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On optimal tax rates and shifts in the peak of the Laffer curve

An empirical study of Swedish municipalities during the years from 2000 to 2017

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Abstract:

This report presents an empirical study of the average Laffer curve of Swedish municipalities, with a focus on determining whether the position of the peak of the curve has shifted or, put differently, whether the optimal value of the average municipal tax rate has changed over time. A regression model based on the Laffer curve relationship between tax revenue and tax rates and including several control variables is proposed. The results from several regressions for different time periods between the years 2000 and 2017 are presented, and they contain some evidence suggesting that the position of the peak of the average Laffer curve of Swedish municipalities moved during the period from 2000 to 2017.

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1 Introduction

All Swedish municipalities impose a flat tax on the incomes earned by their citizens. The municipal income tax is an important source of revenue for the municipalities and contributes to the funding of a variety of services that they provide to their citizens, including basic welfare services such as education, daycare and eldercare.

Each municipality determines its local income tax rate, and historically the rates have varied over time and between municipalities. A typical reason why a municipality might change the rate is that the costs for the services it provides have increased. The rate may, however, be adjusted for reasons that are not directly related to the economic situation of the municipality. For example, newly-elected politicians may prefer that the current tax rate be raised or lowered simply for ideological reasons. As another example, some studies have shown that a lowering of the tax rate in one municipality tends to be followed by similar tax decreases in neighboring municipalities, possibly as a result of politicians trying to reduce the risk of people moving in order to lower their taxes (Edmark & Ågren 2008).

Since people may adjust their trade-off between labor and leisure, or may change their behavior in some other way, in response to a tax rate decrease or increase, the tax revenue do not necessarily change linearly with a change in tax rate. This is graphically illustrated by the so-called Laffer curve, which shows a proposed dependence of tax revenue on tax rates. As originally depicted, the Laffer curve has the shape of an inverted U, the top of the curve representing the tax rate above which an increase results in lower, not higher, tax revenue. In other words, the Laffer curve implies that increasing the tax rate above a maximum rate has adverse effects on the productivity of the economy, which counteracts the tax increase. Clearly, if the assumptions behind the Laffer curve hold, politicians should be wary not to increase tax rates beyond the top of the curve.

A complicating factor is that, since the shape of the Laffer curve essentially reflects people's preferences, the shape may change if people's preferences change or if people with different

preferences move into or out of a municipality. This obviously makes it more difficult to determine a suitable tax rate, and tax policy makers should preferably be informed if the Laffer curve relevant to their jurisdiction changes shape or if the top moves.

The general objective of the present study is to examine the average Laffer curve of Swedish municipalities. The main question which this study seeks to answer is whether the top of that curve has moved during the years from 2000 to 2017. That is to say, has the optimal value of the average municipality tax rate changed during this period?

The remainder of this report is organized as follows. Section 2 offers a brief review of previous work on topics related to the present study. Section 3 provides a theoretical background to the study, and Section 4 presents the regression model. Next, in Section 5, follows a discussion of the empirical data used for estimating the regression model. The results of the regression analysis are presented and discussed in Section 6, and, finally, Section 7 concludes and summarizes the report.

2 Literature review

The Laffer curve has been discussed in many studies conducted to better understand various relationships between tax revenue and rates of taxation. This section presents a brief summary of some of the previous work that is particularly relevant to the present study.

For instance, much work has been devoted to estimating Laffer curves for the economies of entire countries in order to determine where on the curve the country is located and, in particular, whether or not the country is located on the downward-sloping section of the curve. For example, in an early paper, Fullerton (1982) uses a microeconomic model to estimate Laffer curves for the United States. The model includes nineteen producers, fifteen commodities and twelve consumer groups representing different levels of income. The model is parametrized using governmental data for 1973 and solved to obtain Laffer curves illustrating the relationship between tax revenue and income tax. The curves are computed for different labor supply elasticities ranging from 0.15 and 4.00, and Fullerton finds that the economy of the United States was probably not operating in the so-called prohibitive range of the Laffer curve, i.e. the downward-sloping section, provided that the actual labor elasticity is not close to the high end of the range.

Laffer curves for Sweden have also been estimated. Stuart (1981), for example, uses a model in which a single household divides labor between a taxed sector and an untaxed sector. The taxed sector is the regular part of the economy where labor is taxed, and the untaxed sector represents labor that is not taxed, such as household work in one's own home and undeclared work in the illicit economy. The model includes various analytical functions, such as a Cobb-Douglas production function assigned to each sector and a household utility function which determine the allocation of labor between the sectors, and these functions are parametrized using empirical data with a base year of 1969. The model is solved numerically to obtain the tax on labor income that maximizes revenue. The tax rate is found to be circa 70 percent, while the actual tax rate at the time was circa 80 percent.

Similar to Stuart (1981), Feige and McGee (1983) estimate Laffer curves for Sweden while taking into account not only the observed part of the economy but also the unobserved part. However, they divide the unobserved part into a monetary sector, corresponding to activities that are intentionally not reported to avoid taxes, and a non-monetary sector, corresponding to activities that are not taxable, such as work in one's home. Hence, their model divides the economy into three parts: a monetary observed sector, a monetary unobserved sector and a non-monetary unobserved sector, or the black economy. They derive Sweden's Laffer curve by numerically solving a set of equations which describe the interaction between these sectors using utility, production, labor supply functions, etc., which have been parametrized using empirical data with a base year of 1979. Their result agrees with that of Stuart (1981) in that they conclude that Sweden at the time had probably passed its Laffer curve peak.

In contrast with the two preceding papers, the focus of this report is not Sweden as a nation but rather Swedish municipalities. This was also the focus of a recent study by Stener and Wintenstråle (2016). Specifically, they compute an average Laffer curve for 286 Swedish municipalities using five different models of varying degrees of complexity. In the simplest model, the tax revenue is the dependent variable and the municipal tax rate is the only independent variable. The other models include additional dependent variables, such as education, unemployment and time trend controls. The parameters of the models are estimated with a regression analysis using empirical data from 1992 to 2015. The authors find that the peak of the Laffer curve for the municipalities is located at 31.38 percent, slightly lower than the average municipal tax rate during 1992 to 2015, which they compute to be 31.95 percent. It is noted that this tax rate seems to correspond to the sum of the tax that is allocated to the municipalities[1] and the tax that is allocated to the county council[2]. It is also noted that the authors do not investigate whether the position of the Laffer curve peak has moved, unlike the present study, and their model does not include variables corresponding to the tax base and political ideology variables used in the present study.

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[1] Swedish: "kommuner".
[2] Swedish: "landsting".

Stener and Wintenstråle assume that the Laffer curve has a parabolic shape, which is the conventional shape of the curve, and this assumption is also made in the present study, see Section 3.3. It should be noted, however, that this assumption may not always hold, and there have been studies investigating under what conditions the curve is parabolic and what factors may affect the shape of the curve.

