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The Size of Tax Jurisdiction and Tax Density

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Abstract

Theoretical background: Theory of public finance theory quite widely recognized that the purest indicator of government size is to observe the determinants and trend of level of public spending. It could be easy translates into the statement that following demand of government for money, first satisfied by taxes, enables to conclude, in particular, that the ratio of tax revenues to gross domestic product is the most appropriate indicator of the fiscal efficiency of the tax system.
Purpose of the article: The very aim of paper is to determine, on the basis of constructed original taxation density rate, the diversification of the spatial economics of local revenues from taxation of land and developments. The supplementary goal comes from the identification of attributes of tax jurisdiction size shaping density of taxation. In particular, it is undertaken to determine whether there is a statistically significant difference in the rudimentary statistics of the correlation between the size of tax jurisdiction and intensity of land and development taxation measured by brand new index: tax density.
Research methods: The research methods, apart from the query and analysis of the literature on the subject, are descriptive statistics of the population of 2,477 communes in Poland in terms of taxation density and the strength of the correlation between taxation density and attributes of tax jurisdiction defined by its size in both fiscal perspective (total tax revenues, tax revenues per capita) and demographic indexes (population, population density). The area of tax jurisdiction is correspondingly discussed. There is also

employed OLS method for study correlation between tax density and indexes of tax jurisdiction size. The data are for the fiscal year of 2021.

Main findings: Taxation density is, on average, the highest in urban communes, which results from a significant share of land and improvements subject to property tax. In urban communes, the share of real estate tax is on average 98.91% of total revenues from taxation of land and improvements. While in rural communes, where the lowest average level density of taxation has been recorded, the share in question is on average 73.73%. Examination of taxation density statistics for each of three subpopulations of communes (urban ones, urban-rural ones, and rural ones) indicates that in each case statistics of the distribution of tax density is attributed by positive skew and has sharper peak around the mean, but kurtosis is the highest for rural communes. It has been observed that the shapes of the distribution of total tax revenues, tax revenues per capita and population density are most similar to the shape of the distribution of taxation density in rural communes. The crucial conclusion is that the most significance for tax density growth is the increase of population in accordance with population density. The greater tax jurisdiction measured by population the greater intensity of fiscal exploitation of land occurs. Empirics of tax density for Polish communes fails to observe diseconomies of scale according to population density. There is a very parallel structure of elasticity of tax density for different features of tax jurisdiction, excluding for urban tax jurisdiction two attributes: tax revenues per capita (no statistical significant evidence of elasticity) and area (in contrast to another types of communes elasticity is positive).

Introduction

Research on regional and local taxation divergences in the field of public economics has been based primarily on the exercise of the tax revenues per capita. Spatial economics of taxation, notwithstanding, requires consideration of the applicability of the novel measure: density of taxation. The paper provides the attributes of the index in question and the empirical application of its decomposition. The paper presents the results of and comments on the study on the degree of diversification and determinants of the density of land taxation across Polish communes. Further investigation concerns introducing distance between communes into the study of spatial inequality of tax revenues and the development of tax density for welfare economics.

Taxation density remains a proposal for developing an indicator to evaluate the fiscal efficiency of taxes, calculated in relation to the size of tax jurisdiction measured rather by the area of its territory than by the number of its taxpayers or inhabitants. In this sense, the interpretation and decomposition of the indicator taking into account beside tax revenues also area is located within the scope of both public economics and regional economics. Public economics that studies the economic conditions and consequences of taxation could be interested in the outcomes of the study of the determinants of taxation density as a means for analysing the spatial distribution of tax revenues. The regional economics could treasure in the density of taxation as an indicator illustrating the impact of decisions in the field of spatial development on tax revenue.

