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In Search of an Optimal Size for Local Government: An Assessment of Economies of Scale in Local Government in Croatia

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An Assessment of Economies of Scale in Local Government in Croatia

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Abstract

Local units perform many important functions in a society. Since their fiscal capacities are often constrained, they should operate efficiently. This paper gives an empirical assessment of the efficiency of local units in Croatia through an analysis of economies of scale. Using cross-section OLS models, we found a statistically significant U-shaped relationship between local per capita expenditures and population size, while controlling for various demographic, socio-economic and institutional factors. The choice of control variables in the paper is based on the existing empirical literature but also includes factors capturing the specifics of the Croatian economy and local government institutional setup. Using estimated regression coefficients we calculated the optimal size of local units and showed that population size is below optimal in 72% of cities and 76% of municipalities (based on median results). In the most conservative case (lower band of the confidence interval), these numbers fall to a still relatively high 30% of local units below the optimal size. However, these results should be interpreted with a grain of salt due to the high level of uncertainty that surrounds the methodology for the calculation of the optimal size of local governments.

Keywords: local public expenditures, local government, economies of scale, territorial fragmentation, Croatia

JEL: H11, H72, H77

Sažetak

Lokalne jedinice obavljaju mnoge važne javne funkcije. Budući da su njihovi fiskalni kapaciteti često ograničeni, one bi trebale biti učinkovite u obavljanju tih funkcija. Ovaj rad donosi empirijsku procjenu učinkovitosti lokalnih jedinica u Hrvatskoj analizom ekonomije obujma. Korištenjem regresijskih OLS modela vremenskog presjeka u radu je utvrđen nelinearan odnos između rashoda lokalnih jedinica po stanovniku i veličine stanovništva, pri čemu su uzete u obzir razne demografske, socijalno-ekonomske i institucionalne kontrolne varijable. Izbor kontrolnih varijabli u radu zasniva se na postojećoj empirijskoj literaturi, ali također uključuje i čimbenike koji odražavaju specifičnosti hrvatskoga gospodarstva i institucionalnog okvira lokalnih jedinica. Na osnovi procijenjenih koeficijenta regresije u radu je izračunata optimalna veličina lokalnih jedinica, a rezultati upućuju na to da je veličina stanovništva ispod optimalne u 72% gradova i 76% općina, ako se optimalnom smatra medijalna veličina. U najkonzervativnijem slučaju, ako se veličina stanovništva uspoređuje s nižom granicom intervala pouzdanosti za optimum, ovi udjeli padaju na još uvijek relativno visokih 30% lokalnih jedinica ispod optimalne veličine. Međutim, ove rezultate treba oprezno tumačiti uvažavajući ograničenja primijenjene metodologije izračuna optimalne veličine lokalnih jedinica.

Ključne riječi: rashodi lokalnih jedinica, lokalne jedinice, ekonomija obujma, teritorijalna fragmentacija, Hrvatska

JEL klasifikacija: H11, H72, H77

Contents

1 Introduction

There are 556 local government units in Croatia, with an average population of 7300 and an average area of 102 square kilometres. The views on the current territorial organization are polarized – some find it excessively fragmented, while the others believe that the existence of small jurisdictions is crucial for the development of rural and peripheral areas.

This paper puts the issue of territorial fragmentation in Croatia in a theoretical context and brings empirical evidence on the optimal size of local jurisdictions from an economic efficiency perspective. It provides estimates of the relationship between population size and per capita local public expenditures, while looking for various determinants of public expenditures on the local government level. It contributes to the body of empirical literature on economies of scale in local government and to the search foran optimal size for local government units. Although the paper does not take into account the political, societal, and cultural criteria that should be considered in the process of designing a local government reform, its findings may spur informed discussion on a possible territorial reorganisation.

We conduct the empirical analysis on the sample of 555 local units and on sub-samples of 428 municipalities and 127 cities,[1] using cross-section OLS models. Our findings suggest that there is a U-shaped relationship between expenditures per capita and population size in all samples analysed. Besides population size, we found other important determinants of per capita expenditures in local units as well, such as population density and other demographic factors, socio-economic factors, transfers, tourism and so on. According to our analysis, population size is below the optimum level in more than 72% of Croatian cities and 76% of municipalities Even though there are a number of local units above the optimum size, economic interpretation of the results in the literature on the economies of scale in local units is limited to identifying potential for amalgamations of smaller local units. Fragmentation of large local units is considered economically inefficient as these units form economic, territorial and cultural indivisible wholes.

This paper contributes to the literature in several ways. First, it provides the first empirical assessment of the determinants of per capita expenditures and the optimal size of local units in Croatia. Second, taking into account the specifics of the Croatian economy and local government institutional setup, we propose additional determinants of local per capita expenditures that are not standard in the existing literature, such as tourism activity, EU fund inflows and so-called decentralized functions of local units. It

[1] The City of Zagreb is excluded from the analysis due to specific features that might strongly affect the results (e.g. size, functions (as city and county), socio-economic characteristics etc.).

can be assumed that such determinants play an important role in some other countries as well. Third, unlike other studies, we analyse the sensitivity of the results on the optimal size of local units arising from different model specifications, coefficient uncertainty and non-linearity.

The paper is structured as follows. After the introductory section, the second section describes the relevant theories. The third section gives basic indicators of territorial fragmentation in Croatia and puts them into the international comparison. The fourth section brings the overview of the empirical literature on the subject, presents the data and explains the methodology applied in this paper. The fifth section discusses the main empirical findings, and the final section concludes.

2 Theoretical framework

The size of local jurisdictions in terms of population and area varies widely not only across countries, but also within the same country. Therefore, this issue has attracted quite a lot of attention. Experts from political science, public administration and economics have explored whether the size of the local government units affects their efficiency in providing local public goods, democratic outcomes and success in serving the needs of local communities, and whether there is an optimal size for a local jurisdiction.

From an economic point of view, jurisdictions are mostly judged according to their efficiency, but other criteria, such as effectiveness, measured by the citizen satisfaction with the locally provided goods and services, can be used as well. Efficiency is usually defined as the ability to provide (a defined quality of) local public goods and services, or specific public goods or services, at the least possible cost. There is not, however, any single economic reasoning capable of providing a straightforward answer as to what size of local jurisdiction would be the most efficient. Moreover, there are at least three equally valid theories that might end up with quite different policy recommendations: public choice theory, theory of clubs, and theory of firms.

According to the public choice theory, people choose where to live based on the tax they have to pay in a jurisdiction, and the local public goods and services it provides. Local governments compete for people, trying to offer attractive tax-service packages and to prioritize among different local public goods and services, thus promoting allocative efficiency (Oates, 1985). Tiebout (1956) argues that people will settle in a jurisdiction whose local government best satisfies their preferences in terms of tax and expenditure patterns. People will “vote-with-their-feet” if taxes are too high given the amount of local public goods provided in a community, if the amount of local public goods is too small given the taxes collected, or if the local public goods do not match

their tastes. Public choice theory implies that the size of the jurisdiction should be as small as possible. Small and versatile jurisdictions can best meet the preferences of population regarding the size and structure of local public revenues and expenditures. Competition between smaller local governments does not only offer a better choice of tax-service packages, it also prevents the public sector from growing disproportionately (Brannan and Buchanan, 1980).

The theory of clubs is an extension of the public choice theory. It does not consider efficient allocation of local public goods, but focuses on the assessment of the optimal size of a unit i.e. club providing goods characterized by excludable benefits (Buchanan, 1965). Since there are only a few goods that satisfy the conditions of extreme collectiveness, this theory can be used in many real life cases (Sandler, 2013). Unlike the Tiebout hypothesis, it does not recommend designing as small jurisdictions as possible butargues that there is an optimal size for a local unit, which depends on two opposing effects (Bises and Sacchi, 2009). The first one that of tax-sharing advantages, resulting from the fact that the cost of a good or a facility for an individual will go down as the size of the population rises. The second is related to the congestion costs, meaning that due to congestion the benefit of using a good or a facility for an individual will go down (or the nuisance will rise) as the size of the unit rises. Therefore, the size of the local unit is optimal at the point where the derivatives of the total cost and total benefit functions are equal.

Another way of approaching the issue of the optimal community size is to use the theory of the firm. According to the theory of the firm, the economically efficient level of production is determined by economies and diseconomies of scale. Economies of scale appear since the long-run average total cost decreases as output increases (Chenery, 1949; Smith, 1955; Silberston, 1972). Therefore, it makes sense to increase the level of production until the minimum efficient level of production is attained and the economies of scale are fully exploited. Economies of scale occur since some setup costs are indivisible. There are such indivisible costs in the provision of public goods as well, as in, for example, building a hospital or a theatre. When the theory of the firm is applied to evaluate the optimal size of local government unit, population size, although somewhat inappropriate, serves most often as measure of output. When applied to the design of jurisdictions, the theory of firms implies that the size of a jurisdiction should be large enough to reach the minimum efficient size in order to take advantage of economies of scale. The idea that the concept of economies of scale might be applied to a local jurisdiction is justified by some types of local services being characterised by substantial fixed costs, the marginal costs thus falling as the output increases i.e. the service is provided to a greater population. In addition, since there is no rivalry in consumption of many local public goods, the marginal costs of those public goods are zero by definition (Tran, Kortt and Dollery, 2019).

In the context of jurisdictions, it is not fully correct to use the term *economies of scale,* which examines how the proportionate change of all inputs affects the output,

because some of the inputs in case of jurisdictions might not be scalable in proportional amounts, such as land area, population density or geographical attributes. Therefore, using the expression *economies of size*, although less common, is considered more accurate in local government context (Fox and Gurley, 2006).

