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## **Modelling of Municipality Indebtedness Evaluation at Regional Level**

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### **Abstract**

The objective of this article is to evaluate and analyse municipal indebtedness of the Czech Republic (CR) municipalities (with the exclusion of the capital city Prague) from the point of view of their size - both for the entire CR for year 2013 and the NUTS2-Northeast (NUTS2-NE) region for the years 2010, 2011, 2012 and 2013. Selected indicators have been used to evaluate municipal debt (MD). One of them is the "budget responsibility" indicator. This indicator will be compulsory for municipalities based on approving the CR constitution law. Another indicator is the share of debt in the total municipality assets. We have used a system approach for executing this analysis.

*Keywords:* Data analysis; indicators of indebtedness; modelling; municipal debt; North-East cohesion region.

JEL Classification: H74, H81, C88

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### **1 Introduction**

There are 6 248 municipalities in the CR. Their size structure, however, is quite unusual compared to other countries. Eighty percent of municipalities have less than 1000 inhabitants, but only 20% of the population lives in these municipalities. Most inhabitants live in the four largest cities (Prague, Brno, Ostrava and Pilsen). Other countries with this size structure in Europe are only Slovakia, France and Portugal. This size structure complicates not only the financing of municipalities, but also the quality of self-government of small municipalities [5]. This also concerns the problem of municipal indebtedness in CR. The total volume of the CR MD does not represent a serious problem from the overall public finance viewpoint. The indebtedness itself and the volume of the debt may represent a risk just for some individual municipalities, mainly for small municipalities. The risk of getting into unhealthy debt has a couple of sources and reasons. Some are valid generally, some are the result of the environment in which CR municipalities function [3, 9, 10]. Unlike in other countries, there is no direct regulation applied to MD in the CR [15]. The Ministry of Finance of the CR (hereinafter "the MFCR") has been using, since year 2008, a system of informative and monitoring indicators [12]. Currently the Chamber of Deputies Parliament of the CR is hearing a draft of a constitutional law on budget responsibility that shall regulate the indebtedness of all public finance budgets elements which means that this law shall apply also to municipalities [8]. According to the draft, the share of debt should not exceed 60% of the average income in last 3 years.

Some European states have already taken steps or are currently taking steps to directly regulate and to limit local government debt - these steps are represented by adopting the National stability pacts (Austria, Italy, Spain, Greece, Germany) [18]. Other countries hope to improve local government financial management [17] and MD decline by executing institutional reforms and consolidation of municipalities e.g. Switzerland [4], Denmark [6] and Slovakia [14].

The objective of this article is to evaluate and to analyse the indebtedness of municipalities from the NUTS2-NE cohesion region. This cohesion region includes Královéhradecký (KHR), Liberecký (LIR) and Pardubický region (PAR). The real data was used for the years 2010, 2011, 2012 and 2013.

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## 2 Material and Methods

For evaluating the indebtedness of selected sample of the cohesion region NUTS-NE municipalities we had to create a model for evaluating the indebtedness of all municipalities in CR based on selected indicators. Comparing the data gathered for all municipalities in CR with data from the selected sample let us evaluate if both models correspond with each other.

### 2.1 Problem formulation

The model of evaluation of municipality indebtedness works with real data for year 2013 for 6 247 municipalities in the CR [13]. The capital city Prague has been omitted since Prague has a very specific legal situation – it is both the municipality and the region at the same time. It uses the special legislation (the Act on the City of Prague, No. 131/2000 Coll.); there is located, at the same time, also the administrative headquarters of the Central Bohemia Region; in year 2013 the indebtedness of Prague was 34.1 billion CZK, therefore all of the remaining 6 247 municipalities had together total debt 58.1 billion CZK. The data matrix were put together databases of the MFCR and of the Czech Statistical Office (CSO) [2, 12]. The data about municipality revenues, MD, municipality property have used from these databases. The information about number of inhabitants in individual municipalities has been taken from area-analysis background data.

