EVALUATION OF SOCIO-ECONOMIC IMPACT OF LATVIAN MUNICIPAL ADJUSTMENT FUND WITH REGRESSION DISCONTINUITY DESIGN MODEL

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Abstract. The arrangement of the Latvian Municipal Adjustment Fund encompasses the concept of the average annual revenue of conditional inhabitant, where the original population numbers are modified by adding conditional values based upon the number of children, schoolchildren, retirement age persons and area of the municipality. Besides that, the annual corrections are based on the average assessed revenues. Depending upon the value of the average annual revenue of conditional inhabitant relative to national average cut-point, districts are defined as donors or recipients. As the main objective of the adjustment is the provision of the basic functions, the socio-economic impact of the adjustment has not been extensively studied. The research objective is the evaluation of the net direct impact of the adjustment on the socio-economic variables such as Gross Domestic Product, Gross Value Added, Net Migration and Social Payments both at the local and national level. To reach the research objective, the Regression Discontinuity Design method is applied. The method compared to other quasi-experimental design methods has its advantages, as additional pre-treatment variables are not needed. Moreover, the values of the dependent variable are measured only once at a single point of time. The results of the research at the micro level show that the adjustment at the national level contributes to the decline in Gross Domestic Product and Gross Value Added, increase in Net Migration and Social Payments burden. While the average impacts on the recipient district are positive for all socio-economic indicators concerned the negative impacts on the donor districts more than outweigh these gains. This would suggest that the revenue equalization funding has to be revised to avoid the negative socio-economic consequences in the future.

Keywords: revenue equalization, regression discontinuity design, treatment effect, socio-economic impact.

Introduction

Equalization of local government finances is the redistribution of local government revenues and state budget grants to create similar opportunities for local governments to perform the basic functions like utilities, security, road maintenance, operations of educational and cultural institutions and provision of social services. The arrangement of the Municipal Adjustment Fund (MAF) for Latvian administrative divisions has been effective from 2015. It has been based on average annual per capita revenues with the original population numbers modified by adding conditional values based upon the number of children, schoolchildren, retirement age persons and area of the municipality. Depending upon the level of revenues relative to the national average, districts qualify either for being a donor or a recipient. After the territorial reform of the 2021, in 2022 there were 16 donor districts and 27 recipient districts in Latvia. Besides transfers from MAF, large amounts of transfers to municipalities are either earmarked state transfers or EU transfers, which often are earmarked, too. As the equalization is aimed to provision of the basic local functions, the broader impact of the financial adjustment on socio-economic indicators has not been extensively studied in the academic research so far. According to Orz et.al. (2020) [1], in Latvia the partisan alignment of a municipal government with the ruling parliamentary coalition increases the amount of EU transfers received by the municipality and might increase the amount of discretionary earmarked transfers received as well. This is not the case with the equalization as here the exact amount of transfers is established by a transparent algorithm.

Fiscal equalisation mechanisms across local governments are managed in both neighbouring Baltic States, too [2]. In Lithuania, transferring of the resources to less wealthy municipalities is based on peronal income tax (PIT). Similar to Latvia, PIT from a few predominantly city donor municipalities is used to support rural municipalities. In Estonia, an equalisation fund exists. The exact amount transferred from the fund to each local government is defined in the yearly state budget negotiations and is based on two major principles: an average expense need based on population size and age structure, and the weighted lagged accounting revenues of each local administration.

The research objective is to evaluate the net direct impact of the financial equalization on the indicators such as Gross National Product, Gross Value Added, Social Welfare Contributions and Net Migration at both the local government and national level.

To reach the research objective, Regression Discontinuity Design (RDD) model method is considered appropriate as the average national district revenue creates a useful threshold value for the cutpoint necessary for the model. RDD first was applied in the evaluation of the USA national college student scholarship programs by Thistlewaite and Campbell in 1960 [3] by matching two groups of near winners in a competition on several background variables. After that the method was somewhat disregarded until it was enlivened by Goldberger [4] in the analysis of compensatory school educational programs. The method compared to other quasi-experimental design methods has its advantages, as additional pre-treatment variables are not needed. Moreover, the values of the dependent variable are measured only once at a single point of time. Nevertheless, similarly to other methods data on untreated units are necessary which almost always prove to be a problem. Traditionally, support programmes require only data on participants. The method also could yield results with low statistical significance if there is no marked change in the dependent variable at the cutpoint. Usually analysis begins with an examination of the scatterplot of the outcome variable and rating variable. In most cases, the relationship between these variables is non-linear. With respect to populations, two types of design can be distinguished (Battistin and Rettore, 2008) [5]. In the "sharp" design all units on both sides of the cutoff either receive or do not receive their treatment, thus the treatment variable is binary. In the Type I "fuzzy" design, there are units in the treatment group which do not receive treatment referred to as "no-shows". In the Type II "fuzzy" design, there are both "no-shows" and units in the control group, which receive treatment referred to as "crossovers". In the "fuzzy" design, treatment is assigned based upon the probability of receiving the support. Then the probabilities are calculated as the share of receivers within the treatment or control groups. As a rule, RDD analysis begins with an examination of a scatterplot with an outcome variable plotted on the vertical axis and the independent or rating variable plotted on the horizontal axis. The scatterplot shows whether there is a discontinuity in the outcome variable at the cutoff point. The observed discontinuity justifies further analysis.