It is possible and in line with the theory of the firm that above a certain size the average costs (public expenditures) per capita start to rise due to diseconomies of scale resulting from physical and bureaucratic congestion, problems of control and communication and so on (Williamson, 1967). Therefore, it can be assumed that the local public expenditures per capita follow a U-shaped curve relative to the population size (Fox, 1980; Blom-Hansen et al., 2016). It is also argued that the U-shaped relationship exists between the local public per capita expenditures and population density (not the population size) and that the cost savings might be more attainable when population density increases (Tran, Kortt and Dollery, 2019; Reingewertz and Serritzlew, 2019). Local expenditures per capita might go down with higher population concentration, requiring fewer centres to provide a certain level of services, and lowering the average distance between service users and facilities and transportation and infrastructure costs. Higher population density reduces the urban sprawl that is usually connected with services based on networks, such as sewerage system, waste management, road maintenance etc. (Hortas-Rico and Ríos, 2020).

Whereas the public choice theory indicates that the size of local government units should be as small as possible, two other theories imply that small government units are not necessarily efficient even from a purely economic point of view, i.e. without considering the possible negative effects of larger jurisdictions on local democracy (Lassen and Serritzlew, 2011). Although conceptually different, two other theories lead to a similar conclusion – there is the size of jurisdiction minimising the cost per inhabitant, or putting costs and benefits into an equilibrium. However, the theory of the firm does not exclude the extreme case in which there are no diseconomies of scale, so that the optimal size of a jurisdiction is equal to the entire territory. The existing, equally relevant economic theories, obviously do not provide clear guidance in the search for an appropriate size for local government units.

Moreover, it can be argued that, since local governments are in charge of providing different public goods and services, the optimal size is different for each particular type of public good or service (Ostrom, Tiebout and Warren, 1961). Some authors even claim that the quest for the optimal size of jurisdiction is in vain, since there are many optimal sizes, not one (Blom-Hansen et al., 2016). To some extent, such reasoning is close to the one suggested by Oates (1972) who, being aware of the importance of satisfying the needs of small groups of residents, and the requirement to reduce spillover effects on efficiency grounds, came to the conclusion that a rational administrative division should not be based on one, but on three principles. According to Oates, the rational map should entail relatively large regional governments that would encompass jointly used public goods and environmental resources, small local jurisdictions providing local goods

according to the local tastes, and metropolitan governments stretching over the areas inhabited by people benefitting from public goods provided by the cities (Oates, 1999).

In addition, the optimal size of jurisdictions should not only be determined according to economic considerations. The existence of local government also has to do with local participation and citizen control of politicians and bureaucracy. Like the economic, the political point of view leaves us without a clear instruction on the design of local units, as well. On one hand, smaller jurisdictions promote political participation since their citizens are closer to politicians, can be better informed about activities of administration and politicians and can exert greater influence than in larger communities (Fox and Gurley, 2006). In addition, political yardstick competition, which might increase allocative and productive efficiency is more effective in small than in larger communities (Besley and Case, 1995). On the other hand, larger communities are better at controlling policies implemented by higher tiers of government (Fox and Gurley, 2006).

3 Territorial fragmentation in Croatia

The Republic of Croatia is a unitary state with a population of close to 4.1 million[2] and an area of 56.6 thousand square kilometres. Its public administration is shared between the national government and two territorial tiers – regional government and local government. There are 21 regional government units called counties, and 555 local government units, of which 127 are cities and 428 municipalities. The City of Zagreb has a dual status as both a city and a county. The current administrative division of Croatia is not based on any historic division. It was established 30 years ago, enshrined in the Constitution in 1990, and started to function in 1993 after the Law on Local Government and Self-Government had been adopted and the first free local elections held (Ivanišević et al., 2001; Kregar, 2011).

The responsibilities of cities, municipalities and counties are not precisely delineated. Generally, counties are responsible for functions of a regional character, while municipalities and cities perform tasks of local significance that directly address the needs of citizens. Cities with more than 35 thousand have somewhat larger responsibilities than smaller cities. Cities with populations of more than 35 thousand and that are county centres may also be responsible for functions that otherwise fall within the competence of counties. Many local government units lack sufficient fiscal capacity to carry out the allocated function, so that the quality and supply of local government goods and services differ widely (Krtalić, Šuman-Tolić and Primorac, 2020; Jurlina Alibegović, 2010).

[2] According to Croatian Bureau of Statistics estimates.

This paper analyses whether the size of Croatian cities and municipalities allows them to perform their duties in an efficient way. This issue has been addressed by a number of authors, who largely agree that the current territorial organisation is detrimental to efficiency in local public spending and advocate territorial reorganisation leading to larger local and regional government units (see e.g. Đulabić and Čepo, 2017; Jurlina Alibegović, 2010; Koprić, 2015; Koprić, 2010; Ott and Bajo, 2001). However, empirical proof of Croatia's excessive territorial fragmentation is still in short supply.

We construct some of the usual indicators of territorial fragmentation – the average population size per local government unit, the number of municipalities per 100 thousand residents, and the average area of local government units (Bartolini, 2015). Table 1 provides data on average, median, minimum and maximum values of the indicators for the EU-27 and for Croatia. It is evident that the values for all three of the fragmentation indicators for Croatia are close to median for the EU-27.

A simple comparison does not indicate that Croatia is an extremely fragmented country, at least not in the European context. However, on a subnational level, we can observe

Table 1 Size of local government units in Croatia and the EU

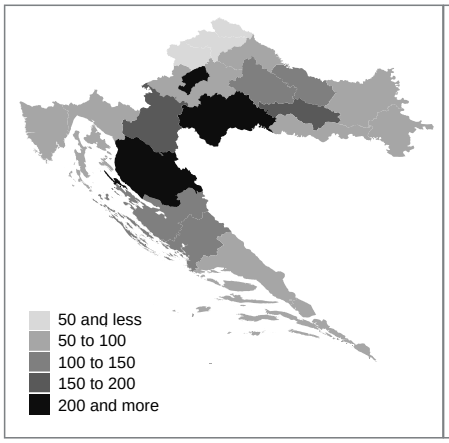
	Population per unit	Area per unit	Units per 100,000 inhabitants
Croatia (rank within the EU)	7,344.6 (17/27)	102.0 (15/27)	13.6 (11/27)
Unweighted average EU	22,053.4	351.2	15.9
Median EU	9,815.6	95.6	10.2
Min EU	1,701.8 (France)	4.6 (Malta)	0,6 (Ireland)
Max EU	158,201.3 (Ireland)	2,251.5 (Ireland)	58.8 (Czech Republic)

Source: Authors based on OECD and European Commission data for number of municipalities and area (2017-2018) and Eurostat data for population (2019).

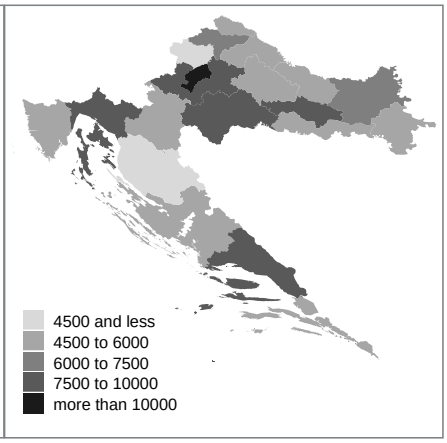
substantial differences in the size of municipalities and cities. Municipalities that are smaller in terms of the area, are clustered in North-Western Croatia, Eastern Slavonia and Istria (Figure 1a). Those local units are relatively small in terms of population size as well, but there are jurisdictions in other parts of the country that are small in terms of population, but occupy relatively large areas (Figure 1b). The number of local government units per 100,000 inhabitants shows high fragmentation in North-Western counties, as well as in Istria and counties stretching from Lika to Dalmatia (Figure 1c). The fragmentation indicators indicate that Croatia is not homogeneous, but it is difficult to see a pattern since different fragmentation indicators rank Croatian counties differently.

Figure 1 Counties according to averages for fragmentation indicators

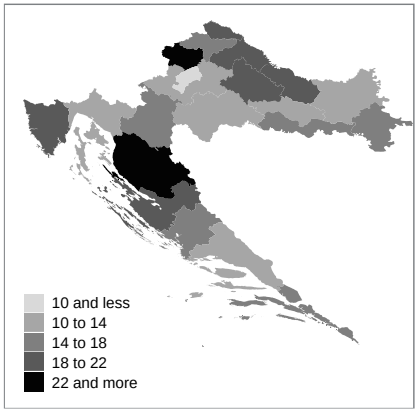
a) area in square km per local unit



b) population per local unit



c) local units per 100,000 inhabitants



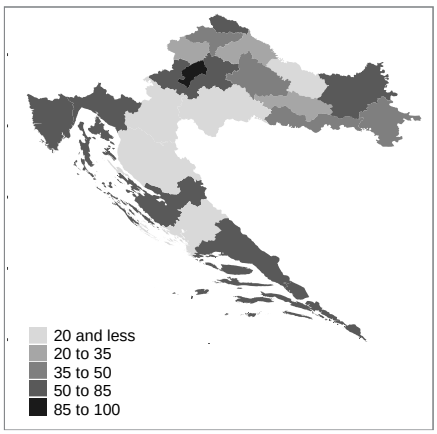
Source: Authors.