Malcomson (1986), for example, considers a three-good economy consisting of one private good, one public good and labor which is provided by identical consumers whose income is taxed. He develops an algebraic expression for the tax revenue as a function of the tax rate, and, based on an algebraic analysis of the behavior of this function, he argues that the shape of the Laffer curve may depart from the conventional, parabolic shape, even under reasonable assumptions regarding, in particular, how hours of work depend on changes in the income tax rate. For example, he shows that the Laffer curve may lack an interior maximum and may be discontinuous when the tax rate equals 100 percent. Malcomson's study thus suggests that it may in some situations be necessary to allow for the Laffer curve to depart from the parabolic shape.

This conclusion may also be drawn from a study by Guesnerie and Jerison (1991). Like Malcomson (1986), they include three goods in their model – a private consumption good, a public good and labor provided by consumers – and they analyze the model algebraically. Their model does, however, differ from Malcomson's model in several ways, in particular in that it allows for consumers' tastes to differ. Their model predicts that the Laffer curve may, under certain assumptions, have several local maxima. In other words, knowing that the Laffer curve slopes downward, say, at a current tax rate does not necessarily imply that tax revenue cannot be increased by increasing tax rates.

Gahvari (1989) has also studied what affects the shape of the Laffer curve, although with a somewhat different focus than Malcomson (1986) and Guesnerie and Jerison (1991). Specifically, he investigates how the nature of government's expenditures affects the shape of the Laffer curve. Using an algebraic model, he shows that, if the government uses its tax revenue to give cash transfers to consumers, increasing the tax rate eventually causes the labor supply to start declining. The Laffer curve then has the conventional, parabolic shape. On the other hand, if

the government uses its tax revenue to finance military operations or some other government good, the Laffer curve may always slope upwards. That is to say, the expansionary effects of government spending may dominate the contractionary effects of raised taxes over the entire tax range.

Finally, similar results to those of Gahvari (1989) have been obtained more recently by Besci (2000), who found that different Laffer curves are associated with different types of government spending. He arrived at this conclusion by first deriving six algebraic equations describing various conditions on marginal rates of substitution between labor and leisure, the marginal products of labor and capital, and the government's budget constraint. He then analyzes the equations to deduce how public expenditures affect household and firm decisions and, thus, the (long-term) disposition of the Laffer curve. He finds that there will be no long-term change in the shape of the Laffer curve if the government uses the increase in tax revenue to make lump-sum transfers to firms and households. If the government, on the other hand, invests the increase in revenue, the long-term Laffer curve will move upwards. Lastly, if the government uses the revenue increase for consumption, the long-term Laffer curve is moved upwards even further. Thus, the way in which the government spends revenue has an impact on the economic activity and, consequently, also the revenue resulting from a tax increase.

3   Theoretical framework

The theoretical background to the present study is discussed in this section.

3.1 The Laffer curve

The question whether an increase in tax rate will lead to a direct increase in tax revenue or not is hardly a modern phenomenon. For example, the issue was addressed as early as in the 18th century by Adam Smith (Smith 1776), where he already then argued that higher taxes would lead to smaller government revenue through a loss in consumption. About two centuries later, Arthur Laffer presented a relationship between tax revenue and tax rate as a curve having the shape of an inverted U, and the curve has since then been part of modern economics.

The basic concept of the Laffer curve is very intuitive (Laffer 2004 & Wanniski 1978). The curve represents a relationship between tax rate and tax revenue. Tax revenue by Laffer's definition is the product of the average tax rate and the tax base. Laffer argued that if the average tax rate is zero, then there understandably is no tax revenue. If the tax rate on the other hand is 100 percent, then the tax revenue would also be zero because no rational individual would generate a tax base for a 100 percent tax. In between these extremes, as the tax rate is increased from zero to 100 percent, the tax revenue must first increase, reach a maximum, and finally decrease. This gives the Laffer curve its characteristic shape, as seen in Figure 1.

3.2   Microeconomic perspective

To fully understand the underlying factors behind the Laffer curve, its origin and shape, we must also incorporate the microeconomic theory of rational choice in the analysis, an account of which can be found in for example the textbook by Perloff (2014). The discussion in this section is based on the account given in that book.

A starting assumption is here made that individuals make choices that will maximize their utility, and that when choosing between two goods the individual will choose a combination of goods that will maximize the utility from these two goods. Figure 2 shows such a scenario, where the number of combinations between the two goods are limited by a budget constraint and
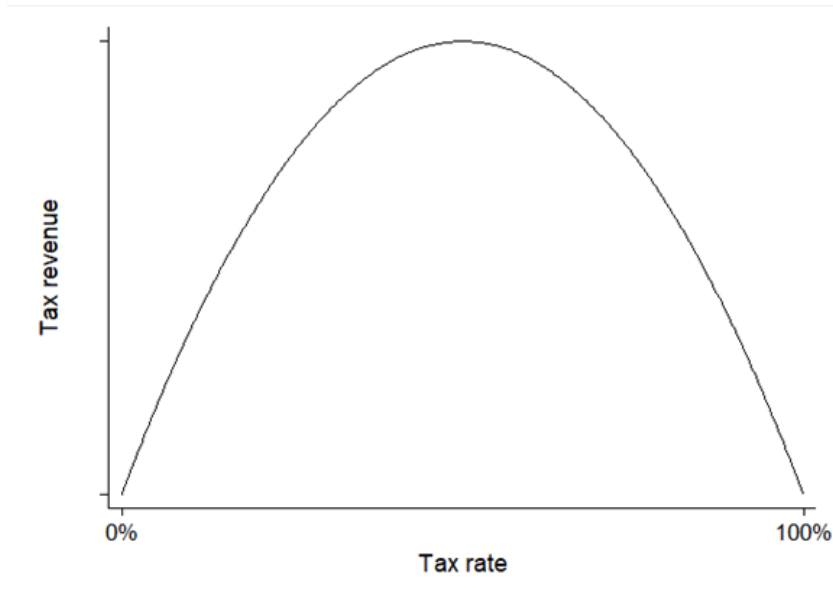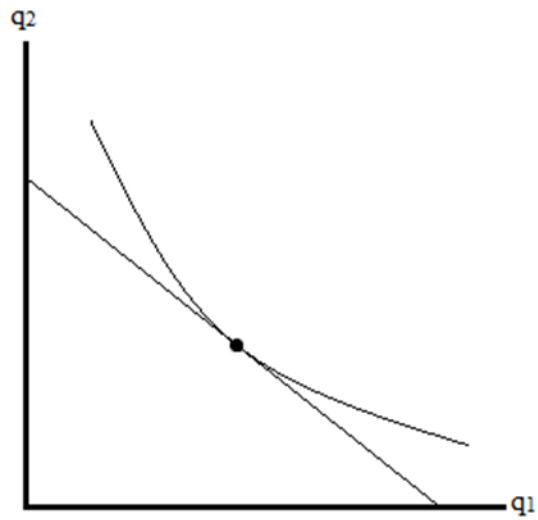
Figure 1. The Laffer curve.

