University of Economics, Prague

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Major: Economic Analysis

ELASTICITY OF THE PROPERTY TAX IN THE CZECH REPUBLIC

Master's Thesis

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Declaration

I hereby declare that this Master's thesis is entirely my own work, and all the sources used are listed.

Paulína Očkajová

Prague, 10th May 2019

Acknowledgment

I would like to express my gratitude to my supervisor, doc. Mgr. Libor Dušek, Ph.D., for his valuable guidance, advice and comments, and to my family for their loving support.

Thesis Assignment

Topic:

Elasticity of the Property Tax in the Czech Republic

General content:

1. The main aim of the thesis will be to estimate the revenue elasticity of the property tax with respect to the tax rates in the context of the taxation of property in the Czech Republic.

2. Already 200 years ago, economists by the likes of Ricardo have argued about the importance of property taxation. Being characterized by large economic rents and inelastic supply of the tax base, it is still considered to be one of the most efficient means of financing the provision of public goods by local governments. Theoretically, the revenue elasticity of the property tax with respect to the tax rates should be unity. However, the empirical tests of this hypothesis are absent even in the international context, and the real-world revenue elasticities may be less than unity due to evasion, avoidance, and a use of exceptions. The academic contribution of the thesis is in providing the first estimates of the elasticity of the property tax. The thesis will also have implications for the revenue planning of the Czech municipalities as well as for the future of the Czech property tax in general; as suggested in reports by OECD, Czech Republic has been under-using the property taxation.

3. In the theoretical part, the thesis will examine theories of property taxation and its role in the tax system. I will review modern research on estimation of the revenue elasticities for income and consumption taxes, optimal taxation and international estimates of the property tax elasticities. The theoretical part will also describe the key features of the property tax in the Czech Republic.

4. In the analytical part, I will estimate the elasticity of property tax with respect to the tax rates in the Czech Republic. The identification strategy will be based on the institutional setting of the property taxation in the Czech Republic which, theoretically, should make the tax base perfectly inelastic: i) the tax base is defined by physical characteristics of the property such as land and floor area, not on land values;

ii) the tax rates are set by the national legislation; iii) municipalities may increase the tax rates by a so-called local coefficient. In the 2000's, many municipalities increased the local coefficients. This provides a variation in the tax rates across municipalities and over time which will be used to estimate the elasticity. The data will consist of a novel panel data set at the municipality-year level. It will contain information on the property tax revenues and land areas from the Czech Statistical Office, detailed information on the tax rates and local coefficients from the Financial Administration, and additional control variables at the municipal level.

Length of thesis:
65

Selected bibliography:

1. Ricardo, D. (1821). *On the Principles of Political Economy and Taxation*. London: John Murray.

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Abstract

The main motivation of this thesis is to investigate whether, as already claimed by early economists such as Ricardo, the property tax is indeed the ideal tax because of perfectly inelastic tax base. For this purpose, I estimate the revenue elasticity of the property tax with respect to tax rates in the Czech Republic using municipality-level data on property tax revenue, tax rates and municipality characteristics during the period of 2004 to 2017. The research design exploits a variation in tax rates across municipalities and years caused by a policy change in 2008 when municipalities obtained an option to multiply the final tax liability of taxpayers by a so-called local coefficient. Using difference-in-differences estimator, I find the total revenue elasticity to be 0.76, while theoretically it should be one under perfectly inelastic tax base. However, further analysis indicates that the less-than-one elasticity is primarily due to substantial exemptions rather than behavioural responses in the tax base.

Keywords: elasticity of property tax, property taxation, tax responsiveness, local government, local coefficient. **JEL Classification**: H20, H30, H71

Abstrakt

Hlavní motivací této práce je prozkoumat, zda je daň z nemovitosti pro svůj neelastický základ takovou ideální daní, za kterou ji pokládali již raní ekonomové od dob Ricarda. Za tímto účelem odhaduji elasticitu příjmů daně z nemovitosti ve vztahu k daňovým sazbám v České republice s využitím údajů na úrovni obcí, které zachycují příjmy daně z nemovitosti, daňové sazby a charakteristiky obcí během let 2004 až 2017. Výzkumný design využívá variaci v daňových sazbách mezi obcemi, která vznikla po reformě v roce 2008. Obce tehdy získaly možnost vynásobit konečnou daňovou povinnost poplatníků tzv. lokálním koeficientem. Pomocí odhadu rozdílu v rozdílech jsem zjistila, že celková elasticita příjmů daně z nemovitostí je 0.76, zatímco teoreticky by v případě dokonale nepružného daňového základu měla být 1. Další analýza však ukazuje, že výsledná elasticita je způsobena spíše značnými daňovými výjimkami než reakcemi v úpravě daňového základu.

Klíčová slova: elasticita daně z nemovitosti, daň z nemovitosti, elasticita daňových příjmů, místní samospráva, lokální koeficient. **JEL Klasifikace:** H20, H30, H71

Contents

Introduction

For over 200 years, economic theory has proposed that a tax on real property may be an efficient source of revenue for local government. According to this widely-held view, property provides an ideal base for taxation because of large economic rents, relative inelasticity and local connection. Theory thus predicts that revenue elasticity of property tax should be equal to unity. However, literature does not provide clear evidence on the validity of this theory and estimates are missing even on international level. In order to fill this void, I conduct an empirical research in the context of the Czech Republic.

Despite having only a minor role in the structure of local government revenue, the Czech institutional setting indicates the potential of the property tax may be underutilized. The tax is based on area-size valuation and nationally set tax rates which changed only once since 1993. However, in 2008, a major policy change happened. Municipalities obtained an option to raise the revenue by applying a so-called local coefficient, multiplying the tax rates from two to five times. This reform caused a large variation in effective tax rates across municipalities and years, which can be exploited to estimate the revenue elasticity of the property tax with respect to tax rates.

This thesis thus contributes to the New Tax Responsiveness literature that reinvigorated the study of taxation in the past 20 years (e.g., Feldstein 1999, Saez 2001, Giertz, Slemrod and Saez 2012). This literature estimates behavioral responses to taxation using large micro data. However, most of the studies investigate the income tax or consumption taxes. Extending this literature to the property tax is a new contribution of this thesis.

Furthermore, empirical estimation of the elasticity will not only contribute to the paucity of academic literature, but also have implications on revenue planning of the Czech municipalities and on the future of the property tax in general. In spite of the specific nature of the institutional setting, the results of this thesis may serve as a point of reference for other countries, too.

In the theoretical part of this thesis I establish a theoretical background of property taxation, describe specific features of the Czech system and define the concept of elasticity. I begin with the role of the property taxation and dimensions of its design. Since the property tax needs to be viewed in a particular institutional context, I describe the system of property taxations in the Czech Republic, its history and specific features. On the basis of theoretical and institutional background, I examine theoretical predictions for the elasticity of the property tax. By reviewing the literature on empirical estimates and research on optimal taxation, I develop a conceptual framework for the revenue elasticity of the property tax with respect to tax rates in the context of the Czech Republic.

In the practical part, I develop a research methodology to estimate the theoretically derived elasticity. The identification strategy exploits the variation in the property tax rates across municipalities which originated with the legislation of the local coefficient in 2008. This framework thus serves as a quasi-experiment where method of difference-in-differences can be applied. Furthermore, the research design emphasizes the role of tax-exemptions in the determination of the tax base. For the econometric estimation, I construct a novel panel data set on a municipality level, using data on tax coefficients from the Financial Administration and information on the property tax revenue and municipality characteristics from the Czech Statistical Office.

To sum up, the aim of this thesis is to estimate the revenue elasticity of the property tax with respect to the tax rates in the context of the taxation of property in the Czech Republic. By doing so, I test the theoretical hypothesis if the elasticity is equal to unity. The result will be used to measure the real efficiency and revenue potential of the property tax in the Czech Republic.

1 Theoretical Part

In order to study the effects of the property tax[1], theoretical foundations need to be laid. In the first part of this thesis, I therefore establish the role and structure of the property tax in the taxation system. Because every tax needs to be analyzed in a specific institutional context, I describe the system of property taxation in the Czech Republic and outline the features important for measuring the responsiveness of the property tax. The theoretical and institutional backgrounds are then applied to examine the concept of revenue elasticity of the property tax. By deriving the theoretical effect of tax rates on property tax revenue, I form foundations for empirical research in the practical part.

1.1 Theory of Property Taxation

"*If we are to have public spending, we must also have taxation*." (Mirrlees, 2011, p. 21) One of the first taxes that have been used to finance expenditures of the state was the property tax. Already during the medieval times, occupiers of land were thought to be directly obliged to the common interest in the maintenance of the state (Hale, 1985). This obligation was supposed to represent their ability to pay, "*the principle that each individual should be held to help the state in proportion to his ability to help himself.*" (Seligman, 1895, p. 21)

Even though the property tax has been thoroughly revised ever since, property is until these days considered as an ideal tax base for taxation. In order to analyze why it is so, I describe the role of the property tax and importance of the tax design in studying its effects.

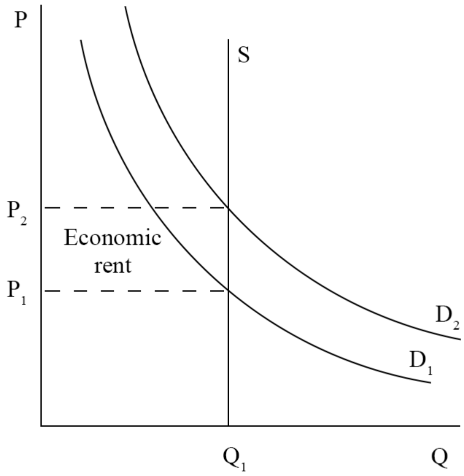
1.1.1. Role of the Property Tax

The role of the property tax is based on two main principles: inelasticity of its tax base and revenue potential for local government. The idea that property may serve as an ideal tax base was first established already by early economists. According to Ricardo (1821),

[1]Property tax, as analyzed in this thesis, is a recurrent tax on real estate, i.e. immovable land and buildings. It should be noted that there are also other types of property tax liabilities – e.g. stamp duties, transfer taxes, value-added taxes, or inheritance taxes. Due to their very own nature, these are not in the scope of this thesis and should not be confused with the recurrent property tax.

the value of a land is a source of economic rent. Since the supply of land is fixed, if demand for it increases, the resulting higher price does not change the amount of land supplied. The idea is illustrated in *Figure 1*.

Figure 1: Economic Rent from Land



Source: own processed

Owner of a land thus earns returns from land even without making any productive effort. If these unearned rents are taxed, no excess burden is created because the supply is perfectly inelastic.[2] Property tax on unimproved value of land is hence considered to be a very efficient way to raise the revenue (George, 1884).

Because property extracts unearned value from its location, e.g. from quality of local public goods as schools, roads or environment, property tax should be a local tax. If it is, it may provide a direct connection between benefits and costs of local services (Oates, 1967). If the property tax revenue is used to finance local public goods at level desired by residents, who can freely move to different location, local property tax can be perceived as a benefit tax (Mieszkowski and Zodrow, 1989). Furthermore, since taxpayers are more aware how their taxes are used, property tax may promote accountability of government's policies (Slack, 2013).

The visibility aspect of the property tax makes it one of the most salient taxes. Tax on property is neither withheld at source as income tax, nor paid indirectly as consumption taxes. On the contrary, taxpayers have to pay it all at once and periodically. Salience of

[2] Feldstein (1977) showed that even a pure rental income can be shifted and alter the capital stock, but it left the conclusions of no excess burden unchanged.

the payment thus raises taxpayers' awareness of the tax compared to other taxes (Rosengard, 2012). From the behavioural point of view, payment of the property tax can also evoke loss aversion and cause reluctance towards the tax. By many, it is considered to be one of the least popular taxes (Fox, 2017).

Besides the benefit view which considers the property tax to be a non-distortionary user fee for local services, there are two main other views on its incidence. Firstly, the traditional view argues the property tax is pushed to consumers in form of higher housing prices. Secondly, the capital view argues the property tax distorts investment decisions and leads to misallocation of capital across jurisdictions (Zodrow, 2001). These views take into account the fact, that in real life, property tax is usually not applied only on unimproved value of the land, but on both land and constructions built on it. Therefore, the efficiency and revenue potential of the tax greatly depends on the dimensions of its design.

1.1.2. Design of the Property Tax

"The property tax is, economically speaking, a combination of one of the worst taxes—the part that is assessed on real estate improvements ...—and one of the best taxes—the tax on land or site value." (Vickrey, 1999, p. 17) Although the tax on property is broadly considered to be very efficient if it covers inelastic supply, the effects of the tax crucially depend on its structure. Since determination of the tax base, exemptions, valuation methods and tax rates may generate inefficiencies and distortions, I describe their dimensions.

Tax Base

The determination of the tax base may differ across various types of property. As argued in the previous section, taxation of land creates no excess burden whereas taxation of improvements may distort incentives and discourage investment in property. Furthermore, one must distinguish between different functions of property – residential and business. When land is concerned, economic argument is always towards its taxation. If the ownership is in business or residential hands is of no importance as the concept of economic rent applies for both.

In the case of residential housing, modern tax theory concludes some taxation of it is desirable. However, one must further separate owner-occupied and rental housing. According to *Mirrlees Review*, owner-occupied housing should be taxed from the perspective of investment and consumption good. Rental housing separates these features between owner and renter. Therefore, the tax incidence is more complicated. The presumption is in favour of taxing it at a similar level as owner-occupied housing (Mirrlees et al, 2011).

On the other hand, buildings used by businesses are viewed mainly as a capital. Since this type of property is considered to be an input to the production process, taxing it disincentivizes investment and alters decisions and economic activity of firms. Therefore, except from land, economic argument is against taxation of business property.

Exemptions

Importantly, the determination of the tax base is influenced by the extent of exemptions. On the basis of ownership, tax-exempt may be property owned by state, universities, churches, foreign countries or international organizations. In some cases, there may be additional exemptions based on specific characteristics of the occupier of the property, e.g. if she is disadvantaged. Moreover, a major type of exempt property is often agricultural land.

Besides the fact the exemptions erode the tax base, they also create distortions. For instance, if tax-exempt properties vary across municipalities, disproportionate tax burden can be created if those do not have a correction tool at their disposal (Bird and Slack, 2002). Exemptions may also incentivize property owners to alter the function of the property by changing their economic activity or an effort to avoid taxation.

Valuation Methods

In order to determine the value of the tax base, tax authority may choose between distinct assessment methods. Most commonly, the value of property may be based on the market value, rental value or area size.

Property tax based on the market or rental value of the property is used mainly in the Western Europe and developed countries. Value of land or land and buildings is either estimated on the basis of value by which the property would be traded on the market or on the predicted value of the annual rent. The disadvantage of this method may be twofold. Firstly, if the value is not frequently re-assessed, it may not reflect changes in the market. Secondly, the variation caused e.g. by housing bubbles may not provide a realistic assessment of the real value of the property.

In the Central and Eastern Europe countries often apply area-based approach for property assessment. As the name suggests, the tax base is defined by the size of area of land or of land and construction site. Considering the inelasticity of the tax base, the revenues from this method may be rather stable over time. Compared to the market-based approach, this method does not reflect distinctions in the value of property. Properties similar in dimensions, one in poor neighbourhood and the other in developed one pay a similar tax, although the value of the latter property may extract benefits from the public goods and amenities of the neighbourhood. To account for these differences, zoning may be used. This concept allows applying adjustment factors for different location zones that in effect increase or decrease the tax liability (Fischel, 1992).

Tax Rates

Finally, to determine the property tax liability, assessed value of tax base must be multiplied by tax rates. In this part, it is important to consider how the rates are differentiated and what level of government sets them.

As was already outlined, tax should be higher on those types of the base which are the least elastic in supply. Higher land rates may lead to more efficient use of land and higher investment to property. On the contrary, higher rates on improvements may decrease development in the taxed location. Similarly, higher business rates compared to residential rates may distort location choices toward residential housing since business capital tends to be more mobile. Also, exemptions may lead to a higher concentration of tax-exempt types of property. Nonetheless, the choice of a distortionary policy may also serve to promote developing the land for desired use (Bird and Slack, 2002).

Therefore the results of the tax design also depend on what level of the government sets the tax rates and what level collects the tax revenue. If the tax rates are set uniformly by central government, the choices behind the land use can be distorted. From the benefit point of view, property tax needs to be a local tax. For property tax to not create deadweight loss, local governments therefore must have authority to adapt the tax rates to the individual needs of the community. According to Hamilton, property tax then can become only a fee for local public services (Hamilton, 1975).

Summary of the Chapter

To sum up, property tax is widely regarded as a convenient source of revenue for local government due to site-specific economic rents, immovable character of the property tax base and benefits it could provide to local community via direct financing of local public goods. However, the efficiency of its use crucially depends on the dimensions of the tax structure. Distortions may be created by determination of the tax base on land or improvements, taxing residential versus business property and defining exemptions from the tax. The valuation methods may under- or over-estimate the real value of the property and so affect the taxpayer's behaviour. Undesired incentives may also come from differentiated structure of tax rates.

1.2 Property Taxation in the Czech Republic

The theory of property taxation showed the importance of examining the effects of property tax in the context of particular institutional setting. In this chapter I therefore describe the key features of the system of property taxation in the Czech Republic. I overview the structure of the current system and its specific characteristics, provide history of the main changes in law and describe the use of property tax as a source of revenue for local government.

1.2.1. Overview of the Current System

Property tax in the Czech Republic is regulated by *Act No. 338/1992 Coll*. (*Zákon o dani z nemovitých věcí*). The subject of the tax is land[3] registered in the *Land Register*, taxable buildings (buildings and engineering structures) and units (apartments or non-residential premises). In this section, I broadly review the core features of *the Act* – tax base, exemptions, tax rates, tax coefficients and tax administration.

Tax Base

The property tax base is determined by area of taxable land, built-up area of taxable buildings and floor area of taxable units. In addition, the land area of arable land, hop fields, vineyards, gardens, orchards, permanent grasslands, farm forests and ponds with intensive and industrial fish farming is multiplied by the average land price according to price regulations issued annually by the Ministry of Agriculture. The area of taxable units is multiplied by factor 1.20 or 1.22 if it is a part of an apartment building.

Exemptions

The Act considers a list of property types exempt from the tax. In general, those are land and buildings:

- owned by the Czech Republic, county or municipality;

[3] The subject of the land tax is not land occupied by taxable buildings; land with protective or special purpose forests; water surface with the exception of ponds used for intensive and industrial fish farming; lands intended for the defence of the Czech Republic.

- used by diplomatic agents;
- of cultural monuments, registered churches, cemeteries, public benefit organizations, trade unions, kindergartens, schools, universities, public research institutions, museums and galleries, libraries, public archives, medical and social service facilities, public parks, roads, sports grounds;
- for waste treatment, operation of electricity generated by alternative energy sources;
- in specially designed protected areas;
- of industrial zones approved by the government for maximum of 5 years;
- taxable buildings owned by disabled persons, and other.

Furthermore, arable land, hop gardens, vineyards, orchards and permanent grasslands are also exempt from the property tax, if a municipality decides so by issuing a generally binding regulation.

Tax Rates

The basic tax rates are determined on the national level and are expressed in:

- % for tax base of: arable land, hop fields, vineyards, gardens, orchards; permanent grassland, farm forests and ponds with intensive and industrial fish farming;
- price per m^2 for tax base consisting of:
  - other types of land, with rate differentiated for: the land used for business – agricultural primary production, forestry and water management; industry, construction, transport, energy and other types of business; building land; other areas; built-up areas and courtyards.
  - buildings and units, with distinct rates for: residential building, building used for family recreation, garage; taxable building and unit whose predominant part is used for business as sub-divided in previous point; other types of taxable buildings and units. Furthermore, the basic tax rates are increased for each additional above-ground storey.

In general, the current values of the land tax rates are lower than those of buildings. Business rates are higher than residential rates, except for agricultural business. This broad comparison is in contrast to economic arguments listed in the first chapter.

Tax coefficients

Basic rates are further adjusted by local scaling factors, so-called *tax coefficients*. Municipalities have several types of such coefficients at their disposal:

1) According to § 6/4 of *the Act*, the basic tax rates for land are multiplied by the following coefficients according to the population size of a municipality:
   - 1.0 in municipalities with less than 1,000 inhabitants;
   - 1.4 in municipalities with over 1,000 up to 6,000 inhabitants;
   - 1.6 in municipalities with over 6,000 up to 10,000 inhabitants;
   - 2.0 in municipalities with over 10,000 up to 25,000 inhabitants;
   - 2.5 in municipalities with over 25,000 up to 50,000 inhabitants;
   - 3.5 in municipalities with over 50,000 inhabitants, in statutory towns and in Františkovy Lázně, Luhačovice, Mariánské Lázně, and Poděbrady;
   - 4.5 in Prague.

   A municipality may raise the legally set coefficient by one category or reduce it by one to three categories for individual cadastral areas or even specific parcels by issuing a generally binding regulation.

2) According to § 11/3a, the same rules as in 1) apply for multiplying the basic tax rates for taxable buildings and units. Due to their nature, I further refer to coefficients according to § 6/4 and § 11/3a also as *population size coefficients*.

3) According to § 11/3b, the basic tax rate for individual types of taxable buildings and units may be multiplied by a factor of 1.5 in the whole municipality if a municipality sets it by a generally binding regulation. This coefficient may be applied on any of these building types: i) buildings used for family recreation; ii) garages; taxable buildings and units the predominant part of which is used to conduct business in iii) primary agricultural, forestry or water management; iv) industry, construction, transport, energy or other agricultural production; or v) other types of business. For simplification, I may further refer to this coefficient also as a *correction coefficient*.

4) According to § 11/4, for buildings used for family recreation, the basic tax rate is multiplied by a factor of 2 if these buildings are located in national parks and in

protected landscape areas. For brevity, I may further refer to this coefficient as a *recreational coefficient.*

5) According to § 12, a municipality may set a *local coefficient* multiplying the tax rates on all immovable property within the municipality by a factor of 2, 3, 4 or 5. In order to do so, a municipality must set the *local coefficient* in a generally binding regulation. In effect, this coefficient then multiplies tax rates for each type of taxable land, building or unit with the exception of exempt land – arable land, hop fields, vineyards, gardens, orchards and permanent grassland.

By using the tax coefficients, the basic tax rates set on the national level may reflect specific features of the location. Coefficients according to § 6/4 and § 11/3a take into account the population size of the municipalities. By adjusting them, municipality may vary the tax rates among zones or between taxation of land and buildings. However, the limit for modification is rather constrained. The use of *correction coefficient* (§ 11/3b) is limited due to its small value and extent of the applicable tax base. The *recreational coefficient* (§ 11/4) has a very specific nature which does not presume it to be used by a large number of jurisdictions. A municipality may hold the largest powers with the *local coefficient* (§ 12).