Some authors (e.g. Oates, 1972) argue that size of jurisdictions indeed need not be equal for the whole country, but that their size should reflect their territorial characteristics, thus taking into account spill-over effects and a request for proximity of local politicians to the citizens. Local units should be bigger in densely populated i.e. urban regions, and smaller in scarcely populated rural areas. Following that logic, we construct the so-called rural index, showing for each region (i.e. county) the percentage of local units with a population density of over 150 per square kilometre[3]. This measure shows

[3] Rural index is constructed using the OECD classification of local communities. The index differentiates rural, intermediate and urban regions on the basis of the share of rural local communities i.e. communities with less than 150 inhabitants per square kilometres. A region is defined as predominantly rural if more than 50% of the population lives in rural communities; it is considered intermediate if between 15 and 50% of the population lives in urban communities, and it is classified as predominantly urban if less than 15% of the population lives in rural communities (Bartolini, 2015).

that the City of Zagreb is the only urban region in Croatia. Since it consists of only one local unit, it is in line with the abovementioned recommendation. There are only 8 intermediate regions, and the other 12 regions are predominantly rural (Figure 2). The intermediate regions might be good candidates for municipal amalgamation, in cases in which they are characterized by small sized local units. According to the calculated indicators, all of them but Primorje-Gorski kotar are also characterized by fragmentation above median, at least according to one of the fragmentation indicators.

Figure 2 Croatian counties according to the share of local units with population density > 150 inhabitants per km² (predominantly urban communities), in %



Source: Authors.

Since physical characteristics do not disclose much about the efficiency of the municipalities in performing their duties, we continue by exploring the factors influencing their efficiency measured by local expenditures per capita.

4 Economies of scale in local government in Croatia: an empirical assessment

4.1 Overview of the empirical literature on economies of scale in local government

There are numerous studies on economies of scale in local government and related topics such as optimal municipal size, territorial fragmentation, municipal amalgamations and local government efficiency. In one of the first systematic literature reviews Byrnes and Dollery (2002) examine 9 Australian and 22 international empirical papers (mostly studying UK, US and Canada). Byrnes and Dollery (2002, 5) concluded

that “29 percent of the empirical papers find evidence of U-shaped cost curves, 39 percent find no statistical relationship between per capita expenditure and size, 8 percent find evidence of economies of scale, and 24 percent find diseconomies of scale”. According to Byrnes and Dollery there is, thus, high uncertainty about the existence of the economies of scale in local government service provision.

Holzer at al. (2009) analysed 65 studies of the optimal municipal size and local government efficiency published from 1959 to 2008. Those studies show little correlation between size and efficiency, especially for municipalities with populations between 25,000 and 250,000 inhabitants. They find that economies of scale can be associated with capital-intensive and highly specialized services, but that large units are less efficient in providing labour-intensive services. Generally, the largest and smallest municipalities are the least efficient, and therefore there is an inverted U-shaped relationship between local government size and efficiency.

Tavares (2018) offers an extensive review of 52 empirical papers published between 1985 and 2017 on the impact of municipal amalgamations on economic efficiency, managerial goals, and democratic outcomes. The review concludes that the majority of the studies did not find significant reductions in expenditure resulting from municipal amalgamations. Some studies showed that the reduction of general administration expenditures was mostly offset by the increase of other expenditure categories. Other found unutilised economies of scale, but these effects tended to be small.

Swianiewicz et al. (2017) examines 28 studies published between 2001 and 2017 on impacts of territorial reforms in 9 countries (Austria, Denmark, Finland, Georgia, Germany, Poland, Sweden, Switzerland and The Netherlands). The studies reviewed did not only analyse the impact of territorial reforms on efficiency, but also their political implications, impact on managerial goals and citizen satisfaction, common pool problem and transformation on territorial identities. Among seven studies concentrated on efficiency implications, three provided evidence of cost savings after municipal mergers, three had mixed results or found no systematic effect on local government spending, while one found that mergers increased the spending.

Similar conclusions can be found in Turley at al. (2018), who reviewed 18 studies of local government size and economies of scale, published between 2008 and 2017. According to the survey of the results of those studies, four studies found some evidence of economies of scale, ten studies found limited evidence while four studies discovered no evidence of the economies of scale.

In our paper, we present a non-exhaustive overview of 18 empirical studies of the economies of scale in the provision of local public services that were published between 2008 and 2019. Those papers coincided with the outbreak of the global financial crisis and the ensuing sovereign debt crisis, when the idea of municipal amalgamation gained in popularity and was considered by many a convenient policy measure that could bring

about cost reduction without jeopardizing the provision of public goods and services. The papers can be divided in two groups – those that assess the economies of scale in the provision of local public goods prior to a reform aimed at increasing the size of local jurisdictions[4], and those assessing the effects of municipal amalgamations after their voluntary or compulsory implementation[5]. Interestingly, in countries that had municipal amalgamations, the decision to introduce them was generally politically motivated, and as a rule not supported by empirical analyses (Tavares, 2018). The basic information on those papers, such as the information on the author, publication year, country that is the subject of investigation, methodology, data selection, variables, research goals and results can be found in the Table A1 in Appendix 1.

The group of papers assessing economies of scale before the reform is methodologically rather heterogeneous, as opposed to that analysing the effects of the reforms that mostly apply difference-in-difference and make use of large data sets. As a measure of cost as the dependent variable, authors mostly use total local expenditures per capita examining overall cost functions, but there are also studies that examine cost characteristics of specific municipal services by functional categories, e.g. waste management, transportation, education and road maintenance. The majority of papers take the number of inhabitants as the independent variable measuring output. The employment of population size as a proxy for local government output is often disputed in theoretical papers, but it seems that there are no good alternatives when it comes to empirical research. In general, modelling includes two types of independent variables – population variables, and control variables. As population variables, apart from the size of the population, models include population squared in order to explore the existence of U-shaped cost curve and to calculate the number of inhabitants minimizing local government expenditures, and some extended models comprise population growth and population density as well.

The control variables that appear in the models can be divided in following groups: i) variables representing municipal wealth (e.g. local tax revenues, revenues from grants received from upper tiers, average wage level, average price of housing per m^2); ii) socioeconomic variables (share of single parents, unemployed persons, persons aged 65 or more, population aged 0 to 14, dependency ratio etc.); iii) political variables (share of the left in local councils, political fragmentation in local councils); iv) dummy variables for e.g. metropolitan regions, urban and rural municipalities, dummies representing the different levels of responsibility; and v) other variables (e.g. the size of agricultural land, elevation, terrain ruggedness etc.).

[4] Bikker and van den Linde (2016); Breunig and Rocaboy (2008); Drew and Dollery (2016); Drew, Kortt and Dollery (2012); Hortas-Rico and Ríos (2020); Matějová, Plaček, Krápek, Půček and Ochranac (2014); Pevcin (2012); Soukopová, Nemec, Matějová and Struk (2014) and Tavares, Rodrigues (2015).

[5] Allers and Geertsema (2016); Blesse and Baskaran (2016); Blom-Hansen, Houlberg, Serritzlew and Treisman (2016); Hanes (2015); Drew, Kortt and Dollery (2016); Reingewertz (2012); Steiner and Kaiser (2017) and Turley, McDonagh, McNena and Grzedzinski (2018).

The main findings of the papers investigating economies of scale in local government before reforms are: i) economies of scale in total expenditures or some functional category are found in seven out of ten papers; ii) the majority of papers (six out of ten) found a U-shaped relationship between population size and per capita expenditures (total or some expenditure area, e.g. education); iii) local expenditures are not only or primarily determined by population size, but also by its density, by expenditure structure, e.g. share of labour intensive vs. share of capital intensive expenditures, topography etc.

Findings of post-amalgamation papers provide less support for reforms based on municipal amalgamation aimed at exploiting economies of scale. Generally, their main messages are: i) amalgamations have no significant effect on overall spending, and efficiency savings are possible primarily in expenditures on administration and some capital-intensive functional areas such as road maintenance or water management; and ii) some papers even indicate that amalgamations led to "overshooting" i.e. increasing population size of the municipalities above optimal, and reaching the territory where diseconomies started to show (Drew, Kortt and Dollery, 2016; Hanes, 2015). Only one out of eight papers found an undoubtedly negative effect of amalgamation on local spending (Reingewertz, 2012). There is one noteworthy observation by Blom-Hansen et al. (2016), who claim that empirical research could find no clear and systematic effect of amalgamations since the most expensive public services are provided at units (such as schools, kindergartens, nursing homes). Therefore, it is the size of a unit and not the size of a jurisdiction that matters.

To our knowledge, there are no empirical studies assessing the economies of scale in local government and the optimal size of local government units in Croatia. Thus far, the empirical research on the efficiency in sub-regional public spending in Croatia was primarily focused on the regional i.e. county level (see e.g. Hodžić and Muharemović, 2019, and Hodžić, Jurlina Alibegović and Bečić, 2017).

4.2 Methodology

In our assessment of the economies of scale in local governments in Croatia, we follow the strand of before-reform investigations and rely on the cross-section OLS models, like Drew, Kortt and Dollery (2016), Drew, Kortt and Dollery (2012), Matějová et al. (2014), Pevcin (2012) and Tavares (2015). Our empirical strategy is based on two main model specifications.

Firstly, we analyse the linear relationship between population size and per capita expenditures in order to determine whether there is empirical evidence of linear economies of scale in local government units in Croatia.

Our benchmark model is defined as follows:

$$ln(E_i) = \alpha + \beta\, ln(P_i) + \theta\, ln(Dens_i) + \gamma' X_i + \vartheta' D_i + \varepsilon_i, \quad (1)$$

where E_i represents total per capita expenditures of the local government unit i, P_i is the number of inhabitants in the respective local unit (population size), $Dens_i$ is population density in the local unit, vector X_i contains the number of control variables and vector D_i contains the number of dummy variable α, β, θ, γ and ϑ are the set of parameters to be estimated, while ε_i is an error term that is assumed to be $\varepsilon \sim i.i.d.N(0,\sigma^2)$ If $\beta < 0$ there is evidence of economies of scale, while $\beta > 0$ would suggest the presence of diseconomies of scale.