Literature review

The subject of the study falls within the broadly understood issues of public sector economics. The issues of the territorial distribution of tax revenues are addressed primarily in terms of the analysis of the differentiation of local tax jurisdictions in terms of the efficiency of local taxes, which is a derivative of the adopted model of the division of tax powers. To a large extent, the conducted empirical research is used to assess the impact of separating the most efficient consumption and income taxes as the revenues of the central government and the corresponding need to finance local government by means of subsidies and subsidies.

In the literature, the measurement of the revenue efficiency of local taxes is based, firstly, on determining their share in the total revenue of local budgets, and secondly, by calculating the level of tax revenue per capita. In the case of the first indicator (the share of local tax revenues in total revenues), comparing its level among different tax jurisdictions enables to determine the territorial distribution of fiscal independence of local authorities. Such comparisons may also be made on an international scale. The second indicator (tax income per capita) makes it possible to determine the extent to which residents are burdened with local taxes. The differentiation of its level between territorial units indicates the dependence of the tax system on the socio-economic characteristics of local communities.

The originality of introduced approach to examining the revenue efficiency of taxes is related to the credence in the cognitive utility of concerning the investigation of the amount of tax revenue gained by local authorities with the size of the territory enclosed by the tax jurisdiction. The theoretical foundations of research on territorial differentiation in fiscal ability as geography of payment for public goods can be found in the still inspiring monograph on the geography of public finances (Bennett, 1980). In monograph, the issues related to taxation were also associated with the geography of revenue incidence.

Although neither public economics nor regional economics directly address the issues of taxation density, there are papers in which other density indicators are examined and analysed. Starting form a bulk of methods to draw population density as a function of the distance from centre of city and for approximate empirically observed population density, especially detailed discussion is provided by (Mills, 1970) as well as by (Nairn & O'Neill, 1988). Most often, these concern population density, in particular its impact on the structure and openness of the economy (Keesing & Sherk, 1971). Population density have been address of seminal paper (Solow, 1972), where an residential density most depends on distance from the central business district, but also on the density of traffic. Other studies address the issue of the optimal division of the city territory into areas for business, residence and transport, introducing the concept of density of traffic that is the ratio of the number of travellers to the amount of land used for transportation (Sheshinski, 1973). Housing density is the next index introduced to study mixture of land – property – developments

taxation, Peng and Ping (2009) develop a competitive spatial equilibrium model and conclude that a globally optimal tax scheme in the housing market is always to eliminate the property tax and to impose a lower gross revenue tax rate than either the development or the land tax.

There is a wide range of theoretical as well as empirical studies related to the influence of land taxation on population density, in particulars focused on how property tax rates might affect building footprint and height decisions of developers (England & Ravichandran, 2010). Some authors focus on the problem of the impact of the differentiation of pre- and post-development tax rates on the timing of development, and find the property tax rates are non-neutral in most cases, accelerating or delaying development (Anderson, 1986). Another authors observes that increase in the property-tax rate on raw land accelerates land conversion, but with uniform tax rates before and after conversion, increase in the tax rate delays land conversion (Capozza & Li, 1994).

Another example of connecting public finance and population density is the analysis of fiscal capacity projected by Akin (1973), who in function of actual tax revenue per capita take into account two kinds of factors: related to taste and connected with cost. Respectively taste are measured by: median years of education completes of adults over 25 years of age, percentage of adjusted gross income going to person in adjusted gross income classes below USD 4,000, and percentage of the population under age 15 or above age 65; cost are because of two factors calibrating the tax base: population and population density. At the same time, the estimation of the parameters of the function allowed for the formulation of conclusions that while population size tends to increase actual tax revenue per capita confirming diseconomies of scale, population density tends to produce decreased actual revenue per capita, which expresses the occurrence of economics of density.

In the field of real estate economics there are discussion concerned with the influence of the scheme of taxation of land and improvements (two-rate property tax regimes or graded property tax systems) on the timing (speed) and capital intensity (density) of development with origins from (Breuckner, 1986). Turnbull (1988) examines the land and improvements tax effect on development and structural density at urban fringe. Anderson (1999) investigates and discusses the shifting from uniform property tax to a graded land-improvements tax and finds that holding tax revenue constant, the fiscal effect depends on the relationship between capital and development time in the land developer's profit function. There is also empirical approach to study the influence of the implementation of two-rate property tax scheme on residential density (Cho et al., 2013).