To sum up, due to the complicated structure, tax rates vary extensively not only over types of property, but because of tax coefficients, also across municipalities. For illustration, consider a tax liability of 1) owner of an apartment of 70 m^2, and 2) owner of a house of 120 m^2 with one above-ground storey, and with a garden of 800 m^2. For residential properties, following basic tax rates could be applied:

1) Flat = 70 m^2 *x 1.20 x 2 CZK* = 168 CZK
2) House with garden = 120 m^2 *x (2* CZK + *0.75* CZK*)* + 800 m^2 *x 0.2* = 490 CZK

However, the final tax liability depends on the location of the property and resulting tax coefficients. Consider 3 cases: i) village of 900 inhabitants, ii) town of 11,000 inhabitants, and iii) town of more than 50,000 inhabitants. For simplicity, suppose the municipalities did not adjust the *population size coefficients* (§ 6/4 and § 11/3a) so they are equal, and *correction* and *recreational* coefficients (§ 11/3b and § 11/4) are not applied. The final tax liability is then conditional on the number of inhabitants and, on the choice of the *local coefficient*. This example is illustrated in *Table 1*.

Table 1: Example of Use of Coefficients

Number of inhabitants	Population size coefficients[4] (§6/4, § 11/3a)	Local coefficient (§ 12)	Basic tax rates multiplied by
900	1.0 *(1.0-1.4)*	1 to 5	1 to 5 times
11,000	2.0 *(1.0-2.5)*	1 to 5	2 to 10 times
> 50,000	3.5 *(1.6-4.5)*	1 to 5	3.5 to 17.5 times

Source: own

In addition, if the properties were used for business purposes, besides higher basic tax rates, tax liability would depend on the portion of property used for business and on the legal status of the land area. If the land was categorized e.g. as permanent grassland, it would be exempt from the use of the local coefficient.

Tax Administration

Tax administration of property tax is directed centrally by *Financial Administration*, but all revenue is distributed to municipalities where the property is located. The taxpayer is the owner of the taxable land, building or unit. If the landowner is unknown, the tax liability is held by the user of the land. Property tax is payable annually and in advance.

For a given year, taxpayer has to file a tax return if she has purchased a property in the previous year or if changes in the property have been made, e.g. in the area or type of a land, a building or an exempt property. If there are no changes compared to the last tax return, taxpayer does not file another one. *Financial Administration* calculates the tax liability on the basis of the last tax return and municipality specific tax coefficients. Taxpayer is then informed about the amount due by post or electronically. She has to pay the tax in one or two instalments at the local office of *Financial Administration*.

To sum up, the structure of the property taxation in the Czech Republic is rather complicated. The tax base is defined over area of land, buildings and units. It may be fairly eroded due to tax-preferential treatment of agricultural land. Basic tax rates vary broadly across types of property but the largest variation in rates across municipalities comes from application of tax coefficients, most importantly, *local coefficient*. If there were no changes in property, tax administration is automatic.

[4] A particular limit for increasing and decreasing the coefficients according to § 6/4 and § 11/3a is displayed in the brackets. Since the limit is restricted by 1 category increase and 3 categories decrease, even if a municipality adjusted the population size coefficients, the effect would be on average smaller compared to the possibilities of application of local coefficient.

1.2.2. History of the Main Changes

Since the adoption of *the Act* in 1993, not many major changes have been made to the law. In this section, I briefly overview those I consider significant for the purpose of estimating the effects of the property tax – changes in the tax base and in tax rates.

In the definition of the tax base, the most significant modifications were adoptions of new exemptions. From 2008, municipalities were provided an option to tax-exempt arable land, hop gardens, vineyards, orchards and permanent grasslands, by a generally binding regulation. Until 2009, new residential houses or their units owned by individuals who used them for permanent housing were tax-exempt for a period of 15 years after their formal approval. Until 2013, the 15-years exemption period from the enablement of *the Act* applied to residential houses returned in restitutions and houses built before 1948 with further conditions fulfilled. From 2015, option of tax-exemption of industrial zones approved by the government for maximum of 5 years arose.

Basic tax rates were raised only once. From 2010, most of the original rates for both land and buildings were doubled, except from % rates for agricultural land.[5] From 2008, tax coefficients based on the population size for both land and buildings and units were raised for municipalities with up to 600 inhabitants. Until then, there were three categories distinguishing the coefficients: 0.3 for municipalities with less than 300 inhabitants; 0.6 for municipalities with over 300 up to 600 inhabitants; and 1.0 for municipalities with over 600 up to 1,000 inhabitants. After the reform, all municipalities with less than 1,000 inhabitants were assigned coefficient 1.0. Since majority of the municipalities in the Czech Republic have a small number of inhabitants, a considerable number of municipalities faced doubling or tripling of the amount of their tax liabilities. From 2012, statutory cities were added under the coefficient category 3.5.

The most important update of the law came in 2008 with enactment of the possibility of municipalities to adopt a *local coefficient*. In the following year, the revenue potential of *local coefficient* was diminished by legislation of exemptions to its use.[6] The explanatory report of the Czech Parliament (Důvodová zpráva) described the following expectations on the effects of the coefficient: "*In some cases, setting a higher local*

[5] Agricultural land is in this occasion used as a shortcut for arable land, hop fields, vineyards, gardens, orchards; permanent grassland, farm forests and ponds with intensive and industrial fish farming.
[6] Exempt is arable land, hop fields, vineyards, gardens, orchards and permanent grassland.

coefficient, especially in larger cities, could result in a substantial increase in tax revenue. ... A proposed change in the exemption of arable land, hop fields, vineyards, orchards and permanent grasslands by a generally binding municipality decree would support the business environment. For the remaining real estate by applying a local coefficient, the tax liability may increase several times." (Parliament of the Czech Republic, 2007, p. 218) and, "*It is anticipated that the local coefficient will be used by municipalities to earn revenue into their budgets to fund actions for the benefit of citizens and in accordance with local conditions or to alleviate the effects of exemptions on local budgets if the municipality decides to exempt individual types of agricultural land.*" (Parliament of the Czech Republic, 2007, p. 268)

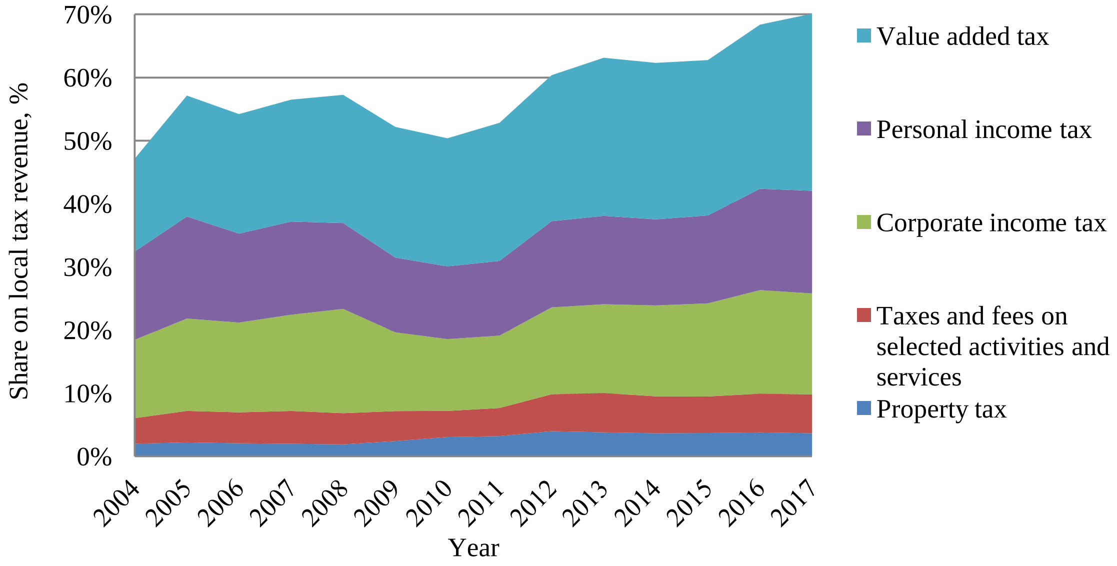
1.2.3. Source of Revenue for Local Government

Historically, property tax played a rather minor role in the Czech Republic (Blöchliger, 2015). In the last 20 years, property tax revenue accounted for over 3% of GDP in countries as France, Canada or United Kingdom. On the other end of the ladder, in Estonia, Lithuania, Slovakia and Czech Republic, it has not exceeded 0.5% (OECD, 2019).

In the Czech system, property tax revenue is solely a source of local government. Besides the property tax, local budgets receive income from other types of tax revenue, non-tax revenue, capital revenue and transfers, from which the largest share on total revenue during has had the tax revenue. While during years 2004 to 2017 the share of tax revenue had increasing trend and accounted for over 70% of the local government revenue in 2017, the trend of the second major source, transfers, was overall decreasing (besides the period of economic crises when the roles of these sources interchanged). Non-tax and capital revenue had only a minor and stable share (CZCO, 2018).

Development of structure of the largest source of municipality bugets, tax revenue, is visualized in *Figure 2*. The largest tax sources were continually during the observed period centrally collected value added tax and income taxes, respectively. Property tax corresponded only to 2% of local revenue before 2008 but doubled to 4% in 2017.

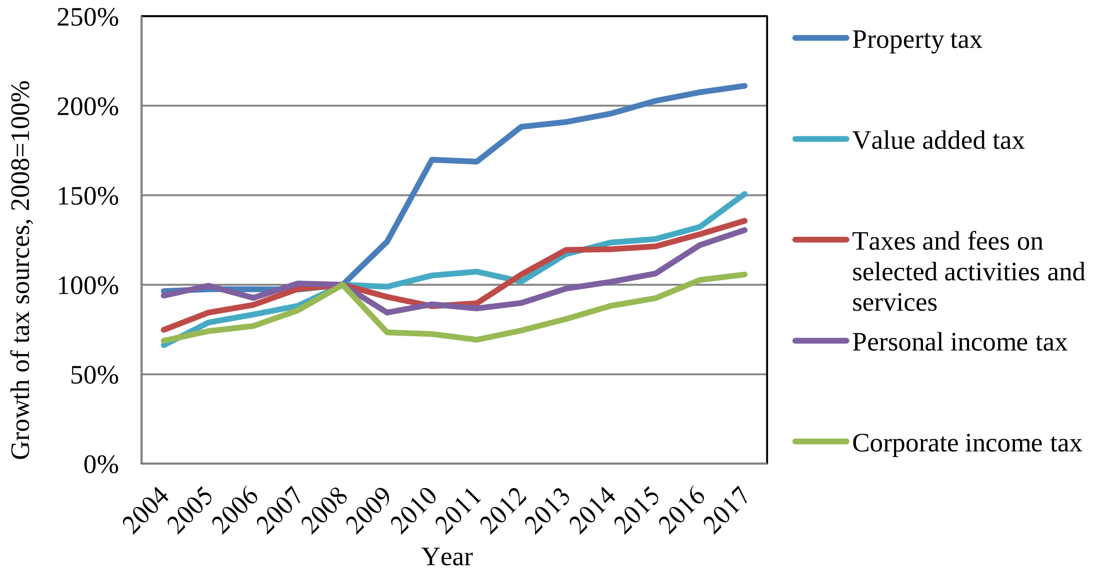
Figure 2: Tax Revenue Structure in Local Government Revenue, 2004-2017



Source: CZSO, own calculations

As can be seen in *Figure 3*, property tax revenue was indeed the most rapidly growing source of the local tax revenue. The relative increase in 2009 could be attributed to the legislation of *local coefficient*, and further in 2010 to overall increase in the basic tax rates. The second largest increase was in user fees and value added tax. All in all, the role of property tax as a source of local revenue rised since the adoption of *local coefficients* and reform of the basic rates. However, it still plays only a minor role in the overall structure of municipality finance.

Figure 3: Growth of Tax Revenue Categories in Local Government Revenue (2018=100%)



Source: CZSO, own calculations

Arguments from the explanatory report (Důvodová zpráva) behind the tax reform in 2008 suggest the policy-makers view the property tax as a benefit tax. The question then is, how the property tax revenue is being used. Since this type of data is not available, I can only illustrate the structure of the overall expenditures of municipalities. According to CZSO, the largest share on expenditures amounts to i) purchases of water, fuel, energy, services and other; ii) investment purchases and related expenses; iii) non-investment transfers to contributory and similar organizations; iv) salaries of the employees and other workers; and v) expenditures on transport services. The shares are relatively stable over time. In general, these items indicate the public expenditures should be of benefit to local communities.

Summary of the Chapter

The property taxation in the Czech Republic is based on physical characteristics of the land and buildings, such as the area size. The basic tax rates vary over types of property, but are unified at the national level and changed only once. The final tax liability depends to a large extent on the application of tax coefficients. Since 2008, municipalities may have significantly increased the basic tax rates by setting a so-called *local coefficient* which is the main factor behind a large variation in the tax rates across municipalities since then. Even though the importance of the property tax as a revenue source increased with the legislation of the *local coefficient*, the property tax continues to cover only a small share of the total revenue of local governments.

1.3 Elasticity of the Property Tax

So far, the first two chapters established two opposing facts. From the economic point of view, property tax is considered to be an efficient source of local revenue. Also, the institutional setting of the property taxation in the Czech Republic should, theoretically, make the tax base inelastic. Yet, the property tax plays only a minor role in the finance of local governments.

To examine the real revenue potential and efficiency of the property tax, I study the revenue elasticity of the property tax. This chapter describes the theory behind the concept, reviews the literature on estimation, and develops a conceptual framework based on the specific features of the policy context of the Czech Republic.

1.3.1. Elasticity in Theory

Elasticity is a widely used tool for measuring changes in economic activity and well-being. It determines how a variable responds to a change in another variable. If the percentage change in the dependent variable is proportional to percentage change in the independent variable, the elasticity is unity. If it is greater than 1, the dependent variable is elastic; if it is less than 1, it is inelastic. In special cases, the elasticity may be equal to zero (perfect inelasticity) or infinity (perfect elasticity).

In taxation, elasticities are used to analyze the effect of changes in taxes on changes in behaviour. During the last decades, empirical research on this topic experienced a large revival in optimal taxation theory with the so called New Tax Responsiveness (Feldstein, 1999). As Feldstein explained, taxpayers have many margins of adjustments to taxes and all of them are sources of inefficiencies. For income tax, those include mainly changes in the form of compensation, deductions, and evasion, i.e. hiding the income and avoiding its detection. All of these margins translate into lower taxable income. Hence, the elasticity of taxable income with respect to tax rates may serve as an ideal measure for most of these behavioural responses. Consequently, elasticity of taxable income is *the* parameter needed to compute the predicted change in revenue due to a change in marginal tax rate and may be generalized to other tax bases (Saez et al, 2012).

As was argued in the first chapter, the ideal base for taxation is inelastic one. A tax hike than should not be opposed by a change in the supply of the taxed property because it is fixed. Hence, when the tax rate increases, the revenue should increase by the same order. This explanation is the core of the hypothesis that, strictly speaking, revenue elasticity of the property tax should be equal to one, particularly in the short run.

There are several reasons which indicate it may be true in the Czech Republic. The tax is based on area size which does not change in the short term. Property is difficult to evade because of its public visibility and identification in the Land Register. Since the property tax finances the provision of local public goods which in turn provide location rents, the incentives to avoid it may be negligible. Also, the tax is payable only once a year and the amount may be too low to make real responses worthwhile; to adjust the liability, one would need to file new tax returns and require changes in the cadastre every time the changes in the tax rates happen due to adjustment of *tax coefficients.*

On the other hand, the real-world revenue elasticity may be lower than the hypothesized unity due to evasion, avoidance and a use of exemptions. The behavioural changes can happen at different margins: by legally changing the status of the property or by altering the complete use of the land. Tax avoidance is largely dependent on the availability of tax exemptions. Because of tax-preferential treatment of certain types of areas, distortions can be made towards the erosion of the tax base in order to avoid the tax liability. Reduced or zero rates on unused or undeveloped land provide a clear incentive to use land inefficiently[7] (Mirrlees et al, 2010). For jurisdictions with a large portion of exempt land, it may be difficult to raise the revenue, if most of their tax base is eroded. Furthermore, in long run, tax structure can create incentives for total changes in location and investment decisions, as described in previous chapters.

1.3.2. Literature Review

While empirical research on the effects of income taxes has flourished in the recent time, it was not so with the property tax. This paucity may have been caused by data limitations, since acquiring information on tax base, preferably from the tax returns, is much more difficult than in the case of income tax. Most of the research analyzing the

[7] Interestingly, the municipal option to exempt it in the Czech law code was argued to be a tax relief to businesses. (Důvodová zpráva, 2007)

effects of property taxations concentrated on capital distortions and income elasticity of the property tax. Besides that, most of the studies were done in the United States.

The dominance of the literature on distortionary effect of property tax on capital comes from the central discussion surrounding the tax incidence of the property tax. Arnott and Petrova (2006) provide evidence that property tax distorts capital intensity the higher is the elasticity of substitution between land and capital. According to Wildasin (1989), the reluctance of jurisdictions to raise property taxes due to the concern about outflow of capital was associated with lower local public expenditures. Fact that the imposition of property tax drives out capital and leads to under-provision of local public services was also found by Muthitacharoen and Zodrow (2010). Furthermore, Lutz (2006) shows that a property tax reduction in New Hampshire led to a significant increase in housing investment with elasticity of roughly one.

The second branch of the research concentrates predominantly on the income elasticity of the property tax base, where dependent variable is market value of the property and independent predictor is personal income or GNP (Bridges, 1964). The concept has been used since Netzer (1961) asserted that this type of elasticity is approximately unity. Authors recognize it as a convenient tool to forecast tax revenues, measure its stability over business cycle and its capacity to generate growth in revenue (Sexton and Sexton, 1986). Since the property tax base depends on the level of income generated in the economy, income elasticity predicts how fluctuations in income may affect property tax revenues. In the papers, revenue is calculated as a product of tax rate and property tax base determined by market value of taxable property, primarily used assessment method in developed countries. Change in revenue thus reflects tax-rate, tax-base effects and if assessed, not market, value of property is used, also measurement errors. Resulting values of the elasticity "*reflect the potential relative change in tax yields with changes in income rather than the actual relative change*." (Kurnow, 1963, p.57)

The resulting income elasticities of all above mentioned studies confirmed the income elasticity to be approximately unity for the major types of property with the exception of farm property. Furthermore, Anderson and Shimul (2012) argue about importance of distinguishing between short-term and long-term elasticities. According to them, changes in income may need an adjustment period until they realize in the tax base. Their estimates are lower and range from 0.57 to 0.86.

Direct estimates of the elasticity of property tax revenue come from studies measuring an effect of real estate prices on revenues. Lutz (2008) found that property tax revenue is quite responsive to changes in house prices. His long-run elasticity is in the order of 0.4. Commonly, this type of elasticity belongs to the category of revenue elasticities where tax revenue is predicted by macroeconomic value of its respective taxable base or GDP. These predictions are often used for macroeconomic forecasts (Koester and Priesmeier, 2017) but also not usual for property taxation

At last, some research has concentrated on other behavioural effects of property tax in the US. The evidence summarized by Deskins and Fox (2010) suggests that higher property taxes increase outmigration and interregional movement of economic activity, affect decisions to improve existing property, lead to housing abandonment and reduce urban sprawl, mainly because of preferential tax treatment of agricultural land.

The only paper focusing on an analysis of the elasticity of taxable property tax base with respect to changes in the property tax rate that I managed to find was done by Stine (1988). He argues that continuous increases in the property tax rate in the US had long-run disincentive effects and led to erosion of the property tax base. His estimates for cities in the state of New York predicted elasticity in the range from -0.2 to -0.3. Apart from this study, empirical tests of hypothesis that the revenue elasticity of the property tax with respect to the tax rates is unity are absent even in the international context. In order to provide the first estimates, I develop a conceptual framework for analysis.

1.3.3. Conceptual Framework

Because the foundations for analyzing the revenue elasticity of the property tax rates are missing in the literature, I develop the concept of this elasticity on the basis of framework of the elasticity of taxable income used e.g. in Saez (2001) and Saez, Slemrod and Giertz (2012). Moreover, due to the complicated structure of the property tax, I apply the institutional features of the property tax system in the Czech Republic.

In an ideal situation, to analyze the effect of tax on tax revenue would involve decomposing the change in revenue to mechanical and behavioural effect of an increase in tax rates:

$$R = t\,B(t)$$

$$dR = \frac{\partial R}{\partial t}dt + \frac{\partial R}{\partial B}\frac{\partial B}{\partial t}dt$$

$$dR = B\,dt + t\,\frac{\partial B}{\partial t}dt$$

where R is a tax revenue, t is a tax rate and $B(t)$ is a tax base conditional on tax rate. The above equation decomposes the change in revenue due to a change in tax rates to two effects. The first expression accounts for the mechanical effect of increase in tax revenue due to a change in tax rate. The second part of the equation captures the behavioural effect of change in tax base due to a change in tax rates. Using the concept of elasticity of taxable income, the effect of a change in revenue due to a change in tax rates then may be further derived as

$$dR = TI\,dt + \frac{\partial TI}{\partial t}\frac{1-t}{TI}\frac{t}{1-t}TI\,dt$$

$$dR = TI\,dt - ETI\frac{t}{1-t}TI\,dt$$

where TI is income tax base defined by taxable income, and ETI is the elasticity of taxable income with respect to tax rates. Application of this concept on corresponding elasticity of taxable property is very limited in the context of the property tax in the Czech Republic. Since the taxable property base consists of area sizes and sometimes even prices of taxable land, buildings and units, capturing all behavioural effects of change in tax rates would require an access to individual-level data used by tax authorities on specific areas and their legal status. This is beyond the possibilities of this thesis.

Nonetheless, in order to determine the effect of property tax on revenue, it is possible to calculate the total revenue elasticity of the property tax which will incorporate both the effect of change in tax rates and change in tax base. Due to the complicated structure of the Czech property taxation, for these purposes, determination of the property tax revenue must be simplified into the following expression:

$$R = k_{12}\,(k_{6/4}t_1B_1 + k_{11/3}t_2B_2) + t_3B_3$$

where k_{12} is a *local coefficient*; $k_{6/4}$ and $k_{11/3}$ are *population size coefficients*; t_1, t_2 and B_1, B_2 are tax rates and taxable bases of land, buildings and units, respectively;

t_3 and B_3 are tax rates and taxable base of areas which are exempt from the use of *local coefficient*.[8] This equation makes several assumptions. Firstly, it abides the fact the tax rates differ across types of properties. However, this omission is based on the conclusions of *Section 2.2*, describing the overall tax structure of rates as fairly stable, with only change in the basic tax rates that could be considered mainly as a necessary update. Secondly, it abstracts from the possible use of further tax coefficients (*correction* or *recreational coefficient*). As argued, their use does not presume to largely affect the tax revenue.