Materials and methods

Data on the average annual adjusted per capita revenues in 43 Latvian territorial units in 2022 were retrieved from the Latvian Association of Local and Regional Governments website [6]. Data on the selected socio-economic indicators for 43 Latvian territorial units in 2022 were retrieved from the National Statistics database [7].

Bloom (2012) [8] suggests two types of strategies for the correct specification of the functional form of the model. The parametric or global strategy uses all observations in the sample. The nonparametric or local strategy uses only the observations that lie in the vicinity of the cutpoint (called a bandwidth).

The rating variable can be cantered on the cutpoint by including a new variable $x_i - c$ in the model. Then the most common approach to estimation using RDD can be expressed with the equation:

$$y_i = \beta_0 + \sum_{i=1}^{m} \beta_{1m}(x_i - c)^m + \beta_2 t_i + \sum_{i=1}^{m} \beta_{3m}(x_i - c)^m t_i + \varepsilon_i, \quad (1)$$

where $\beta_0, \beta_1, \beta_2, \beta_3$ – regression coefficients;
$y_1, \dots, y_n$ – vector of the dependent variable;
$x_1, \dots, x_n$ – vector of the independent variable;
$t_1, \dots, t_n$ – vector of the treatment variable;
$\varepsilon_1, \dots, \varepsilon_n$ – vector of residuals;
c – cutoff point;
n – number of observations;
m – polynomial degrees.

The coefficient β_2 shows the average treatment effect on the treated (ATT). Usually, only linear and second-order polynomial models are applied. Gelman and Imbens [9] think that higher order polynomial regressions are a poor choice in regression discontinuity analysis because imprecise estimates due to noise, sensitivity to the polynomial degree, and inadequate coverage of confidence intervals.

Huntington-Klein [10] recommends the use of local regression to obtain “smoothed” values of the dependent variable for the estimation with the linear or polynomial model. The locally weighted polynomial regression method (LOESS) was originally proposed by Cleveland in 1979 [11]. The set of the independent variable is divided into subsets using a “smoothing parameter” selected by the user, which shows the size of the subsets. For every value of the independent variable, a respective number of nearest neighbours are included in a subset. For each localized subset, weighted least squares regression (WOLS) introduced by Aitken in 1935 [12] is performed to find the coefficients for calculation of adjusted values of the dependent variables by simple regression. First, the distances from each point in a subset to the point of estimation are calculated. Then the distances are scaled by the maximum distance between all possible pairs of points in a subset. For calculation of the weights from scaled distances, most commonly Tukey’s tri-cube weight function (Tukey, 1977) [13] is used:

$$w(x) = \begin{cases} (1-|x|^3)^3 for\ |x| < 1 \\ 0\ for\ |x| \geq 1 \end{cases}, \tag{2}$$

After the obtaining the weights, WOLS regression is performed by the matrix equation:

$$B = (X^T W X)^{-1} X^T W Y, \tag{3}$$

where X – matrix with the independent variable in second column and first column set to one;
X^T– transposed matrix of X;
W– square matrix with weights on the diagonal and other elements set to zero;
Y– vector of the dependent variable;
B– vector of regression coefficients.

Then the vector of predicted y values $\hat{Y}$ can be expressed as:

$$\hat{Y} = B^T X, \tag{4}$$

where X – matrix with the independent variable in second column and first column set to one;
B^T– transposed matrix of B;
$\hat{Y}$– vector of predicted values of the dependent variable.

After obtaining the predicted “smoothed” values of the dependent variable from equations (3) and (4), regression is performed with the equation (1) to calculate the regression coefficients. If several models are employed, Akaike Information Criterion (AIC) (Akaike, 1974) [14] is used. AIC aims to select the model which best explains the variance in the dependent variable with the fewest number of independent variables (parameters). So it helps select a simpler model (fewer parameters) over a complex model (more parameters). AIC measures the information lost, so the model with a lower AIC score indicates a better fit. AIC is calculated by formula:

$$AIC = Nlog\left(\frac{SS_e}{N}\right) + 2K, \tag{5}$$

where N – number of observations;
K – number of parameters;
SS_e – sum square of errors.

