlike Olsztyn, only a small part of Wrocław is occupied by districts with low access to public services. Hence, only the last scenario, the least financially profitable for the municipality, would mean a decrease in income, while in the remaining scenarios, the income would increase by 2%, 27% and 52% respectively. The simulations show that the number of zones and criteria and the way they are measured, which translates into the size of the multipliers, are important for the municipality's income.

Table 5

Estimation of the change in the amount of budget income from real estate tax (excluding tax from buildings) as a result of the introduction of the zone tax in relation to the actual income of the municipality in 2023

Zone	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1 (best access)	1.75	1.5	1.25	1
2 (good access)	1.5	1.25	1	0.75
3 (bad access)	1.25	1	0.75	0.5
4 (worst access)	1	0.75	0.5	0.25
Wrocław	152.1%	127.1%	102.1%	77.1%
Olsztyn	82.6%	69.8%	57.1%	44.3%

Source: own study.

9. The impact of zone tax on the real estate market

The impact of introducing a zonal tax on the real estate market can be discussed from various perspectives, one of the most intriguing being the perspective of the entities affected by this tax. This includes individual and institutional investors purchasing properties for rental income or capital appreciation (including tenants), individuals buying properties for personal residence (for both consumption and potential appreciation), and developers. According to the zonal tax model presented in the article, each of these groups will experience different consequences due to variations in tax rates depending on the property's location or the availability of public services. Evaluating the effects with regard to the risks and opportunities for development of the real estate market has a crucial influence on policymakers in Poland in terms of the choice of the property tax model.

Rental market investors acquiring properties to generate a steady income might benefit significantly from the introduction of the zonal tax. The stability and predictability of local government unit revenues favor long-term investments, and preferential tax rates in less developed zones can significantly incentivize investment in these areas. This could lead to gradual future development and the appreciation of properties, as well as attracting potential tenants. However, the complexity of the tax system and higher administrative costs might deter less experienced investors. Risk assessment associated with sudden changes in local policies highlights the need for protective mechanisms such as fixed transition periods to new rates in order to minimize unpredictability. Additionally, the zonal tax may increase costs for tenants, potentially leading to higher rents and a reduced availability of rental housing. Investors might also be discouraged from investing in higher tax zones, resulting in a decreased supply of rental properties and hampering local real estate market

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development.

For individual buyers purchasing properties for personal residence, the zonal tax might increase the availability of public services in selected zones, enhancing the residents' quality of life. Meanwhile, choosing locations with lower tax rates is attractive for cost-conscious individuals. Despite this, the rising maintenance costs in desirable locations with higher tax rates may limit the accessibility of these properties for a broad range of buyers. This could lead to urban sprawl, increased traffic and longer commutes. Diverse tax burdens may also impact buyers' creditworthiness and financial decisions. These factors indicate the need for support systems, such as subsidies for mortgages for buyers in higher tax zones (especially for large families, who use municipal services more frequently than childless individuals) so as to ensure equal access to the real estate market.

Developers responsible for constructing new residential and commercial properties face perhaps the most challenging task of adapting their investment strategies to the new tax system, regardless of its specifics; although the tax will not affect them directly, it will alter client preferences and target group characteristics. The zonal tax will significantly influence planned investment structures depending on the location. Developers can potentially guide urban development through strategic investments in zones with favorable tax rates, leading to revitalization and sustainable urban growth. Conversely, higher tax rates in more attractive locations could slow down property sales, forcing developers to rethink their pricing and marketing strategies. Addressing these challenges suggests that increased developer investments in less urbanized areas will necessitate enhanced infrastructure investments in such locations, ultimately improving their quality and increasing property tax rates due to higher area assessments.

A summary of the essential features from the perspective of all three stakeholders is shown in Figure 5.