The data matrix is composed and calculated for 6 274 objects (municipalities). Vector  $\mathbf{o} = \{o_1, o_2, \dots, o_{6247}\}$ ,  $o_i$  is  $i$ -th object (municipality) can be characterized as a sextuplet by the following way:

$$\mathbf{o} = \{ \mathbf{x}, \mathbf{a}, \mathbf{b}, \mathbf{c}, k, d \} \quad (1)$$

where  $\mathbf{x}$  is the vector of absolute indicators,  $\mathbf{a}$  is the vector of relative indicators calculated from the absolute indicators  $\mathbf{x}$ ,  $\mathbf{b}$  is the vector of median values of the relative indicators  $\mathbf{a}$ ,  $\mathbf{c}$  is the vector of "risky indebtedness" indicators,  $k$  is the value representing the size category of the municipality and  $d$  is the percentage of municipalities with debt in the given category  $k$  [13].

The elements of  $\mathbf{x} = \{x_1, x_2, \dots, x_5\}$  are defined in the following way:  $x_1$  is number of inhabitants of a given municipality,  $x_2$  is a given municipality total revenues (tax transfers, non-tax transfers revenues, capital revenues and received subsidies),  $x_3$  are "selected" (tax, non-tax and received subsidies) of a given municipality revenues,  $x_4$  are the municipality total assets and  $x_5$  is the total amount of the MD.

The elements of  $\mathbf{a} = \{a_1, a_2, \dots, a_6\}$  are defined in the following way:  $a_1$  is the MD per one inhabitant ( $x_5/x_1$ ) in CZK,  $a_2$  is the total municipal revenues per one inhabitant ( $x_2/x_1$ ) in CZK,  $a_3$  is the "selected" municipal revenue (without the influence of the nonrecurring capital revenues) per inhabitant is ( $x_3/x_1$ ) in CZK,  $a_4$  is the share of the total debt to the municipal revenue ( $x_5/x_2$ ) in %,  $a_5$  is the share of the total debt to the "selected" municipal revenues ( $x_5/x_3$ ) in %,  $a_6$  is the share of the total debt to municipal assets ( $x_5/x_4$ ) in %. The indicators  $a_1, a_2, a_3, a_4, a_5$  reflect the various population sizes of municipalities and are related to resources that can be used to repay MD. The indicator  $a_6$  (the share of debt in the total municipality assets) is related to the municipality total assets.

The elements of  $\mathbf{b} = \{b_1, b_2, \dots, b_6\}$  are calculated for individual municipal size categories, where  $b_i$  is the mean value of  $a_i$ , where  $i = 1, 2, \dots, 6$ . It means that  $b_1$  is the mean value of  $a_1$ ,  $b_2$  is the mean value of  $a_2$  etc. The elements of  $\mathbf{c} = \{c_1, c_3\}$ , where  $c_1$  is the number of municipalities in a region over the 60% limit from  $a_4$ ,  $c_3$  is the number of municipalities that are over the 25% limit from  $a_6$ . The coefficients  $a_4$  and  $a_6$  represent certain indicators of cautious indebtedness of a municipality. The value of the indicator  $a_6$  (share of debt to the total assets) should not exceed the 25% limit. This indicator shows what share of the municipality assets is covered by external resources while it is valid that the lower the value of this indicator the better for the municipality. The MFCR follows this indicator as one of the indicators used to monitor municipal financial management [12]. The indicator  $a_4$  (the share of the total debt in the total revenues) is an indicator that shall be used for the evaluation of municipal management responsibility. If any

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MD is larger than the 60% of the average of municipality revenues for the last 4 years, then such municipality must start reducing its debt by 5% of the difference between the amount of its debt and those 60% average of its revenues for the last four budgetary years [11]. In the model design [13] for all municipalities in CR we used only the index calculated for 2013 for simplification (i.e. share of total 2013 debt on total revenue in 2013).

To categorize municipalities by their size is possible and can be done according to various needs and approaches [2, 12]. The division of municipalities into 7 size categories for  $k = \{1, 2, \dots, 7\}$  is used by the following way: Category 1 equals the size of a municipality from 1 to 199 inhabitants, 2 is from 200 to 399, 3 is from 400 to 599, 4 is from 600 to 999, 5 is from 1 000 to 1 999, 6 is from 2 000 to 9 999 and category 7 is 10 000 and more.