Results and discussion

As there are no districts other than donors or recipients, “sharp” design with binary treatment variable is used in the study. The average adjusted annual revenues in 43 administrative units range from 417.12 EUR to 555.39 EUR with the national average at 469.50 EUR. The national average is considered a cutpoint with 27 units below this value being recipients and 16 units above this value being donors. The indicators selected for the research, Gross Value Added, Gross National Product, Net Migration and Social Payments are normalized before the calculations to avoid large variations in their values. Social Payments are expressed as a share of GDP, the other indicators are expressed on per capita basis. The scatterplot with the Gross Value Added per one person employed in all districts in 2022 is mapped in Figure 1.

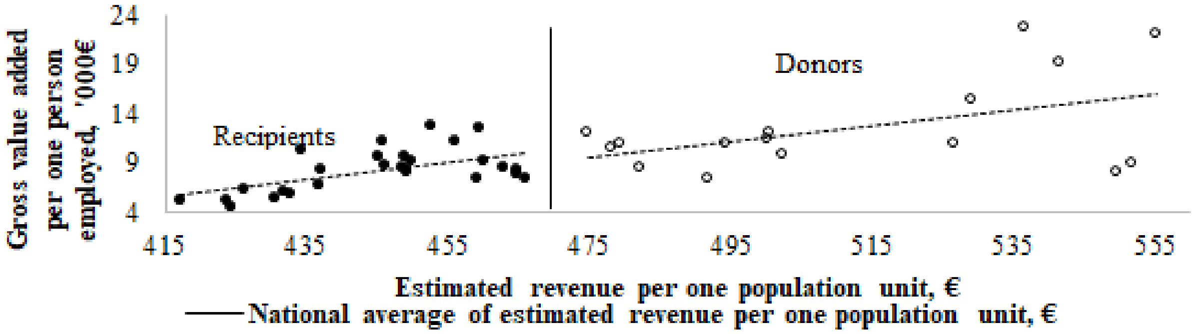

Fig. 1. **Gross Value Added per one person employed and estimated revenue per one population unit in 43 Latvian districts in 2022**

As there is a discontinuity in the outcome variable at the cutoff point (National average), the research continues with the construction of several regression models. Similarly with the Gross Value Added, discontinuity at the cutoff point can be seen for the other indicators – Gross National Product, Social Contributions and Net Migration. The number of observations is rather limited, so the parametric or global strategy is selected using all observations for modelling the outcome as a function of the rating and treatment variables. The study uses two specifications of the equation (1) - linear with interactions (m = 1) and quadratic with interactions (m = 2). Three smoothing parameters are used with values 0.5, 0.33 and 0.25. First, for all four indicators and every specification of the equation and value of the smoothing parameter, weights are calculated by formula (2), WOLS regression is performed by the equation (3) and predicted (smoothed) values of the dependent variable are calculated by the equation (4). Then the regression is performed with equation (1) to calculate the regression coefficients. After that AIC criterion is calculated by formula (5). The statistically significant values of ATT (coefficients β_2) from all 24 models along with respective AIC criterion values are shown in Table 1.

Table 1

Models with statistically significant ATT effects and respective AIC criterion values

Indicator	Model specification	Smoothing parameter	ATT effect	AIC
GDP per capita	Linear	0.5	2.09 (5.23)***	-7
GDP per capita	Linear	0.33	2.56 (6.26)***	-6
GDP per capita	Linear	0.25	1.43 (1.71)*	21
GVA per capita	Linear	0.5	1.83 (5.23)***	-12
GVA per capita	Linear	0.33	2.24 (6.26)***	-11
GVA per capita	Linear	0.25	1.25 (1.71)*	15
Net migration per capita	Linear	0.33	0.001 (4.71)***	-300
Net migration per capita	Linear	0.25	0.001 (3.08)***	-272
Social payments as of GDP	Quadratic	0.33	-1.62 (-5.13)***	-31
Social payments as of GDP	Quadratic	0.5	-1.36 (-3.8)***	-26
Social payments as of GDP	Linear	0.5	-0.79 (-3.15)***	-25
Social payments as of GDP	Linear	0.33	-0.77 (-3.06)***	-24
Social payments as of GDP	Linear	0.25	-1.06 (-1.94)*	5
Social payments as of GDP	Quadratic	0.25	-2.18 (-2.62)**	6

For further assessment, values of the treatment effect with the lowest AIC criterion scores are kept. The linear model is selected for GDP per capita, GVA per capita and Net migration per capita. The quadratic model is preferred for social payments as of GDP. The ATE for four indicators are shown in Table 2.