Figure 2. The straight line and the curved line represent the budget constraint and a utility curve, respectively.

the optimal choice for the individual is the point where the budget constraint meets the utility curve. When transferring this concept to an individual's labor supply, the utility of an individual is now dependent on a combination of the two variables income Y and leisure N:

$$U = Y(Y, N). \tag{1}$$

The amount of hours H that an individual will choose to work per day equals the hours of leisure subtracted from the number of hours of a day:

$$H = 24 - N. \tag{2}$$

Also, an individual's opportunity cost, or the "price" of leisure, w is the hours worked times the net gain from one extra hour of work:

$$Y = wH = w(24 - N). \tag{3}$$

With these microeconomic foundations in mind, we can now anticipate how an individual will change his or her behavior due to changes in taxes. For this question, we will assume that an increase in taxes is equal to a decrease in income. The behavior of individuals will depend on the sizes of the income and substitution effects. Figure 3 illustrates a situation where an individual is exposed to an increase in income. As income increases, the original budget constraint L^1 shifts upwards to L^2. The new equilibrium point will remain on the original utility curve I^1 but at a new level of income Y_2. A third budget constraint L^* will be tangent to the utility curve I^1 at the point e*, which is the new equilibrium. The substitution effect is the change from e_1 to e* and the income effect from e* to e_2. We notice that in this case, the income effect is larger than the substitution effect and therefore the increase in income will lead to a decrease in hours worked for this specific individual. This relationship is what gives the Laffer curve its shape of an inverted U, and by examine the income and substitution effects we can determine if the individual is located on the upward or downward side of the maximum. In this case, as the income effect dominates the substitution effect, this specific individual is located on the
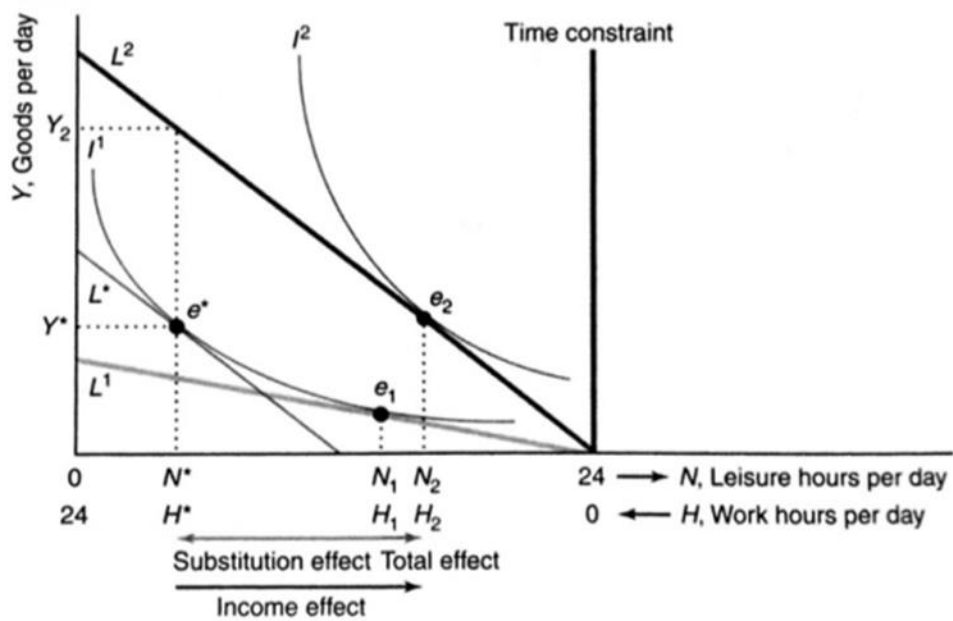
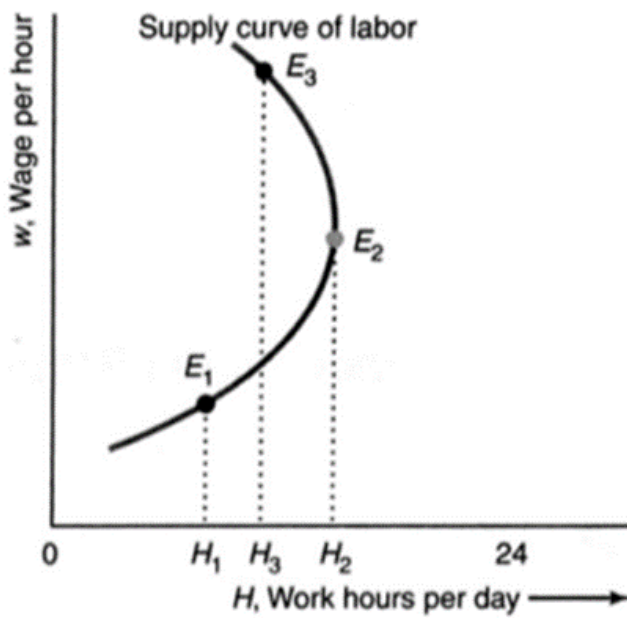*Figure 3. Income and substitution effects (Perloff 2014).*

Figure 4. A labor supply curve (Perloff 2014).

downward slope of the curve. If, on the other hand, the substitution effect dominates the income effect, the individual is located on the upward slope of the curve.

When we transfer this concept from an individual's perspective to instead investigate all levels of wage, we can derive the labor supply curve for the individual, as visualized in Figure 4. H_1, H_2 and H_3 represents the different amount of hours the individual might choose to work per day, each associated with an equilibrium level of wage. Usually in microeconomics, a supply curve is always upwards sloping. When prices increase, the supply is expected to follow. Labor supply can sometimes act differently. Although we observe an increase in wage, an individual can choose to work less. This is due to the income effect being greater than the substitution effect.

The labor supply curve is an effective tool when anticipating how individuals will change their behavior due to changes in their income. The elasticity of labor supply n, defined as the change in percent in hours worked, Q_h, that follows a one percent change in the price of labor P_w, i.e

$$n = \frac{\Delta Q_h}{Q_h} \times \frac{P_w}{\Delta P_w},$$
(4)

will help us answer what change we can expect in hours worked when the tax on wage changes.