The attributes values of the model (see Tab. 1) for the whole CR show that the mean value of indebtedness per inhabitant ( $b_1$ ) reached 5 742 CZK. When comparing the value of the total municipal revenue per inhabitant attribute ( $b_2$ ) and the selected revenue per inhabitant ( $b_3$ ) there is demonstrated a slightly lower level of this attribute in all of the observed categories. The influence of capital revenues is no longer so prominent as it was in the 90s when municipalities privatized a lot of municipal property. What is interesting is the finding that revenues per inhabitant are the highest in the smallest municipalities – the size category of up to 200 inhabitants. This is the result of the taxes allocation scheme that still provides, despite the amendment of the relevant legislation, such high tax transfer revenues to these types of municipalities. The mean value of the share of debt to the total revenues ( $b_4$ ) does not exceed in any of the size categories the "critical" 60% value (indicator  $c_1$ ). The same situation is with the debt to total assets indicator ( $b_6$ ) where municipalities do not even closely reach the critical level in any of the categories ( $c_3$ ).

**Table 1. Attributes' mean values for individual municipal categories and for the CR total (Source: [13])**

| Attributes |      |             |             |             |           |           |           |         |  |
|------------|------|-------------|-------------|-------------|-----------|-----------|-----------|---------|--|
| $k$        | $p$  | $b_1$ [CZK] | $b_2$ [CZK] | $b_3$ [CZK] | $b_4$ [%] | $b_5$ [%] | $b_6$ [%] | $d$ [%] |  |
| 1          | 1453 | 3 203       | 22 823      | 21 251      | 13        | 14        | 2         | 20      |  |
| 2          | 1524 | 3 574       | 19 284      | 18 435      | 18        | 19        | 2         | 34      |  |
| 3          | 890  | 3 312       | 17 808      | 17 026      | 18        | 19        | 2         | 47      |  |
| 4          | 954  | 3 114       | 18 593      | 17 823      | 17        | 18        | 2         | 51      |  |
| 5          | 744  | 3 542       | 18 548      | 17 902      | 19        | 20        | 3         | 63      |  |
| 6          | 552  | 4 008       | 19 034      | 18 367      | 21        | 22        | 3         | 82      |  |
| 7          | 130  | 4 791       | 20 162      | 19 361      | 23        | 24        | 3         | 91      |  |
| CR         | 6247 | 5 742       | 20 563      | 19 751      | 28        | 29        | 4         | 44      |  |

When observing the results from the municipality size viewpoint we can state that the share of municipalities with debt is growing with the growing number of inhabitants in such municipalities. The lowest percentage share of municipalities with debt can be found in the first category (1-200 inhabitants). Municipalities of the size 10 000 plus inhabitants have 91% share of municipalities with debt. All municipalities with 50 000 plus inhabitants have debt.

For more detailed analysis we have selected a sample of municipalities from NUTS2-NE from the matrix. The data matrix has 1 114 objects.

KHR and PAR municipalities have similar size structure while LIR municipalities have different size structure. This is the result of different historic development and of the geographical location of LIR. There are in total 448 municipalities in KHR, 451 municipalities in PAR and only 215 municipalities in LIR. The municipal structure in KHR and PAR corresponds with municipal structure of the entire CR. The most frequent size of municipality is the category size 1 and 2. In KHR the share of size 1 and 2 municipalities is 53% (it is 98 respectively 139 municipalities). In PAR region the share is the same as in KHR (it is 106 respectively 131 municipalities). In LIR municipalities of size 1 and 2 represent only 37% of the total number of municipalities (it is 28 respectively 52 municipalities).

Data quality (accuracy, completeness, consistency etc.) has an impact on modelling results. Outlying data can have a considerable influence on the result of analysis [1]. For further analysis we have removed the outlier values [7, 16]. The data matrix has 1 001 objects (that means 113

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municipalities were removed from the NUTS-2 NE sample). In Tab. 2 we can see attribute  $a_1$  for NUTS-2 NE after removing the outlier values for the mean value of the debt per inhabitant, the maximum value and the standard deviation, the number of municipalities in a given region  $p$  and the number of municipalities in a region for  $c_1$  and  $c_3$  [13].