After that, we look for a non-linear relationship between population size and per capita expenditures by including squared population size in our benchmark model specification. In this step we test the U-shaped cost curve hypothesis and use the following specification:

$$ln(E_i) = \alpha + \beta_1 ln(P_i) + \beta_2 ln(P_i)^2 + \ln(Dens_i) + \gamma' X_i + \vartheta' D_i + \varepsilon \quad (2)$$

Provided that there is an empirical evidence of the U-shaped relationship between population size and per capita expenditures (i.e. $\beta_1 < 0$ and $\beta_2 > 0$), based on estimated parameters β_1 and β_2 we can calculate the indicative optimal size of population that minimizes the per capita expenditures by using the first order condition (Hortas-Rico and Rios, 2020):

$$\frac{\partial ln(E_i)}{\partial ln(P_i)} = \beta_1 + 2\beta_2 ln(P_i) = 0 \quad (3)$$

The optimal size of the local unit in terms of population is calculated as:

$$\ln(Pi)^* = \frac{-\beta_1}{2\beta_2} \quad (4)$$

Although the literature focuses on population size as the main determinant of local per capita expenditures, other factors can affect them as well. Thus, our models include various additional explanatory variables. The choice of variables is based on existing empirical literature but we also take into account some Croatian specifics.

Firstly, we pay special attention to the role of population density ($Dens_i$), and we additionally stratify local units by population density as in Drew, Kortt and Dollery (2012) in order to explore whether population density causes the appearance of economies of scale.[6] In the vector of control variables we also include other explanatory variables suggested by the literature. They can be divided in several categories.

Other demographic factors include *population growth*, the share of the population older than 65 (*population 65+*) and the share of the population below 15 years of age *(population 0-14)*. Population growth can directly affect per capita expenditures because a growing population could lead to increased needs for additional infrastructure while falling population reduces the need for various services (e.g. teachers in local schools). As Croatia faces problems of de-population, de-ruralisation and emigration this factor might have a very important effect on per capita expenditures. The shares of the older and the younger population act as a proxy for the dependent population that creates a demand for social welfare services, pre-school and primary education, which are mostly provided by local units.[7]

Socio-economic factors include *taxable income per capita* and *share of unemployed in total population.* Most authors suggest that a higher taxable income per capita implies a higher demand for local services, which have the characteristics of normal goods. This factor reflects the so-called Wagner law, which states that per capita (local) government expenditures tend to rise with the level of development, caused by the rising demand of the society for culture and recreation, environmental protection, social security and so on. A higher share of unemployed persons in the total population increases the need for social welfare.

Transfers per capita – local units receive transfers from the central government or supranational institutions as part of horizontal equalisation, i.e. the transfer of fiscal resources among jurisdictions of the same government level, with the aim of offsetting differences in revenue raising capacity and the cost of delivering services. Transfers are a significant source of revenues especially for less-developed local units. Local units in the EU have direct access to various EU financial programs and schemes (most importantly EU funds) that can substantially affect local government expenditures, both current and capital.

Tourism could be an important determinant of per capita expenditures in countries such as Croatia, where tourism has an important role in the creation of gross value

[6] We divide the sample of all local government units into cities and municipalities, which differ substantially in population density. As there are notable differences in population density within each of these two groups, we find it necessary to stratify the sample additionally.

[7] Cities and municipalities in Croatia are responsible for covering compensation of employees, current and capital expenditures in pre-school education, while cities are also responsible for covering current and capital expenditures in primary school education.

added. Tourists can significantly increase the demand for local services such as waste management, public safety, and public transportation, especially during the tourist season. To our knowledge, this is the first paper that includes a variable related to tourism (*number of tourist overnight stays*) and revenues from EU funds as determinants of local per capita expenditures.

Finally, D_i includes dummy variables that act as additional control variables in our models. In the sample of cities, we use dummy variables for county-centres as these cities have some additional legal responsibilities compared to other cities. In addition, we use dummy variables for cities and municipalities assumed some of the responsibilities of central government, i.e. the responsibilities for health care, social welfare, firefighting, primary and secondary education (80 cities and 97 municipalities in 2018).

We conduct our analysis for the whole sample of 555 local units and for two separate samples of 127 cities and 428 municipalities. The City of Zagreb is not included in the analysis as it has a status of both city and county and is larger by far than other local government units. The division of the sample allows us to concentrate on some specifics and to calculate indicative optimal sizes of each of those types of local units – one with more urban, and the other with more rural characteristics. This can result in additional insights that could be useful in designing policy proposals focused on potential benefits of amalgamation of municipalities. Separate results for those two types of local government units may indicate how to shape the policy without having to recourse to an over-simplistic one-size-fits-all solution.

4.2.1 Data and descriptive statistics

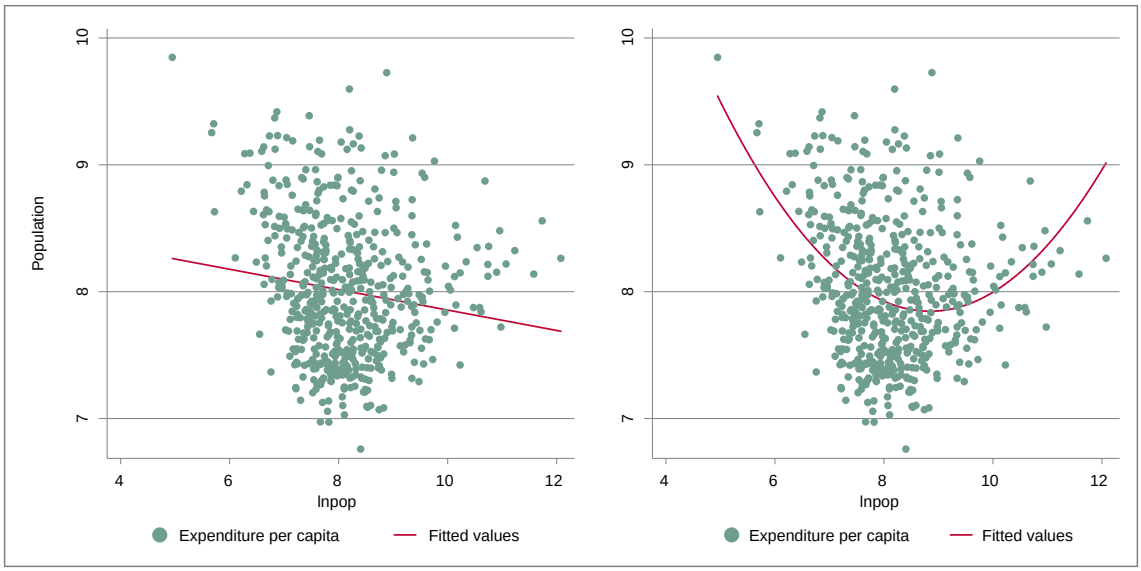
Due to data availability, data averages cover the period from 2008 to 2018 and are obtained from the official sources – Ministry of Finance (local government budget data), Croatian Bureau of Statistics (population size, structure, density, number of unemployed and surface area) and Croatian Tax Administration (taxable income).[8] Using these data, we plot the figures showing the relationship between population size and per capita expenditures in local units to motivate the analysis (see Figure 1).

Following the theoretical and empirical literature we examine the existence of linear and quadratic relationship between the two variables. The left panel of Figure 3 shows that there is a negative but weak linear relationship between these variables, while the right panel indicates that there could be some evidence of a U-shaped cost curve. However, to get a clear picture of the relationship between population size and per capita expenditures one has to take into account various other determinants.

Table 2 shows the main descriptive statistics of data included in the analysis.

[8] Data on population density and the shares of the older and the younger populations are obtained from the last official population census in 2011 while data on tourist overnight stays are available only from 2010 due to changes in the methodology.

Figure 3 Relationship between population size and expenditures per capita in local units



Source: Authors.

Table 2 Descriptive statistics

Variable	All local government units (555 observations)				Cities (127 observations)				Municipalities (428 observations)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Expenditure pc (HRK)	3,535.8	2,341.7	862.2	18,905.0	3,842.7	1,890.7	1,467.7	10,018.6	3,444.7	2,454.2	862.2	18,905.0
Population	6,232.2	12,891.8	140.9	175,668.2	17,439.0	23,525.6	1,548.3	175,668.2	2,906.8	1,969.7	140.9	15,369.6
Population growth (%)	−1.3	2.7	−8.2	51.1	−1.1	1.1	−8.2	1.5	−1.3	3.0	−5.6	51.1
Pop. density (p/km2)	94.8	197.1	2.3	2,965.0	199.6	367.1	8.9	2965.0	63.7	80.1	2.3	782.7
Population 65+ (% total)	19.6	5.2	10.4	61.1	17.9	3.1	10.5	27.4	20.1	5.5	10.4	61.1
Population 0-14 (% total)	15.1	2.8	4.2	26.3	15.1	2.1	10.7	23.1	15.1	3.0	4.2	26.3
Taxable income pc (HRK)	21,980.1	5,979.4	6,542.1	39,415.3	26,394.2	4,997.5	16,942.1	39,415.2	20,670.3	5,612.8	61,542.1	37,173.5
Unemployed (% of pop.)	7.1	3.7	1.5	21.8	6.8	2.8	2.1	15.0	7.2	4.0	1.5	21.8
Transfers from central state pc (HRK)	768.5	956.1	23.8	13,788.9	547.9	449.2	23.8	2,413.6	833.9	1,052.5	52.5	13,788.9
EU transfers pc (HRK)	18.9	67.8	0	781.9	17.9	35.6	0	240.6	19.1	74.8	0	781.9
Tourist nights pc	28.5	91.6	0	1,429.1	31.3	64.2	0	325.8	27.7	98.3	0	1,429.1
Area (km2)	100.8	108.9	6.0	967.1	165.9	149.4	11.4	967.1	81.4	84.6	6.046	957.1

Source: Authors' calculations.