The size of tax jurisdiction is under investigation because of the impact of decentralization or fragmentation process on competitiveness of state or local government. In details, transmission channels of fiscal federalism on the size of government is theoretically discussed and empirically investigated on the example of Swiss municipalities by Feld et al. (2010). The size of tax jurisdiction is crucial because

its confluence with agglomeration effect in constitution of the power of subcentral government to compete for tax revenues (Blöchliger & Pinero-Campos, 2011). Liberati and Sacchi (2013) investigate the relationship between fiscal federalism and the size of local government and find that tax decentralization organized on tax bases used separately by local government (tax-separation) would restrain local public expenditures (size of local government) further than tax-base sharing scheme of tax decentralization.

Research method

Density of taxation for study of spatial economics of taxation

Based on the model developed by Walasik and Gałuszka (2017), tax density will be discussed because of its relation to both the size and the magnitude of tax jurisdiction, as well as the power of tax jurisdiction. In order to analyse the determinants of tax density, it is assumed that the research population will be constituted by communes, being both basic units of territorial division and units of local tax authorities with legal power to tax land and improvements. Brueckner (1986) in his seminal paper provides index of capital (improvements) per acre of land for detailed analysis of the impact of the twist form standard tax system (where tax rates on land and on improvements are the same) into graded tax system (where they are different) on rental prices of land and capital respectively. Index in question is discussed as a measure of land-use intensity, density of taxation could be interpret in similar manner as a measure of land-use taxation intensity. Paper is for the proof of the hypothesis that the growth of tax jurisdiction is in relation to the higher density of land and development taxation across Polish communes.

Different local jurisdictions can be simply compared by reference to their size in terms of simple: population or area, as well as to population density, but also by reference to fiscal attributes such as total tax revenues, per capita taxes, and finally brand new tax density. Hence, each of tax jurisdiction would be defined by three basic attributes:

– number of inhabitants POPUL,
– size of territory AREA (hectare),
– total tax revenues TOT.TAX (zloty),

which constitute its size and supplemented by three attributes derived from above:

– population density POP.DEN (inhabitants per sq. km),
– tax revenues per capita TAX.CAP (zloty per capita),
– tax density TAX.DEN (zloty per hectare).

The size of territory AREA seems to be obvious feature of the tax jurisdiction size if density of land taxation is discussed. Simply any jurisdiction may levy a tax on all land situated within its boundaries, more the detail that the land is the prop-

erty of a non-resident does not withdraw it from taxing power of the sovereign of situs (Beale, 1919). The local community constitute self-government, and the number of inhabitants POPUL should be taken into consideration as the demographic index of tax jurisdiction size. The age-structure of local community have played increasing role, because of population aging creates new long-term fiscal challenges for sub-central governments (Kim & Doughert, 2020). Consequently, if AREA is spatial index of tax jurisdiction size, POPUL would be demographic one. The next index of tax jurisdiction size is fiscal one, and it is because of the aim of paper total tax revenues from land, real estate and development taxation. Hene, TOT.TAX is defined as commune revenues collected from land and real estate taxation, it is the sum of agricultural tax AGR.TAX; forest tax FOR.TAX, and real estate tax RES. TAX. Hence:

$$TOT.TAX = AGR.TAX + FOR.TAX + RES.TAX$$

The significant differentiation of the structure of land, property and development taxation across type of commune shows Table 1.