Figure 5 shows different supply curves associated with different elasticities. When the elasticity is zero, a change in the price of labor does not lead to a change in hours worked and as the elasticity increases towards infinity, hours worked will be more and more sensitive to a change in the price of labor. For example, a supply curve with an elasticity of 2 will generate a larger change in hours worked when the price of labor changes, in comparison to an elasticity of 0.5. The elasticity of the labor supply for individuals will help us understand the shape of the Laffer curve. A larger elasticity, i.e. when a change in tax rates will generate a large change in hours worked, the Laffer curve will have a steeper slope. If the opposite scenario will occur, i.e. when a change in tax rates will generate a small change in hours worked, the curve will occur flatter.

When returning to the Laffer curve, we have seen that the expected effect on the amount of hours an individual will work followed by an increase in tax varies depending on where the individual is located on the labor supply curve. At first, tax revenue will increase simply because hours worked will increase. But as tax rates increases, hours worked will eventually decrease since the individual will have fewer incentives to work more when the income from that work will not follow proportionally, as seen in Figure 4. This principal is directly translated to the Laffer curve, as tax revenue will increase along with the tax rate until a maximum is reach. It will then, as be seen also in the labor supply curve, decrease as individual's will gain less income from increasing their hours of work.
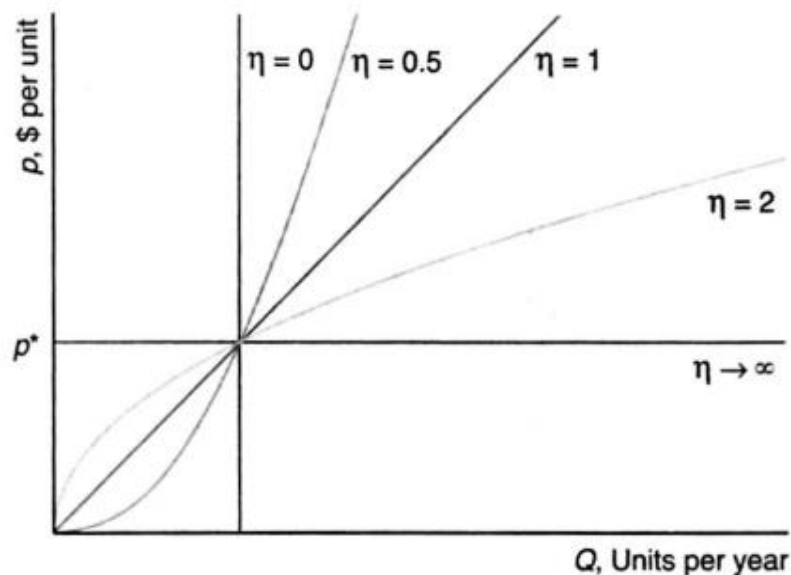

Figure 5. Supply curves for different elasticities (Perloff 2014).

4   The model

This section first introduces the regression model which forms the basis of the analysis presented in subsequent sections and ends with a brief discussion of some the difficulties associated with the type of regression analysis used in this study.

4.1   The regression model

In this section, we propose a regression model for studying the average Laffer curve of Swedish municipalities. The model is based on the Laffer curve which, assuming a parabolic shape, may be written as:

$$\log R_{my} = \beta_0 + \beta_1 T_{my} + \beta_2 T_{my}^2 + \varepsilon_{my}, \tag{5}$$

where R_{my} represents the tax revenue for municipality m in year y, T_{my} represents the municipality tax rates for municipality m in year y, and ε_{my} is the error term for municipality m in year y. The dependent variable R_{my} is logged in order to receive an interpretation of the variable in percentage form. A positive β_1 and a negative β_2 result in a curve having the shape of an inverted U, as shown in Figure 1 and discussed in Section 3.

The model used in this study introduces several additions to the Laffer curve (5). As will be further discussed below, it includes control variables for public expenditures, unemployment, the tax base, and the ruling political majority at the municipal level. The model also includes dummy variables to account for time effects. The purpose of including these control variables is to reduce the effect of factors that over time may have had a significant effect on tax revenue through other channels than the tax rate. Formally, the model which will be used in the regressions can be written as:

$$\log R_{my} = \beta_0 + \beta_1 T_{my} + \beta_2 T_{my}^2 + \beta_3 \log C_{my} + \beta_4 U_{my} + \beta_5 \log B_{my} \tag{6}$$
$$+ \beta_6 D_{5my} + \beta_7 D_{6my} + w_8 t_{1-18} + \beta_9 FE_m + \beta_{10} FE_{my} + \varepsilon_{my},$$

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where R_{my}, T_{my} and ε_{my} are to be interpreted as in equation (5), C_{my} is the public expenditures per capita for municipality m in year y, U_{my} the unemployment rate for municipality m in year y and B_{my} the tax base for municipality m in year y. D_{5my} is a dummy variable that takes the value 1 if center-right politicians are in power in municipality m in year y, and D_{6my} is a dummy variable that takes the value 1 if a coalition is in power in the municipality m in year y. These political dummy variables are intended to capture the impact on the tax revenue of the ruling party or parties not being left-wing, which, hence, is the reference case. The dummy variables t_{1-18} capture yearly effects of the years 2000 through 2017 (1-18). Finally, FE_m represents the effect of municipality specific fixed effects and FE_{my} the municipality specific fixed effects over time. The variables in the model (6) will be discussed in more detail in Section 5.1. As will be further discussed in Section 6, we have regressed the model (6) using different time periods during 2000 to 2017 in order to compare the estimates for β_1 and β_2, which define the position of the peak of the Laffer curve.

4.2   Potential problems

As discussed in Section 2, previous studies regarding the Laffer curve and the effect of tax rates on tax revenue have often used theoretical macroeconomic models as the prime method, or in other cases, descriptive data analyses. With this comes a series of problems that needs to be considered in order to ensure the trustworthiness of the experiment.

First, it is a common problem that this category of experiment suffers from endogeneity problems (Wooldridge 2016). It is problematic that the effect of changes in tax rates on tax revenue is hard to both isolate and recognize. This could potentially lead to beliefs that what initially seems to be a significant relationship is actually not, due to exogenous effects.

It is also questionable to what degree we can assume that theoretical economic models can properly be used to solve real-life problems. The microeconomic theories on which the Laffer curve is based on will differ between individuals based on several attributions assigned the individuals. The measure of abstract values might therefor bias the estimates.

Another complicating factor is simultaneity, or reversed causality. A potential reasonable scenario might be that a decrease in tax revenue provokes politicians to increase tax rates to stay at a chosen level of tax revenue, i.e. a change in tax revenue results in a change in tax rate. Using our model, it is difficult to distinguish such a scenario from an opposite situation where a change in tax rate results in a change in tax revenue.

In order to reduce these types of problems the study uses econometric methods to elude possible biasness. More specific, the study tries to reduce all endogen variation through the incorporation of both fixed effects and control variables.