5 Results

5.1 Main results

The main results of our empirical analysis (Table 3) show no evidence of linear economies of scale, but there is evidence of a U-shaped relationship between population and expenditures per capita as the estimated coefficient next to population^2 is statistically significant for the sample of all local units and for the two sub-samples. It could thus be inferred that there are economies of scale up to some number of inhabitants, beyond which diseconomies of scale prevail. Ten alternative specifications of models confirm these findings as statistically robust (see Table 2 in the Appendix 2).

The estimated parameters next to relevant control variables show that the effects of determinants of per capita expenditures in local units are mostly in line with theoretical assumptions and previous empirical evidence.

Estimated parameter next to population density points to a negative relationship with per capita expenditures. However, in the case of cities the relationship between population density and per capita expenditures is not statistically significant, which mostly reflects the fact that there is less variance in population density across cities compared to municipalities and the whole sample.

Population growth is positively related to per capita expenditures in all samples. The share of the older population is related to per capita expenditures of local units with the expected sign, although this relationship is not statistically significant in the case of cities. There is a negative relationship between the share of the young population and per capita expenditures. This result is somewhat unexpected since a higher share of the young population should be related with higher expenditures on pre-elementary and elementary schools. However, pre-elementary and elementary education in Croatia is partially financed on regional and central government level or through EU transfers.

The relationship between the share of unemployed persons in total population and per capita expenditures is not statistically significant in any of the model specifications, which probably reflects that fact that the unemployment benefits are paid out of the central budget. Taxable income per capita, which is a key demand-side factor in our analysis, seems a highly significant determinant of per capita expenditures in all samples.

Table 3 Empirical results

	Quadratic model			Linear model		
	All	Cities	Munic.	All	Cities	Munic.
ln(Population)	−0.584***	−0.770*	−0.729*	−0.0140	−0.00608	−0.0435
	(0.197)	(0.440)	(0.402)	(0.0233)	(0.0473)	(0.0353)
ln(Population)^2	0.0345***	0.0400*	0.0443*			
	(0.0118)	(0.0229)	(0.0259)			
ln(Density)	−0.0432*	−0.00216	−0.0676**	−0.0246	0.0136	−0.0593**
	(0.0226)	(0.0311)	(0.0287)	(0.0218)	(0.0301)	(0.0284)
Pop. growth	0.0319***	0.0399*	0.0311***	0.0326***	0.0425	0.0330***
	(0.00557)	(0.0193)	(0.00609)	(0.00560)	(0.0245)	(0.00601)
Share 65+	0.0132**	0.0133	0.0115*	0.0178***	0.0174	0.0138**
	(0.00541)	(0.0122)	(0.00616)	(0.00520)	(0.0120)	(0.00602)
Share 0-14	−0.0175**	−0.00187	−0.0169*	−0.0165*	−0.00581	−0.0164*
	(0.00844)	(0.0182)	(0.00954)	(0.00849)	(0.0183)	(0.00956)
ln(Taxable income pc)	0.779***	0.943***	0.752***	0.803***	0.934***	0.773***
	(0.0743)	(0.185)	(0.0838)	(0.0744)	(0.187)	(0.0830)
Unemployment	0.00325	0.00595	0.00343	0.00446	0.00594	0.00417
	(0.00512)	(0.0110)	(0.00588)	(0.00514)	(0.0111)	(0.00588)
ln(National transfers)	0.202***	0.166***	0.202***	0.212***	0.180***	0.208***
	(0.0231)	(0.0412)	(0.0287)	(0.0231)	(0.0407)	(0.0285)
ln(EU transfers)	0.0219**	0.0194	0.0220**	0.0224**	0.0180	0.0224**
	(0.00869)	(0.0130)	(0.0106)	(0.00874)	(0.0131)	(0.0107)
Tourists	0.00230***	0.00382***	0.00212***	0.00229***	0.00384***	0.00211***
	(0.000161)	(0.000412)	(0.000179)	(0.000162)	(0.000415)	(0.000179)
Decentralization	0.133***	0.0737	0.162***	0.154***	0.0521	0.166***
	(0.0384)	(0.0554)	(0.0507)	(0.0380)	(0.0545)	(0.0508)
County centre	−0.0711	0.00638		0.0628	0.0382	
	(0.103)	(0.0832)		(0.0926)	(0.0819)	
_cons	1.493	0.853	2.404	−1.330	−2.827	−0.574
	(1.277)	(2.991)	(2.001)	(0.839)	(2.139)	(0.993)
N	555	127	428	555	127	428
R^2	0.662	0.755	0.654	0.657	0.749	0.652
Optimal size	4740	15139	3744			

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations.

National transfers are positively related with per capita expenditures in all samples, with statistically significant coefficients. There is also a positive but weaker relationship between EU transfers and per capita expenditures. However, in the case of cities the estimated parameter is not statistically significant, which suggests that municipalities rely more on EU transfers than cities. The estimated coefficients next to tourist overnight stays per capita point to a positive and statistically significant relationship with per capita expenditures.

The estimated coefficients next to decentralized functions dummies are positive in all samples, although the coefficient is not statistically significant in the sub-sample of cities. We cannot find statistically significant evidence that cities that are county-centres have higher per capita expenditures, which could be explained by the fact that the sample of county-centres is really small (only 20 cities) so it is hard to find statistically significant results.

5.2 Optimal size of local units in Croatia

Based on results from non-linear models, we can calculate indicative size of local units that minimizes per capita expenditures (equation (4)). The last row in Table 3 shows the calculated indicative optimal size of all local units (4740), cities (15139) and municipalities (3744). The calculated optimal size of local units allow us to compare it with population mean and median and count the number of local units with the number of inhabitants above and below the optimum (Table 4).

Table 4 Optimal size of local units vs. current structure

	All local units	Cities	Municipalities
Optimal size	4740	15139	3744
Mean	6232	17439	2907
Median	2939	10531	2368
Number above optimal	167	35	102
Number below optimal	388	92	326

Source: Authors' calculations.

In the case of the total sample of local units calculated, the optimal size is below the current mean but well above the median, as extreme values exert an upward pressure on the average figure. Only 167 out of 555 jurisdictions have populations larger than the optimum while 388 out of 555 have smaller populations. Optimum population size in municipalities is higher compared to both mean and median, while the number of municipalities with a population below the optimum stands at a high 76% (326/428). In the sample of cities, 72% have a population size below optimal (92/127). The presented

numbers should be interpreted with caution because the calculation of the optimal size of local governments is highly sensitive.

5.3 Sensitivity of the results on the optimal size of local units

The calculation of the optimal size of local units is a two-step procedure that is coupled with a relatively high degree of uncertainty. The main source of uncertainty in the first step lies in the model specification. In order to point to the weakness of this approach, we apply ten different model specifications for each sub-sample of our analysis and calculate the minimum and maximum for the calculated optimal size of local units. Table 5 shows that optimal size of local units varies significantly across models. In our benchmark specification, we took the most conservative figures based on the minimum of the interval as these figures are based on model specifications with the most control variables.

Table 5 Optimal size of local units – different model specifications

	Min	Max	St.Dev.
All local units	4740	12360	2371
Cities	15139	46535	9464
Municipalities	3744	11937	2650

Source: Authors' calculations.

Uncertainty in the second step of the analysis stems from the coefficient uncertainty and non-linearity that additionally enhances the sensitivity of the result. Table 6 shows calculations of the optimal size of the government based on models presented in Table 3 with 68% confidence intervals. The confidence intervals are relatively wide due to large standard errors, which are largely a result of non-linearity in the model that is crucial for the calculation of the optimal size of local units, as suggested by (4).

Table 6 Optimal size of local units – confidence intervals

	Estimate	Std.Err.		[68% Conf. Interval]
All	4740	1617	3113	6330
Cities	15139	8968	6323	24159
Municipalities	3744	1843	1928	5593

Source: Authors' calculations.

In the literature on economies of scale in local units it is common to calculate only the "point estimate" of the optimal size of the government. However, in this paper we

point to the sensitivity of such an approach as confidence bands are pretty wide. Thus, the main results presented in the previous section (that 76% of municipalities and 72% of cities have population sizes below the optimal level) should be interpreted with a grain of salt. If we look at the number of local units inside the "optimal interval" we can conclude that population size is inside the interval in 53% of cities and 57% of municipalities, while 35% of municipalities and 28% of cities have population sizes below the lower band of the interval.

6 Conclusions

Local units perform many important functions in a society. Since their fiscal capacities are often constrained, they should operate efficiently. According to the economic literature, efficiency could be related to the size of local units; however, the relevant theories provide only limited guidance in the quest for the optimal local government size.

In this paper, we relied on the theory of firms and took a purely economic standpoint in the search for the optimal size of local units in Croatia by analysing the existence of economies of scale in the provision of local public goods. The main advantage of this approach is that it is a priori agnostic regarding the size of local units as it seeks to assess the optimal size of local government directly from the data. This is at the same time the main disadvantage of this approach as many authors describe it as overly technical. Although the optimal size of local units is not only an economic but also a political, societal and cultural issue, we think that insight into the most economically efficient size of the local government could be useful in a considering potential amalgamations.

To the best of our knowledge, in this paper we have provided the first estimates of the relationship between population size and per capita expenditure for the Croatian local government system while controlling for various important determinants of per capita expenditures at the local government level. In addition, unlike all the other authors, in this paper we analysed the sensitivity of the dominantly used methodology by calculating confidence bands for the optimal size of the government.

Our results point to a U-shaped relationship between population size and per capita expenditures in local units in Croatia. Such a relationship implies that the costs of local government units fall at the beginning and start to rise after certain size of local government units is achieved. This result indicates that costs of medium-sized units are the lowest and implies that there is some "optimal" size of local government units. The U-shaped curve can be explained by two opposing effects: the economies of scale effect that is dominant in small local units and the (bureaucratic) congestion effect that

prevails in overly-large local units. However, as we explained in the paper, literature and policy makers focus on small local units, as the disaggregation of large local units (especially cities) is too challenging, given the complexity and homogeneity of large local units. Thus, in large units the focus should be on wasteful expenditures and not on the size.