Table 1. The share of particular taxes in total tax revenues TOT.TAX across Polish communes

Tax	All communes	Urban communes	Urban-rural communes	Rural communes
AGR.TAX	aver. = 17.29% min. = 0.00% max. = 82.51% 1Q = 3.86% 2Q = 12.90% 3Q = 25.93%	aver. = 0.88% min. = 0.00% max. = 12.94% 1Q = 0.18% 2Q = 0.42% 3Q = 0.92%	aver. = 13.91% min. = 0.00% max. = 64.08% 1Q = 4.88% 2Q = 10.44% 3Q = 19.99%	aver. = 21.98% min. = 0.02% max. = 82.51% 1Q = 7.86% 2Q = 19.19% 3Q = 31.90%
FOR.TAX	aver. = 3.35% min. = 0.00% max. = 50.07% 1Q = 0.51% 2Q = 1.81% 3Q = 4.46%	aver. = 0.21% min. = 0.00% max. = 5.01% 1Q = 0.01% 2Q = 0.04% 3Q = 0.16%	aver. = 2.64% min. = 0.00% max. = 22.26% 1Q = 0.65% 2Q = 1.63% 3Q = 3.65%	aver. = 4.28% min. = 0.00% max. = 50.07% 1Q = 1.02% 2Q = 2.69% 3Q = 5.61%
RES.TAX	aver. = 79.36% min. = 0.00% max. = 100.00% 1Q = 69.09% 2Q = 82.89% 3Q = 93.37%	aver. = 98.91% min. = 85.56% max. = 100.00% 1Q = 98.76% 2Q = 99.45% 3Q = 99.73%	aver. = 83.44% min. = 30.15% max. = 99.83% 1Q = 76.75% 2Q = 86.72% 3Q = 92.77%	aver. = 73.73% min. = 0.00% max. = 99.95% 1Q = 62.91% 2Q = 76.60% 3Q = 87.65%

aver. – average share of revenues from particular tax in sum of tax revenues from agricultural tax, forest tax and real estate tax
min. – minimal share of revenues from particular tax
max. – maximum share of revenues from particular tax
1Q / 2Q / 3Q – the first, second (median) and third quartile of share of revenues from particular tax, respectively

Source: Author's own study based on (BDL, 2023).

The detailed analysis of the statistics of the structure of tax revenues in question across 2,477 Polish communes (Table 1) indicates only eight communes with extreme shares in TOT.TAX. The first one there is the city of Lubin with zero revenues from AGR.TAX and FOR.TAX, hence for the column "All communes" and "Urban communes" there are minimum at 0%, and respectively there are maximum at 100% for REL.TAX. Among 652 urban-rural communes, there are two communes with zero revenues from particular taxes, respectively from FOR.TAX in commune Błonie, and AGR.TAX in commune Jastarnia. It makes minimum at 0% in column "Urban-rural communes". At the end, among 1,523 rural communes, there are five communes with zero revenues form particular taxes, respectively one commune Chełmiec, where there is no revenues from RES.TAX and four communes: Cedry Wielkie, Gręboszów, Gać, and Suchy Dąb, where there are no revenues from FOR. TAX. And, it is reported as minimum at 0% in column "Rural communes". The modest number of municipalities with extreme tax revenue distributions (0.3% of the research population) would not affect the study of the relationship between the size of tax jurisdiction and tax density. The discussion of the distribution of the density of taxation TAX.DEN across Polish communes will be based on:

$$\text{TAX.DEN} = \frac{\text{TOT.TAX}}{\text{AREA}}$$

by definition, and on the study of correlation between another attributes of TAX. JUR and TAX.DEN. Supplementary the estimation of linear regression functions for each of the attributes of tax jurisdiction as independent variable, and TAX.DEN as dependent variable. The analysis of the taxation density distribution statistics (values of the function) will be provided at start.

The research will be provided for population of N.TOT = 2,477 Polish communes, and for comparison the study will be complemented respectively for three subpopulations according to three types of communes, i.e. N.URB = 302 urban communes, N.URU = 652 urban-rural communes and N.RUR = 1,523 rural communes.