The “mirrored” procedures elaborated with the reversed treatment variable considering being a donor yield the same results with opposite signs. Thus, the average gain by a recipient district equals the average loss by a donor district, and vice versa.

Table 2

ATT effects and average values of indicators for recipients and donors

Indicator	Unit	ATT on recipients	ATT on donors	Average for recipients	Average for donors
District population	Persons	-	-	28593	70075
District GDP	EUR 1000	-	-	279809	1418522
GDP per capita	EUR 1000	2.09	-2.09	-	-
GVA per capita	EUR 1000	1.83	-1.83	-	-
Net migration per capita	Persons	0.001	-0.001	-	-
Social payments as of GDP	EUR 1000	-1.62	1.62	-	-

As the four indicators were normalized before the calculations, a reverse procedure to get the absolute values is performed. For Gross Value Added, Gross National Product and Net Migration, the estimated ATT effects are multiplied by average district population to calculate the impact on a single district. For Social payments, the estimated ATT effect is multiplied by average district GDP to calculate the impact on a single district. After that, the calculated impacts are multiplied by the number of the districts in the treatment and control groups, respectively. Finally, the impact at the national level is calculated simply by adding the impacts in both groups. The impact on four indicators at the national level is shown in Table 3.

Table 3

ATT effects and average values of indicators for recipients and donors

Indicator	GDP (EUR 1000)	GVA (EUR 1000)	Net migration (persons)	Social payments (EUR 1000)
Impact on recipient	59845	52225	21	-451913
Total impact on recipients	1615827	1410078	566	-12201654
Total recipients	7554833	6592844	-606	34832728
Share of the impact	21%	21%	-	-
Impact on donor	-146668	-127992	-51	2291025
Total impact on donors	-2346683	-2047871	-821	36656407
Total donors	22696353	19806340	320	70690718
Share of the impact	-10%	-10%	-	-
Total national impact	-730856	-637793	-256	24454754
National total	30251186	26399184	-286	105523446
Share of the impact	-2%	-2%	89%	23%

The gains from the revenue equalization for recipient districts as a single entity are marked. Equalization provides about one fifth of GDP and GVA. Without the equalization, the negative migration balance would be almost double of its actual size and social payments would be about one third larger. The losses in economic growth indicators for donor districts are less pronounced. The negative impact on GDP and GVA stands at ten percentage points. Without the equalization, the negative migration balance would be almost double of its actual size and social payments would be about one third larger. However, the equalization more than reverses positive migration balance. The calculated shares of the impact of the equalization for all four socio-economic indicators at the national level clearly show the overall negative consequences of the procedure. The benefits accrued by the recipient districts are more than offset by losses incurred by the donor districts. The equalization contributes to a 2% decline both in Latvian National GDP and Latvian National GVA and for almost 90% of negative migration balance. Without the equalization, social payments would be for almost one quarter lower. Hence, at the national level the overall impact is negative.

The research results are in line with the statements from a number of officials. The necessity to revise the municipal equalization procedure was discussed before and after the administrative-territorial reform in 2021. However, the process was limited to discussions in the working group. Currently, this task is also included in the government declaration, promising to promote the interest of municipalities in the development of their territory. As stated by the former Riga Mayor [15] the financial equalization system is flawed because there are recipient municipalities, which would perform their basic functions without any additional funding. Then former Minister of Environmental Protection and Regional Development [16] considers the equalization system outdated. He suggests that instead of relying on contributions recipient municipalities should promote the activities by themselves. Financially weaker municipalities should be assisted by state with respect to investment projects.

Estonian Minister of Regional Affairs suggests the way local governments are funded should be based on fixed tax revenue as opposed to Estonia's equalization fund model [17]. The former would guarantee stable income, growth and greater financial autonomy. The empirical study of the data on Lithuanian rural municipalities by Skauronė and Montvydaitė [18] concludes that after the inter-budgetary reallocation of funds the revenue and expenditure remain unequalized between the municipalities.

Conclusions

1. There are marked economic gains from the revenue equalization for recipient districts as a single entity with a net impact of 21% contribution to growth in GVA and GDP. At the same time, respective losses for donor districts stand at 10%. At the national level, equalization causes 2% decline of both GVA and GDP.
2. Without equalization, the negative migration balance in the recipient districts as a single entity would be almost double of its actual size. In the donor districts, equalization more than reverses positive net migration. At the national level, the negative migration balance is caused almost entirely by equalization.
3. Without equalization, social payments in the recipient districts as a single entity would be about one third larger. The increase in social payments in the donor districts caused by the equalization stands at 6%. At the national level, equalization contributes to a 23% increase in social welfare payments.
4. Considering the overall negative impact of the revenue equalization the funding system has to be revised to avoid the negative socio-economic consequences in the future.

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