If we focus on our median results, we can conclude that number of inhabitants is below the optimum level in more than 72% of cities and 76% of municipalities, However, as we explained in the previous section, these results should be interpreted with a grain of salt due to wide confidence bands calculated for the optimal size of the local units. More precisely, if we look at the number of local units inside the "optimal interval" we can conclude that population size is inside the interval in 53% of cities and 57% of municipalities, while 35% of municipalities and 28% of cities have population sizes below the lower band of the interval. Due to the high level of uncertainty that surrounds such calculations, we are aware that we have not offered the final answer to what the optimal size of local units in Croatia should be but hope that it will serve as a motivation for further research on the subject. In our future research we will rely on panel models as cross-section analysis cannot capture the dynamics in both expenditures per capita and population size, which can have notable effects on the results. In addition, we can expand our analysis to different types of local government unit expenditures (based on economic or functional classification of expenditures).

Finally, our results imply some policy recommendations. If we take the most conservative estimation of the lower band of the optimal size interval, we can conclude that around 30% of local units can be labelled too small, with the potential to achieve economies of scale. Hence, the focus of policy makers in Croatia should primarily be on these local units. However, we are aware that forced amalgamations and mergers could be politically challenging and that there is strong opposition for full-scaled reform of local government units system both at local and at central government level. Thus, we would like to propose two alternative options as the starting point for the reform, based on experiences of some other countries. One option is to financially stimulate voluntary mergers of the smallest local units. The other is to encourage and/or to force inter-municipal cooperation, where local units would keep relatively high level of local autonomy but would share some expenditures and investments, thus achieving economies of scale.

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7 Appendix

7.1 Appendix 1: Literature review

Table 1 Literature review

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Bikker, van den Linde (2016); The Netherlands	*Model:* *Cross-sectional stochastic cost frontier estimation using Maximum Likelihood method* *Dependent variable:* *Spending on local public administration per capita* *Independent variables:* *– number of inhabitants (six different functional specifications)* *– demographic pressure (% of the sum of young and old inhabitants in working population)* *– wealth (average home value)* *– area* *– dummy for specific municipalities (Wadden islands)* *– hourly wage rate for staff in public administration and government services* *– time trend* *Data:* *Panel data (10 years: 2005-2014)* *4327 observations (from 467 to 403 municipalities)*	Research goal: Discovering possible economies of scale in local public administration and estimating the size of a municipality that will minimize the costs of local public administration. Results: There are substantial unused scale economies of around 17% for the average municipality – higher for smaller, and lower for large municipalities. Optimum size of municipalities increased from around 49,000 in 2005 to 66,260 in 2015.
Breunig, Rocaboy (2008); France	Model: Semi-parametric regression, allowing the effect of population size on per capita expenditures to vary in non-parametric way, while the effect of other variables is estimated parametrically. Dependent variable: Per capita expenditures on local public services Independent variables (all in logs): – municipal population – tax base per capita excluding local business tax – tax base per capita including local business tax – total household wage and non–wage income divided by municipality size – grants received by the municipality per inhabitant – surface area – average altitude – dummy for co–operation with other communes Data: Cross-sectional data for 2004, 36000 municipalities	Research goal: Testing the relationship between population size and per capita public expenditures, which results from a joint action of congestion costs and tax sharing. Results: There is a U-shaped relationship between population size and per capita local public expenditures. Per capita local public expenditures reach a minimum for a population size of around 400 inhabitants.

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Drew, Dollery (2016); Victoria, Australia	Model: Fixed effects panel regression Dependent variable: Satisfaction Rating (overall satisfaction, advocacy satisfaction, engagement satisfaction) Independent variables (all in logs): – population / 100.000 – population growth (3-year compound growth rate) – population density – % of population under 15 – % of population over 65 – Aboriginal and Torres Strait Islanders as % of population – % of population speaking a language other than English at home – unemployment rate – average wage (ln) – number of dwelling approvals (in log) – hectares of agricultural land – total length of roads – % of population receiving government disability pension Data: 3-year longitudinal data from Annual Community Satisfaction Survey (2008 – 2010), 79 Victorian local governments; councils stratified as Metropolitan, Rural and Regional Centre authorities	Research goal: Exploring the relationship between population parameters (size, density and growth), and citizen satisfaction. Results: There is a negative correlation between population size and citizen satisfaction (as a proxy for effectiveness of local government performance). There is, however, a positive relationship between population density and growth, and citizen satisfaction.

Appendix

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Drew, Kortt, Dollery (2012); Australia, New South Wales	Model: OLS Dependent variable (all in logs): – total per capita expenditure – community expenditure per capita (aged care centres, child care facilities, youth centres, senior citizens group…) – ecreational expenditure per capita – environmental and health expenditure per capita Independent variables (all in logs): – population/10000 – population squared – population growth over 5 years – Aboriginal and Torres Strait Islanders as % of population – dummies for population density groups – metropolitan, regional, very large agricultural land, agricultural and remote islands – average wage – % of unemployed – number of single parents – number of persons receiving a federal government pension Data: 152 local councils, 2009/2010 (one year)	Research goal: Examining whether scale economies exist in local government outlays in NSW. Results: There is an evidence of a U-shaped cost curve – inclusion of population density variable diminishes the impact of the population variable and population squared variable. There is no evidence for economies of scale for per capita local government expenditure on community, recreation, environment and health services. Residual expenditure category is the principal cost-driver of local government expenditures. There may be diseconomies of scale in “metropolitan” councils, there is no evidence of scale economies in “agricultural and remote” councils, economies of scale are present only in “regional and very large agricultural” councils.

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Hortas-Rico, Ríos (2020); Spain	Model: Spatial Durbin model (spatial panel model with fixed effects and non-linearities in the population variable) Dependent variables (in logs): (variables chosen based on the assumption that they are most directly influenced by scale economies, economies of density, external effects and geography) – total spending per capita – current spending per capita – expenditures for general services per capita – expenditures for community facilities per capita – expenditures for social services per capita – expenditures for basic infrastructures per capita – expenditures for local police per capita Independent variables (all in logs): 1. Cost factors – population – population squared – dummy variables representing the different levels of responsibility of the municipalities – % of population over 65 – % of migrants – population clusters per capita (capturing spatial distribution of the population among the existing clusters) – wages – mean elevation (altitude) – Terrain ruggedness index 2. Demand factors – tax-share in % (proportion of total tax bill paid by the resident) – income per capita – current transfers per capita – capital transfers per capita – ideology (index ranging from 0 (left) to 10 (right), taken from Deusto Polls database) – government strength (measured by the share of seats obtained by the ruling party in the local council) Data: A sample of 5556 Spanish municipalities representing 70% of total municipalities and 87 percent of the whole population, 9 years (2003-2011)	Research goal: Determining for which population levels there are (dis)economies of scale in the provision of public goods, and whether this efficiency scale varies depending on the public service provided, and/or geographical heterogeneity of the territory. Results: There is an evidence of a U-shaped relationship between population and municipal spending – economies of scale exist as long as the municipality does not exceed the critical size, which is between 6,000 and 8,000 inhabitants. Spatial distribution of the population and the physical geography have a non-negligible impact on costs. More dispersed populations lead to increasing costs (diseconomies of density). Topography, and especially mean elevation of the municipality is crucial for determining the optimal size of the cities – municipalities with high mean elevation exhibit a lower optimal size than those located in lower altitudes and important diseconomies of scale beyond that point. Municipalities with a rugged terrain exhibit greater optimal size than those located in the plains. U-shaped relationship is consistent when evaluating specific service types (except for expenditures for basic infrastructures), but optimal sizes range from 842 to 26,100 inhabitants, depending on the public service.

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Matějová, Plaček, Krápek, Půček, Ochranac (2014); Czechia	Model: OLS Dependent variable: Per capita municipal costs on pre-school and basic education Independent variables: – population – population squared – 1/populaton Data: 8 years (2005-2012), 3279 municipalities out of 6250, i.e. only municipalities with more than 395 are included because smaller municipalities do not have the responsibility for pre-school and basic education	Research goal: Examining the existence of economies of scale in the current form of territorial fragmentation in the Czech Republic with the focus on pre-school and primary schools in order to determine the optimal size of the municipality for choosing the area for this type of public service. Results: The curve of per capita costs on pre-school and basic education in the Czech Republic is U-shaped, and the optimal size of municipality that has responsibility for pre-school and basic education is 233,606 inhabitants
Pevcin (2012); Slovenia	Model: OLS Dependent variable: Total municipal expenditure per capita Independent variables (all in logs): – population/1000 – population squared – wealth (average yearly gross salary per employed person) – grants (per capita municipal transfer revenues) – core services (the costs of administrative operation, public utilities and education per capita) – population density – unemployment rate – % of population under 15 – % of population over 65 Data: 210 municipalities, cross-sectional data for 2009	Research goal: Testing the relationship between the size of local government and its efficiency. Results: There is a statistically significant negative effect of municipal size on total per capita expenditures, but the effect tends to be relatively small.