Results

The statistics of tax density across Polish communes

The core of investigation is the analysis of the relationship between the size of the tax jurisdiction and the density of taxation. Therefore, at very beginning a statistical description of the research population in terms of the distribution of taxation density should be discussed. Table 2 presents basic statistics of taxation density for the entire population covering all communes and three subpopulations: urban communes, urban-rural communes and rural communes.

Table 2. Statistics of tax density TAX.DEN for Polish communes

Attribute	All communes	Urban communes	Urban-rural communes	Rural communes
Number	2,477	302	652	1,523
Mean	1,487.04	8,227.01	761.53	461.14
Median	372.10	7,693.57	452.05	260.97
Minimum	40.71	377.96	76.33	40.71
Maximum	32,419.57	32,419.57	7,873.20	11,983.98
Standard deviation	3,181.92	5,165.00	931.05	729.20
Coefficient of variation	2.14	0.63	1.22	1.58
Skewness	3.70	0.96	3.53	7.09
Kurtosis	16.25	1.60	15.59	74.12

Source: Author's own study based on (BDL, 2023).

The study of the taxation density shows a far-reaching differentiation of statistics for types of communes. The mean taxation density, which could be expected due to the greater fiscal efficiency of the real estate tax, occurs in urban communes with tax revenues PLN 8,277.01 per hectare, and it is almost thirty times higher than in the case of taxation density in rural communes. The range of taxation density is the lowest for urban-rural communes and amounts to PLN 7,796.87 per hectare; the highest spread occurs in the case of urban communes, for which it amounts to PLN 32,041.61 per hectare. For rural communes, the range is PLN 11,943.27 per hectare. Though, when referring the indicated values to average values, the relative range is the largest for rural communes, for which the range is 25.90 times higher than the mean value of taxation density. The lowest ratio is in the case of urban communes, for which the span is relatively higher than the mean value by 3.89 times. In the case of urban-rural communes, this ratio is 10.24. The differences in coefficient of variation proof conclusions.

Detailed analysis of tax density is for the study of both the deviation of the distribution from symmetry (skewedness) and the its peakedness. The analysis of statistics enables to notice that distributions of tax density are both asymmetrical and leptokurtic for each of commune type. According to the type of communes, the distributions of tax density are nothing but positive skew. It shows the mass of distribution is concentrated for lower level of tax density; but the greatest concentration is for rural communes, the smallest one is for urban communes, and it is approximately equal to one, what indicates half-normal distribution. Distributions of taxation density for population of all communes as well as each of three subpopulation because of type of communes have sharper peak around the mean with longer, fatter tails. But kurtosis is radically higher for rural communes than for urban ones. To find discuss the attributes of the distribution of tax density, there is Table 3, where skewness and kurtosis for tax density distribution could be compared with analogous statistics for the distribution of total tax revenues TOT.TAX and respectively distribution of tax revenues per capita TAX.CAP and population density.

Table 3. The comparison of skewness and kurtosis

Attribute	All communes	Urban communes	Urban-rural communes	Rural communes
Skewness				
TAX.DEN	3.70	0.96	3.53	7.09
TOT.TAX	19.39	7.51	3.11	10.99
TAX.CAP	20.53	3.78	3.29	20.62
POP.DEN	3.88	0.99	3.43	3.40
Kurtosis				
TAX.DEN	16.25	1.60	15.59	74.12
TOT.TAX	532.95	76.23	14.42	196.47
TAX.CAP	706.32	22.13	16.92	616.22
POP.DEN	17.79	1.60	15.99	15.27

Source: Author's own study based on (BDL, 2023).