Finally, there is the issue of highly correlated variables. As will be further discussed in Sections 5.1 and 5.2, the independent variables are, as expected, correlated, but they do not seem to be correlated to such a high degree that the validity of the model becomes questionable.

5 Data

This section begins with a general description of the data used in the present study and ends with an account of several statistical tests that were performed on the data.

5.1   General description

The data gathered comes from Statistics Sweden[3] (SCB 2018), except the data on unemployment rates and the ruling political ideology, which was gathered from RKA[4] (RKA 2018), a nonprofit organization with the Swedish government and municipalities as members. The data used is organized as panel data, sorted by year from 2000 to 2017. The reason for this specific time interval is changes in definition in the main variables and incomplete raw data, limiting the time period of the study to 18 years. All of the financial variables were inflation adjusted to the base year 2000, using yearly averages of the Consumer Price Index from Statistics Sweden.

As a result of the establishment of the municipality Knivsta in 2003, it is removed from the study. We argue that this does not jeopardize the validity of the study since the removed observations represents less than a percent of the total number of observations. The resulting panel data set is balanced. Further, it should be noted that Gotland is not included in the data set because of its special status as a region that not only deals with the responsibilities of regular municipalities[5] but also some responsibilities normally carried out by county councils[6]. Accordingly, Statistics Sweden does not report the income tax rate for Gotland separated into a municipality part and a city council part.

After processing the data, the study relies on yearly data on 288 Swedish municipalities from 2000 to 2017. Overviewing descriptive statistics of the data can be found in Table 1, and a subset of the data is illustrated graphically in Figure 6 (see also Figure 7 in Section 5.2 below). The second-to-last row of Table 1 indicates that the municipalities, together, had center-right rule during 41.7 percent of the time during the period from 2000 to 2017. The last row should be

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[3] Swedish: "Statistiska centralbyrån".
[4] Swedish: "Rådet för främjande av kommunala analyser".
[5] Swedish: "kommuner".
[6] Swedish: "landsting".

	Mean	Std. dev.	Min.	Max.
Tax revenue per capita	30191	4037	18877	54696
Municipality tax rate	0.2142	0.117	0.1618	0.2395
Public expenditures per capita	46697	8556	27300	93297
Unemployment rate	0.62	0.25	0.11	0.195
Tax base	179822	31436	123000	430756
Center-right rule	0.417			
Coalition rule	0.209			

*Table 1. Descriptive statistics of the data collected for the study. The tax revenue,
public expenditures and tax base are reported in Swedish krona (SEK)
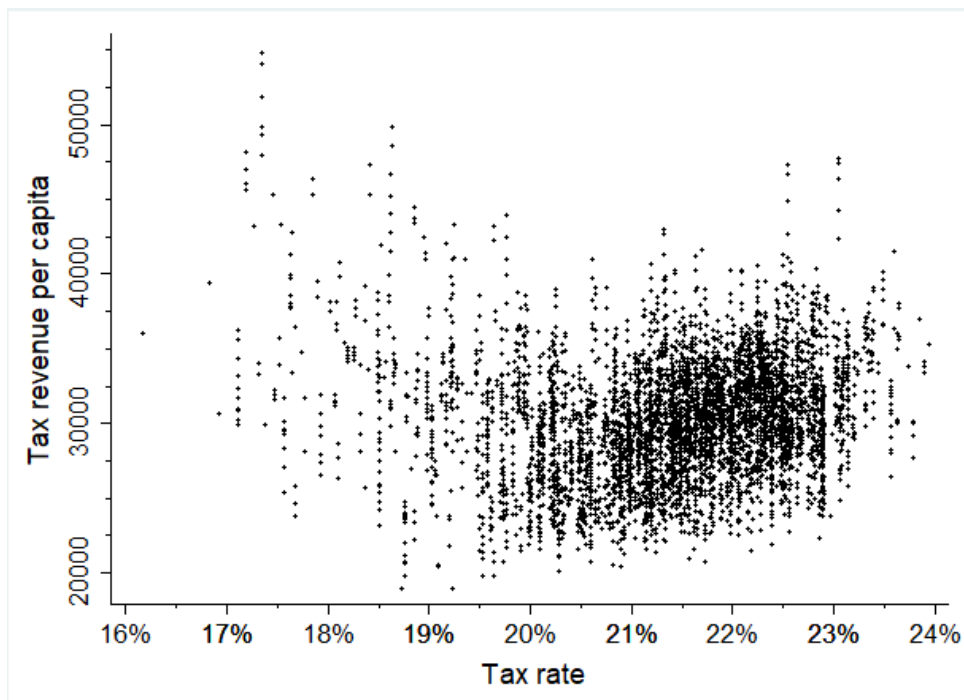per capita, inflation adjusted to 2000 base year.*

*Figure 6. A graphic illustration of tax revenue per capita versus municipality
tax rate. Each data point represents a specific municipality and a specific
year. The tax revenue are in Swedish krona per capita, inflation adjusted
to 2000 base year.*

interpreted analogously. The dependent variable and the independent variables are described in more detail below.

Tax revenue (R_{my})

The dependent variable of the model (6) is defined as the total amount of real income that a municipality receives annually from taxes divided by the number of citizens. Thus, it does not include any income from the municipal redistribution system[7]. Statistics Sweden reports the revenue in per capita terms based on the number of inhabitants on December 31st each year. It may be noted that using tax revenue per capita represents a departure from the typical definition of Laffer curve, which describes a relationship between tax rates and total tax revenue (see Section 3.1). Using tax revenue per capita is a way of controlling for tax revenue changes due to a population increase or decrease, and this approach has been previously employed by for example Hsing (1996).

Municipality tax rate (T_{my})

The main independent variable of the model, and our a priori assumption is that tax rate changes have a major impact on the tax revenue, except possibly when the tax rate is close to the top of the Laffer curve, i.e. when the slope of the curve is nearly flat. Also, as discussed in Section 3, a tax rate increase may increase or decrease the tax revenue, depending on whether the municipality is located on the upward or downward sloping part of the curve. The tax rate in Swedish municipalities differs between municipalities and we argue that it therefore provides a solid estimate of the impact on the tax revenue of that specific municipality. In order to provide an interaction between the tax rate and tax revenue and a fitted line that have the potential to simulate the theoretical shape of the Laffer curve, a quadratic term of the tax rate variable is included in the model (6). It should be noted that the municipal tax rate as defined in the present study does not include the tax that is allocated to the county councils. As noted in Section 2, this definition seems to be different from that used by Stener and Wintenstråle (2016).

Public expenditures (C_{my})

One of the control variables included in the model is the public expenditures per capita of the municipalities. We argue that a larger public sector would reflect the characteristics of a

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[7] Swedish: "Kommunala utjämningssystemet".

municipality regarding demographics, which could possibly affect the tax revenue through other channels than the direct tax rate. Expenditures on education, eldercare and daycare constitute a major portion of the total expenditures of the municipalities. We expect municipalities with large public sectors to generally collect correspondingly large tax revenues to finance the public expenditures.