Author(s), country and reform type	Model description	Research goal and results
Before reform investigation		
Soukopová, Nemec, Matějová, Struk (2014); Czechia	Model: Polynomial regression model Dependent variable: Municipal expenditures per capita (total and expenditures for individual services) Independent variable: Number of inhabitants in logs Data: 5 years (2008 – 2012), but only data for 2012 are presented and discussed in the paper since the results for all years did not differ; all 205 municipalities with extended powers.	Research goal: Answering the question whether economies of scale can be identified for individual municipal services in municipalities with the extended powers in the Czech Republic (205 out of 6248 municipalities that took over 80 percent of the competencies previously assumed by the districts). Results: In aggregate, there are economies of scale in provision of all municipal services. However, when individual services are analysed, economies of scale can be found only for expenditures on culture, church and media, as well as for expenditures on education. On the other hand, economies of scale are not present in expenditures for sports and leisure, environmental protection, housing, communal services and territorial development. In the area of education, the most efficient size of municipality is around 20,000 citizens.
Tavares, Rodrigues (2015); Portugal	Model: OLS Dependent variable (in log): Total municipal expenditure per capita Independent variables (all in logs): – number of civil parishes per 1000 individuals – % of parish governments in the municipality headed by officials belonging to the same political party as the mayor – net debt (overall fiscal situation in municipality) – % of municipal own revenues – % of urban parishes in municipality – % of rural parishes in municipality – government grants to parishes per capita – municipal government grant to parishes – population density – % of population under 15 – % of population over 65 – area size Data: 278 municipalities with 4050 parishes, cross-sectional data for 2010	Research goal: Analysing whether territorial fragmentation within municipalities (number of civil parishes within municipalities) is determinant of municipal government expenditures and transfers to parishes. Results: More fragmented municipalities increase total expenditures, capital expenditures and grant transfers to sub-city governments

Author(s), country and reform type	Model description	Research goal and results
After reform investigation (quasi-natural experimental evidence)		
Allers, Geertsema (2016); The Netherlands; small number of amalgamations every year during 15 years	Model: Difference-in-difference estimation Static analysis plus dynamic panel data models – fixed effects model Corrected Least Squares Dummy Variable method due to limited T Hedonic regression (testing the effect of amalgamation on house prices) Dependent variable (in logs): Total expenditures per capita; Alternatively: – % of expenditures on culture and recreation – % of expenditures on administration Independent variables (all in logs): – total central government grants per capita – population – population density – unemployment benefit recipients per capita – ideology (council seats held by left-wing parties) – political concentration of the municipal ouncil (Herfindahl index) – % of seats by ruling coalition in the council Data: 12 years (2002-2013) spending data for 387 municipalities; 101 of which were created through amalgamation, 252 were not amalgamated; 34 were left intact; spending data organised as if all amalgamations had been implemented by 2002	Research goal: Evaluating the effect of municipal amalgamation on local government spending, public service levels and house prices Result: There is no significant effect of amalgamation on aggregate spending, irrespective of the size or homogeneity of preferences of municipalities Amalgamation reduces spending on administration, but does not increase spending on public services (e.g. culture and recreation) and does not capitalize into house prices.
Blom-Hansen, Houlberg, Serritzlew, Treisman (2016); Denmark; municipal reform from 2007 which changed the size of most of the country's municipalities, number of municipalities from 271 down to 98	Model: Difference-in-difference regression; panel data Dependent variable: Net current expenditure (expenditures financed by municipality itself) per user in 8 policy areas – day-care, schools, elder care, children and young people with special needs, roads, culture, administration and labour market Independent variables (all in logs): – indicators for spending needs (dispersed settlements and socioeconomic expenditure needs – index measure used in the national equalization scheme for municipalities) – indicator of fiscal pressure (an estimate of expenditure needs relative to the tax base) – political fragmentation – effective number of political parties – % of socialist seats in the council Data: 12 years (2003-2014) 1140 observations; 95 municipalities – 66 that resulted from mergers (treatment group), and 29 that did not experience a change in borders	Research goal: Exploring whether municipal mergers decrease the costs of provision of public services (schools, roads, infrastructure) i.e. costs other than administrative costs Result: There are no clear and systematic effects of amalgamations on costs of provision of public services; probably because the most expensive public services are provided at units within local government jurisdictions (schools, kindergartens and nursing homes).

Author(s), country and reform type	Model description	Research goal and results
After reform investigation (quasi-natural experimental evidence)		
Hanes (2015); Sweden; in 1952, reduction in number of municipalities from 2498 to 1037	Model: OLS Dependent variable: Percentage change in per capita expenditure growth between 1953 and 1959 Independent variables: – population size at the beginning of the period – population growth – growth rate of mean income – growth rate of national state grants (measuring "fly-paper effect") – per capita expenditures at the beginning of the period – a dummy variable for the city – Herfindahl index for population (capturing the concentration of the population among the municipalities amalgamated in to the new municipality) Data: 1005 municipalities (some of them excluded – subject to further amalgamations, some due to the loss of data) – 553 municipalities affected by the reform / 452 municipalities not affected by the reform 2 years data, for 1953 and 1959	Research goal: Assessment of amalgamation impact on expenditure growth in amalgamated municipalities. Results: The municipal reform in 1952 had a negative impact on per capita expenditure growth between 1953 and 1959. Amalgamated municipalities exploit economies of scale as long as they do not exceed some critical size. Amalgamated municipalities with fragmented structure (measured as a Herfindahl index for population) had slower expenditure growth than amalgamated municipalities with more concentrated structure (the case of e.g. a large municipality amalgamated with a small municipality).
Drew, Kortt, Dollery (2016); Australia, Queensland; forced merger program from 2007 leading to a reduction of the number of local councils from 157 to 73	Model: Separate OLS regressions for 2006/7 and 2009/10 Dependent variables (all in logs); – total per capita current expenditure – road expenditure per capita – waste expenditure per capita – expenditure for maintaining parks and gardens per capita Independent variables (in logs): – population – population squared – population density – four-year average population growth – hectares of agricultural land / 1000 (due to lower rate of property taxation for agricultural land) – average wage of taxable individuals – distance of urban roads in km – % of individuals unemployed – % of population under 15 – % of population over 65 – % of population speaking a language other than English at home and Aboriginal and Torres Strait Islanders Data: 114 councils in 2006/2007 and 57 in 2009/2010	Research goal: Assessment of scale economies before (2006/2007) and after forced amalgamation (2009/2010). Results: In both years there is an evidence of U-shaped cost curves, and evidence of economies of scale for populations up to 98/99,000 persons. For larger councils there is an evidence of diseconomies of scale. Economies of scale are observed only for expenditure on parks (representing only 5% of expenditures), both in pre- and post-amalgamation periods. It is doubtful whether the amalgamation program has improved the operational efficiency since after the reform a higher proportion of population lived in local units exhibiting diseconomies of scale

Author(s), country and reform type	Model description	Research goal and results
After reform investigation (quasi-natural experimental evidence)		
Reingewertz (2012); Israel; forced amalgamation reform in 2003 in which 11 of the 33 proposed amalgamations passed the Israeli parliament	Model: Difference-in-difference regression, panel data Dependent variables (all in logs); Total expenditures per capita Alternatively, expenditure items – labour expenses, municipal activities, education, welfare, finance and general expenses Independent variables (in logs): – population in 1000 – monthly wage of salaried worker – number of unemployment transfer beneficiaries Data: 9 years (1999 – 2007) 23 municipalities that were involved in 11 amalgamations (treatment group); 52 municipalities that were chosen to be amalgamated in 22 further amalgamations, but did not in fact amalgamate and non-amalgamated municipalities (control group)	Research goal: Analysis of the effect of municipal amalgamation on municipal expenditures and level of services provided. Result: Amalgamations resulted in lower levels of expenditures, but seem not to decrease the quality of services provided to the residents.
Steiner, Kaiser (2017); Switzerland; voluntary mergers of municipalities in which the number of municipalities decreased from 3021 in 1990 to 2294 in 2016	Model: Matching of a quasi-experimental group with a control group. Difference-in-differences analysis applied when possible. Data: data obtained from two comprehensive postal surveys of all local secretaries, conducted in 1998 and 2009, local secretaries being civil servants in municipalities, acting at the intersection between politics and administration 33 municipalities in quasi-experimental group and 33 in control group	Research goal: Analysis of the effects of mergers on five aspects – service provision, local finances, personnel, autonomy and democracy. Results: Some, but not strong evidence that a merger has increased the quality of public services. Mergers allowed personnel cuts and higher professionalization. Citizens' interest in local politics did not decrease after a merger. Local autonomy has strengthened after the merger. The effects of mergers are ambiguous, there are some positive effects, but not in all cases.

Author(s), country and reform type	Model description	Research goal and results
After reform investigation (quasi-natural experimental evidence)		
Turley, McDonagh, McNena, Grzedzinski (2018); abolition of all 80 town councils and amalgamation of some neighbouring city and county councils thereby reducing the number of local authorities from 114 to 31 in 2014; transfer of responsibility for water services from local government to national water utility	Model: Separate OLS regressions for 2011 and 2016 (empirical strategy in the study follows Drew, Kortt, Dollery (2016) analysis Dependent variables (all in logs); Total budgeted expenditures per capita Alternatively, budgeted expenditure items per capita – on amenities, on environment, on housing, on planning, on roads and on water. Independent variables (in logs): – population – population growth (5 year) – population density – unemployment rate – single-parent families as % of total families – disposable income per capita – Pobal deprivation index (a series of maps measuring the relative affluence or disadvantage of a particular geographical area in the Republic of Ireland, using data compiled from various censuses) – council size (surface area, km^2) Data: 88 councils for 2011 (26 so-called town commissioners are omitted from the dataset since they had very limited functions and no rate-setting powers) and 31 councils for 2016	Research goal: Assessment of the scale economies before (2011) and after city and county council amalgamation and town council abolition (2016) and testing for the presence of a U-shaped relationship between expenditure per capita and population size. Results: Economies of scale are found in spending on roads for both 2011 and 2016 and in expenditure on water post-amalgamation. Amalgamations thus may result in efficiency savings in these two functional areas, but may lead to higher costs in the other service areas. The study finds econometric evidence of U-shaped cost curves for both 2011 and 2016. The estimated population turning points increase post-amalgamation by a significant order of magnitude. In both years turning points are near median council size.