It can be observed that in the case of urban-rural communes there is the greatest likeness between the distribution of taxation density and the distribution of other characteristics of the tax jurisdiction, both in terms of skewness and kurtosis. Significant differences can be noted in the case of the population of all communes and subpopulations of rural communes. In both cases, the distributions of total tax revenues and tax revenues per capita are more skewed in relation to the tax density distribution, and the same applies to kurtosis, which means a greater peakedness than it is for tax density distribution. An interesting observation is that in the case of urban communes there are the greatest differences in the shape of the distribution of taxation density and total tax revenues, but a smaller scale of differences occurs when comparing the distribution of taxation density and tax revenues per capita. On the other hand, both skewness and kurtosis in urban communes estimated for tax density are very close to the corresponding statistics for population density. It minds that in urban areas there is a strong association between growth of population and increasing revenues from land taxation. Similar relationships between the distribution of taxation density and population density occur in the case of the population of all communes and subpopulations of urban-rural communes. For rural communes, both skewness and kurtosis are higher for tax density than for population density.

Discussion

The coincidence of tax density and the size of tax jurisdiction

For all attributes of tax jurisdiction size (population, area and total tax revenues) there are statistical significance correlation with tax density. But there are negative corelation between tax density and area, and positive one with population as well as total tax revenues. For coincidence of tax density with relative power of tax jurisdic-

tion attributes (population density and tax revenue per capita), except tax revenues per capita for subpopulation of urban communes, there are strong statistical significant correlation with tax density (Table 4).

Table 4. Correlations of tax density TAX.DEN for Polish communes

Variable	All communes	Urban communes	Urban-rural communes	Rural communes
POPUL	r = 0.512676* t = 29.7063	r = 0.458781* t = 8.9430	r = 0.588895* t = 18.5768	r = 0.473269* t = 20.9526
AREA	r = -0.296929* t = -15.4697	r = 0.273852* t = 4.9318	r = -0.277760* t = -7.37159	r = -0.225148* t = -9.0122
TOT.TAX	r = 0.546906* t = 32.4993	r = 0.487809* t = 9.6788	r = 0.780768* t = 31.8583	r = 0.799280* t = 51.8719
POP.DEN	r = 0.936607* t = 132.9850	r = 0.847858* t = 27.6965	r = 0.783466* t = 32.1426	r = 0.679880* t = 36.1578
TAX.CAP	r = 0.159676* t = 8.0471	r = 0.031632 t = 0.5482	r = 0.501079* t = 14.7620	r = 0.569367* t = 27.0110

* marked correlations are significant at $p < 0.05$

Source: Author's own study based on (BDL, 2023).

Estimated coefficient of corelation enables to observe that the strongest coincidence there is for population density. For all communes we can observe approximately linear correlation (r = 0.94). It proofs that population density could be accepted as statistics for the spatial concentration of economic activity, and especially in the context of urban concentration there is wide scope of the economics of urban density (Duranton & Puga, 2020), with the seminal paper (Henderson, 1974) where optimum city size is found on the paths of utility and capital rent and determined by maximizing welfare. The strong correlation between POP.DEN and TAX.DEN evidences the higher improvements in relation to the same land following the growth of population (because of migration or natural increase). Polish system of land taxation differs not only tax rates because of forest, agriculture, and dwelling purpose of land; but what more crucial there are preferences for land taxation in relation to the improvements taxation. Hence, tax density is the most correlated with population density for urban communities (r = 0.8479), and the weakest correlated for rural communities (r = 0.6799). Population density was indicated by Blase and Staub (1971) as one of fifth statistically significant determinants of property tax per acre for farms in Kansas City rural-urban fringe, next to number of acres on sample farm, farm owner's estimate of the price per acre of comparable farm, age od house on sample farm, and distance from highway leading for Kansas City. On the base of the case study of 279 Northeastern New Jersey municipalities, Beck (1965) finds population density as determinant of effective property tax rate, beside property density (real property per square mile), all taxable property per capita, and municipal expenditures per capita. The demographic attribute of tax jurisdiction (population) is in positive correlation with tax density, in reverse to the spatial attribute of tax jurisdiction size

(area). Area is in negative correlation with tax density for all communes, and out of urban communities, for all subpopulation of communes.