Since the largest dynamics in the final tax rates comes from the use of *population size coefficients* and *local coefficient*, these are the tax rates of interest in deriving the revenue elasticity of the property tax with respect to tax rates. However, in the centre of my attention are mainly the changes in the *local coefficient.* This is due to three main reasons. Firstly, the limit for adjustment of the *population size coefficients* is restricted and largest variation in final tax rates comes from the use of *local coefficient*. Secondly, the variation was caused by a legislation in 2008, which may be used as a quasi-experiment for measuring the effects of the property tax. Thirdly, data limitations allow me to only reach the level of municipalities. Hence, even if it could be appreciated, the analysis will not be able to capture the adjustment of *population size coefficient* on margins of particular cadastral areas or parcels.

Therefore, to model the tax revenue for further purposes, I will abstract from the possible deviations in the *population size coefficients* and concentrate on a change in revenue due to a change in the *local coefficient*. Then, property tax revenue can be expressed by the following equation:

$$R = k_{12}\,(t_1 B_1 + t_2 B_2) + t_3 B_3$$

Total change in revenue can be decomposed to:

$$dR = \frac{\partial R}{\partial k_{12}} dk_{12} + \frac{\partial R}{\partial t_1} dt_1 + \frac{\partial R}{\partial t_2} dt_2 + \frac{\partial R}{\partial t_3} dt_3 + \frac{\partial R}{\partial B_1} dB_1 + \frac{\partial R}{\partial B_2} dB_2 + \frac{\partial R}{\partial B_3} dB_3$$

Assuming away changes in the basic tax rates:

$$dt_1 = dt_2 = dt_3 = 0,$$

[8] From 2008, a municipality may decide to exempt these areas from the whole tax liability; then t_3=0.

$$dR = (t_1 B_1 + t_2 B_2)\, dk_{12} + k_{12} t_1\, dB_1 + k_{12} t_2\, dB_2 + t_3\, dB_3$$

To calculate the revenue elasticity,

$$\frac{dR}{R} = \frac{k_{12}(t_1 B_1 + t_2 B_2)}{R}\, dk_{12} + \frac{k_{12} t_1 B_1}{R} dB_1 + \frac{k_{12} t_2 B_2}{R} dB_2 + \frac{t_3 B_3}{R} dB_3$$

$$d \log R = (s_1 + s_2)\, d \log k_{12} + s_1\, d \log B_1 + s_2\, d \log B_2 + s_3\, d \log B_3$$

where s_1 and s_2 are shares of revenue from taxable land and buildings respectively, and s_3 is a share of revenue from area exempt under local coefficient. If a municipality exempts this area also from the general tax rate, $s_3 = 0$. The resulting equation provides important predictions. Firstly, the revenue elasticity of the property tax with respect to tax rates depends on the share of the non-exempt area and adjustments of the taxable bases. Assuming the property tax would not create any behavioural responses, the value of the elasticity would depend only on the share of exempt land. Secondly, this means that the elasticity could equal to hypothesized value of one only if there was no land exempt in a municipality.

$$\frac{d \log R}{d \log k_{12}} = s_1 + s_2$$

However, it should be noted that the interpretation possibilities are restricted by described data limitations. Since it is not possible to capture the particular shares of tax bases on tax revenue, the elasticity includes the total effect of mechanical and behavioural responses.

At last, if we assume the total elasticity should be one due to the inelasticity of the property tax base (at least in the short term), elasticity of the property tax base is:

$$\frac{d \log B}{d \log k_{12}} = 1 - \frac{d \log R}{d \log k_{12}}$$

Theoretically, this result may be further compared to empirical estimates on property tax base elasticities of other types of taxation.

Summary of the Chapter

Despite the institutional context of property taxation in the Czech Republic suggests the taxable base may be perfectly inelastic, the theory on tax responsiveness provides reasons why the elasticity may not equal to unity in the real world. At first, property tax may alter taxpayer's incentives. Level of the tax rates and complexity of the taxation system, mainly if it includes a large space for exceptions, may incentivize the taxpayer to avoid the tax. The behavioural changes can happen at different margins: by legally changing the status of the property towards categories taxed at a lower rates or tax exemptions, or by altering the complete use or investment in the property. Outright evasion cannot be excluded either. Theoretical derivation of the revenue elasticity of the property tax with respect to tax rates further emphasizes the importance of tax-exempt areas share on the total tax liability: elasticity could be equal to one only if there was no avoidance and no share of exempt land in the municipality.

2 Practical Part

On the basis of the theoretical foundations, in the practical part I estimate the elasticity of property tax with respect to tax rates in the Czech Republic. By doing so, I test the hypothesis that the revenue elasticity of the property tax with respect to tax rates equals to unity. For this purposes, I develop a methodology, create a novel dataset, describe the use of coefficients, estimate the econometric models and discuss the results.

2.1 Methodology

To estimate the effects of tax rates on property tax revenue, I use the variation in the tax rates across municipalities and over time caused by a legislation of *local coefficient* in 2008. In this chapter, I discuss the details behind the identification strategy which is based on the difference-in-difference estimator and further extended by matching. With it, I model the theoretically derived elasticity that will be further estimated.

2.1.1. Identification strategy

Firstly, one must define how to identify the effect of change in tax rates on property tax revenue. Property tax revenue of a municipality before and after the adoption of a coefficient cannot be compared since it is impossible to know what would happen if it would not apply it. In an ideal setting, this would require observing the outcome of a municipality if it applied the coefficient as well as the counterfactual outcome. In such situation, the treatment effect could be calculated by comparing the real value with the counterfactual:

$$Y_m = \begin{cases} Y_{1m} \; if \; T_m = 1 \\ Y_{0m} \; if \; T_m = 0 \end{cases}$$

$$Y_m = Y_{0m} + (Y_{1m} - Y_{0m})\, D_m$$

where Y_m is the real observed property tax revenue of a municipality m, T_m is 1 if a municipality would apply *local coefficient* – is treated, and 0 otherwise. Y_{1m} is the property tax revenue if a municipality adopted *local coefficient* and Y_{0m} is the counterfactual property tax revenue if a municipality did not adopt *local coefficient*. $(Y_{1m} - Y_{0m})$ is the treatment effect τ (Wooldridge, 2015).

However, since in reality only one of the outcomes for each municipality can be observed, the only counterfactual scenario for municipalities that applied the *local coefficient* is represented by municipalities that did not adopt the coefficient. If those two groups would be perfectly equal and the only difference would be their treatment status, the observed difference in their outcome could be considered as an average treatment effect. But if the municipalities that changed the coefficient would have a different outcome if there was no reform at all, the observed effect would comprise also *selection bias* which may over- or under-estimate the resulting difference, flawing a causal interpretation.

$$E[\tau] = E[Y_{1m} - Y_{0m}] = E[Y_{1m}] - E[Y_{0m}]$$

$$E[Y_m|T_m = 1] - E[Y_m|T_m = 0] = E[Y_{1m}|T_m = 1] - E[Y_{0m}|T_m = 0]$$

$$\begin{aligned} &E[Y_m|T_m = 1] - E[Y_m|T_m = 0] = \\ &\quad = E[Y_{1m}|T_m = 1] - E[Y_{0m}|T_m = 1] + E[Y_{0m}|T_m = 1] - E[Y_{0m}|T_m = 0] \end{aligned}$$

$$\begin{aligned} &Observed\ difference\ in\ average\ property\ tax\ revenue \\ &\quad = average\ treatment\ effect\ on\ the\ treated + selection\ bias \end{aligned}$$

The selection bias could be caused by various factors which coincide with the application of the *local coefficient*. These characteristics may be both observable and unobservable. One could expect the municipalities that apply the coefficient to be more prosperous, with fast-growing population and lower share of tax-exempt land. The population growth speaks for itself; new residential construction necessitates new public investment in schools, roads and so on. If this was true, the effect of these variables on the property tax revenue would be absorbed by the effect of the *local coefficient*. In turn, the estimate of the revenue elasticity would be upwardly biased. Also, as shown in the derivation of the theoretical model of this elasticity, the resulting effect depends on the adjustments of the taxable base and share of tax-exempt areas.

Albeit these variables could be controlled for if they are observed, there may still be other unobservable factors causing the omitted variable bias. For instance, the political situation in the municipality, ability and skills of the mayor and deputies or degree of reliance on other revenue sources (transfers, user fees). Also, a possibility of reverse causation cannot be excluded; is it the application of a *local coefficient* that causes a rise in the revenue or does a small revenue cause application of a coefficient?

An ideal solution of the selection bias would be a random assignment, in which the treatment – value of the *local coefficient* – would be assigned to municipalities at random, i.e. independently of potential outcome. But even though I cannot control the self-selection of municipalities into treatment, selection bias could be overcome by a quasi-experimental design, exploiting the fact the policy was adopted in different municipalities at different times.

2.1.2. Difference-in-differences

If we assume that the source of selection bias is fixed over time and municipalities, method of difference in differences can be used. We cannot compare simple *before* and *after* outcomes because of time-varying effects. We also cannot compare treated with non-treated outcomes, because of both observed and unobserved individual time-invariant characteristics. But comparing the change in outcome of the municipalities that varied the *local coefficient* with the change in outcome of the municipalities not applying the *local coefficient* should tackle both issues at once. In this framework, the change of the *local coefficient* – adoption or adjustment different from 1 – is treatment. Municipalities applying the *local coefficient* are a part of treatment group and municipalities that did not set the value of the *local coefficient* comprise control group.

The difference-in-differences is typically used for analyzing the effects of various policy changes with exogenously determined treatment. In these cases, it is enough to have a binary treatment variable distinguishing treatment and control groups and two periods – before and after the reform. The effect of interest than can be simply calculated as a difference of the following two differences:

$$E[\hat{\alpha}] = E[Y_{mt}|m = A, T_m = 1] - E[Y_{mt}|m = A, T_m = 0] - E[Y_{mt}|m = B, T_m = 1] - E[Y_{mt}|m = B, T_m = 0]$$

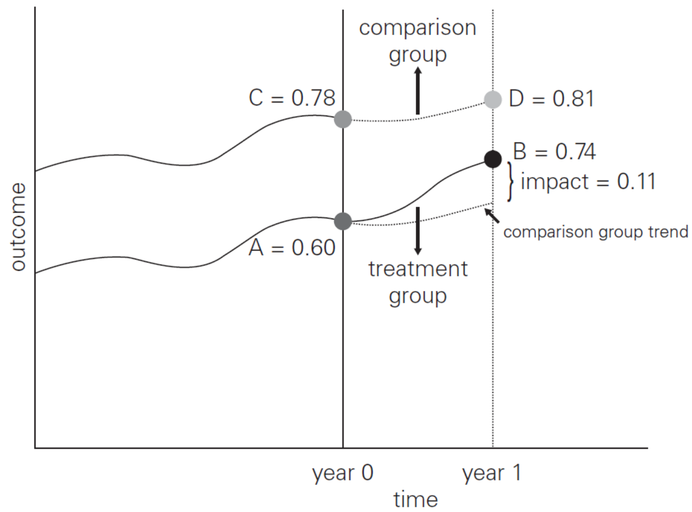
where $\hat{\alpha}$ is the average effect of treatment on treated, Y_{mt} is a property tax revenue of a municipality m at time t. However, the concept may be as well applied to the cases where timing or usage of treatment varies across regions and years. This fact serves well to the needs of my research question. Since the value of the treatment differs across municipalities and years, changes of the *local coefficient* can be exploited (Angrist and Pischke, 2008).

In this framework, expected revenue depends on municipality and time and can be decomposed to the time invariant municipality effect and a time effect that is common across municipalities. To obtain the average treatment effect, these effects need to be equal across the treatment and control group. If this is true, the fixed municipality and year effects control for unobserved but fixed time and municipality omitted variables and assignment to groups can be considered almost as good as random. Therefore the primal condition for using the difference-in-differences is the *common trend assumption*: the average pre-treatment trends must be equal for both compared groups. Then, it is true that,

$$\widehat{\alpha} = \alpha + (\lambda_A + \lambda_{T=1}) - (\lambda_A + \lambda_{T=0}) - \left((\lambda_B + \lambda_{T=1}) - (\lambda_B + \lambda_{T=0})\right) = \alpha$$

where λ_A and λ_B are municipality specific fixed effects, and $\lambda_{T=1}$and $\lambda_{T=0}$ are year fixed effects. This idea is visualized in the *Figure 4.*

Figure 4: Visualization of Difference-in-Differences



Source: Gertler et al (2010)

Considering the outcome is dependent also on set of observable covariates $\boldsymbol{X}_{mt}$, the method may be effectively converted into the regression framework:

$$Y_{mt} = \alpha T_{mt} + \boldsymbol{X}'_{mt}\beta + \lambda_m + \lambda_t + \epsilon_{mt}$$

where α is coefficient *not* on a dummy assigning treatment but on a particular intensity of the treatment, i.e. value of *local coefficient*; β is the effect of covariates X_{mt}; and $\epsilon_{mt}$is the unexplained variation.

The equation may be estimated by a linear regression with dummies or demeaning. In the first case, the fixed effects are specified by individual dummies for all municipalities and years. The second method for estimating the difference-in-differences equation is demeaning or a within-estimator, based on subtracting the municipality means of variables:

$$Y_{mt} - \overline{Y_m} \ = \alpha(T_{mt} - \overline{T_m}) + (\boldsymbol{X'}_{mt} - \boldsymbol{X'}_m)\beta + (\lambda_m - \bar{\lambda}) + (\lambda_t - \bar{\lambda}) + \epsilon_{mt} - \overline{\epsilon_m}$$

The former method has the advantage over the latter if the variables of interest do not change over time and thus cannot be demeaned out of the framework, or for acquiring individual coefficients for fixed effects. On the other hand, it may be impossible to estimate, if the number of observations is small. In general, these methods are equivalent.

Consequently, the primary model for estimating the revenue elasticity of property tax with respect to tax rates – *Model A*, can be specified as:

$$\ln R_{mt} = \alpha \ln K_{mt} + \beta_i \boldsymbol{X}_{imt} + \gamma_i \boldsymbol{A}_{imt} + \lambda_m + \lambda_t + \epsilon_{mt}$$

In *Model A*,

- $\ln R$ is a logarithm of property tax revenue of municipality m at time t,
- α is *the revenue elasticity of property tax with respect to tax rates*, where tax rates are expressed as a logarithm of *local coefficient* value (i.e. 1 if not applied; 2, 3, 4 or 5 if applied) in municipality m at time t,
- β_i are the effects of observable municipality characteristics $\boldsymbol{X}_{imt}$ at time t,
- γ_i are the effects of particular land shares $\boldsymbol{A}_{imt}$ on total area of municipality m at time t,
- λ_m and λ_t are municipality and year fixed effects, respectively,
- and $\epsilon_{mt}$is the unexplained variation in property tax revenue of municipality m at time t.

This model estimates the revenue elasticity in the classical *log-log* framework, with the functional forms of the variables of interest transformed to natural logarithms. Logarithmic transformation should also cater to the stationary aspect of the property tax revenue time series and normalize the distribution. The revenue elasticity estimate, α, then may be interpreted in the following way: if the value of a *local coefficient* increases by 1 %, the property tax revenue changes by α %.

Secondly, besides the main explanatory variable, the revenue is predicted by a set of control variables $\boldsymbol{X}_{imt}$ and $\boldsymbol{A}_{imt}$. The first vector is supposed to cover the observable municipality characteristics that may influence the amount of property tax revenue, mainly variables describing the prosperity and population of the municipality. The latter vector, $\boldsymbol{A}_{imt}$, is supposed to capture the land structure of the municipality. As shown in the derivations of the theoretical model of revenue elasticity, the shares of tax-exempt areas importantly determine the property tax revenue. However, it must be noted that *local coefficient* is applicable on taxable land *and* buildings – but the land shares $\boldsymbol{A}_{imt}$ do not take into account the total built-up areas of taxable buildings, only total municipality area. Therefore, the interpretation of the revenue elasticity would not be exact to the theoretical derivation in *Chapter 1.3*. The revenue elasticity coefficient α, on the other hand, presents a total effect of the *local coefficient* on the property tax revenue: including distortions, avoidance, and exemptions.

Thirdly, the fixed effects should capture the unobservable part of the selection bias. To further reduce its extent, the specification may also control for trends specific for a district d (okres), $\lambda_d\lambda_t$ and trends specific for population size categories p, $\lambda_p\lambda_t$.

Since *Model A* is not able to disentangle the individual effects of raising the *local coefficient*, I estimate also *Model B*. Exploiting the importance of tax-exempt area shares on the resulting change of the revenue could be approached by interacting it directly with the *local coefficient*. By doing so, the municipality-specific treatment intensity would be multiplied by the fraction of area affected by the *local coefficient.* Then, the interaction term would take on a distinct value for each municipality depending on the share of its taxable land:

$$\ln R_{mt} = \alpha \ln K_{mt} + \rho \ln K_{mt} \times TA_{mt} + \delta TA_{mt} + \beta_i \boldsymbol{X}_{imt} + \lambda_m + \lambda_t + \epsilon_{mt}$$

In *Model B*, the total revenue elasticity is decomposed into two coefficients:

- α, a partial effect capturing the revenue elasticity with respect to tax rates, i.e. log values of *local coefficient*, applied in municipality m at time t,

- ρ, a partial effect caused by the fact the revenue elasticity is conditional on TA_{mt}, share of taxable land on total area of municipality m at time t.

The total revenue elasticity thus equals to $\alpha + \rho TA_{mt}$. If the effect of taxable land share would be insignificant, $\rho = 0$ and α would be equal to its counterpart in *Model A*. However, since the theoretical derivation emphasizes the importance of exemptions on change in revenue, it is expected that $\rho > 0$. Then, the final revenue elasticity directly depends on the share of taxable land on the total municipality area. Theoretically, if there would be no distortions and avoidance, as the share increases, the revenue elasticity should approach the value of one. So even though the adjustments in bases of taxable buildings and units cannot be captured, results of *Model B* may be used as a verification of the unity hypothesis.

Besides the decomposition of the revenue elasticity, compared to *Model A*, the only further change is in inclusion of δ, effect of share of taxable land TA_{mt}, instead of γ on particular area shares A'_{mt}. Given that most of these area shares cover tax-exempt land, the two variables would explain the same effect.

To recapitulate, the identification strategy behind the effect of tax rates on the property tax revenue is based on the variation in *local coefficients* across municipalities and time, which originated with the policy change in 2008. The method of difference-in-differences exploits differences in the change in revenue between municipalities which applied the *local coefficient* in particular year, and municipalities which did not. The application of municipality and year fixed effects presumes the latter municipalities to be good counterfactuals. To support the validity of this assumption, I extend the research design by an additional feature.

2.1.3. Matching

To make sure the compared municipalities are similar in the prosperity, population characteristics and shares of land, the method of matching can be used to create an artificial counterfactual. Commonly, matching is used for estimating the marginal effects based on an assumption the treatment and control group differ only in observable characteristics. However, it can also be used as a supportive feature for the difference-in-differences to assign counterfactual observations to treatment group.

Matching can be done by pairing observations with the exactly same observed characteristics or by using a propensity score. The latter method calculates the probability that a municipality is treated based on its pre-treatment characteristics – a so-called p-score. Observations with the closest p-score then can be paired using methods of nearest-neighbour, radius or kernel matching. This approach assumes that $P(X)$, a municipality p-score, represents the probability that a municipality is treated (T) only on the basis of observable variables $\boldsymbol{X}$**:**

$$P(X) = P(T = 1|\boldsymbol{X}) = E(T|\boldsymbol{X})$$

By creating a restricted control group involving only municipalities with the similar probability of being treated, matching may further reduce the selection bias and test the estimates of the full sample model.

Summary of the Chapter

To sum up, the main features of my identification strategy exploit the variation in *local coefficients* across municipalities and years that originated with the policy reform in 2008. To overcome the selection bias, difference-in-differences model based on fixed effects is used. I estimate it in two versions: firstly, I estimate the total revenue elasticity using *Model A*, where property tax revenue is explained by *local coefficient*, other tax coefficients, municipality characteristics and particular area shares. Secondly, I condition the elasticity on the share of non-tax-exempt area. To support the validity of this design, I extend the analysis by creation of a restricted sample, where counterfactual municipalities to those that adopted the *local coefficient* are obtained by matching.

2.2 Data

For the purposes of this research, I created a novel panel dataset at the municipality-year level consisting of information on tax coefficients from the *Financial Administration* of the Czech Republic[9] and on municipalities' property tax revenue and other characteristics from the *Czech Statistical Office* (*CZSO*)[10]. The data cover the period of 2004 to 2017, a boundary determined by the availability of municipality data on the property tax revenue. In this chapter, I describe the sources and creation of the final dataset, and map the patterns of the use of tax coefficients by municipalities.

2.2.1. Sources

Due to significant differences in the structure of the data sources, in this section I describe the process of creation of the final dataset which is used in the further analysis. The data on coefficients from Financial Administration contain data on municipalities' use of available coefficients, in particular: an identification number of a municipality, the value of a coefficient used and the start and expiration date of a given coefficient value. If a municipality decided to adjust the value of population size coefficients[11] in some of its parts, the data are further decomposed on the level of specific cadastral areas and plot numbers.

On the other hand, the data on municipalities' characteristics consist of municipality level data on property tax revenue, available municipality characteristics describing population features as number of inhabitants, age structure, migration, natural increase, unemployment, number of new dwellings and area shares of different land types.

Using the identification number and year, I was able to merge the individual datasets. In the process, I had to deal with the difference in the definition of a municipality between the two data sources. According to the *CZSO*, there were 6,254 municipalities in the Czech Republic as of year 2017, while in the data from *the Financial Administration* it was 6,378. The difference came from the wider definition of municipality in the latter

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[9] I use datasets "19 - DNE - Koeficient 1,5 dle § 11 odst. 3b", "36 - DNE - koeficientu dle § 6/4 zákona", "37 - DNE - koeficienty dle § 11/3, 4 ZDNE pro stavby a místní koeficient dle §12 ZDNE pro nemovitosti" downloaded from https://adisepo.mfcr.cz/adistc/adis/idpr_pub/epo2_info/rozhrani_ciselniku.faces.

[10] Data from the Czech Statistical Office were acquired upon e-mail requests.