Unemployment (U_{my})

Another control variable we assume affects the tax revenue is unemployment. We believe this to be a relevant control variable because economic intuition tells us that a larger number of employed citizens in a municipality would increase the tax revenue through another channel than the tax rate. The unemployment variable would also capture the economic situation of the municipality, since a high unemployment is corresponding to a low growth rate and vice versa. RKA reports the unemployment rate for the month of March each year. Further, the unemployment rate is here defined as the number of persons who are aged between 18 and 64 years and unemployed, divided by the total number of inhabitants.

Tax base (B_{my})

Defined as the taxable income per capita in a municipality of the previous year, the tax base is included in the model because of its intuitive effect on tax revenue. Since tax revenue is defined as the tax base times the tax rate, it seems reasonable that the two components with a direct influence on tax revenue should be included in the model. It is noted that the data does not include firms or other legal entities. Our expectation is that a municipality collects more tax revenues when its tax base increases and less tax revenue when its tax base decreases.

Ruling political ideology $(D_{5my}$ and $D_{6my})$

Our model allows for the political affiliation of the party or parties in power to have an impact on municipalities' tax revenue per capita. Although we do not expect such an effect to be large, it is conceivable that it exists. For example, voters in municipalities having right-wing parties in power can reasonably be expected to have a generally low willingness to pay taxes and therefore prone to adopt strategies to lower their taxes by maximizing tax deductions, for instance. Our data classifies the political affiliation of the politicians in power into one of the following three categories: (i) left-wing, (ii) center-right, and (iii) coalition. By left-wing rule is meant rule by

the Swedish Social Democratic Party and/or the Left Party. By center-right rule is meant rule by one or more of the Moderate Party, the Christian Democrats, the Liberals and the Centre Party. By coalition rule is meant rule by one or more of the center-right parties together with one or both of the left-wing parties. All three types of rule may include the Green Party or some other party not included in the categories (i) and (ii) above. It may be noted that although elections are held every four years, there are a few cases where the ruling political majority changes without the year being an election year. A possible reason for this could be politicians leaving a ruling party that has a thin majority.

Fixed Effects (FE_m and FE_{my})

The method behind fixed effects is founded from the idea that the individual specific effects are correlated with the error term and by controlling for these, the variation of the variable in interest will decrease. To capture the internal variation, i.e. variation over time within one municipality, fixed effects are included in the model. We include the fixed effects to reduce problems associated with hidden variation in the variables.

Time variables (t_{1-18})

As illustrated in Figure 7, there seems to be a general upward trend in the tax revenue per capita, which could indicate that the estimates will be biased unless the model controls for this tendency. In order to control for possible time effects, we have chosen to include a set of yearly dummy variables in the model (6), similarly to Edmark and Ågren (2008). Thereby, the model allows for the effects associated with time to differ between years. Thus, each time variable is a dummy variable intended to capture events which affect the tax revenue of all of the municipalities similarly during a specific year. An example of such an event might be a crisis which temporarily leads to a change in the general economic outlook of the entire country and a corresponding change in the behavior of people and companies, affecting the municipalities' tax revenue. Such crises might for example be the burst of the IT bubble and the financial crisis of the early and late 2000s, respectively. It is noted that an alternative approach could be to include a linear time trend variable instead of yearly dummy variables. We did not choose this approach because the wavy shape of the tax revenue in Figure 7 seems to suggest that the time effects may vary between years, as will be further discussed in the next section.

5.2   Tests

To ensure the model's reliability and to what degree of certainty the results can be interpreted, a series of tests has been conducted to investigate the most common problems with time series data. First, the model is tested for potential highly persistent variables. A variable is highly persistent if

$$Y_t = P_1 Y_{t-1} + u_t, \tag{7}$$

where $P_1 = 1$ and Y_t in this case being the dependent variable tax revenue, although the test includes all variables in the model (Wooldridge 2016). We also know that

$$P_1 = \text{corr}\,(Y_t, Y_{t-1}). \tag{8}$$

If the absolute value of P_1 is close to 1, a highly persistent variable is suspected. After testing for highly persistent variables we conclude that there to some degree are persistent variable present in the model, but not to a degree that would severely contaminate the estimates. The results are presented in Table 2 and we notice that the largest absolute value is 0.57, which is at a comfortable distance from 1.

Secondly, we examine if there are trending variables in the model. If a variable increases or decreases over the sample period, the variable is a trending variable. If both the dependent variable and the explanatory variable is trending, then coefficient estimates might be biased (Wooldridge 2016). After having regressed each of the continuous variables of the model on a linear time variable, we concluded that all of them grow over time. In order to account for the overall upward trend exhibited by the continuous variables, we therefore included a set of yearly dummy time variables in the model. The model is thereby able to capture not only an overall linear time trend in the data but also, as discussed in Section 5.1, other temporal effects, such as year-specific effects.

Thirdly, it is investigated if the model suffers from seasonality. If a variable demonstrates a periodic pattern over the sample period, seasonality might be present in the data. If both the dependent variable and an independent variable have seasonality, coefficient estimates might be biased (Wooldridge 2016). We find no clear evidence of seasonality in the dependent variable by visual inspection of Figure 7. Should yearly seasonality be present in one or more of the independent variables, such effects will be captured by the set of dummy time variables in the model (6).

Another common problem with time series data is serially correlated errors, which occurs when the present error term correlates with a past error term. This potential problem may lead to incorrect standard errors, but the unbiasedness and consistency of the estimates are not affected (Wooldridge 2016). We investigate potential serially correlated errors by looking at the null hypothesis

$$H_0: \rho = 0, \tag{9}$$

and the alternative hypothesis

$$H_a: \rho \neq 0, \tag{10}$$

where

$$\rho = \text{corr} \; (U_t, U_{t-1}). \tag{11}$$

We find that there is significant evidence for first order autocorrelation in the error term and the null hypothesis is rejected. As a solution to this, we use the Driscoll and Kraay method which is appropriate for the type of panel data used in this study and produces standard errors which are robust to autocorrelation and heteroscedasticity (Driscoll & Kraay 1998).

Another potential problem is that the model might not achieve strict exogeneity, something which may cause the regression estimates to be biased. Completely strict exogeneity is close to

impossible to reach. However, a lack thereof is usually not a major issue with larger sample sizes, and in this study we assume that the sample size is large enough to avoid a strict exogeneity problem (Wooldridge 2016).