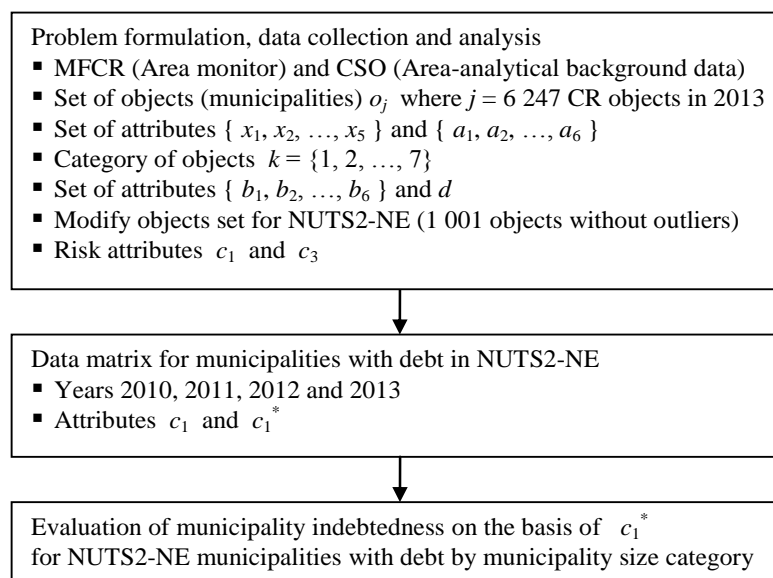
The maximum amount of debt per inhabitant is comparable in all three regions (it is the highest in PAR) and also the rate of variability, which is expressed by the standard deviation, is comparable in all three NUTS2-NE regions. It is the highest in PAR region. Compared to the mean value of indicator  $a_4$  for the whole CR the values in NUTS2-NE regions are much lower. Values of these indexes are counted for the total number of municipalities (indebted and non-indebted municipalities - after removing the outlier values). The percentage of municipalities with zero debt is the same in KHR and PAR - it is 40%. In LIR there is 20% of municipalities with zero debt. The values of the coefficients that indicate unhealthy indebtedness are zero for all regions in case of  $c_3$ . This is the result of the simplified calculation that works only with revenues of 2013. within the  $c_1$  indicator, 15 NUTS2-NE municipalities exceed the 25% share of debt on the assets [13].

**Table 2. Values of attributes in NUTS2-NE without outlier values (Source: [13])**

| Region | Attributes    |              |                 |     |       |       |
|--------|---------------|--------------|-----------------|-----|-------|-------|
|        | Mean of $a_1$ | Max of $a_1$ | StdDev of $a_1$ | $p$ | $c_1$ | $c_3$ |
| KHR    | 1404.9        | 9482.0       | 2476.5          | 398 | 7     | 0     |
| LIR    | 1243.0        | 9467.2       | 2284.3          | 206 | 2     | 0     |
| PAR    | 1468.7        | 9995.5       | 2709.1          | 397 | 6     | 0     |

**2.2 Model design**

The proposed regional model of municipality indebtedness evaluation in Fig. 1 illustrates the option to evaluate NUTS2-NE municipality indebtedness by size categories  $k$ .

**Figure 1. Regional model of municipality indebtedness evaluation (Source: Authors)**

The proposed regional model of municipality indebtedness evaluation works with a new coefficient  $c_1^*$ . The value of  $c_1^*$  is calculated the same way as in the draft of the budget responsibility bill - it represents the share of debt on the average of total revenues of the municipality in the years 2010, 2011, 2012 a 2013 [8, 13].

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### 3 Results and Discussion

The Tab. 3 shows calculated medians of  $c_1^*$  indicator for each size category of municipalities in three NUTS2-NE regions. The analysis provides more realistic view of the municipality indebtedness than the simplified indicator  $c_1$ . For the evaluation, we use similar characteristics as in Table 2 (min values, max values and standard deviation) shown in percentage. For example for the smallest municipality category (up to 100 inhabitants) in KHR region (90 municipalities in total) the average value of the indicator is 73%, which means that there are municipalities that exceed the required 60% value of the indicator  $c_1^*$  even after deducting the outliers values. Mean value of this indicator is 3.6% in given category, the rate of variability in given category is determined by StDev and its value is 12.1%. In other regions (LIR a PAR) municipalities in this size category don't exceed the 60% value. In other size categories, the municipalities exceed the required  $c_1^*$  indicator mainly in PAR region (size categories 2, 3, 4 and 5). In the largest size category 7, the 60% value is not exceeded in any region, the maximal value being 40% in KHR and PAR region, 32% in LIR region. This reflects the fact that even though almost all large municipalities are indebted, their budget is large enough. Therefore, the share of debt on the average total income doesn't exceed the critical 60% level.