Source: Authors.

7.2 Appendix 2 Alternative model specifications

Table 1 All local units

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp
ln(Population)	–2.576***	–2.562***	–2.194***	–1.116*	–2.102***	–2.036***	–1.631***	–1.322**	–0.958	–0.770*
	(0.661)	(0.665)	(0.602)	(0.606)	(0.547)	(0.614)	(0.479)	(0.586)	(0.581)	(0.440)
ln(Population)2	0.125***	0.123***	0.105***	0.0522	0.101***	0.0985***	0.0823***	0.0615**	0.0457	0.0400*
	(0.0348)	(0.0352)	(0.0319)	(0.0318)	(0.0290)	(0.0322)	(0.0253)	(0.0308)	(0.0303)	(0.0229)
County	0.0819	0.0850	0.0438	–0.0515	–0.0148	0.0474	0.128	–0.0694	–0.106	0.00638
	(0.137)	(0.137)	(0.124)	(0.115)	(0.113)	(0.123)	(0.0981)	(0.111)	(0.109)	(0.0832)
Decentr.	0.332***	0.335***	0.350***	0.301***	0.272***	0.299***	0.215***	0.261***	0.187**	0.0737
	(0.0861)	(0.0866)	(0.0780)	(0.0720)	(0.0723)	(0.0799)	(0.0635)	(0.0702)	(0.0714)	(0.0554)

ln(Density)		0.0147	–0.0285	0.0145	–0.0616*	–0.0102	–0.0484	–0.00554	0.0332	–0.00216
		(0.0434)	(0.0399)	(0.0415)	(0.0367)	(0.0431)	(0.0315)	(0.0404)	(0.0408)	(0.0311)
Pop. growth			0.163***	0.152***	0.114***	0.154***	0.0771***	0.126***	0.0959***	0.0399*
			(0.0299)	(0.0283)	(0.0312)	(0.0297)	(0.0256)	(0.0306)	(0.0312)	(0.0193)
Share 65+				0.0153				0.0307*	0.0253	0.0133
				(0.0160)				(0.0161)	(0.0160)	(0.0122)
Share 0-14				–0.0688***				–0.0194	–0.0192	–0.00187
				(0.0196)				(0.0239)	(0.0240)	(0.0182)
ln(Tax. income)					0.898***			0.709***	0.775***	0.943***
					(0.213)			(0.251)	(0.243)	(0.185)
Unemployed					–0.00842			–0.00808	–0.0204	0.00595
					(0.0141)			(0.0137)	(0.0140)	(0.0110)
ln(Nat. trans.)						0.0429			0.154***	0.166***
						(0.0551)			(0.0544)	(0.0412)
ln(EU trans)						0.0416**			0.0154	0.0194
						(0.0186)			(0.0172)	(0.0130)
Tourist							0.00402***			0.00382***
							(0.000468)			(0.000412)
_cons	21.04***	20.97***	19.46***	14.69***	10.11***	18.23***	16.18***	7.707**	4.098	0.853
	(3.126)	(3.144)	(2.841)	(3.013)	(3.451)	(3.063)	(2.274)	(3.882)	(3.925)	(2.991)
N	127	127	127	127	127	127	127	127	127	127
R2	0.213	0.213	0.369	0.481	0.488	0.400	0.610	0.528	0.569	0.755
Optimal size	29852	33344	34462	43899	33055	30792	20108	46535	35646	15139

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations.

Table 2 Cities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp
ln(Population)	–1.726***	–1.704***	–1.502***	–1.014***	–1.331***	–1.205***	–1.574***	–0.848***	–0.548**	–0.584***
	(0.269)	(0.267)	(0.252)	(0.255)	(0.223)	(0.253)	(0.221)	(0.237)	(0.231)	(0.197)
ln(Population)2	0.0944***	0.0970***	0.0848***	0.0572***	0.0727***	0.0685***	0.0925***	0.0450***	0.0299**	0.0345***
	(0.0163)	(0.0162)	(0.0153)	(0.0154)	(0.0136)	(0.0152)	(0.0134)	(0.0143)	(0.0139)	(0.0118)
County	–0.129	–0.133	–0.0704	–0.0988	–0.0417	–0.0838	–0.0339	–0.0632	–0.106	–0.0711
	(0.157)	(0.156)	(0.147)	(0.136)	(0.130)	(0.143)	(0.128)	(0.126)	(0.120)	(0.103)
Decentr.	0.369***	0.360***	0.355***	0.309***	0.189***	0.349***	0.237***	0.209***	0.209***	0.133***
	(0.0550)	(0.0545)	(0.0512)	(0.0485)	(0.0474)	(0.0509)	(0.0458)	(0.0462)	(0.0446)	(0.0384)
ln(Density)		–0.0932*	–0.112***	–0.0625**	–0.160***	–0.0577**	–0.146***	–0.0852***	–0.0335	–0.0432*
		(0.0262)	(0.0247)	(0.0277)	(0.0229)	(0.0269)	(0.0218)	(0.0267)	(0.0265)	(0.0226)

Appendix

Pop. growth			0.0642***	0.0543***	0.0429***	0.0616***	0.0548***	0.0411***	0.0357***	0.0319***
			(0.00751)	(0.00704)	(0.00698)	(0.00733)	(0.00661)	(0.00678)	(0.00652)	(0.00557)
Share 65+				–0.00570				0.0137**	0.00708	0.0132**
				(0.00669)				(0.00648)	(0.00632)	(0.00541)
Share 0-14				–0.0746***				–0.0279***	–0.0345***	–0.0175**
				(0.00954)				(0.0100)	(0.00979)	(0.00844)
ln(Tax. income)					0.916***			0.826***	0.774***	0.779***
					(0.0854)			(0.0909)	(0.0872)	(0.0743)
Unemployed					0.000592			0.00502	–0.00564	0.00325
					(0.00613)			(0.00599)	(0.00596)	(0.00512)
ln(Nat. trans.)						0.125***			0.185***	0.202***
						(0.0303)			(0.0271)	(0.0231)
ln(EU trans)						0.0422***			0.0180*	0.0219**
						(0.0118)			(0.0102)	(0.00869)
Tourist							0.00252***			0.00230***
							(0.000195)			(0.000161)
_cons	15.63***	15.65***	14.97***	13.90***	5.469***	12.62***	15.12***	4.122***	2.122	1.493
	(1.111)	(1.099)	(1.037)	(1.166)	(1.296)	(1.133)	(0.908)	(1.538)	(1.496)	(1.277)
N	555	555	555	555	555	555	555	555	555	555
R2	0.187	0.205	0.298	0.398	0.455	0.337	0.463	0.489	0.535	0.662
Optimal size	9339	6526	7017	7070	9453	6605	4955	12360	9546	4740

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations.

Table 3 Municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp	lnexp
ln(Population)	–3.121***	–3.030***	–2.123***	–1.565***	–1.575***	–1.794***	–2.306***	–1.042**	–0.613	–0.729*
	(0.527)	(0.522)	(0.509)	(0.505)	(0.460)	(0.512)	(0.452)	(0.473)	(0.465)	(0.402)
ln(Population)2	0.183***	0.181***	0.122***	0.0897***	0.0874***	0.104***	0.138***	0.0555*	0.0334	0.0443*
	(0.0343)	(0.0339)	(0.0331)	(0.0326)	(0.0299)	(0.0331)	(0.0294)	(0.0306)	(0.0299)	(0.0259)
Decentr.	0.352***	0.355***	0.332***	0.293***	0.162***	0.363***	0.214***	0.189***	0.232***	0.162***
	(0.0679)	(0.0672)	(0.0635)	(0.0617)	(0.0597)	(0.0651)	(0.0574)	(0.0592)	(0.0582)	(0.0507)
ln(Density)		–0.0976***	–0.116***	–0.0758**	–0.176***	–0.0751**	–0.153***	–0.103***	–0.0586*	–0.0676**
		(0.0307)	(0.0291)	(0.0336)	(0.0278)	(0.0319)	(0.0261)	(0.0332)	(0.0332)	(0.0287)
Pop. growth			0.0571***	0.0500***	0.0403***	0.0556***	0.0502***	0.0390***	0.0346***	0.0311***
			(0.00789)	(0.00754)	(0.00738)	(0.00779)	(0.00703)	(0.00722)	(0.00704)	(0.00609)
Share 65+				–0.00649				0.0114	0.00590	0.0115*
				(0.00743)				(0.00722)	(0.00710)	(0.00616)
Share 0-14				–0.0640***				–0.0236**	–0.0316***	–0.0169*
				(0.0108)				(0.0111)	(0.0109)	(0.00954)
ln(Tax. income)					0.841***			0.791***	0.756***	0.752***
					(0.0944)			(0.0998)	(0.0969)	(0.0838)
Unemployed					0.00109			0.00645	–0.00245	0.00343
					(0.00678)			(0.00674)	(0.00678)	(0.00588)
ln(Nat. trans.)						0.103***			0.173***	0.202***
						(0.0361)			(0.0331)	(0.0287)
ln(EU trans)						0.0323**			0.0170	0.0220**
						(0.0141)			(0.0123)	(0.0106)
Tourist							0.00225***			0.00212***
							(0.000210)			(0.000179)
_cons	21.06***	20.79***	17.49***	16.08***	7.245***	15.18***	18.07***	5.350**	2.703	2.404
	(2.022)	(2.003)	(1.945)	(2.032)	(2.093)	(2.052)	(1.727)	(2.337)	(2.314)	(2.001)
N	428	428	428	428	428	428	428	428	428	428
R2	0.249	0.266	0.347	0.417	0.478	0.368	0.487	0.503	0.537	0.654

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations.

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