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THE ECONOMIC DISTRIBUTION AND ELASTICITY OF THE TAX BURDEN IN REAL ESTATE MASS APPRAISAL: AN ECONOMETRIC APPROACH

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Abstract. The thesis provides an econometric analysis of the economic consequences of the transition from inventory value to an ad valorem taxation system based on cadastral (market) value – namely, the distribution of the tax burden across value segments and the elasticity of the tax base with respect to market price growth. Building on the tax capitalization hypothesis, it is argued that the relationship between assessed value and market price can be estimated by including a tax variable within a hedonic regression. To measure the fairness of the distribution, the coefficient of dispersion (COD) and the price-related regressivity/progressivity indicators (PRD, PRB) used in mass appraisal practice are examined; a conditional numerical example illustrates how they reveal a systematic difference in the relative assessment level of high- and low-value properties – a state of regressivity. A methodology for estimating the elasticity of the tax base with respect to market price growth via log-linear regression is also proposed. The findings contribute a set of econometric tools that allow quantitative monitoring of horizontal and vertical equity principles in improving the cadastral valuation system.

Keywords: real estate, tax burden, tax incidence, capitalization hypothesis, COD, PRD, PRB, regressivity, elasticity, hedonic regression, mass appraisal.

The shift from inventory value to a cadastral value brought closer to market

value fundamentally changes not only the appraisal methodology but also the economic distribution of the tax burden. Under the old system, virtually all properties were assessed using nearly identical criteria – replacement cost adjusted for physical depreciation – so the real market-value gap between properties in prestigious and outlying areas was not reflected in the tax base at all. Understanding the economic substance of the new system requires two classical theoretical foundations: tax incidence (who actually bears the tax burden) and the hypothesis of tax capitalization into asset prices.

Table 1 summarizes the economic meaning of the level of cadastral value and its impact on the budget. It is evident that a low or high cadastral value is not merely a technical indicator but a direct economic indicator of a territory's tax potential and degree of budgetary self-sufficiency.

Table 1.

Economic meaning of cadastral value levels and their impact on the budget

Level of cadastral value	**Economic meaning**	**Impact on the budget**
Low cadastral value	Characterizes an insufficient tax potential of the territorial structure.	Corresponds to the budget's lack of its own revenue base for the type of use being analyzed.
High cadastral value	Reflects a high tax potential and a developed market.	Ensures high tax revenues and growth of the budget's own revenue base.

Source: the author's thesis "Increasing the Efficiency of the Real Estate Market through the Assessment of the Market Value of Real Estate Objects."

How closely the cadastral value approximates market value depends, in turn, on the appraisal method used. Table 2 shows the main differences between individual and mass appraisal approaches; it is precisely the statistical-modeling nature of mass appraisal that creates the need to analyze the economic distribution of the tax burden using econometric tools.

Table 2.

Comparative analysis of individual and mass appraisal methods

Criterion	Individual appraisal	Mass appraisal
Object	A single, specific property	A group of properties (thousands of units)
Purpose	Sale/purchase transaction, loan collateral	Taxation, cadastral accounting
Method	Direct inspection and analysis of the property	Statistical modeling and databases
Time and cost	High per property	Low per unit, but the system itself is costly to build
Quality control	Review of expert opinion	Statistical tests (regression error, dispersion)

Source: the author's thesis "Increasing the Efficiency of the Real Estate Market through the Assessment of the Market Value of Real Estate Objects."

According to the capitalization hypothesis, a property tax expected to be paid in the future is taken into account by a rational buyer and is therefore partially or fully reflected (negatively) in the property's market price. In other words, the market price of a property in a high-tax-rate area is expected to be lower than that of an otherwise identical property in a low-tax area. To test this hypothesis econometrically, a tax rate

or tax amount variable is added directly to the hedonic price model; if the coefficient of this variable is statistically significant and negative, this indicates confirmation of the capitalization hypothesis.

The author's previously built Cobb-Douglas hybrid model has exactly this kind of multi-factor structure, in which coefficients were separately estimated for groups of legal, physical, locational, and local characteristics (Table 3). This structure can be extended to test the capitalization hypothesis by adding a tax or tax-rate variable as a fourth group, since the model has already demonstrated the ability to separately estimate the effect of local characteristics (such as government offices, shopping centers, transport infrastructure).

Table 3.

Example: coefficients of the local-characteristics group in a multi-factor model

Criterion	Coefficient	t-statistic	Significance (Sig.)
Shopping centers	-0.042	-2.787	0.006
Cultural centers	-0.073	-2.243	0.025
Transport infrastructure index	0.112	5.957	0.000
Neighborhood index	0.066	3.853	0.000

Source: the author's article "Applying the Cobb-Douglas Hybrid Model for the Mass Appraisal of Real Estate Value."