Lastly, the pairwise correlations between the independent variables were also computed. Some of the variables can reasonably be expected to correlate to some degree. For example, we expect the unemployment rate to be negatively correlated with the tax base and positively correlated with public expenditures, since the tax base and the public expenditures of a municipality are likely to decrease and increase, respectively, when the unemployment rate increases. As another example, it seems likely that the tax base and the political affiliation of the party in power are correlated to some degree, since high-income earners and low-income earners can reasonably be expected to predominately vote for right-wing parties favoring tax cuts and left-wing parties opposing tax cuts, respectively.

Our correlation test showed that the largest absolute value of the pairwise correlations between the independent variables were circa 0.5. Thus, contrary to some of our apprehensions, neither of the independent variables correlated to such a degree that would eliminate any of them as useful control variables. Specifically, we note that the control variables indicating political ruling in the municipalities did not correlate to a large degree with any of the other independent variables.

	P_1
Tax revenue	0.21
Income tax rate	0.57
Public expenditures per capita	0.41
Unemployment rate	0.25
Tax base	0.51
Center-right rule	0.14
Coalition rule	0.04

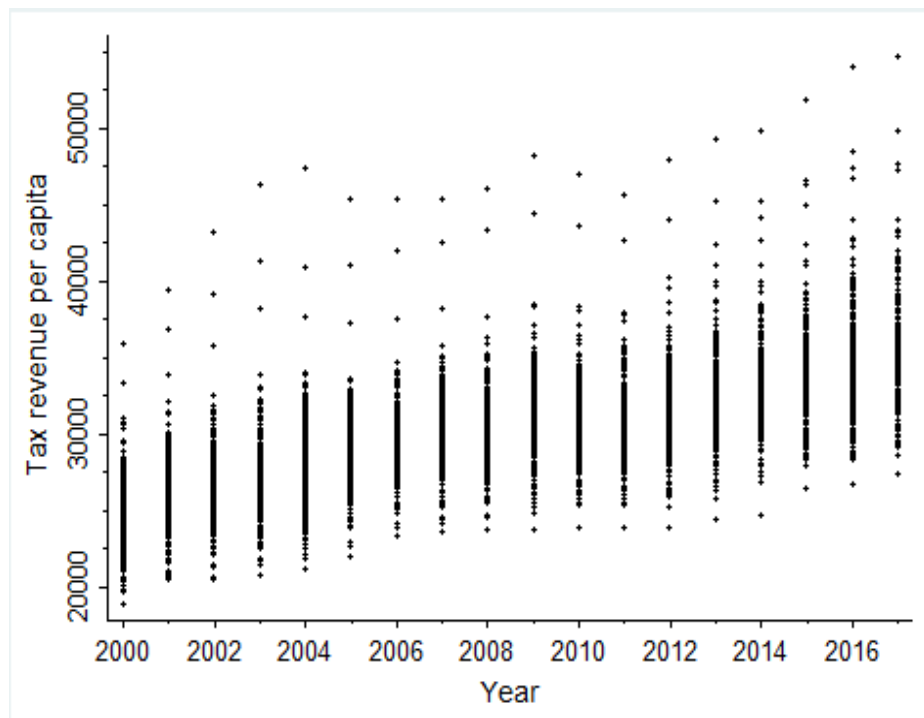*Table 2. Results from the correlation tests investigating highly persistent variables.*

*Figure 7. A graphic illustration of the tax revenue per capita for each year.
Each data point represents a specific municipality. The tax revenue are
in Swedish krona per capita, inflation adjusted to 2000 base year.*

6 Results

This section presents the results of the regression analyses on the panel data presented in Section 5. In order to be able to determine whether the position of the top of the municipalities' average Laffer curve has moved over time, i.e. whether the average optimal tax rate has changed, the coefficients of the independent variables in the model (6) were estimated for several different time periods between 2000 and 2017. Our hope is to identify any changes by comparing estimates for different time periods.

The estimates of the coefficients β_1 and β_2, which multiplying the tax rate variables in model (6), are our main interest, because they define the position of the top of the Laffer curve. Specifically, by taking the derivative of the right-hand side of equation (6) with respect to the tax rate and setting the result to zero, one finds that the maximum of the Laffer curve occurs at a tax rate of

$$-\frac{\beta_1}{2\beta_2} \, . \tag{12}$$

Initially, we chose to perform the regression using six consecutive three-year periods, in order to be able to compare estimates for many time periods, almost as many as our data set allows while still keeping some of the advantages associated with the data having a panel structure. Since the significance levels of the estimates obtained from these regressions were rather low, we also performed regressions using three six-year periods and two nine-year periods in an attempt to see whether or not using longer time periods would improve the significance levels. Lastly, we performed a regression using data on the entire period for which we have data, i.e. from 2000 to 2017.

All of the regressions were fixed-effects regressions, using Driscoll and Kraay standard errors as implemented in the software Stata (Hoechle 2007) for the purpose of obtaining robust coefficient estimates. In order to account for autocorrelation (see the discussion in Section 5.2), the regressions were performed with lag a length of one year (Section 6.1) or two years (Sections

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6.2, 6.3 and 6.4). The lag lengths were computed using the following formula suggested by Hoechle (2007):

$$\text{floor}\left(4 \times (T/100)^{2/9}\right),\qquad(13)$$

where T is the number of periods, which equals three, six, nine or seventeen, depending on the regression.

6.1   Three-year periods

We have performed six separate regressions, where each regression used data on one of the periods 2000 to 2002, 2003 to 2005, 2006 to 2008, 2009 to 2011, 2012 to 2014, and 2015 to 2017. As can be seen in Table 3, the F-statistics of these regressions indicate that the independent variables are jointly statistically significant at levels above the 90 percent confidence level except for the two periods spanning 2009 to 2014. Thus, for the periods spanning 2000 to 2008 and the period 2015 to 2017, the null hypothesis that all of the coefficients multiplying the independent variables are zero may be rejected with an acceptable level of confidence. The R-squared within values vary between 27 percent and 90 percent, so the degree to which the model (6) explains the variation in the tax revenue varies considerably between periods.

Table 3 also shows the estimates obtained for the coefficients β_1 and β_2. For the three periods 2006 to 2008, 2009 to 2011, and 2015 to 2017, the estimates for both β_1 and β_2 are significant at or above the 90 percent confidence level. For these periods, the term that is linear in the tax rate (β_1) is estimated to be positive, and the coefficient that is quadratic in the tax rate (β_2) is estimated to be negative. This means that the tax revenue as a function of the tax rate has the shape of an inverted U, i.e. the conventional Laffer curve shape, and this result agrees with the assumptions behind the model in equation (6). The estimates for β_1 and β_2 yield that the maximum of the Laffer curve occurs at 29 percent, 33 percent and 29 percent during the periods 2006 to 2008, 2009 to 2011, and 2015 to 2017, respectively, indicating that the top of the Laffer curve has not remained at the same position during these years. The magnitude of the shift indicated by these percentages seems large for such short time periods and should probably be interpreted with caution. As reported in Table 1 and Figure 6, the municipal tax rates were

between circa 16 percent and circa 24 percent during the entire period from 2000 through 2017, so we conclude that the municipalities do not seem to have taxed beyond the Laffer curve peak during the years 2006 to 2011 and 2015 to 2017.