[11] For land according to § 6 /4 and for buildings or units according to § 11 / 3, by increasing it by 1 category or decreasing it by 1 to 3 categories

data, which covered four different types. Their frequency in the coefficient data is summarized in the *Table 2*.

Table 2: Frequency of Municipality Types in Data from Financial Administration

Municipality type	Percentage frequency
Municipality	97.70
Statutory city	0.22
City district	2.02
Proving ground	0.06
Total	100.00

Source: Financial Administration, own calculations

In addition to standard municipalities (97.7% of all), there are special types of municipal units: i) 129 city districts, usually parts of cities, e.g. Praha 1 or Brno-Jih; ii) 4 proving grounds, reserved for operation of the armed forces; and iii) 14 statutory cities which unlike other municipalities can be divided into sub-autonomous parts. Since the first two types of municipalities did not correspond to the definition of a municipality in the *CZCO* data, they had to be excluded from the final dataset: foremost, those were major cities as Praha, Brno, Ostrava, Ústí nad Labem, Plzeň, Pardubice and Liberec, fragmented into city districts. The complete list of excluded jurisdictions is in *Appendix A*. *Table 3* describes the number of municipalities by year in the final dataset.

Table 3: Frequency of Municipalities in Final Dataset

Year	Frequency	Percent
2004	5,796	6.78
2005	5,649	6.61
2006	5,794	6.78
2007	5,951	6.96
2008	6,192	7.24
2009	6,230	7.28
2010	6,233	7.29
2011	6,236	7.29
2012	6,236	7.29
2013	6,237	7.29
2014	6,239	7.30
2015	6,239	7.30
2016	6,243	7.30
2017	6,245	7.30
Total	85,520	100.00

Source: own calculations

All in all, the final dataset contains panels of 6,246 municipalities and 14 years. However, since not all of these municipalities are observed during the whole period and there are gaps in the time series of municipal control characteristics, the panel dataset was unbalanced.

The main gaps in the municipal characteristics are in the variables documenting the average age (observations on all municipalities were missing in 2017) and unemployment (observations on all municipalities missing for years 2004, 2012 and 2013). The reason for gaps in unemployment is due to a change in methodology[12]. According to the CZSO, this parameter was not monitored in 2012 and 2013. For the rest of the variables, missing values corresponded to the same 26 observations annually[13] which I deleted.

Since the pattern of the gaps in the values of unemployment and average age could be considered irregular and caused by administrative issues, I used interpolation to infer the missing values. For this process, I opted for inverse distance weighted method which interpolates a weighted average of non-missing values, with the nearest observable values having the highest weight. The confirmation if the interpolation preserved the distribution is checked in the *Results*.

Furthermore, a special role in the data has tax coefficients. Even though the *local coefficient* is in particular interest of this thesis, as argued previously, the patterns of use of *all* available tax coefficients are relevant for the analysis. Hence, in the following section I describe the patterns of their use by municipalities.

2.2.2. Patterns of Tax Coefficients Use

Firstly, I concentrate on the coefficients according to § 6/4 and § 11/3a, secondly on the coefficients according to § 11/3b) and § 11/4 respectively and thirdly on the *local coefficient* according to § 12.

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[12] Until 2011, the unemployment rate on municipal level was calculated as a share, where the numerator was the number of available job applicants and the denominator was the sum of employed, working foreigners registered at labour offices, or with a valid employment permit, or trade license and the number of available job applicants. From 2014, the unemployment is measured as a share of available jobseekers registered in the labour office on the total number of persons with permanent or long-term residence aged 15-64.

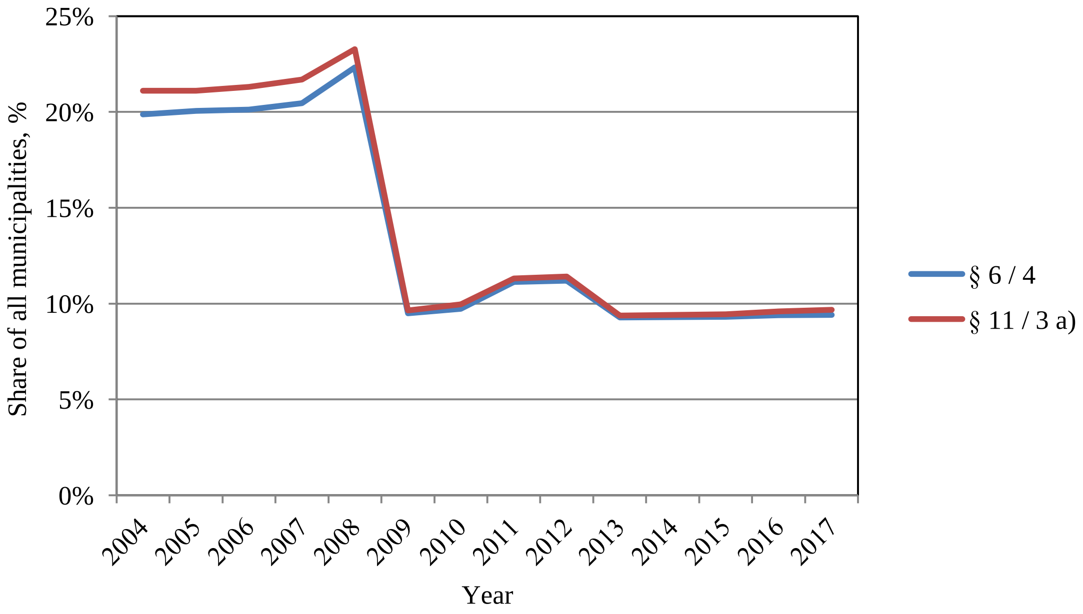
[13] These observations included municipalities: Libhošť, Krhová, Poličná, Bražec, Doupovské Hradiště, Kozlov, Luboměř pod Strážnou, Město Libavá, Polná na Šumavě.

Coefficients according to § 6/4 and § 11/3a

The primary values of coefficients according to § 6/4 for lands and § 11/3a for buildings and units are determined on the basis of the number of inhabitants. However, municipalities have an option to raise them by one category or reduce them by one to three categories for individual cadastral areas or specific parcels by a binding municipal decree.

To identify which municipalities made the adjustments, I calculated implied values of the coefficients on the basis of the number of inhabitants and compared it with the recorded values of these coefficients. For this analysis, I used only the levels of whole municipalities and of cadastral areas, excluding the level of specific parcels. Even though I expected these changes to happen solely at the cadastral level as suggested in *the Act*, the data showed them on both level of cadastral area and whole municipality. The share of municipalities which were identified as adjusting the coefficients at least at one municipal or cadastral level in a particular year is shown in *Figure 5.*

Figure 5: Share of Municipalities Adjusting the Coefficients according to § 6 /4 and § 11/3a



Source: own calculations

Generally, the trends of adjustments in both coefficients were analogous. Before 2008, these coefficients were adjusted by over 20% of observed municipalities but falling by a half in the years after. In 2008, two events happened. On the one hand, the former three population categories up to 1 000 inhabitants were united into one category. Hence, the coefficient was automatically raised in the less populated municipalities representing 78% of municipalities in the Czech Republic, decreasing the incentives to adjust it further. On the other hand, municipalities acquired an option to impose the *local coefficient* of 2, 3, 4 or 5 according to § 12. Afterwards, the shares remained relatively stable again. If this change was caused by municipalities substituting the adjustment of the *population size coefficients* with the *local coefficient*, controlling for these variables in estimation is necessary.

To identify the degree of the adjustments, I calculate the differences between the real and implied coefficients. Since a municipality may have applied different coefficients across its cadastral areas, I was able to summarize this step only for the 7.5% of municipalities which at least once changed the coefficient on the overall, municipal level. From these, the share of increasing and decreasing municipalities was generally the same.

At last, I tested if these manipulations were in the allowed limit of one category increase or one-to-three category decrease. Before 2008, around 10-12% of municipalities that changed the coefficients at the municipal level were out of the allowed limit. In 2008, the data show over 75-80% of such municipalities. This was caused by the fact that the data contained values of already cancelled categories of coefficients 0.3 and 0.6. Afterwards, the share returned from extreme but the number of wrongly adjusting municipalities doubled compared to the period before 2008 for both coefficients.

All in all, since the adjustments of coefficients may have happened on the margin other than is the municipality level, the certainty with which I can identify the changes in the coefficients in the further analysis is restricted.

Coefficients according to § 11/3b and § 11/4

According to § 11/3b, coefficient of factor 1.5 may be applied on one or multiple types of buildings[14] in the whole municipality if a municipality sets it in a generally binding

[14] The individual categories are: (1) buildings used for family recreation; (2) garages; taxable buildings and units the predominant part of which is used (3) to conduct business in primary agricultural, forestry or water management; (4) for business in industry, construction, transport, energy or other agricultural production; (5) for other types of business.

regulation. *Table 4* shows that its overall use increased gradually by more than 36% over the observed period; in 2017, 23.8% of municipalities were using some form of it.

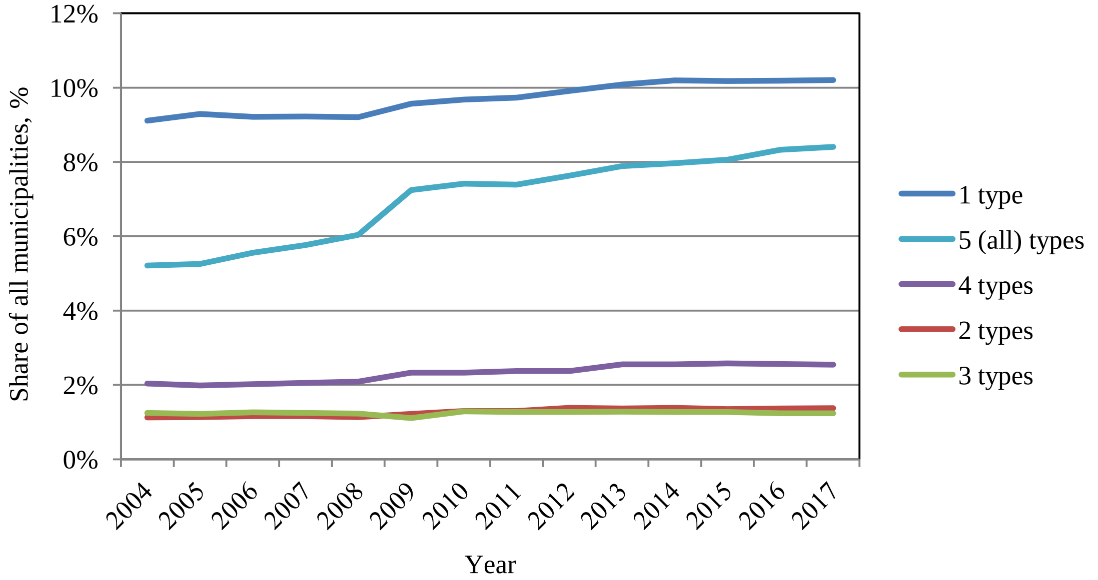
Table 4: Frequency of Municipalities Applying Coefficient according to § 11/3b

Year	Frequency	Percentage of all municipalities
2004	1,085	18.7%
2005	1,067	18.9%
2006	1,113	19.2%
2007	1,157	19.4%
2008	1,219	19.7%
2009	1,337	21.5%
2010	1,371	22.0%
2011	1,376	22.1%
2012	1,407	22.6%
2013	1,445	23.2%
2014	1,457	23.4%
2015	1,462	23.4%
2016	1,478	23.7%
2017	1,484	23.8%

Source: own calculations

Figure 6 shows the development of shares of all municipalities by the number of taxable types the coefficient is used for. Majority of the complying municipalities apply the coefficient only to one type of taxable buildings (over 10% of all municipalities); all types are used by over 8% of all municipalities.

Figure 6: Share of Municipalities Using 1 to all Types of Coefficient according to § 11/3b



Source: own calculations

According to § 11/4, a coefficient of factor 2 is applied to buildings used for family recreation if these are located in national parks or in protected landscape areas. The available data document this coefficient only since 2007. Nonetheless, as can be seen in the *Table 5*, the number of municipalities applying it was rare; in 2017 it was used only by 19 municipalities, i.e. 0.30% of all municipalities.

Table 5: Distribution of Municipalities Using Coefficient according to § 11/4

Year	Frequency	Percentage of all municipalities
2007	4	0.1%
2008	14	0.2%
2009	22	0.4%
2010	19	0.3%
2011	19	0.3%
2012	19	0.3%
2013	19	0.3%
2014	19	0.3%
2015	19	0.3%
2016	19	0.3%
2017	19	0.3%

Source: own calculations

Local Coefficient according to § 12

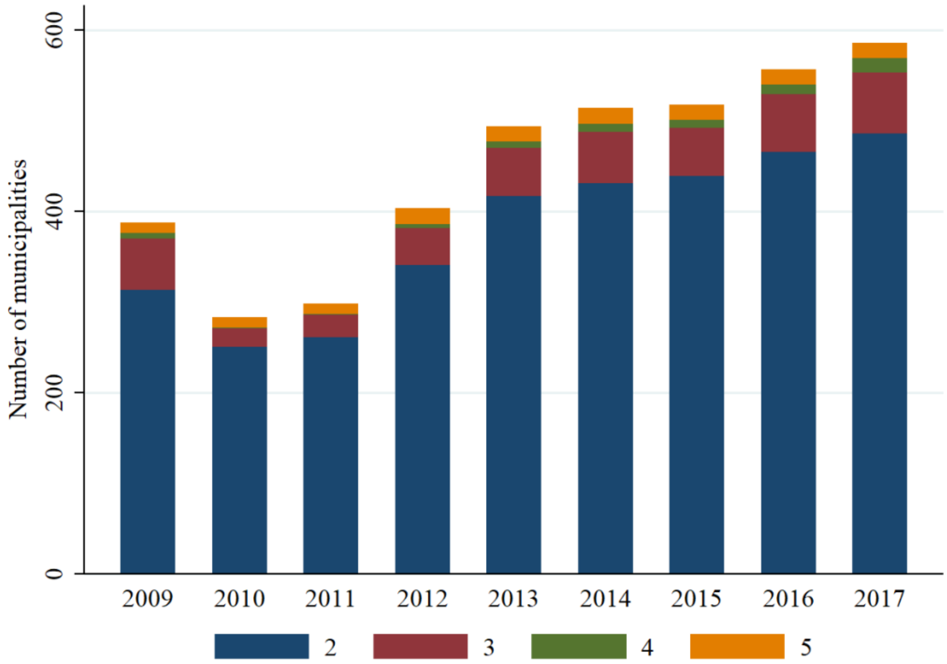
At last, but most importantly, the option of municipalities to adopt the *local coefficient* of factor 2, 3, 4 or 5 for all immovable property within the municipality with the exception of exempt land – arable land, hop fields, vineyards, gardens, orchards and permanent grassland – came into law on January 1, 2008. However, due to procedural details[15], the first period for which municipalities were able to apply it showed up in data in 2009.

Overall, the local coefficient was applied at least once in 772 municipalities; in the first year it was used by 6.2% of all municipalities, while in the last observed year the use increased by more than 50% to 9.4% of all municipalities. The only downfall happened

[15] The law was published in the Collection of Laws on 10th October 2007. This date was already after the deadline until which municipalities may have accepted a generally binding municipal decree determining the local coefficient according to § 16 a) of the Act. (Parlament České republiky, 2007) Parlament České republiky, Sněmovní tisk 222, Vl.n.z. o stabilizaci veřejných rozpočtů, Retrieved from http://www.psp.cz/sqw/historie.sqw?o=5&t=222

in 2010, presumably as a consequence of the economic crises. *Figure 7* shows the yearly development with the emphasis on the structure of coefficient values.

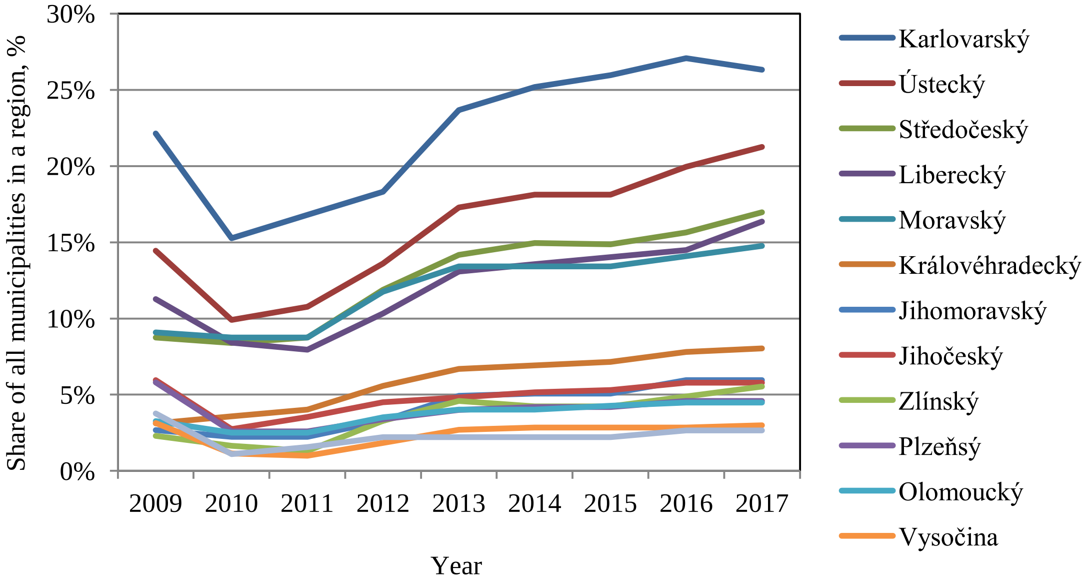
Figure 7: Number of Municipalities Applying Local Coefficient by Value of the Coefficient



Source: own calculations

By regions, the local coefficient was mostly used by municipalities in Karlovarský kraj, Ústecký kraj, Středočeský kraj, Liberecký kraj and Moravskoslezský kraj, as shown in *Figure 8.* In terms of average annual income per household member, Ústecký kraj and Moravskoslezský kraj are among the poorest regions (CZSO, 2017). According to the quality of life index constructed by *Aktuálně.cz*, Karlovarský kraj, Ústecký kraj and Moravskoslezský kraj are also the least prosperous regions in terms of average life expectancy, crime rate, availability of medical care, labour market situation, air pollution and active interest of the population in the region (Holanová, 2016).

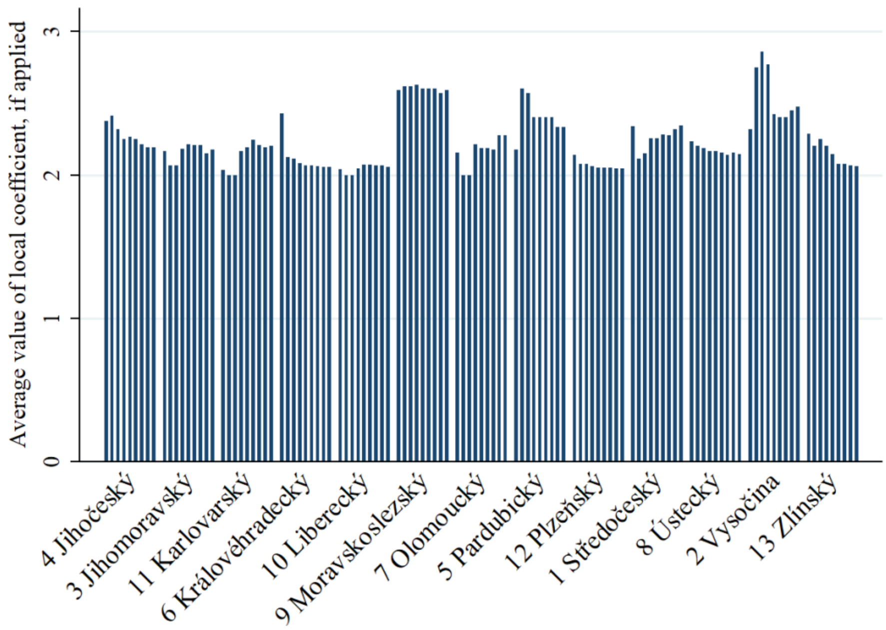
Figure 8: Relative Number of Municipalities Applying Local Coefficient by Region



Source: own calculations

The highest *local coefficient* on average (taking into account only cases when it differed from one) is overally in Moravskoslezský kraj, Vysočina and in Pardubický kraj; the lowest is in Královéhradecký, Plzeňský and Liberecký. *Figure 9* shows the average value of the local coefficient (if it was applied) over years and regions.

Figure 9: Evolution of Average Value of Local Coefficient over Years and Regions

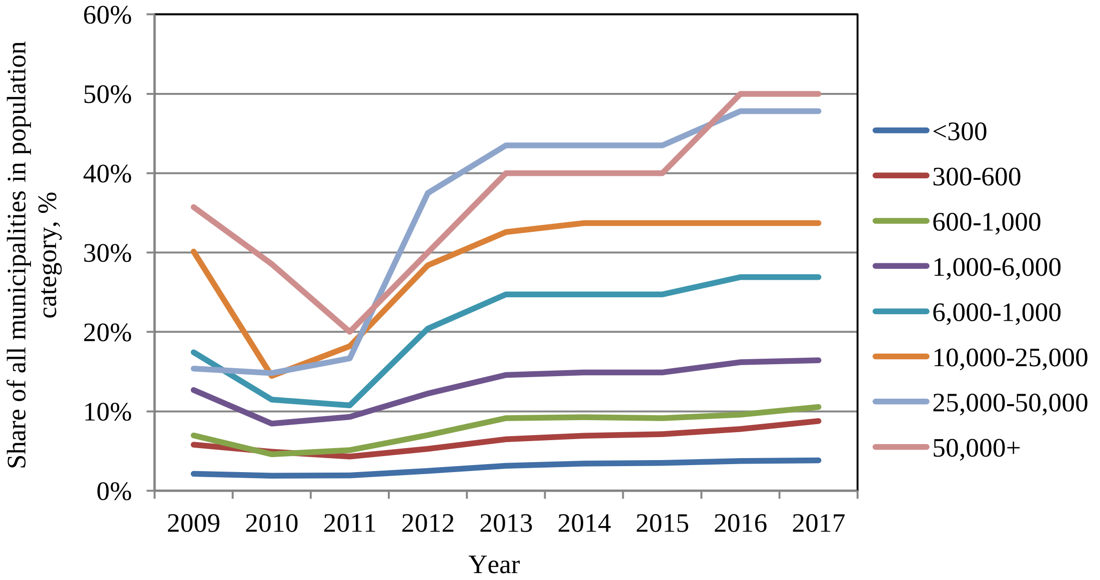


Source: own calculations

Furthermore, considering the population size aspect of municipalities, I overview the relative number of municipalities applying the coefficient on the basis of the population size categories determined by law for coefficients according to § 6/4 and § 11/3a.