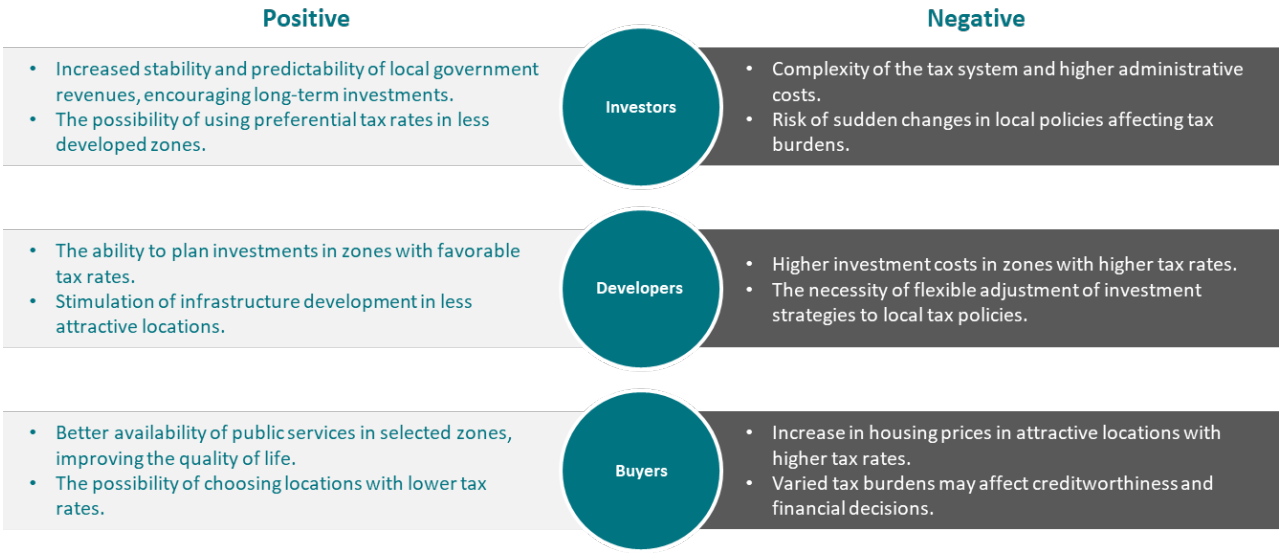


Fig. 5. The impact of zone tax on the real estate market from three perspectives. *Source*: own study.

Finally, it is important to emphasize that the current situation, in which the market faces ongoing reports of work on a new property tax, is unfavorable for long-term real estate purchase planning. It is well-known that the most challenging preparation is for the unknown, while it is much easier to tackle a measurable problem that can be characterized and its effects predicted.

10. Summary

The shortcomings and weaknesses of the Polish real estate taxation system indicate the inevitability of introducing fundamental changes in this area. However, using the ad valorem approach does not seem possible in the current conditions. It is also worth emphasizing that the system's effectiveness based on real estate value depends on many factors, including the frequency of revaluations, which is problematic even in countries with a long tradition of using the ad valorem approach. The concept of tax zoning proposed in the article should not be treated as a target solution; nevertheless, it is worth considering. The introduction of tax zones based on

eISSN: 2300-5289 | Received 2024-08-11 | Revised 2024-12-31 | Accepted 2025-01-16

the criterion of accessibility to public services is justified from the point of view of social justice. The level of tax burden in this approach reflects the benefits for residents that may result from the specific location of their property.

The proposed zoning algorithm is universal and considers various criteria, although the appropriate criteria to be applied should be identified by individual municipalities. The selected criteria may depend on many factors, including the municipality's location and characteristics, planned development directions, perception of the quality of life, and individual social groups' priorities. The idea of zoning described in the article is not complicated, but quantifying and determining some criteria may be difficult in exceptional cases. For example, the presented simulation that operates on the actual walking distance for large urban agglomerations requires more advanced IT work. In most cases, however, the adopted methods of measuring selected criteria can be determined directly based on data already being collected by each municipality, including, for example, the location of water supply networks, roads, or the distribution of public transport stops and public utility facilities.

The zonal tax introduces both new opportunities and challenges for various real estate market participants. Evaluation of these risks suggests the need for stabilizing mechanisms and transition periods. Moreover, implementing the zonal tax requires careful planning and consideration of local real estate market specifics. Only then can the benefits be maximized and the potential negative effects minimized, contributing to greater fairness and efficiency in the property taxation system and, consequently, to sustainable urban development and improved quality of life for residents. It is essential to view the real estate market as an interconnected system, where any change in influencing factors, such as property tax, has numerous implications for all involved entities. Whether one owns a property, rents it, or chooses to purchase it from a developer, everyone participates in the market, as housing has no real substitute as a place of residence.

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