**Table 3. Volume of  $c_3^*$  debt per average revenues in NUTS2-NE regions by category (Source: Authors)**

| Region | Category | Volume of $c_1^*$ in % |      |       | StdDev | $p$ |
|--------|----------|------------------------|------|-------|--------|-----|
|        |          | Mean                   | Min  | Max   |        |     |
| KHR    | 1        | 3.60                   | 0.00 | 73.00 | 12.10  | 90  |
| LIR    | 1        | 1.30                   | 0.00 | 18.00 | 3.90   | 28  |
| PAR    | 1        | 2.20                   | 0.00 | 36.00 | 7.60   | 98  |
| KHR    | 2        | 6.10                   | 0.00 | 77.00 | 15.00  | 121 |
| LIR    | 2        | 1.80                   | 0.00 | 44.00 | 7.20   | 52  |
| PAR    | 2        | 5.40                   | 0.00 | 71.00 | 13.70  | 118 |
| KHR    | 3        | 10.00                  | 0.00 | 60.00 | 16.60  | 66  |
| LIR    | 3        | 6.00                   | 0.00 | 40.00 | 10.60  | 28  |
| PAR    | 3        | 13.40                  | 0.00 | 83.00 | 21.90  | 53  |
| KHR    | 4        | 12.00                  | 0.00 | 58.00 | 17.60  | 50  |
| LIR    | 4        | 9.10                   | 0.00 | 53.00 | 15.70  | 44  |
| PAR    | 4        | 11.50                  | 0.00 | 71.00 | 19.40  | 62  |
| KHR    | 5        | 7.20                   | 0.00 | 30.00 | 8.70   | 31  |
| LIR    | 5        | 10.00                  | 0.00 | 71.00 | 18.70  | 25  |
| PAR    | 5        | 15.50                  | 0.00 | 64.00 | 19.20  | 34  |
| KHR    | 6        | 20.10                  | 0.00 | 64.00 | 17.00  | 33  |
| LIR    | 6        | 16.80                  | 0.00 | 55.00 | 14.10  | 25  |
| PAR    | 6        | 19.90                  | 0.00 | 49.00 | 15.20  | 24  |
| KHR    | 7        | 24.00                  | 7.00 | 40.00 | 14.00  | 7   |
| LIR    | 7        | 21.00                  | 4.00 | 32.00 | 11.90  | 4   |
| PAR    | 7        | 24.30                  | 5.00 | 40.00 | 10.80  | 8   |

The histogram in Fig. 2 shows the number of municipalities in individual regions and individual size categories for which the value of  $c_1^*$  indicator exceed 60%. The results correspond with the results presented in Tab. 3. In Fig. 2 only six size categories of municipalities are shown, because the category 7 has value zero (i.e. no municipality exceeds the 60% indicator level). For example in KHR region, this value is exceeded by two municipalities in first two size categories and by one municipality in categories 3 and 6. But in PAR region, 11 municipalities in total exceed the value (except of the smallest municipalities and municipalities

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with population between 2000 and 9999 inhabitants). The best result according to this criterion is achieved by municipalities from LIR region, where the index value is exceeded only in size category 5.

The results from Tab. 3 can be linked to the values from Tab. 4. We have defined the vector of the indicators "risky indebtedness"  $\mathbf{c}$ . We have used the two already above defined indicators monitored by the MFCR  $a_4$  (share of debt in total revenues) and  $a_6$  (share of debt in total assets) and from them we calculate the indicators  $\mathbf{c}$  and new indicator  $c_1^*$ . The elements of  $\mathbf{c} = \{c_1, c_1^*, c_2, c_3, c_4\}$ , where  $c_1$  is the number of municipalities in a region over the 60% limit from  $a_4$ ,  $c_1^*$  is the number of municipalities in a region over the 60% limit from share of the debt on the average municipality revenues in last four years,  $c_2$  is the number of municipalities below the 60% limit from  $a_4$ ,  $c_3$  is the number of municipalities that are over the 25% limit from  $a_6$ ,  $c_4$  is the number of municipalities in a region that are below the 25% from  $a_6$ . The values of the indicators are presented in Tab. 4.