The coefficients in Table 3 indicate that local infrastructure factors have a statistically significant effect on price and that this effect can be reliably estimated. If a tax variable were introduced within the same structure, its coefficient – theoretically

expected to be negative and statistically significant – would allow the degree of capitalization to be measured directly, in percentage points.

In the matter of tax-burden distribution, the main focus is on the principle of vertical equity – that is, whether high- and low-value properties are assessed with relatively equal accuracy. To illustrate this, consider a conditional numerical example: a hypothetical sample of five properties with their market values and corresponding cadastral values is shown in Table 4.

Table 4.

Conditional example: dependence of the assessment ratio on price segment (illustrative, not real data)

Property	Market value, mln soum	Cadastral value, mln soum	Assessment ratio (cadastral/market)
1 (low-value)	200	190	0.95
2 (low-value)	260	255	0.98
3 (mid-value)	400	380	0.95
4 (high-value)	800	680	0.85
5 (high-value)	1,200	960	0.80

Source: a conditional (hypothetical) example constructed by the author to illustrate the COD/PRD calculation mechanism.

The conditional data in Table 4 can be used to illustrate the calculation logic of the COD and PRD indicators. The average assessment ratio is (0.95+0.98+0.95+0.85+0.80)/5 = 0.906; the COD indicator is calculated as the average absolute deviation of each ratio from the average, expressed as a percentage of the average ratio, and in this example amounts to roughly 7–8 percent (under the IAAO standard, a range of 5–15 percent is considered acceptable for residential property).

However, COD alone does not indicate the direction of the distribution. The PRD indicator – the simple average ratio divided by the value-weighted average ratio – is used precisely for this purpose: if low-value properties are assessed at a higher ratio (0.95–0.98) while high-value properties are assessed at a lower ratio (0.80–0.85), PRD comes out significantly above 1, which indicates regressivity – i.e., owners of lower-value housing bear a relatively higher tax burden. This type of systematic difference is noted in many countries as the most frequently criticized shortcoming of mass appraisal systems, and the IAAO Standard on Ratio Studies designates it as a specific subject of monitoring.

To calculate these indicators, in addition to static ratio analysis, a regression-based approach is also used: here, the ratio of assessed value to market price is the dependent variable, and market price itself (or its logarithm) is the independent variable. If the slope of this regression line is statistically different from zero, this indicates that the assessment ratio depends on the price level, i.e., systematic regressivity or progressivity. Unlike the traditional PRD calculation, this approach is less sensitive to outliers and also allows a confidence interval to be computed – which is especially important in small samples such as the one in Table 4, since a single outlier can substantially distort a static PRD result.

A second important indicator for understanding the economic dynamics of the tax base is its elasticity (buoyancy) with respect to market price growth. If the cadastral value lags behind market price growth (elasticity below one), budget revenues decline in real terms despite real price growth; if values are not updated in a timely manner, this effect intensifies over time. Elasticity is estimated using the regression coefficient between the logarithms of the cadastral value index and the market price index, which follows the same logic as the standard method of estimating elasticity in Cobb-Douglas-type nonlinear models – just as, in the author's earlier study,

area elasticity was estimated at around 0.81 through a log-log model, the elasticity of the tax base can be calculated on the same technical basis.

The practical significance of the elasticity indicator deserves particular emphasis: if a study finds elasticity to be, say, 0.6–0.7, this means that when the market price rises by 10 percent, the tax base (based on cadastral value) rises by only 6–7 percent, with the remaining 3–4 percentage points "accumulating" for the next revaluation cycle. The longer this lag persists, the greater the risk of a sharp ("jump") increase for taxpayers at the time of revaluation, which in turn increases the risk of social discontent. Regular monitoring of the elasticity indicator therefore provides the quantitative basis needed to correctly design indexation policy.

Based on the above analysis, the following methodological recommendations are put forward:

adding a tax or tax-rate variable to hedonic and Cobb-Douglas-type mass appraisal models to regularly test the capitalization hypothesis;

calculating PRD and PRB indicators by price segment (quartile or decile) each quarter or half-year, tracking the dynamics of regressivity, and publishing the results in open reports;

estimating the relationship between the assessment ratio and price level via regression, supplementing the static PRD indicator with a confidence interval, especially for small samples;

annually calculating the elasticity coefficient of the cadastral value index relative to the market price index, and recommending a shorter revaluation cycle where it is found to be significantly below one;

linking identified cases of regressivity or declining elasticity to regional socio-economic indicators (income level, housing provision) to assess the social impact of tax policy.

In conclusion, the economic soundness of a taxation system based on mass appraisal is determined not only by average assessment accuracy but also by how the tax burden is distributed across different value segments and by how this distribution changes over time. A set of econometric tools grounded in the capitalization hypothesis, regressivity indicators, and elasticity analysis – together with the multi-factor regression infrastructure already tested in the author's earlier hedonic and Cobb-Douglas studies – enables quantitative monitoring of the economic fairness of Uzbekistan's ad valorem tax system.

Foydalanilgan adabiyotlar ro‘yxati:

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