For detailed analysis of coincidence of tax density and attributes of tax jurisdiction the estimation of parameters of linear regression has been provided. Table 5 presents results of linear regression estimation of:

$$TAX.DEN = a + bX + \varepsilon$$

where *X* is for particular attribute of tax jurisdiction, respectively: POPUL population (number of inhabitants); AREA area (hectare); total tax revenues (thousands of PLN) TOT.TAX × 10^{-3}; population density (inhabitants per squared km) POP.DEN; and tax revenue per capita (PLN).

Table 5. Parameters of linear regression for dependent TAX.DEN

Independent X	All communes	Urban communes	Urban-rural communes	Rural communes
POPUL	a = 1,009.4562* t = 17.6452 b = 0.0312* t = 29.7063	a = 7,214.6740* t = 25.0744 b = 0.0168* t = 8.9430	a = 11.2427 t = 0.2248 b = 0.0545* t = 18.5768	a = -57.7898 t = -1.9431 b = 0.0733* t = 20.9526
POP.DEN	a = 63.8368* t = 2.5709 b = 6.6315* t = 132.9850	a = 1,381.6084* t = 4.7113 b = 5.8364* t = 27.6965	a = 15.6637 t = 0.4828 b = 7.3194* t = 32.1426	a = -39.5353* t = -2.0292 b = 6.8732* t = 36.1578
AREA	a = 3,001.5666* t = 26.0137 b = -0.1200* t = -15.4697	a = 7,086.1793* t = 19.2511 b = 0.2428* t = 4.9318	a = 1,265.8697* t = 16.4666 b = -0.0304* t = -7.3716	a = 770.1549* t = 19.8368 b = -0.0247* t = -9.0122
TOT.TAX 10^{-3}	a = 1,005.7367* t = 18.1064 b = 0.0425* t = 32.4993	a = 7,142.8667* t = 25.2402 b = 0.0231* t = 9.6788	a = 31.1632 t = 0.9638 b = 0.0701* t = 31.8583	a = 50.2561* t = 3.6564 b = 0.0879* t = 51.8719
TAX.CAP	a = 945.2816* t = 10.2426 b = 0.7812* t = 8.0471	a = 7,887.7279* t = 11.4856 b = 0.4406 t = 0.5482	a = -50.4998 t = -0.7962 b = 1.0913* t = 14.7620	a = 102.8920* t = 5.0690 b = 0.5455* t = 27.0110

a – intercept
* marked correlations are significant at $p < 0.05$

Source: Author's own study based on (BDL, 2023).

Estimation of parameters of linear regression (Table 5) makes room for the discussion of the elasticity of tax density to changes in attributes of tax jurisdiction across types of communes. It could be construct the matrix of elasticity of tax density on attributes of across the kind of tax jurisdiction (Table 6).

Table 6. The characteristic of the elasticity of tax density

Attribute of tax jurisdiction	Urban communes	Urban-rural communes	Rural communes
Population	positive (the weakest)	positive	positive (the strongest)
Population density	positive (the weakest)	positive (the strongest)	positive
Area	positive	negative (the weakest)	negative (the strongest)
TOT.TAX × 10^{-3}	positive (the weakest)	positive	positive (the strongest)
TAX.CAP	no evidence	positive (the strongest)	positive (the weakest)

(the weakest) – the lowest across types of communes
(the strongest) – the highest across types of communes

Source: Author's own study based on Table 4.