The *local coefficient* was predominantly used in the large municipalities with over 10,000 inhabitants. Although the most represented, the least populated municipalities with less than 1,000 inhabitants were among the weakest adopters. Yet, in contrast to large municipalities, the use of the local coefficient was not reduced in them during the financial crises. The overall development of relative share of municipalities with respect to their population size category is shown in *Figure 10*.

Figure 10: Relative Number of Municipalities Applying Local Coefficient by Population Size Category



Source: own calculations

On average, municipalities used the *local coefficient* for 5.3 years, most often during the whole period since the enactment of the law or only for 1 year. Over 77% of municipalities changed the coefficient at least once during its use, on average 1.46 times (where change could have been adoption, adjustment or cancellation of the coefficient). *Table 6* provides an overview of the yearly number of municipalities which increased and decreased the coefficient. In general, 1,107 changes in the value of the *local coefficient* happened – 838 increases and 269 decreases.

Table 6: Number of Municipalities Increasing and Decreasing the Local Coefficient, by Year

Year	Increases	Decreases
2009	387	0
2010	89	232
2011	29	12
2012	119	6
2013	98	5
2014	26	4
2015	7	6
2016	47	1
2017	36	3
Total	838	269

Source: own calculations

Noticeably, 20% of municipalities which were adjusting the value of one or both coefficients according to § 6/4 and § 11/3a also adopted the local coefficient (26% vice versa). If the value of the local coefficient is affected by the fact the municipality adjusted one of the population size coefficients, estimates may be biased. Since the adjustment of the tax coefficients according to §6/4 and §11/3 may have happened on the margin impossible to be captured with the municipality-level data, the value of these coefficients does not necessarily correspond to the reality of the model. Also, adjustment of the definition of these variables by interacting them with the shares of areas affected by the value recorded at the municipality level may not be accurate due to the data limitations. Hence, albeit their estimated effects may be biased, I control for both the recorded values of the coefficients and dummies indicating if the municipality adjusted them.

Summary of the Chapter

To sum up, the final dataset covers 6,246 municipalities and 14 years, excluding mainly the large cities as Prague or Brno. The data provide information on municipal characteristics, area shares and tax coefficients. Due to their special role in tax system, I reviewed the patterns of use of all coefficients a municipality has at their disposal. Most importantly, because the adjustments of *population size coefficients* may happen on the margins not possible to capture with my data, I cannot identify their effects with certainty. Furthermore, the descriptive analysis of *local coefficient* confirmed that the pattern of its use vary largely over municipalities and years.

2.3 Results

In this chapter, I conduct estimation of the econometric models developed in the *Methodology*. For this purpose, I divide the analysis into two parts. At first, I research the full sample of observations. Secondly, I conduct the analysis on the restricted sample obtained by matching. The procedure is following: I describe the mean differences between the treatment and control group, verify the fulfilment of assumptions, estimate the econometric models and discuss the results. In the end, the validity of the results is tested by robustness checks.

2.3.1. Full Sample

The benchmark analysis is conducted on the full sample of observations. *Table 7* describes the summary statistics of the observed municipality characteristics and compares their values across the treatment and control group. In this definition, the treatment group includes all municipalities that applied the *local coefficient* at least for one year, whereas the control group is composed from municipalities that never adopted the coefficient. Since the treatment status of municipalities varied over time, the definition is not ideal. Nevertheless, the general conclusions about the characteristics of municipalities that adopted the *local coefficient* should hold.

The results of the summary statistics show that the differences between the two groups are statistically significant for all variables except from area shares of hop gardens and permanent grassland. On average, municipalities which at least once adopted the *local coefficient* have larger property tax revenue and use all of the available coefficients to a higher degree. Interestingly, they are more likely to apply the correction coefficient (§11/3b) and adjust the population size coefficients (§6/4 and §11/3a), as elaborated. Also, their recorded value is on average higher – 0.97 compared to 1.22. Therefore, although it may bring biased estimates as argued earlier, their inclusion in the estimation seems necessary.

Table 7: Summary Statistics, Full Sample

Variables	Control group Mean	Control group St. dev.	Treatment group Mean	Treatment group St. dev.	Difference
Property tax revenue					
Property tax revenue in thousands CZK	716.76	1 731.89	3 339.80	8 933.62	2 623.04***
Log of property tax revenue	5.95	1.00	7.04	1.34	1.09***
Tax coefficients					
Value of coefficient §12	1.00	0.00	1.48	0.73	0.48***
Value of coefficient §6/4	0.97	0.36	1.22	0.53	0.26***
Value of coefficient §11/3a	0.97	0.36	1.22	0.53	0.25***
Dummy if §11/3b - type 1 used	0.17	0.38	0.43	0.50	0.26***
Dummy if §11/3b - type 2 used	0.06	0.24	0.25	0.43	0.19***
Dummy if §11/3b - type 3 used	0.07	0.26	0.27	0.44	0.20***
Dummy if §11/3b - type 4 used	0.08	0.28	0.30	0.46	0.22***
Dummy if §11/3b - type 5 used	0.08	0.27	0.30	0.46	0.22***
Dummy if adjusted §6/4	0.11	0.32	0.29	0.45	0.17***
Dummy if adjusted §11/3a	0.12	0.33	0.28	0.45	0.16***
Municipality characteristics					
Number of municipality parts	2.21	2.46	3.40	3.77	1.20***
Number of inhabitants	944.75	3 107.69	3 574.00	9 148.49	2 629.25***
Annual change of population	0.6%	0.05	1.3%	0.08	0.70%***
Population density per sq. km	0.75	1.05	1.67	2.44	0.91***
Share of inhabitants younger than 14	0.15	0.04	0.17	0.04	0.01***
Share of inhabitants aged 15-64	0.67	0.05	0.67	0.05	0.00***
Share of inhabitants older than 65	0.17	0.05	0.16	0.04	-0.01***
Average age	41.01	2.83	40.30	2.51	-0.71***
Interpolated average age	41.07	2.83	40.36	2.51	-0.71***
Natural increase	0.01	7.17	1.42	19.68	1.41***
Migration balance	3.01	22.02	4.34	68.17	1.33***
Unemployment rate/share	8.26	5.31	7.89	5.24	-0.37***
Interpolated unemployment rate/share	8.41	5.14	8.08	5.13	-0.34***
Total completed dwellings in family houses, per capita	0.04	0.05	0.06	0.10	0.02***
Total completed dwellings in apartment houses, per capita	0.00	0.02	0.01	0.04	0.01***
Area shares					
Area share of arable land	0.48	0.22	0.38	0.24	-0.10***
Area share of hop gardens	0.00	0.01	0.00	0.01	0.00
Area share of vineyards	0.00	0.02	0.00	0.01	-0.00***
Area share of gardens	0.02	0.02	0.03	0.03	0.01***
Area share of orchards	0.01	0.03	0.01	0.02	0.00***
Area share of permanent grassland	0.12	0.10	0.12	0.11	0.00
Area share of agricultural land	0.63	0.19	0.54	0.21	-0.09***
Area share of forest land	0.26	0.20	0.31	0.23	0.04***
Area share of water surfaces	0.02	0.03	0.02	0.03	0.00***
Area share of built-up areas	0.02	0.01	0.02	0.02	0.01***
Area share of land exempt under §12	0.63	0.19	0.54	0.21	-0.09***
Annual change in area exempt under §12	0.00	0.02	0.00	0.04	0.00**
Total change in area exempt under §12	-0.01	0.04	-0.01	0.06	-0.00***
Observations	74,946		10,518		85,464

*Note: *** p <0.01, ** p <0.05; Source: own calculations*

The resulting disparities between other municipal characteristics confirm the theory that municipalities which adopt the *local coefficient* are more prosperous. On average, these municipalities have around 3,500 inhabitants and more than a twice higher population density. The annual increase of inhabitants is also more than double, presumably coming mainly from the enormous difference in the natural increase of population. Furthermore, the municipalities applying the coefficient tend to have a higher immigration than emigration. The divergence in prosperity is complemented by a higher extent of new constructions of family and apartment buildings per capita in the treated municipalities. However, discrepancies in the population age structure do not seem to play a particularly important role.

Although the analysis also showed significant differences between various types of area shares, these are of a smaller degree than the previous characteristics. Most noticeably, municipalities applying the *local coefficient* have a smaller share of agricultural land and land exempt from the use of § 12. Hence, the application of the *local coefficient* may raise more revenue due to a larger taxable base. Interestingly, the average annual change in the tax-exempt area share is negative and total average change between 2004 and 2017 is very low in both groups. Apart from these differences, the results also suggest the interpolation did not significantly alter the distribution of values of unemployment and average age.

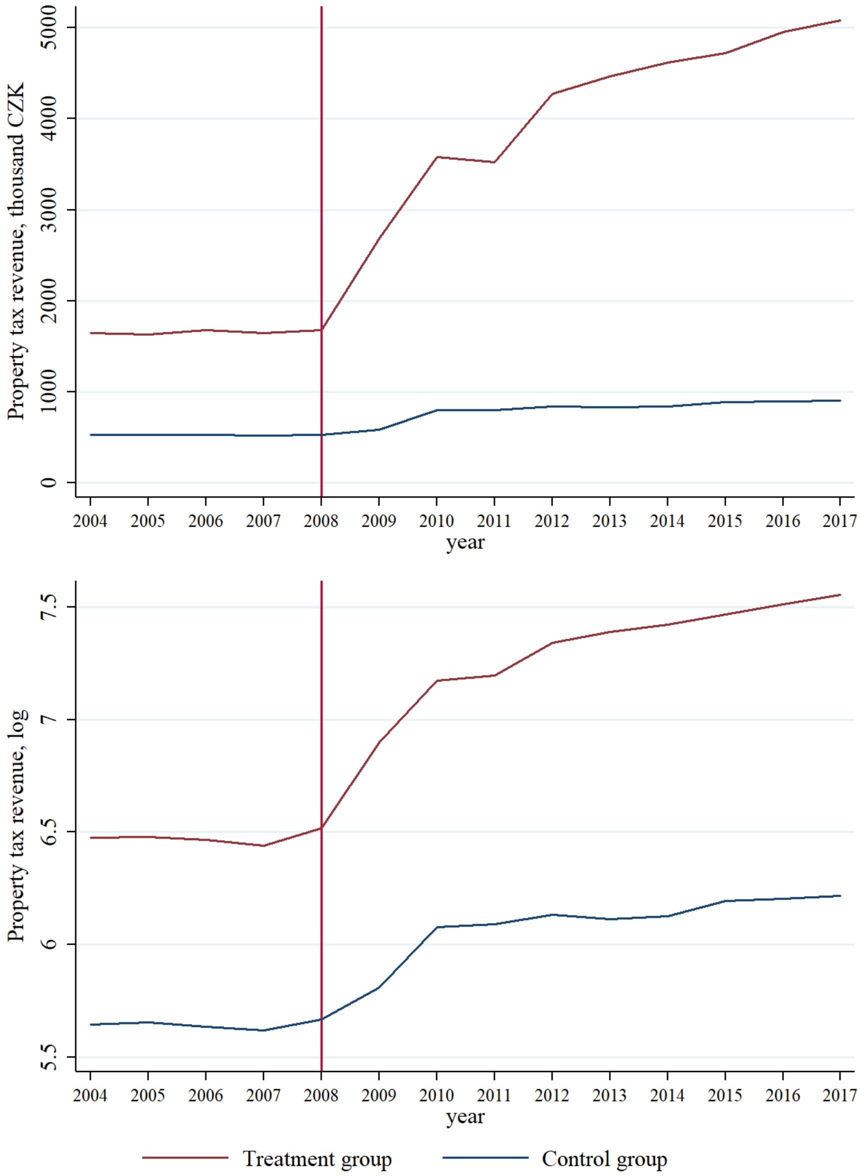
All in all, the statistically significant discrepancies between the municipalities' characteristics emphasize the fact the property tax revenue may be influenced by other factors than is the *local coefficient* and those need to be controlled for in the econometric estimation. However, if the trends are equal, the differences in levels between the treatment and the control group should not invalidate the application of the difference-in-difference estimator.

Assumptions

To check for differential trends in the outcome variable prior to the policy change, I verify the fulfilment of the common trend assumption. According to this assumption, in the absence of the policy, changes in the property tax revenue would be the same for the control and treatment group. Hence, if common shocks happen, both groups should react in the same way. Evidence supporting this assumption can be found by visualization of the pre-policy evolution of the property tax revenue across the groups. Furthermore, the differences in revenue changes may be statistically tested.

For the purpose of the visualization check, the treatment and control group is specified as described above with the summary statistics. As can be seen in *Figure 11*, although the treated municipalities have higher revenues in absolute values, the pre-period trends seem to be parallel. To validate this suggestion statistically, I performed the ANOVA test. Null hypothesis stating annual growth rates of property tax revenue are not different across the groups could not be rejected. Results can be found in *Table B1* in *Appendix B.*

Figure 11: Common Trend Assumption, Full Sample

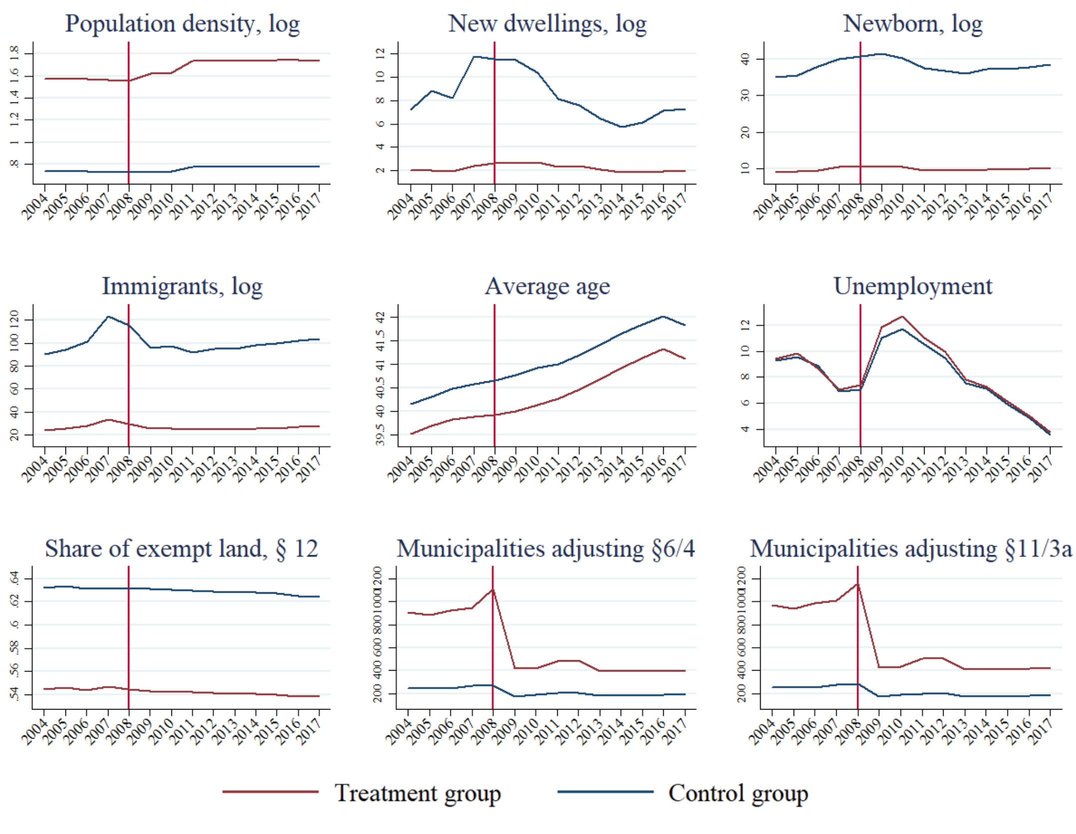


Source: own calculations

Besides confirming the common trend assumption, *Figure 11* demonstrates a visible jump and change in the trend of the treatment group after the policy allowing the adoption of local coefficient came to law in 2008. The visual evidence also hints a similar reaction to the common shock of a general increase in the basic tax rates in 2010. As a result, property tax revenue shortly fell in both groups. At last, since the municipal changes of the *local coefficient* can be observed for a period of nine years, the effect does not seem to diminish over time.

The application of difference-in-differences also requires a consideration of the second assumption which relates to the compositional changes of the treatment and control group: composition of groups must remain constant and should not be affected by the policy. This must be true both for observable and unobservable characteristics. To check the former, I visualize the trends in the main observed variables, see *Figure 12*.

Figure 12: Trends in Observable Variables, Full Sample



Source: own calculations

While the groups differ in levels, the trends are somewhat similar. Some doubt may be caused by the difference in trends in population density, new dwellings, newborn and immigrants. In particular, the trend in population density suggests to be growing more in the treatment group after the policy reform; confirming the expectations stated previously. Hence, this may bias the estimated revenue elasticity towards unity. However, overall trends do not demonstrate any radical change in the trend that could be caused by the 2008 change in policy. Interestingly, trends in the share of exempt land are decreasing in both groups. The figure also illustrates that a drop in a number of municipalities adjusting *population size coefficients* after legislation of *local coefficient* was similar across the groups.

Still, changes in the composition of the groups due to unobservable effects may be problematic. Since my research methodology exploits time and municipality variation in the *local coefficient* changes, the violation of this assumption should not be of concern. All things considered, the assumptions behind the proposed methodology were verified; I proceed to the estimation of the elasticity of the property tax revenue.

Two models of log of property tax revenue, as defined in *Methodology,* are estimated:

– *Model A*, including the main explanatory variable of the log of *local coefficient* and controls,
– *Model B*, with the interaction of the log of *local coefficient* with the area share of non-exempted area and controls.

The models are estimated in three specifications to confirm robustness of the results:

(1) Including year and municipality fixed effects,
(2) Adding district-specific trends,
(3) Adding population-size-specific trends.

The standard errors are clustered by municipality, allowing the heterogeneity to be independent across observations.

Model A

The results of the estimation of *Model A* are displayed in *Table 8.* The magnitude of the revenue elasticity estimates is fairly robust across the specifications. The estimated coefficients are in the limit of 0.794 to 0.77; if the *local coefficient* is raised by 100%, the property tax revenue increases on average by 77%.

If there were no behavioural responses, the estimated revenue elasticity would need to correspond to the real share of taxable area. To separate the individual effects of exemptions and avoidance, one could compare the result with the share of non-exempt area. However, I can only observe the area share of the exempt land on the total municipality area, missing out the total built-up areas of taxable buildings and units. Thus, if the mean value of the area share of taxable land is 46% for treatment group, the result is clearly incomplete. Before analyzing this issue further, I discuss the rest of the results of *Model A*.

The estimates of the remainder of the coefficients are not particularly noticeable – both in terms of significance and volume. From the population size coefficients, significantly positive but low is the effect of the coefficient for taxable buildings. At the same time, the fact a municipality adjusted this tax coefficient appears to lower the revenue. As explained before, these estimates should be considered with caution. Another highly significant and positive is the estimate of population density. Apart from that, the relevance of other observables could be diminished by the inclusion of fixed effects and specific trends.

Table 8: Results of Model A, Full Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient §12	**0.794***	**0.776***	**0.770***
	(0.015)	**(0.014)**	**(0.014)**
Log of coefficient § 6/4	-0.012	-0.011	0.009
	(0.021)	(0.020)	(0.020)
Log of coefficient § 11/3	0.050**	0.046**	0.074***
	(0.021)	(0.020)	(0.020)
Dummy = 1 if § 6/4 changed	0.014	0.012	0.012
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3a changed	-0.023**	-0.013	-0.006
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3b type 1 applied	0.040***	0.052***	0.047***
	(0.013)	(0.012)	(0.012)
Dummy = 1 if § 11/3b type 2 applied	0.028	0.013	0.002
	(0.018)	(0.018)	(0.018)
Dummy = 1 if § 11/3b type 3 applied	-0.014	-0.019	-0.023
	(0.028)	(0.027)	(0.026)
Dummy = 1 if § 11/3b type 4 applied	0.036	0.040	0.060*
	(0.034)	(0.034)	(0.034)
Dummy = 1 if § 11/3b type 5 applied	0.055*	0.051*	0.037
	(0.030)	(0.031)	(0.03)
Population density per sq. km	0.096***	0.091***	0.077***
	(0.023)	(0.022)	(0.021)
Annual change in population	-0.038**	-0.040**	-0.041**
	(0.015)	(0.018)	(0.018)
Average age	0.002	0.001	-0.000
	(0.001)	(0.001)	(0.001)
Natural increase	-0.001***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000	0.000	0.000*
	(0.000)	(0.000)	(0.000)
Unemployment share	0.001	0.001*	0.000
	(0.000)	(0.000)	(0.000)
Completed dwellings in family houses, pc	-0.370**	-0.287*	-0.243
	(0.186)	(0.164)	(0.159)
Completed dwellings in apartment houses, pc	-0.153	-0.008	0.070
	(0.127)	(0.136)	(0.147)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	79,228	79,228	79,228
R-squared	0.746	0.767	0.769
Number of municipalities	6,236	6,236	6,236

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Due to brevity, coefficients on area shares are not displayed. Full results can be found in Appendix C, Table C8.*

Model B

To disentangle the effect of tax exemptions on the revenue elasticity, I estimate *Model B* where the log of local coefficient is interacted with the area share of taxable land. Here, a change in the property tax revenue due to a change in the *local coefficient* is conditional on the specific share of non-exempt land. This specification may approximate the structure of the total effect. If the non-exempt land would not influence the revenue elasticity, the estimated coefficient for the log of *local coefficient* should be in volume of *Model A* and the coefficient on the interaction would be insignificant.

The results presented in *Table 9* show both coefficients to be significant. When the *local coefficient* increases, the revenue increases on average by 0.532 + (0.5 * share of taxable land). Hence, 0.532 could be considered as the certain effect of a tax hike. The latter effect crucially depends on the share of taxable land; the higher is the share, the higher should be the resulting revenue elasticity. To obtain the revenue elasticity equal to one, the share would need to be one as well. This result is exactly in the line of the theoretical derivations in Section 3.3.