Figure 2. Number of municipalities in size categories by the attribute  $c_1^*$  (Source: Authors)

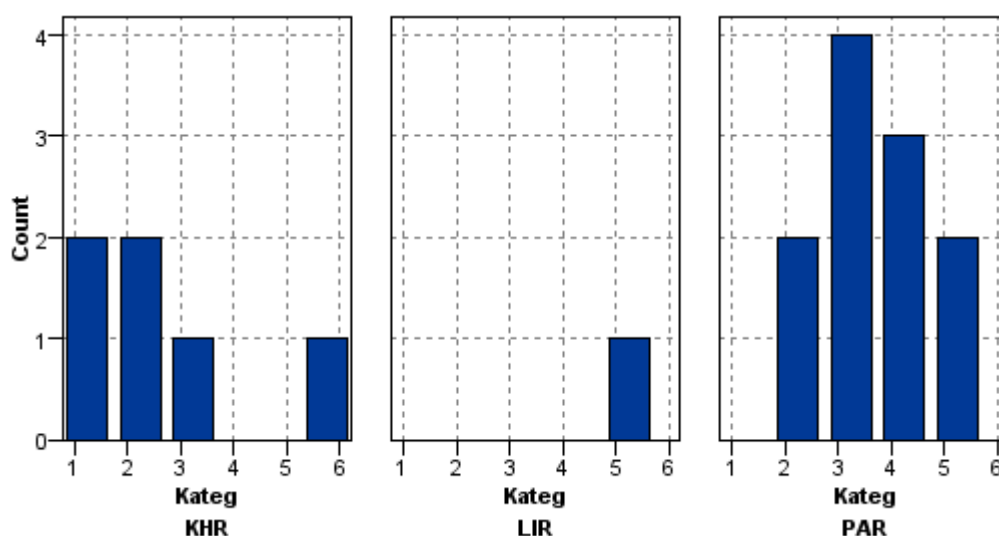


Table 4. Number of municipalities in the region for the attributes  $c_1$  and  $c_1^*$  (Source: Authors)

| Region   | Attributes |         |      |
|----------|------------|---------|------|
|          | $c_1$      | $c_1^*$ | $p$  |
| KHR      | 7          | 6       | 398  |
| LIR      | 2          | 1       | 206  |
| PAR      | 6          | 11      | 397  |
| NUTS2-NE | 15         | 18      | 1001 |

When we considered only the simplified  $c_1$  indicator, the critical value of indebtedness exceeded 15 municipalities. Within the  $c_1^*$  indicator, 18 municipalities would fail the criterion proposed in the code of budgetary responsibility. The most of these municipalities are from PAR region, only one is from LIR region. 15 of municipalities have less than 1 000 inhabitants.

#### 4 Conclusion

The analysis of the indebtedness data from the regional model shows that the basic characteristics of indebtedness that apply to all municipalities in CR are similar for the NUTS2-NE municipalities. The municipality size structure in KHR and PAR is identical with municipality

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size in the entire CR with only the exception of the LIR. For all three regions it is valid that the lowest share of municipalities with debt is in the size category 1 and 2 and on the contrary the largest share of municipalities with debt is in the category 7. The mean values confirm the assumption, that the larger the size of the municipality, the higher the volume of debt per inhabitant. Mean value shows indebtedness per inhabitant. The mean value of debt per inhabitant is lower in 3 regions than in the whole CR.

While evaluating the unhealthy indebtedness with the  $c_3$  indicator of debt share on assets, no NUTS2-SE municipalities exceeded the recommended 25% value. When the simplified indicator of the share of debt on total income in 2013 was used ( $c_1$ ), 15 NUTS2-NE municipalities exceeded the 60% value. Within the MFCR suggested indicator, that calculates the share of debt on the average total revenues from last four years, 18 NUTS2-SE municipalities exceeded its value in the regional model. The average debt per inhabitant in municipalities which exceeded this criterion is approximately 9 000 CZK. Contrary to the entire sample of NUTS2-NE region were the average debt per inhabitant is 3 400 CZK.

However, it is imperative to bear in mind that we have worked without the outlier values within the suggested regional model. If the outlier values were included, the number of municipalities exceeding the indicator would be higher. Mostly in small municipalities whose revenues fluctuate more than in larger municipalities.

The suitability of using these indicators for the evaluation of critical indebtedness for self-governing entities is questionable – the concrete situation depends on a number of additional factors that depend on the individual municipality financial management [13, 17]. Other indicators need to be taken into account for rating/evaluating the indebtedness of a specific municipality: size of funds on municipalities accounts, purpose of loan (if the project generates income or not, or if it burdens the municipality by other expenditures for maintenance, etc.).

Therefore we need to utilize more indicators and carry out a qualitative assessment to determine if the debt is high-risk for the municipality or not. The municipality indebtedness evaluation is then just an indication for another in-depth analysis of the financial management of a particular municipality.

## Acknowledgements

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