The demographics of tax jurisdiction POPUL and POP.DEN are in positive relation to TAX.DEN for all communes as well as for each of subpopulation. The influence of the change in population on the change of tax density is the greatest for rural communes, where the growth of population by 1,000 inhabitants meets the growth of tax density by PLN 16.8 per hectare. The weakest coincidence between population and tax density is for urban communes, where the change in number of inhabitants by 1,000 is for the change in tax density by PLN 3.12 per hectare. The range in the elasticity of tax density to population density is from 5.84 for urban communes by 6.87 for rural communes to 7.32 for urban-rural communes. The growth of population of 1,000 inhabitants correlates with the growth of tax density about PLN 3.12 per hectare for all communes, and ranges from PLN 16.8 per hectare for urban communes to PLN 73.3 per hectare for rural communes. Discussion of relation of spatial attribute of tax jurisdiction AREA to TAX.DEN reports the diminishing effect of the growth of tax jurisdiction. Beside urban communities, the greater area of tax jurisdiction the lower tax density, but the elasticity is very low. The marginal decline in tax density in relation to the growth of tax jurisdiction area of one square km ranges from PLN 2.47 per hectare for rural communes to PLN 3.04 per hectare for urban-rural communes. Only for subpopulation of urban communes there is positive correlation between the area and tax density, the greater urban the higher tax density is observed. In details, the growth of one square kilometre of urban area is correlated with the growth of tax density about PLN 24.28 per hectare. The observed positive and strong correlation of tax density and both population and population density could be interpret as next to indicated by Gabler (1969) confirmation of positive effects of economies of scale in public sector. The observed correlation in question could be interpret as the proof of the path of incidence the density of economic activity on the density of housing transferred by the demand for labour (Beckmann & Puu, 1985, pp. 91–95). As expected there is the impact of tax revenues TOT.TAX on tax density TAX.DEN, but the greatest not for urban communes but rural ones, what is explained by the significant differentiation of agricultural tax base because of the economic power of localization (according to Agricultural Tax Act, the fiscal calculated conversion hectare depended on qualification to one of fourth tax districts).

The inquisitive results are for the relation between tax revenues per capita TAX.CAP and tax density TAX.DEN. It is unique issue where there is no statistical significant elasticity of tax density for discussed attributes of tax jurisdiction, and it occurs for none but urban communes.

Conclusions

The literature review in the field of public sector economics, fiscal federalism and economics of taxation has indicated that the issues of study the relation between the size of tax jurisdiction and taxation density remained outside the scope of interest. Density of taxation as a measure of land-use taxation intensity could be introduced to the spatial economics of taxation. The conducted empirical research on the population of communes in Poland enables notice significant differences in the statistics of tax density depending on the type of commune. Taxation density is, on average, the highest in urban communes, which results from a significant share of land and improvements subject to property tax. In urban communes, the share of real estate tax is on average 98.91% of total revenues from taxation of land and improvements. While in rural communes, where the lowest average level density of taxation has been recorded, the share in question is on average 73.73%. It cooperates with importance for rural communes finance of agricultural tax with its many economic and fiscal disadvantages (Felis, 2015).

Examination of taxation density statistics for each of three subpopulations of communes (urban ones, urban-rural ones, and rural ones) indicates that in each case statistics of the distribution of tax density is attributed by positive skew and has sharper peak around the mean, but kurtosis is the highest for rural communes. It has been observed that the shapes of the distribution of total tax revenues, tax revenues per capita and population density are most similar to the shape of the distribution of taxation density in rural communes.

The crucial conclusion is that the most significance for tax density growth is the increase of population in accordance with population density. The greater tax jurisdiction measured by population the greater intensity of fiscal exploitation of land occurs. Empirics of tax density for Polish communes fails to observe diseconomies of scale according to population density, hence it is incapable to draw Hotelling style model of saturation tax density (Puu, 1989). There is a very similar scheme of elasticity of tax density for different attributes of tax jurisdiction, excluding for urban tax jurisdiction two attributes: tax revenues per capita (no statistical significant evidence of elasticity) and area (in contrast to another types of communes elasticity is positive).

Further investigation would concern on introducing distance between communes into the study of spatial inequality of tax revenues and the development of tax density for welfare economics and adopt the concept of tax gradient (Agrawal, 2015) for more detailed investigation of spatial economics of tax density.

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