Table 9: Results of Model B, Full Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient	**0.528******	**0.542******	**0.532******
	(0.035)	**(0.036)**	**(0.035)**
Share of non-exempt land	0.222	0.226	0.196
	(0.303)	(0.303)	(0.301)
Log of local coefficient x Share of non-exempt land	**0.557******	**0.491******	**0.500******
	(0.073)	**(0.076)**	**(0.075)**
Log of coefficient § 6/4	-0.010	-0.010	0.010
	(0.020)	(0.020)	(0.020)
Log of coefficient § 11/3a	0.049**	0.045**	0.073***
	(0.021)	(0.020)	(0.020)
Dummy = 1 if § 6/4 changed	0.016	0.014	0.014
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3a changed	-0.025**	-0.015	-0.010
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3b type 1 applied	0.048***	0.058***	0.053***
	(0.012)	(0.012)	(0.012)
Dummy = 1 if § 11/3b type 2 applied	0.022	0.008	-0.004
	(0.018)	(0.018)	(0.018)
Dummy = 1 if § 11/3b type 3 applied	-0.014	-0.018	-0.022
	(0.029)	(0.027)	(0.027)

Table continues on the next page.

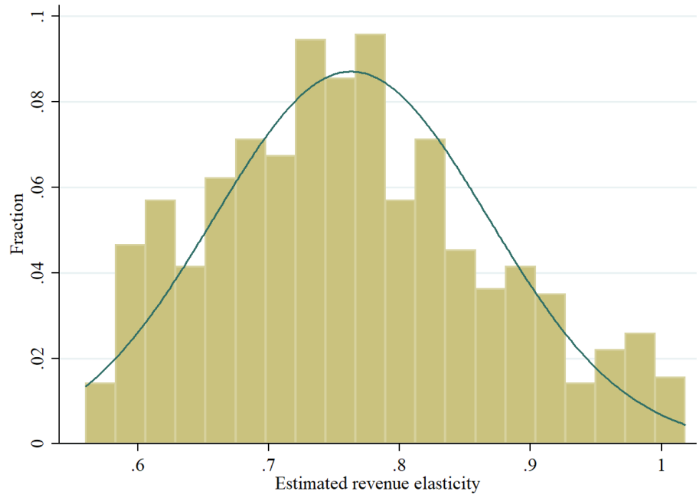
Continuation of Table 9:

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Dummy = 1 if § 11/3b type 4 applied	0.035	0.038	0.058*
	(0.034)	(0.034)	(0.034)
Dummy = 1 if § 11/3b type 5 applied	0.067**	0.062**	0.048
	(0.030)	(0.030)	(0.030)
Population density per sq. km	0.108***	0.102***	0.086***
	(0.024)	(0.024)	(0.023)
Annual change in population	-0.046***	-0.044**	-0.045**
	(0.016)	(0.018)	(0.018)
Average age	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.001)
Natural increase	-0.001***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Unemployment share	0.001*	0.001*	0.000
	(0.000)	(0.000)	(0.000)
Completed dwellings in family houses, pc	-0.363*	-0.269	-0.221
	(0.188)	(0.165)	(0.159)
Completed dwellings in apartment houses, pc	-0.133	0.008	0.0870
	(0.135)	(0.137)	(0.146)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	79,228	79,228	79,228
R-squared	0.747	0.768	0.771
Number of municipalities	6,236	6,236	6,236

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own*

Estimates of *Model B* can be used to calculate both average and municipality-specific elasticities. Firstly, with the mean value of taxable land share for treatment group of 0.46, the total average revenue elasticity amounts to 0.762, confirming the results of *Model A*. To calculate municipality-specific elasticities, I complement the estimated coefficients by individual shares of taxable land area in 2017, the last observed period. *Figure 13* illustrates the distribution of the estimated values.

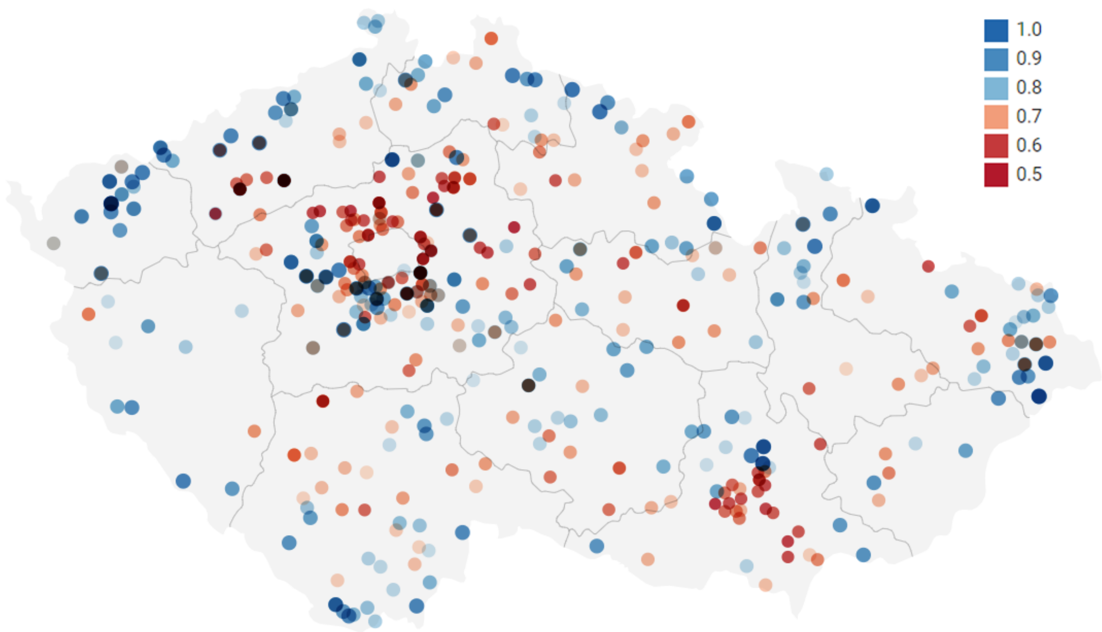
Figure 13: Distribution of Estimated Elasticities, Full Sample



Source: own calculations

The geographical distribution of the estimates is illustrated in *Figure 14*, which displays estimated volumes of the revenue elasticity in municipalities which at least once adopted the *local coefficient*. Due to technical reasons, the map was created using the postal codes of municipalities. Since many of them have the same postal code, more municipalities may be grouped into one point in the map. Then, the colour turns grey.

Figure 14: Map of Municipality-Specific Revenue Elasticity Estimates, Full Sample



Source: own calculations

To further test the question of importance of exemptions on the revenue elasticity of the property tax, I estimate *Model A* also on samples restricted by the share of tax-exempt land. The results in *Table 10* confirm the expectation that revenue elasticity increases with the share of taxable land.

While in the municipalities with over 75% of exempt land the revenue elasticity tends to be under 0.575, the elasticity in the municipalities with less than 25% of tax-exempt land approaches unity. Although this analysis is based only on a small sample of municipalities, and it is only possible to control for the share of land and not taxable buildings, there is a strong suggestion that the main factor influencing the elasticity of the property tax revenue is the share of the tax-exempt land and not tax avoidance or change in behaviour.

Table 10: Results of Model A, Restricted by Share of Tax-Exempt Land, Full Sample

	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1)	(2)	(3)	(4)
Variables	0.9 to 1	0.75 to 0.90	0.25 to 0.10	0 to 0.10
Log of local coefficient §12	**0.337***** **(0.054)**	**0.575***** **(0.031)**	**0.896***** **(0.028)**	**0.976***** **(0.070)**
Log of coefficient § 6/4	-0.149 (0.269)	0.085* (0.044)	0.112 (0.085)	-0.110 (0.116)
Log of coefficient § 11/3	0.198 (0.276)	-0.008 (0.043)	-0.019 (0.085)	0.015 (0.082)
Dummy = 1 if § 6/4 changed	-0.098 (0.171)	0.031 (0.028)	-0.006 (0.051)	0.136* (0.068)
Dummy = 1 if § 11/3a changed	0.097 (0.175)	-0.040 (0.028)	-0.015 (0.052)	0.059 (0.085)
Dummy = 1 if § 11/3b type 1 applied	-0.060 (0.050)	0.054* (0.031)	0.073* (0.041)	0.010 (0.132)
Dummy = 1 if § 11/3b type 2 applied	0.078 (0.074)	-0.013 (0.042)	-0.144 (0.092)	0.263** (0.130)
Dummy = 1 if § 11/3b type 3 applied	-0.382*** (0.100)	-0.023 (0.118)	0.207* (0.105)	-0.073 (0.093)
Dummy = 1 if § 11/3b type 4 applied	0.406*** (0.046)	-0.153 (0.192)	-0.245** (0.101)	
Dummy = 1 if § 11/3b type 5 applied		0.283 (0.244)	0.307*** (0.097)	
Population density per sq. km	0.156* (0.082)	0.135*** (0.022)	0.100 (0.074)	0.472** (0.223)
Annual change in population	0.038 (0.081)	-0.051*** (0.015)	0.100 (0.065)	-0.225 (0.208)
Average age	-0.000 (0.004)	0.001 (0.002)	-0.012** (0.005)	0.002 (0.020)

Table continues on the next page.

Continuation of Table 10:

	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1)	(2)	(3)	(4)
Variables	0.9 to 1	0.75 to 0.90	0.25 to 0.10	0 to 0.10
Natural increase	-0.001	0.000	0.000	-0.001
	(0.001)	(0.000)	(0.000)	(0.002)
Migration balance	-0.001	0.000	0.000	0.001
	(0.001)	(0.000)	(0.000)	(0.001)
Unemployment share	0.000	0.000	-0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.003)
Completed dwellings in family houses, pc	1.210***	-0.108	0.0477	-1.288
	(0.383)	(0.222)	(0.826)	(0.873)
Completed dwellings in apartment houses, pc	-0.252	0.336	-0.247	-2.520**
	(0.632)	(0.270)	(0.168)	(1.043)
Year and municipality fixed effects	Yes	Yes	Yes	Yes
District trends	Yes	Yes	Yes	Yes
Population deciles trends	Yes	Yes	Yes	Yes
Observations	3,369	19,613	3,523	708
R-squared	0.762	0.753	0.896	0.972
Number of municipalities	309	1,653	295	59

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Due to brevity, coefficients on area shares are not displayed. Full results can be found in Appendix C, Table C10.*

To sum up, the targeted estimate of the revenue elasticity of the property tax with respect to tax rates is 0.77 for the full sample of municipalities. From the definition, this result involves the effect of tax exemptions and of tax avoidance. Further disentanglement of the effect demonstrates the importance of the area share of tax-exempt area in the determination of the total revenue elasticity. The resulting elasticity increases with the share of taxable land and goes to unity for the very low share brackets. These results thus provide evidence that supports the proposed efficiency of the property tax in the Czech Republic, mainly in municipalities with low proportion of tax-exempt land.

2.3.2. Matched Sample

To support the validity of the results estimated on the full sample, I conduct the same analysis on a restricted sample constructed by matching. This sample consists of the municipalities that at least once applied the *local coefficient* and their closest counterfactuals assigned to them by propensity-score method of the nearest-neighbour matching on the basis of the selected observable characteristics representing prosperity, population and land structure.

These variables involve two types – absolute values in 2007 and relative changes from 2004 to 2007. In this way, I could capture not only similarities in the overall characteristics of the municipalities but also trends in the period before the local coefficient came into law. Therefore, the change variables are supposed to represent a proxy for prosperity. The overview of all variables used in matching is in *Table 11*.[16]

Table 11: Matching Variables

	Value in 2007	Change 2004-2007
Number of inhabitants	yes	yes
Number of inhabitants per square km	yes	yes
Number of inhabitants younger than 14	yes	yes
Number of inhabitants aged 15-64	yes	yes
Number of inhabitants older than 65	yes	yes
Share of inhabitants younger than 14	yes	
Share of inhabitants aged 15-64	yes	
Share of inhabitants older than 65	yes	
Average age, interpolated	yes	yes
Natural increase	yes	yes
Number of live births	yes	yes
Migration balance	yes	yes
Number of immigrants	yes	yes
Unemployment rate/share, interpolated	yes	yes
No. of completed dwellings in family houses	yes	
No. of completed dwellings in apartm. houses	yes	
Area share of arable land	yes	
Area share of hop gardens	yes	
Area share of vineyards	yes	
Area share of gardens	yes	
Area share of orchards	yes	
Area share of permanent grassland	yes	
Area share of agricultural land	yes	
Area share of water surfaces	yes	
Area share of built-up areas	yes	
Area share of land exempt under §12	yes	
Total area	yes	
Area share of forest land	yes	

Source: own

Matching was done using the one-to-one method. Even if I opted for a higher number of desired neighbours, the resulting size of the control group remained the same and did not enlarge. Hence, the matched sample includes observations of 734 treatment and 614

[16] The selection of matching variables depended to a large extent on the availability of data. Another, unrealized method for matching could be based on the geographical distance from the regional capitals.

matched control municipalities, accounting for approximately one eight of the full dataset. In order to verify whether matching improved the quality of the control group, I compare the distribution of values of observed variables and check the trend assumptions.

To elaborate on differences in the distributions of variables across the two groups, I calculate the summary statistics. The results in *Table 12* indicate a much higher structural similarity between the groups. Central differences in values of population size coefficients, number of municipalities adjusting these coefficients, population density, age, natural increase, migration balance and unemployment are insignificant. The same is true for some of the area shares; the differences in the rest are about 1 percentage point. Low but significant difference remains in the number of new dwellings per capita and share of area exempt from the application of the local coefficient. However, annual change of the area is the same and total change is lower than before.

Table 12: Summary Statistics, Matched Sample

	Control group		Treatment group		
Variable	Mean	St. dev.	Mean	St. dev.	Difference
Property tax revenue					
Property tax revenue in thousands CZK	1 954.44	4 007.54	3 300.25	9 006.06	1345.81***
Log of property tax revenue	6.73	1.22	7.02	1.33	0.29***
Coefficients					
Value of coefficient §12	1.00	0.00	1.47	0.73	0.47***
Value of coefficient §6/4	1.22	0.50	1.22	0.53	-0.00
Value of coefficient §11/3a	1.22	0.49	1.22	0.53	-0.00
Dummy if municipality adjusted §6/4	0.27	0.45	0.28	0.45	0.01
Dummy if municipality adjusted §11/3a	0.27	0.45	0.28	0.45	0.01
Dummy if municipality uses §11/3b - type 1	0.30	0.46	0.43	0.50	0.13***
Dummy if municipality uses §11/3b - type 2	0.16	0.37	0.25	0.43	0.09***
Dummy if municipality uses §11/3b - type 3	0.17	0.37	0.27	0.44	0.10***
Dummy if municipality uses §11/3b - type 4	0.18	0.39	0.30	0.46	0.12***
Dummy if municipality uses §11/3b - type 5	0.18	0.39	0.30	0.46	0.12***
Municipality characteristics					
Number of municipality parts	3.45	4.00	3.40	3.75	-0.05
Number of inhabitants	3 270.64	7 423.47	3 563.59	9 025.19	292.96**
Annual change in number of inhabitants %	0.01	0.05	0.01	0.08	0.00***
Number of inhabitants per square km	1.65	2.32	1.64	2.36	-0.00
Share of inhabitants younger than 14	0.16	0.03	0.17	0.04	0.00***
Share of inhabitants in the age 15-64	0.68	0.04	0.67	0.05	-0.00***
Share of inhabitants older than 65	0.16	0.04	0.16	0.04	0.00
Average age	40.29	2.19	40.34	2.48	0.05
Interpolated average age	40.36	2.19	40.40	2.49	0.04

Table continues on the next page.

Continuation of Table 12:

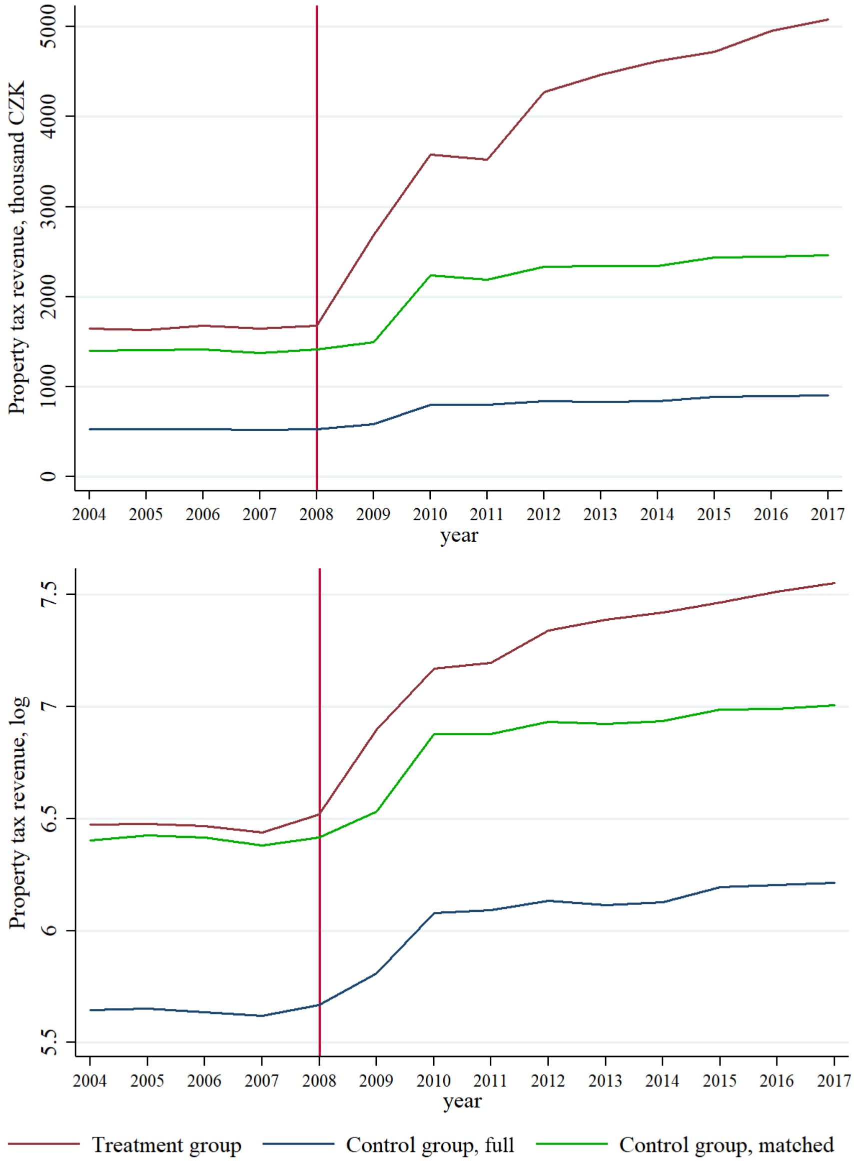
Variable	Control group Mean	Control group St. dev.	Treatment group Mean	Treatment group St. dev.	Difference
Municipality characteristics, cont'd					
Natural increase	1.03	15.85	1.34	19.13	0.31
Migration balance	4.22	52.06	4.39	63.68	0.18
Unemployment rate/share	7.79	4.62	7.92	5.19	0.12
Interpolated unemployment rate/share	7.97	4.48	8.10	5.08	0.13
Total completed dwellings in family houses, per capita	0.04	0.05	0.06	0.1	0.01***
Total completed dwellings in apartment houses, per capita	0.00	0.02	0.01	0.04	0.01***
Area shares					
Area share of arable land	0.36	-0.23	0.38	-0.24	0.02***
Area share of hop gardens	0.00	-0.01	0.00	-0.01	0.00**
Area share of vineyards	0.00	-0.02	0.00	-0.01	-0.00***
Area share of gardens	0.03	-0.03	0.03	-0.03	0.00
Area share of orchards	0.01	-0.04	0.01	-0.02	-0.00***
Area share of permanent grassland	0.12	-0.10	0.12	-0.11	-0.00**
Area share of agricultural land	0.53	-0.21	0.54	-0.21	0.01***
Area share of forest land	0.32	-0.23	0.31	-0.23	-0.02***
Area share of water surfaces	0.02	-0.04	0.02	-0.03	0.00
Area share of built-up areas	0.02	-0.02	0.02	-0.02	0.00
Area share of land exempt under §12	0.53	-0.21	0.54	-0.21	0.01***
Annual change in area exempt under §12	0.00	0.04	0.00	0.04	0.00
Total change in area exempt under §12	-0.01	0.06	-0.01	0.06	-0.00**
Observations	8 521		10 142		18 663

*Note: *** p <0.01, ** p <0.05; Source: own calculations*

Assumptions

Next, the difference-in-differences assumptions are verified. Visual evidence of common trend assumption presented in *Figure 15* suggests the matching almost closed the gap in the level of property tax revenue between the two groups, leaving the pre-period differences in trends unaffected. This interpretation was also supported by the ANOVA test, results of which can be found in *Table B2* in *Appendix B.*

Figure 15: Common Trend Assumption, Comparison of Full and Matched Sample

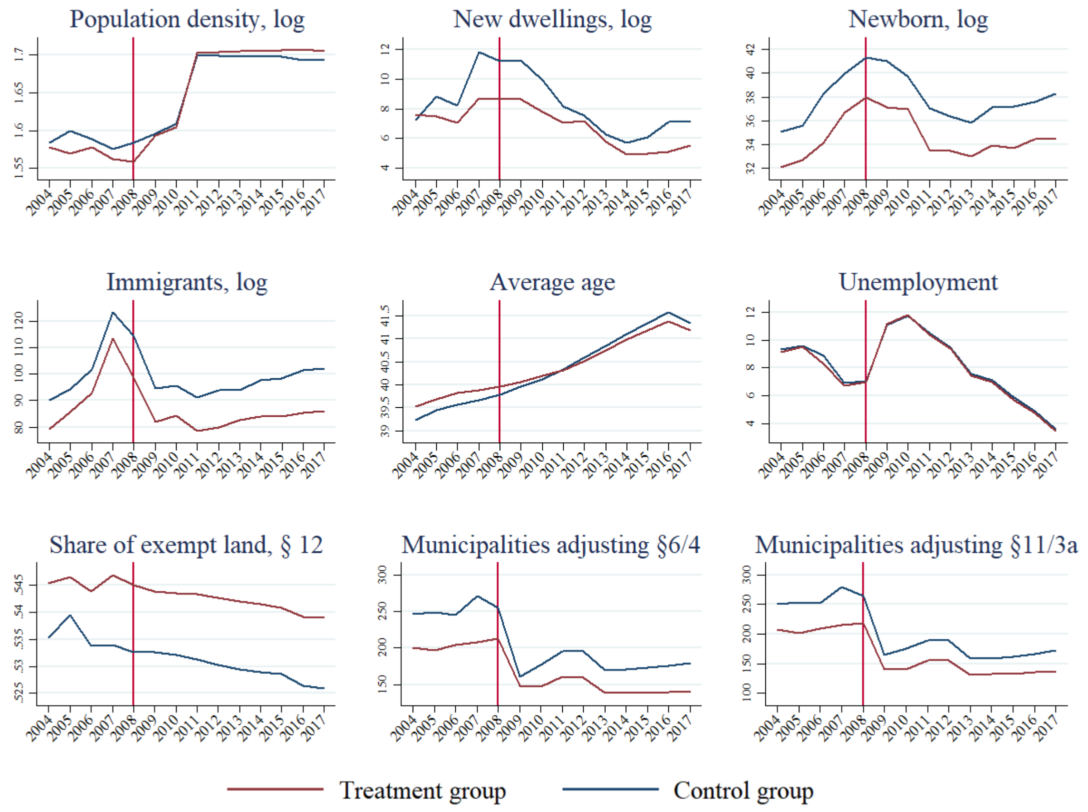


Source: own calculations

The post-policy trends visualized in the above figure also suggest the control group may be a better fit for the counterfactual than was the full sample of municipalities which did not apply the coefficient.

Figure 16 shows the pre- and post-policy trends in the composition of the two groups by visualizing the main observable variables. Compared to the full sample, now the trends seem almost equal in all of the cases. Remarkable differences show proxies of prosperity, share of exempt land and as well trends in adjustment of the *population size coefficients.*

Figure 16: Trends in Observable Variables, Matched Sample



Source: own calculations

Since the assumptions behind the methodology were verified, I continue with estimation of the same models as in the previous section.

Model A

Firstly, the total estimates of the revenue elasticity of the property tax with respect to the tax rates of *Model A* shown in *Table 13* are slightly lower on the matched sample compared to the full sample. While the primary estimates on full sample were in the limit of 0.79 to 0.77, now the range is between 0.77 and 0.76. Albeit the difference is of a very small volume, it may indicate the real elasticity to be more distorted; if we accept that matching was successful in reducing the selection bias. Apart from that, all other effects are along the lines of the previous section so I do not discuss them again.

Table 13: Results of Model A, Matched Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient §12	**0.767*** **	**0.756*** **	**0.761*** **
	(0.013)	**(0.013)**	**(0.012)**
Log of coefficient § 6/4	-0.014	-0.019	0.020
	(0.054)	(0.052)	(0.053)
Log of coefficient § 11/3	0.053	0.057	0.105**
	(0.054)	(0.052)	(0.052)
Dummy = 1 if § 6/4 changed	0.020	0.018	0.012
	(0.017)	(0.017)	(0.016)
Dummy = 1 if § 11/3a changed	-0.012	-0.010	-0.006
	(0.017)	(0.017)	(0.016)
Dummy = 1 if § 11/3b type 1 applied	0.032	0.049***	0.041**
	(0.021)	(0.021)	(0.020)
Dummy = 1 if § 11/3b type 2 applied	0.054*	0.049*	0.037
	(0.028)	(0.029)	(0.029)
Dummy = 1 if § 11/3b type 3 applied	-0.011	0.001	-0.007
	(0.034)	(0.034)	(0.034)
Dummy = 1 if § 11/3b type 4 applied	0.006	-0.021	0.0016
	(0.038)	(0.040)	(0.040)
Dummy = 1 if § 11/3b type 5 applied	0.053	0.059	0.047
	(0.034)	(0.037)	(0.037)
Population density per sq. km	0.074***	0.075***	0.061***
	(0.024)	(0.022)	(0.020)
Annual change in population	-0.079*	-0.111**	-0.106**
	(0.041)	(0.054)	(0.054)
Average age	-0.001	-0.003	-0.007
	(0.004)	(0.005)	(0.004)
Natural increase	-0.001***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Unemployment share	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.001)
Completed dwellings in family houses, pc	-0.646	-0.457	-0.516
	(0.398)	(0.360)	(0.327)
Completed dwellings in apartment houses, pc	-0.085	0.0958	0.184
	(0.186)	(0.236)	(0.262)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	17,315	17,315	17,315
R-squared	0.829	0.846	0.850
Number of municipalities	1,348	1,348	1,348

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Due to brevity, coefficients on area shares are not displayed. Full results can be found in Appendix C, Table C13.*

Model B

To further disentangle the effect of tax-exempt area share on the total revenue elasticity, I proceed with the estimation of *Model* B. The results shown in *Table 14* are also very similar to those estimated on the full sample. Comparing the most sensible specification (Column 3), the primary estimates of the coefficient on *local tax coefficient* was 0.532 and on the interaction term 0.5; in the matched sample the values are 0.538 and 0.467, respectively. Assuming there would be no exempt area share, their summation equals to unity. For the mean value of taxable land share for treatment group, which is 0.46 as in the full sample, the resulting average revenue elasticity amounts to 0.752, slightly lower than Model A's value of 0.762.

Table 14: Results of Model B, Matched Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient	**0.515*** **	**0.542*** **	**0.538*** **
	(0.033)	**(0.033)**	**(0.031)**
Share of non-exempt land	1.090**	1.016**	0.968*
	(0.493)	(0.493)	(0.508)
Log of local coefficient x	**0.527*** **	**0.449*** **	**0.467*** **
x Share of non-exempt land	**(0.060)**	**(0.061)**	**(0.057)**
Log of coefficient § 6/4	-0.015	-0.020	0.022
	(0.054)	(0.053)	(0.054)
Log of coefficient § 11/3	0.053	0.055	0.104**
	(0.054)	(0.053)	(0.053)
Dummy = 1 if § 6/4 changed	0.023	0.020	0.015
	(0.017)	(0.017)	(0.016)
Dummy = 1 if § 11/3a changed	-0.016	-0.013	-0.008
	(0.016)	(0.017)	(0.016)
Dummy = 1 if § 11/3b type 1 applied	0.048**	0.060***	0.051***
	(0.020)	(0.020)	(0.019)
Dummy = 1 if § 11/3b type 2 applied	0.038	0.032	0.020
	(0.028)	(0.029)	(0.028)
Dummy = 1 if § 11/3b type 3 applied	-0.011	0.003	-0.004
	(0.036)	(0.035)	(0.035)
Dummy = 1 if § 11/3b type 4 applied	0.004	-0.024	-0.001
	(0.039)	(0.041)	(0.040)
Dummy = 1 if § 11/3b type 5 applied	0.077**	0.078**	0.067*
	(0.035)	(0.037)	(0.037)
Population density per sq. km	0.092***	0.089***	0.074***
	(0.029)	(0.027)	(0.024)
Annual change in population	-0.096**	-0.118**	-0.114**
	(0.043)	(0.056)	(0.055)
Average age	-0.004	-0.004	-0.009**
	(0.004)	(0.005)	(0.004)

Table continues on the next page.

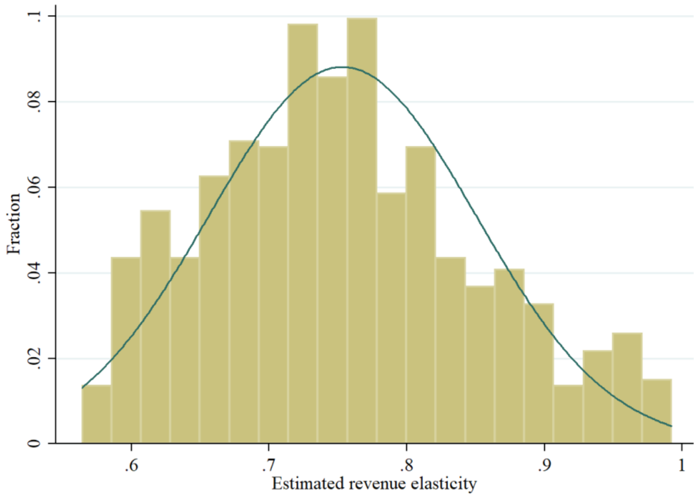
Continuation of Table 14:

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Natural increase	-0.000***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Unemployment share	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.001)
Completed dwellings in family houses, pc	-0.625	-0.411	-0.450
	(0.394)	(0.352)	(0.318)
Completed dwellings in apartment houses, pc	-0.051	0.128	0.218
	(0.183)	(0.230)	(0.254)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	17,315	17,315	17,315
R-squared	0.832	0.848	0.852
Number of municipalities	1,348	1,348	1,348

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own*

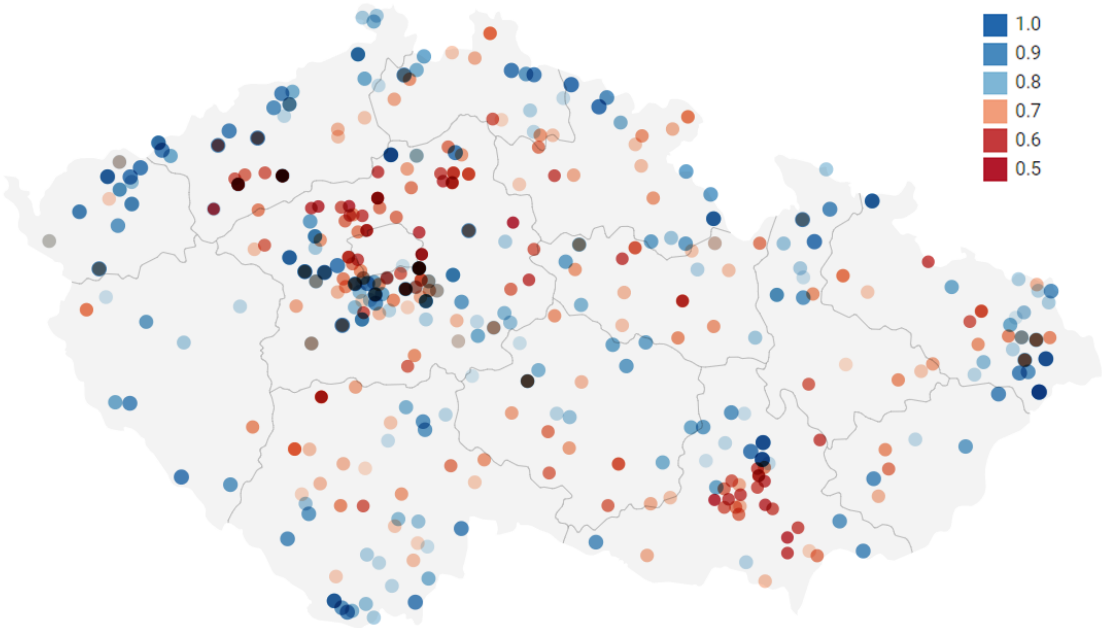
Furthermore, municipality-specific revenue elasticities are calculated using the shares of taxable land area in 2017. As can be seen in *Figure 17*, the distribution of estimates is almost identical to the full sample. But overall, the estimates are higher. Geographical distribution of the estimated revenue elasticities is represented in *Figure 18*.

Figure 17: Distribution of Estimated Elasticities, Matched Sample



Source: own calculations

Figure 18: Map of Municipality-Specific Revenue Elasticity Estimates, Matched Sample



Source: own calculcations

Finally, to test the differential effects of the *local coefficient* conditional on the share of tax-exempt land, I estimate *Model A* on samples restricted by the share of tax-exempt land; results are in *Table 15*. Due to already restricted size of the matched sample, further restrictions push the number of observations to very low number. Two main differences compared to full sample then may be noticed at the extremes. At first, for the municipalities with more than 90% of exempt land, the small sample size probably led to insignificant revenue elasticity coefficient and peculira values of other estimated coefficients. Secondly, for the tax-exempt share of less than 10%, the estimated revenue elasticity is significant 0.92, slightly lower than in the full sample. However, even though the sample size is fairly restricted, the discrepancy over matched and full sample accounts only to a standard error.

To sum up, the results of matched sample validate the conclusions drawn from the full sample and suggest their robustness. The most sensible result of the total revenue elasticity with respect to tax rates is 0.76, inferred from the matched sample, but the value of revenue elasticity increases with the proportion of the non-exempt land and thus indicates the efficiency potential of the property tax.

Table 15: Results of Model A, Restricted by Share of Tax-Exempt Land, Matched Sample

	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1)	(2)	(3)	(4)
Variables	0.9 to 1	0.75 to 0.90	0.25 to 0.10	0 to 0.10
Log of local coefficient §12	**1.139**	**0.570*** **	**0.905*** **	**0.921*** **
	(10.74)	(0.035)	(0.036)	(0.061)
Log of coefficient § 6/4	0.324	0.235	0.179	2.317**
	(16,043)	(0.213)	(0.177)	(0.858)
Log of coefficient § 11/3		-0.106	-0.024	-2.087**
		(0.210)	(0.173)	(0.863)
Dummy = 1 if § 6/4 changed	1.148	0.169**	-0.025	0.055
	(4,737)	(0.073)	(0.111)	(0.183)
Dummy = 1 if § 11/3a changed		-0.157**	-0.022	0.063
		(0.077)	(0.108)	(0.126)
Dummy = 1 if § 11/3b type 1 applied	0.261	0.000	-0.015	-0.720
	(79.62)	(0.040)	(0.065)	(0.556)
Dummy = 1 if § 11/3b type 2 applied		0.013	-0.198*	0.609
		(0.095)	(0.102)	(0.559)
Dummy = 1 if § 11/3b type 3 applied		0.076	0.323**	0.381*
		(0.165)	(0.143)	(0.210)
Dummy = 1 if § 11/3b type 4 applied	-1.664	-0.559**	-0.421***	
	(4,572)	(0.225)	(0.161)	
Dummy = 1 if § 11/3b type 5 applied		0.646**	0.438***	
		(0.288)	(0.156)	
Population density per sq. km	-0.312	0.140***	0.0407	0.556
	(9,747)	(0.035)	(0.070)	(0.841)
Annual change in population	1.439	-0.052	0.043	0.106
	(15.49)	(0.034)	(0.132)	(0.126)
Average age	0.012	-0.015	-0.032**	0.007
	(86.64)	(0.011)	(0.013)	(0.025)
Natural increase	-0.055	0.000	-0.000	-0.000
	(18.20)	(0.001)	(0.000)	(0.001)
Migration balance	0.016	0.000	0.000	-0.000
	(2.489)	(0.000)	(0.000)	(0.001)
Unemployment share	0.003	-0.008**	0.005*	-0.009
	(0.864)	(0.003)	(0.003)	(0.008)
Completed dwellings in family houses, pc	16.52	-0.084	-1.011	-7.581
	(9,689)	(0.482)	(1.178)	(6.586)
Completed dwellings in apartment houses, pc		0.971	-0.068	-3.125
		(1.198)	(0.322)	(2.949)
Year and municipality fixed effects	Yes	Yes	Yes	Yes
District trends	Yes	Yes	Yes	Yes
Population deciles trends	Yes	Yes	Yes	Yes
Observations	221	2,681	1,526	410
R-squared	0.998	0.868	0.952	0.998
Number of municipalities	21	230	127	32

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Due to brevity, coefficients on area shares are not displayed. Full results can be found in Appendix C, Table C15.*

2.4 Robustness checks

To confirm, if the estimated results hold also under other specifications of the model, I conduct further robustness checks. I utilize the fully specified model of the revenue elasticity, including all controls, fixed effects and specific trends. The robustness checks control for exclusion of outliers, restrict the sample over population size and share of tax-exempt areas. *Table 16* provides results.

The first robustness check (*Column 1*) excludes municipalities adopting local coefficient of the factor 4 and 5. This criterion concerns 21 and 24 municipalities respectively; most notably municipalities with nuclear power plants Temelín and Dukovany. The second and third robustness checks exclude larger towns with over 25,000 inhabitants or 10,000 inhabitants respectively. All of these results copy the most sensible result of previous Section, 0.76. Hence, the estimated revenue elasticity of the property tax is very robust and I proceed to the conclusion.

Table 16: Robustness Checks

	Log of property tax revenue		
	Sample restricted to		
	(1)	(2)	(3)
Variables	§ 12 < 4	< 25,000 inhabitants	<10,000 inhabitants
Log of local coefficient §12	**0.759***** **(0.016)**	**0.766***** **(0.014)**	**0.761***** **(0.014)**
Log of coefficient § 6/4	0.007 (0.020)	0.009 (0.020)	0.010 (0.020)
Log of coefficient § 11/3	0.075*** (0.020)	0.073*** (0.020)	0.072*** (0.020)
Dummy = 1 if § 6/4 changed	0.009 (0.010)	0.012 (0.010)	0.015 (0.010)
Dummy = 1 if § 11/3a changed	-0.004 (0.010)	-0.006 (0.010)	-0.008 (0.010)
Dummy = 1 if § 11/3b type 1 applied	0.047*** (0.012)	0.047*** (0.012)	0.046*** (0.012)
Dummy = 1 if § 11/3b type 2 applied	0.001 (0.019)	0.002 (0.018)	0.001 (0.019)
Dummy = 1 if § 11/3b type 3 applied	-0.028 (0.027)	-0.024 (0.027)	-0.022 (0.030)
Dummy = 1 if § 11/3b type 4 applied	0.054 (0.035)	0.058* (0.034)	0.059 (0.040)
Dummy = 1 if § 11/3b type 5 applied	0.045 (0.032)	0.037 (0.031)	0.033 (0.036)

Table continues on the next page.

Continuation of Table 16:

	Log of property tax revenue		
	Sample restricted to		
	(1)	(2)	(3)
Variables	§ 12 < 4	< 25,000 inhabitants	<10,000 inhabitants
Population density per sq. km	0.075***	0.083***	0.083***
	(0.021)	(0.024)	(0.025)
Annual change in population	-0.040**	-0.043**	-0.044**
	(0.018)	(0.018)	(0.018)
Average age	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Natural increase	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000*	0.000	0.000***
	(0.000)	(0.000)	(0.000)
Unemployment share	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Completed dwellings in family houses, pc	-0.246	-0.231	-0.254
	(0.160)	(0.160)	(0.160)
Completed dwellings in apartment houses, pc	0.069	0.085	0.080
	(0.145)	(0.150)	(0.150)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	79,027	78,763	77,654
R-squared	0.764	0.768	0.764
Number of municipalities	6,236	6,203	6,118

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Due to brevity, coefficients on area shares are not displayed. Full results can be found in Appendix C, Table C16.*

Conclusion

The aim of this thesis was to estimate the revenue elasticity of the property tax with respect to the tax rates in the institutional setting of the Czech Republic, and verify the theoretical hypothesis that it equals to unity. Results of this research are among the first empirical estimates of such elasticity; not only in the Czech Republic, but also in the international context. Besides that, the thesis examined the efficiency and revenue potential of the property tax, with implications on revenue planning of the Czech municipalities.

Economically speaking, the property tax is considered to be a very efficient source of revenue for local governments, proposing the elasticity of the property tax revenue to be unity. For this to be true, the design of the property tax is crucial. In the Czech Republic, the value of the property tax base determined by the area size does not change in the short term. Property may be difficult to evade due to its immovability and public evidence in the Land Register. Also, the tax may provide only negligible incentives to avoid the tax, as the rates are low, unified at the national level and their structure is very complicated. The only major change came in 2008 with the legislation of the so-called local coefficient. By adopting it, municipalities may have multiplied the basic tax rates and take into account the location dynamics that should extract the economic rents.

The estimation of the revenue elasticity was done on two samples – full sample of all municipalities in the dataset, and restricted sample created by matching the counterfactual municipalities to those which at least once adopted the local coefficient. Since the results are fairly robust across the two analyses, I use the outcomes of the most sensible specification estimated on the matched sample to discuss the conclusions.

The main finding of this thesis estimated the revenue elasticity with respect to tax rates to be 0.76, significantly different from the hypothesized value of unity. This result should be interpreted as the total revenue elasticity; it includes both the effect of tax exemptions and tax avoidance. If the property tax did not distort behaviour, the estimated revenue elasticity would correspond to the real share of taxable area.

Since this variable cannot be observed in the scope of this thesis, I tried to disentangle the effect of tax exemptions by estimating a better specified model, where the effect of the local coefficient was conditioned on the level of non-exempt land share. While the separate effect of the local coefficient amounted to 0.538, the effect dependent on the area share was 0.467. Hence, if there were no exemptions, the total revenue elasticity would be equal to the hypothesized unity. Indeed, calculation of the municipality-specific elasticities using the share of exempt land in 2017 illustrated there were many municipalities approaching the theoretical value of one. This finding demonstrated the importance of the proportion of tax-exempt area in the determination of the total revenue elasticity. The raise in revenue due to an increase of local coefficient hence depends mainly on the erosion of the tax base in particular municipality.

As a final test that could verify this theory, I estimated the revenue elasticity on "extreme" samples restricted by the share of exempt land. While for municipalities with over 75% of their land being exempt from the application of local coefficient the elasticity was 0.57, for municipalities on the other extreme the elasticity exceeded value of 0.9. These findings support the evidence that the unity hypothesis may be nearly valid in municipalities with very low share of tax-exempt land. Hence, to some extent, the effect could be attributed to jurisdictions with fast growing population and new construction.

Because of the paucity of research, the findings cannot be compared with similar estimates of the revenue elasticity of the property tax. Also, the specific definition of the revenue elasticity measured in this thesis makes it rather difficult to compare the resulting estimate with other types of taxes. Havránek et al (2016) estimated the long-run revenue elasticities with respect to tax bases in the Czech Republic to be 0.9 for value added tax, 1.4 for wage tax, and 1.7 for profit tax.

Additionally, if we assume the elasticity of the property tax base is 0.24 (the difference between 1 and 0.76), the finding could be compared to other tax bases. Kaucká (2010) estimated the elasticity of taxable income in the Czech Republic to be 0.23. These results are almost identical. However, the fact that a large part of the revenue elasticity of the property tax depends on the extent of exceptions needs to be considered. Since this is not generally analogous with the income tax, and also because of its connection with the local public goods, the property tax seems as a more efficient instrument.

Altogether, the revenue elasticity of the property tax in the Czech Republic depends to a large effect on the extent of exemptions in the particular jurisdiction. Although it cannot be precisely measured, the results of this thesis suggest the use of local coefficients does not create large distortions and tax avoidance. On the contrary, the property tax should provide an efficient means to finance the local government. Albeit there is only a limited space for further interpretation, the result indicates the property tax may be viewed as a benefit tax if taxpayers profit from the public investment financed by the property tax.

This thesis suggests the property tax could be utilized to a larger extent than it currently is. Even though the local coefficient may only be capable of capturing the disparities across municipalities and not between zones or parcels, it may serve well to extract the location rents. Furthermore, it challenges the common view held in the literature that condemns the obsolescence of the system based on area sizes rather than market values. During the economic crises or housing bubbles, it may provide a more stable and fair alternative to rely on.

All things considered, the aim of this thesis was fulfilled. The estimated revenue elasticity significantly differs from one but further analysis showed it is conditional on the share of tax-exempt land. As suggested, the external validity of these results is limited by the specific structure of property taxation in the Czech Republic. At least, the results may be applicable in countries using the area-based system of property tax valuation as, for example, Slovak Republic. However, general conclusions could be used also in different countries.

In the end, the topic of this thesis provides ideas for many other questions related to the use of the local coefficient and property taxation in the Czech Republic in general. For instance, it would be fruitful to study what makes the municipality adopt the local coefficient. But, most importantly, availability of data on cadastral or even individual level from tax returns would bring not only more precise analyses, but create a whole new space for researching the effects of the property tax in the Czech Republic.

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Zákon č. 338/1992 Sb. o dani z nemovitých věcí

Appendix A

List of municipalities excluded from the final dataset

Proving grounds (vojenský újezd):

Boletice, Březina, Hradiště, Libavá

City districts (městská část, městský obvod):

Brno-Bohunice, Brno-Bosonohy, Brno-Bystrc, Brno-Chrlice, Brno-Ivanovice, Brno-Jehnice, Brno-Jih, Brno-Jundrov, Brno-Kníničky, Brno-Kohoutovice, Brno-Komín, Brno-Královo Pole, Brno-Líšeň, Brno-Maloměřice A O.. Brno-Medlánky, Brno-Nový Lískovec, Brno-Ořešín, Brno-Sever, Brno-Slatina, Brno-Starý Lískovec, Brno-Střed, Brno-Tuřany, Brno-Vinohrady, Brno-Útěchov, Brno-Černovice, Brno-Řečkovice, Brno-Žabovřesky, Brno-Žebětín, Brno-Židenice, Hošťálkovice, Hrabová, Krásné Pole, Lhotka, Liberec, Liberec-Vratislavic.., Mariánské Hory A Hu.., Martinov, Michálkovice, Moravská Ostrava A .., Nová Bělá, Nová Ves, Opava, Ostrava-Jih, Pardubice I, Pardubice II, Pardubice III, Pardubice IV, Pardubice V, Pardubice VI, Pardubice VII, Pardubice VIII, Petřkovice, Plesná, Plzeň 1, Plzeň 10-Lhota, Plzeň, 2-Slovany, Plzeň 3, Plzeň 4, Plzeň 5-Křimice, Plzeň 6-Litice, Plzeň 7-Radčice, Plzeň 8-Černice, Plzeň 9-Malesice, Polanka Nad Odrou, Poruba, Praha 1, Praha 3, Praha 4, Praha 5, Praha 6, Praha 7, Praha 8, Praha 9, Praha 10, Praha 11, Praha 12, Praha 13, Praha 14, Praha 15, Praha 16, Praha 17, Praha 18, Praha 19, Praha 2, Praha 20, Praha 21, Praha 22, Praha-Benice, Praha-Běchovice, Praha-Březiněves, Praha-Dolní Chabry, Praha-Dolní Měcholupy, Praha-Dolní Počernice, Praha-Dubeč, Praha-Klánovice, Praha-Koloděje, Praha-Kolovraty, Praha-Královice, Praha-Kunratice, Praha-Křeslice, Praha-Libuš, Praha-Lipence, Praha-Lochkov, Praha-Lysolaje, Praha-Nebušice, Praha-Nedvězí, Praha-Petrovice, Praha-Přední Kopanina, Praha-Satalice, Praha-Slivenec, Praha-Suchdol, Praha-Troja, Praha-Velká Chuchle, Praha-Vinoř, Praha-Zbraslav, Praha-Zličín, Praha-Újezd, Praha-Čakovice, Praha-Ďáblice, Praha-Řeporyje, Praha-Šeberov, Praha-Štěrboholy, Proskovice, Pustkovec, Radvanice A Bartovice, Slezská Ostrava, Stará Bělá, Svinov, Třebovice, Vítkovice, Ústí Nad Labem-Město, Ústí Nad Labem-Nešt.., Ústí Nad Labem-Seve.., Ústí Nad Labem-Stře..

Appendix B

ANOVA tests of non-differential trends in property tax revenue before 2008 between control and treatment group. Null hypothesis: annual growth rates of property tax revenue are not different across the groups

Table B1: ANOVA Test of Differential Pre-Policy Trends in Property Tax Revenue, Full Sample

Number of obs =	17,219	R-squared =	0.0000
Root MSE =	2.87615	Adj R-squared =	-0.0001

Source	Partial SS	df	MS	F	Prob>F
Model	.70925683	1	.70925683	0.09	0.7697
treated	.70925682	1	.70925682	0.09	0.7697
Residual	142423	17,217	8.272231		
Total	142423.71	17,218	8.2717918		

Source: own calculations

Table B2: ANOVA Test of Differential Pre-Policy Trends in Property Tax Revenue, Matched Sample

Number of obs =	3,856	R-squared =	0.0002
Root MSE =	.508877	Adj R-squared =	-0.0001

Source	Partial SS	df	MS	F	Prob>F
Model	.17333258	1	.17333258	0.67	0.4133
treat_n1	.17333258	1	.17333258	0.67	0.4133
Residual	998.01618	3,854	.25895594		
Total	998.18952	3,855	.25893373		

Source: own calculations

Appendix C

Full results of Models estimated in Chapter 6

Table C8: Full Results of Model A, Full Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient §12	0.794***	0.776***	0.770***
	(0.015)	(0.014)	(0.014)
Log of coefficient § 6/4	-0.012	-0.011	0.009
	(0.021)	(0.020)	(0.020)
Log of coefficient § 11/3	0.050**	0.046**	0.074***
	(0.021)	(0.020)	(0.020)
Dummy = 1 if § 6/4 changed	0.014	0.012	0.012
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3a changed	-0.023**	-0.013	-0.006
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3b type 1 applied	0.040***	0.052***	0.047***
	(0.013)	(0.012)	(0.012)
Dummy = 1 if § 11/3b type 2 applied	0.028	0.013	0.002
	(0.018)	(0.018)	(0.018)
Dummy = 1 if § 11/3b type 3 applied	-0.014	-0.019	-0.023
	(0.028)	(0.027)	(0.026)
Dummy = 1 if § 11/3b type 4 applied	0.036	0.040	0.060*
	(0.034)	(0.034)	(0.034)
Dummy = 1 if § 11/3b type 5 applied	0.055*	0.051*	0.037
	(0.030)	(0.031)	(0.031)
Population density per sq. km	0.096***	0.091***	0.077***
	(0.023)	(0.022)	(0.021)
Annual change in population	-0.038**	-0.040**	-0.041**
	(0.015)	(0.018)	(0.018)
Average age	0.002	0.001	-0.000
	(0.001)	(0.001)	(0.001)
Natural increase	-0.001***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Migration balance	0.000	0.000	0.000*
	(0.000)	(0.000)	(0.000)
Unemployment share	0.001	0.001*	0.000
	(0.000)	(0.000)	(0.000)
Completed dwellings in family houses, pc	-0.370**	-0.287*	-0.243
	(0.186)	(0.164)	(0.159)
Completed dwellings in apartment houses, pc	-0.153	-0.008	0.070
	(0.127)	(0.136)	(0.147)

Table continues on the next page.

Continuation of Table C8.

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Area share of arable land	-0.260	-0.430	-0.382
	(0.409)	(0.399)	(0.403)
Area share of hop gardens	-0.384	-0.580	-0.580
	(1.028)	(0.960)	(0.942)
Area share of vineyards	-0.631	-0.028	0.0368
	(0.726)	(0.644)	(0.606)
Area share of gardens	1.768	0.984	1.151
	(1.095)	(1.067)	(1.069)
Area share of orchards	-0.522	-1.144**	-1.104**
	(0.509)	(0.484)	(0.479)
Area share of permanent grassland	0.027	-0.286	-0.217
	(0.560)	(0.562)	(0.562)
Area share of forest land	0.145	-0.150	-0.113
	(0.355)	(0.345)	(0.348)
Area share of water surfaces	-1.272	-1.292*	-1.164
	(0.838)	(0.763)	(0.759)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	79,228	79,228	79,228
R-squared	0.746	0.767	0.769
Number of municipalities	6,236	6,236	6,236

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Full results of Table 8*

Table C10: Full Results of Model A, Restricted by Share of Tax-Exempt Land, Full Sample

	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1)	(2)	(3)	(4)
Variables	0.9 to 1	0.75 to 0.90	0.25 to 0.10	0 to 0.10
Log of local coefficient §12	**0.337*** **	**0.575*** **	**0.896*** **	**0.976*** **
	(0.054)	(0.031)	(0.028)	(0.070)
Log of coefficient § 6/4	-0.149	0.085*	0.112	-0.110
	(0.269)	(0.044)	(0.085)	(0.116)
Log of coefficient § 11/3	0.198	-0.008	-0.019	0.015
	(0.276)	(0.043)	(0.085)	(0.082)
Dummy = 1 if § 6/4 changed	-0.098	0.031	-0.006	0.136*
	(0.171)	(0.028)	(0.051)	(0.068)
Dummy = 1 if § 11/3a changed	0.097	-0.040	-0.015	0.059
	(0.175)	(0.028)	(0.052)	(0.085)
Dummy = 1 if § 11/3b type 1 applied	-0.060	0.054*	0.073*	0.010
	(0.050)	(0.031)	(0.041)	(0.132)
Dummy = 1 if § 11/3b type 2 applied	0.078	-0.013	-0.144	0.263**
	(0.074)	(0.042)	(0.092)	(0.130)

Table continues on the next page.

Continuation of Table C10.

Variables	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1) 0.9 to 1	(2) 0.75 to 0.90	(3) 0.25 to 0.10	(4) 0 to 0.10
Dummy = 1 if § 11/3b type 3 applied	-0.382***	-0.023	0.207*	-0.073
	(0.100)	(0.118)	(0.105)	(0.093)
Dummy = 1 if § 11/3b type 4 applied	0.406***	-0.153	-0.245**	
	(0.046)	(0.192)	(0.101)	
Dummy = 1 if § 11/3b type 5 applied		0.283	0.307***	
		(0.244)	(0.097)	
Population density per sq. km	0.156*	0.135***	0.100	0.472**
	(0.082)	(0.022)	(0.074)	(0.223)
Annual change in population	0.038	-0.051***	0.100	-0.225
	(0.081)	(0.015)	(0.065)	(0.208)
Average age	-0.000	0.001	-0.012**	0.002
	(0.004)	(0.002)	(0.005)	(0.020)
Natural increase	-0.001	0.000	0.000	-0.001
	(0.001)	(0.000)	(0.000)	(0.002)
Migration balance	-0.001	0.000	0.000	0.001
	(0.001)	(0.000)	(0.000)	(0.001)
Unemployment share	0.000	0.000	-0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.003)
Completed dwellings in family houses, pc	1.210***	-0.108	0.0477	-1.288
	(0.383)	(0.222)	(0.826)	(0.873)
Completed dwellings in apartment houses, pc	-0.252	0.336	-0.247	-2.520**
	(0.632)	(0.270)	(0.168)	(1.043)
Area share of arable land	0.646	-0.124	-0.794	-3.282
	(1.744)	(0.428)	(0.870)	(4.239)
Area share of hop gardens	0.291	-0.370	13,200**	
	(3.239)	(1.054)	(6,04)	
Area share of vineyards	0.908	0.271	120.4	
	(2.819)	(0.690)	(433.6)	
Area share of gardens	3.490	0.242	-13.94	10.05
	(2.330)	(1.056)	(13.58)	(10.82)
Area share of orchards	0.350	-0.788	-12.13	-71.57
	(2.430)	(0.488)	(7.800)	(188.5)
Area share of permanent grassland	-0.154	-0.143	-2.753**	-4.595
	(1.698)	(0.492)	(1.261)	(5.828)
Area share of forest land	-3.973	-2.386*	-1.356**	2.115
	(4.602)	(1.356)	(0.568)	(1.568)
Area share of water surfaces	0.921	-1.996	-1.709	-4.034
	(4.278)	(1.221)	(2.854)	(8.305)
Year and municipality fixed effects	Yes	Yes	Yes	Yes
District trends	Yes	Yes	Yes	Yes
Population deciles trends	Yes	Yes	Yes	Yes
Observations	3,369	19,613	3,523	708
R-squared	0.762	0.753	0.896	0.972
Number of municipalities	309	1,653	295	59

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Full results of Table 10.*

Table C14: Full Results of Model A, Matched Sample

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Log of local coefficient §12	**0.767***** **(0.013)**	**0.756***** **(0.013)**	**0.761***** **(0.012)**
Log of coefficient § 6/4	-0.014 (0.054)	-0.019 (0.052)	0.020 (0.053)
Log of coefficient § 11/3	0.053 (0.054)	0.057 (0.052)	0.105** (0.052)
Dummy = 1 if § 6/4 changed	0.020 (0.017)	0.018 (0.017)	0.012 (0.016)
Dummy = 1 if § 11/3a changed	-0.012 (0.017)	-0.010 (0.017)	-0.006 (0.016)
Dummy = 1 if § 11/3b type 1 applied	0.032 (0.021)	0.049*** (0.021)	0.041** (0.020)
Dummy = 1 if § 11/3b type 2 applied	0.054* (0.028)	0.049* (0.029)	0.037 (0.029)
Dummy = 1 if § 11/3b type 3 applied	-0.011 (0.034)	0.001 (0.034)	-0.007 (0.034)
Dummy = 1 if § 11/3b type 4 applied	0.006 (0.038)	-0.021 (0.040)	0.0016 (0.040)
Dummy = 1 if § 11/3b type 5 applied	0.053 (0.034)	0.059 (0.037)	0.047 (0.037)
Population density per sq. km	0.074*** (0.024)	0.075*** (0.022)	0.061*** (0.020)
Annual change in population	-0.079* (0.041)	-0.111** (0.054)	-0.106** (0.054)
Average age	-0.001 (0.004)	-0.003 (0.005)	-0.007 (0.004)
Natural increase	-0.001*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)
Migration balance	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Unemployment share	0.001 (0.001)	0.001 (0.001)	-0.000 (0.001)
Completed dwellings in family houses, pc	-0.646 (0.398)	-0.457 (0.360)	-0.516 (0.327)
Completed dwellings in apartment houses, pc	-0.085 (0.186)	0.0958 (0.236)	0.184 (0.262)
Area share of arable land	-1.783** (0.827)	-1.842** (0.774)	-1.777** (0.810)
Area share of hop gardens	2.041* (1.167)	1.153 (1.471)	2.082 (1.442)
Area share of vineyards	-6.896*** (2.515)	0.122 (3.159)	0.520 (3.476)
Area share of gardens	0.932 (1.947)	0.0956 (1.815)	0.190 (1.849)
Area share of orchards	-2.848*** (1.033)	-3.719*** (0.981)	-3.651*** (1.005)

Table continues on the next page.

Continuation of Table C10.

Variables	(1) Log of property tax revenue	(2) Log of property tax revenue	(3) Log of property tax revenue
Area share of permanent grassland	-1.392	-1.700**	-1.550*
	(0.921)	(0.864)	(0.890)
Area share of forest land	-1.046	-1.382*	-1.304*
	(0.737)	(0.705)	(0.731)
Area share of water surfaces	-3.247**	-2.945**	-2.667*
	(1.581)	(1.419)	(1.447)
Observations	17,315	17,315	17,315
R-squared	0.829	0.846	0.850
Number of municipalities	1,348	1,348	1,348

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Full results of Table 14.*

Table 15: Results of Model A, Restricted by Share of Tax-Exempt Land, Matched Sample

	Log of property tax revenue			
	Fraction of tax-exempt land			
Variables	(1) 0.9 to 1	(2) 0.75 to 0.90	(3) 0.25 to 0.10	(4) 0 to 0.10
Log of local coefficient §12	**1.139**	**0.570*** **	**0.905*** **	**0.921*** **
	(10.74)	(0.035)	(0.036)	(0.061)
Log of coefficient § 6/4	0.324	0.235	0.179	2.317**
	(16,043)	(0.213)	(0.177)	(0.858)
Log of coefficient § 11/3		-0.106	-0.024	-2.087**
		(0.210)	(0.173)	(0.863)
Dummy = 1 if § 6/4 changed	1.148	0.169**	-0.025	0.055
	(4,737)	(0.073)	(0.111)	(0.183)
Dummy = 1 if § 11/3a changed		-0.157**	-0.022	0.063
		(0.077)	(0.108)	(0.126)
Dummy = 1 if § 11/3b type 1 applied	0.261	0.000	-0.015	-0.720
	(79.62)	(0.040)	(0.065)	(0.556)
Dummy = 1 if § 11/3b type 2 applied		0.013	-0.198*	0.609
		(0.095)	(0.102)	(0.559)
Dummy = 1 if § 11/3b type 3 applied		0.076	0.323**	0.381*
		(0.165)	(0.143)	(0.210)
Dummy = 1 if § 11/3b type 4 applied	-1.664	-0.559**	-0.421***	
	(4,572)	(0.225)	(0.161)	
Dummy = 1 if § 11/3b type 5 applied		0.646**	0.438***	
		(0.288)	(0.156)	
Population density per sq. km	-0.312	0.140***	0.0407	0.556
	(9,747)	(0.035)	(0.070)	(0.841)
Annual change in population	1.439	-0.052	0.043	0.106
	(15.49)	(0.034)	(0.132)	(0.126)
Average age	0.012	-0.015	-0.032**	0.007
	(86.64)	(0.011)	(0.013)	(0.025)
Natural increase	-0.055	0.000	-0.000	-0.000
	(18.20)	(0.001)	(0.000)	(0.001)

Table continues on the next page.

Continuation of Table C15:

	Log of property tax revenue			
	Fraction of tax-exempt land			
	(1)	(2)	(3)	(4)
Variables	0.9 to 1	0.75 to 0.90	0.25 to 0.10	0 to 0.10
Migration balance	0.016	0.000	0.000	-0.000
	(2.489)	(0.000)	(0.000)	(0.001)
Unemployment share	0.003	-0.008**	0.005*	-0.009
	(0.864)	(0.003)	(0.003)	(0.008)
Completed dwellings in family houses, pc	16.52	-0.084	-1.011	-7.581
	(9,689)	(0.482)	(1.178)	(6.586)
Completed dwellings in apartment houses, pc		0.971	-0.068	-3.125
		(1.198)	(0.322)	(2.949)
Area share of arable land	33.96	-1.857	-0.746	-8.245***
	(25,040)	(1.970)	(0.833)	(2.221)
Area share of hop gardens	0.000	3.925**	22,207	
	(0.000)	(1.846)	(13,475)	
Area share of vineyards	-0.000	2.834	-808.8*	
	(0.000)	(3.171)	(486.4)	
Area share of gardens	-148.2	-5.705**	48.75***	-15.85
	(99,496)	(2.702)	(17.02)	(19.73)
Area share of orchards	-42.84	-2.139	-21.63	485.9
	(299,113)	(1.849)	(21.94)	(501.3)
Area share of permanent grassland	133.5	0.110	-2.148	-4.611
	(73,725)	(2.327)	(1.734)	(5.688)
Area share of forest land	8.565	-13.87*	-1.794***	1.445
	(44,736)	(7.248)	(0.610)	(2.714)
Area share of water surfaces	541.0	-3.039	-2.217	-9.432
	(979,022)	(7.116)	(3.906)	(13.82)
Year and municipality fixed effects	Yes	Yes	Yes	Yes
District trends	Yes	Yes	Yes	Yes
Population deciles trends	Yes	Yes	Yes	Yes
Observations	221	2,681	1,526	410
R-squared	0.998	0.868	0.952	0.998
Number of municipalities	21	230	127	32

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Full results of Table 15*

Table C16: Robustness Checks

	Log of property tax revenue		
	Sample restricted to		
	(1)	(2)	(3)
Variables	§ 12 < 4	< 25,000 inhabitants	<10,000 inhabitants
Log of local coefficient §12	**0.759*** **	**0.766*** **	**0.761*** **
	(0.016)	**(0.014)**	**(0.014)**
Log of coefficient § 6/4	0.007	0.009	0.010
	(0.020)	(0.020)	(0.020)
Log of coefficient § 11/3	0.075***	0.073***	0.072***
	(0.020)	(0.020)	(0.020)
Dummy = 1 if § 6/4 changed	0.009	0.012	0.015
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3a changed	-0.004	-0.006	-0.008
	(0.010)	(0.010)	(0.010)
Dummy = 1 if § 11/3b type 1 applied	0.047***	0.047***	0.046***
	(0.012)	(0.012)	(0.012)
Dummy = 1 if § 11/3b type 2 applied	0.001	0.002	0.001
	(0.019)	(0.018)	(0.019)
Dummy = 1 if § 11/3b type 3 applied	-0.028	-0.024	-0.022
	(0.027)	(0.027)	(0.030)
Dummy = 1 if § 11/3b type 4 applied	0.054	0.058*	0.059
	(0.035)	(0.034)	(0.040)
Dummy = 1 if § 11/3b type 5 applied	0.045	0.037	0.033
	(0.032)	(0.031)	(0.036)
Population density per sq. km	0.075***	0.083***	0.083***
	(0.021)	(0.024)	(0.025)
Annual change in population	-0.040**	-0.043**	-0.044**
	(0.018)	(0.018)	(0.018)
Average age	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Natural increase	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.0004)
Migration balance	0.000*	0.000	0.000***
	(0.000)	(0.000)	(0.000)
Unemployment share	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Completed dwellings in family houses, pc	-0.246	-0.231	-0.254
	(0.160)	(0.160)	(0.160)
Completed dwellings in apartment houses, pc	0.069	0.085	0.080
	(0.145)	(0.150)	(0.150)
Area share of arable land	-0.393	-0.382	-0.369
	(0.406)	(0.406)	(0.413)
Area share of hop gardens	-0.572	-0.580	-0.582
	(0.945)	(0.942)	(0.945)
Area share of vineyards	0.019	0.038	0.047
	(0.609)	(0.609)	(0.611)
Area share of gardens	1.170	1.074	1.120
	(1.072)	(1.081)	(1.088)

Table continues on the next page.

Continuation of Table C16:

Variables	Log of property tax revenue		
	Sample restricted to		
	(1)	(2)	(3)
	§ 12 < 4	< 25,000 inhabitants	<10,000 inhabitants
Area share of orchards	-1.106**	-1.101**	-1.088**
	(0.479)	(0.482)	(0.485)
Area share of permanent grassland	-0.217	-0.213	-0.198
	(0.565)	(0.565)	(0.571)
Area share of forest land	-0.120	-0.105	-0.089
	(0.351)	(0.354)	(0.361)
Area share of water surfaces	-1.162	-1.141	-1.161
	(0.761)	(0.764)	(0.776)
Year and municipality fixed effects	Yes	Yes	Yes
District trends	No	Yes	Yes
Population deciles trends	No	No	Yes
Observations	79,027	78,763	77,654
R-squared	0.764	0.768	0.764
Number of municipalities	6,236	6,203	6,118

*Clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Source: own calculations; Note: Full results of Table 16.*