We have not computed where the top of the Laffer curve is located for the other periods, i.e. 2001 to 2002, 2003 to 2005 and 2012 to 2014, because the significance level of either both or one of the estimates for the coefficients β_1 and β_2 for these periods is lower than 90 percent, which makes meaningful comparisons between periods difficult. Further, we note that the estimates for the period 2003 to 2005 are both positive, something which implies that the Laffer curve has the shape of a U, rather than an inverted U. This result appears to be rather counterintuitive.

The regression results for the control variable coefficients are set out in Tables 4 and 5. The significance levels of these estimates varies between the different periods from below to above 90 percent in what appears to be a fairly random manner. The fact that many of the estimates have low statistical significance seems to suggest that they often have had little or no impact on the tax revenue. However, we do not believe there is sufficient evidence concerning their effects to draw reliable conclusions and, in particular, to make valid comparisons between periods.

6.2   Six-year periods

We have performed three separate regressions, where each regression used data on one of the periods 2000 to 2005, 2006 to 2011, and 2012 to 2017. Table 3 shows that the F-statistics of these regressions are well above the 90 percent confidence level, and the null hypothesis that all of the coefficients multiplying the independent variables are zero may therefore be rejected with high confidence for all three periods. The R-squared within value varies between 74 percent and 94 percent, representing an improvement compared with the regression in Section 6.1.

As can be seen in Table 3, for two of these periods, i.e. 2006 to 2011 and 2012 to 2017, the estimates for both β_1 and β_2 are significant at a level well above 90 percent. The significance level of the estimates for β_1 and β_2 for the period 2000 to 2005 is by contrast well below 90 percent. For all three periods, β_1 and β_2 and are estimated to be positive and negative,

respectively, which is consistent with a Laffer curve having an inverted U shape. During the period 2006 to 2011, the maximum of the Laffer curve occurred at 30 percent, and, during the period 2012 to 2017, the maximum of the Laffer curve occurred at 36 percent. This results suggest that the top of the curve moved during these periods. The magnitude of the movement appears quite large for such short time periods and, again, should probably be interpreted with caution.

The results for the control variable coefficients are set out in Tables 4 and 5. Again, the statistical significance of these estimates varies considerably between periods and, in addition, are in many cases low.

6.3   Nine-year periods

We have performed two separate regressions, where each regression used data on one of the periods 2000 to 2008 and 2009 to 2017. As can be seen in Table 3, and similarly to the regressions in Section 6.2, the F-statistics of both of these regressions are well above the 90 percent confidence level. The R-squared within value is 94 percent for both periods, so the model (6) explains the variance within municipalities to a high degree for these periods.

Table 3 shows that the β_1 and β_2 estimates for the first period, i.e. 2000 to 2008, are both positive, which is inconsistent with an inverted U-type Laffer curve, as noted in Section 6.1. The statistical significance of these estimates is, however, very low. The β_1 and β_2 estimates for the period 2009 to 2017 are positive and negative, respectively, and they are thus consistent with an inverted U-type Laffer curve. The β_1 estimate is statistically significant at a level above 90 percent, whereas the statistical significance of the β_2 estimate is far below the 90 percent level.

Again, the results for the control variable coefficients are set out in Tables 4 and 5. Similar to the results presented in Sections 6.1 and 6.2, the statistical significance of these estimates varies considerably between the two periods and many of them are quite low.

In sum, we do not believe these two regressions have yielded enough evidence to draw reliable conclusions regarding the position of the Laffer curve peak during the periods 2000 to 2008 and

2009 to 2017. The results regarding the control variables are yet again difficult to interpret because of the varying levels of statistical significance.

6.4   The period 2000 to 2017

We have performed a regression on the entire data set, i.e. the period 2000 to 2017. As Table 3 shows, the F-statistic of the regression is well above the 90 percent confidence level, so the coefficients multiplying the independent variables are jointly statistically significant at a high level. The R-squared within value is about 97 percent, which is higher than in Sections 6.1 to 6.3. The β_1 and β_2 estimates are positive and negative, respectively, which is consistent with a Laffer curve having an inverted U shape. However, neither estimate is significant at the 90 percent confidence level.

The results for the control variable coefficients are set out in Tables 4, 5 and 6. Except for the dummy time variables, the estimates for the control variables are all statistically significant above the 90 percent confidence level. The public expenditures coefficient (β_3) is estimated to be positive, the unemployment rate coefficient (β_4) is estimated to be negative, and the tax base coefficient (β_5) is estimated to be positive. The signs of these regression estimates are thus in line with how we expected changes in the corresponding variables to affect the tax revenue, see the discussion in Section 5.1. Further, the estimates of the coefficients multiplying the political dummy variables (β_6 and β_7) are negative. This result suggest that, ceteris paribus, the tax revenue per capita were on average lower during center-right rule and coalition rule than during left-wing rule during 2000 to 2017. This is an interesting result warranting further empirical investigation. All but one of the estimates of the coefficients multiplying the dummy time variables are negative, which is contrary to our expectation of there being a general positive time trend in the data. However, since the significance of many of the estimates is low, this result should be interpreted with caution.

In sum, based on this regression, we are unable to establish at any conventional confidence level that the tax rate has had an impact on the tax revenue during the period 2000 to 2017, but we are able to establish that the many of the control variables have had such an impact. This result is unexpected, and contrary to our expectation, since the tax rate can reasonably be expected to

have a large influence on the tax revenue unless the tax rate is close to the top of the Laffer curve, which as noted in Section 6.1 probably was not the case during any of the years from 2000 to 2017.

	b_1	b_2	Std. error	t	p_t	p_F	R^2
2000–2002	13	–18	4.4; 11	2.87; –1.67	0.10; 0.24	< 0.01	0.90
2003–2005	–34	94	13; 31	–2.65; 3.06	0.12; 0.09	< 0.01	0.79
2006–2008	16	–28	4.3; 9.5	3.82; –2.96	0.06; 0.10	0.08	0.62
2009–2011	13	–20	2.9; 6.7	4.56; –2.96	0.05; 0.10	0.12	0.27
2012–2014	13	–20	3.7; 8.8	3.47; –2.25	0.07; 0.15	0.15	0.87
2015–2017	17	–29	2.0; 5.2	8.49; –5.51	0.01; 0.03	< 0.01	0.86
2000–2005	9.5	–8.8	7.5; 18	1.26; –0.49	0.26; 0.65	< 0.01	0.92
2006–2011	18	–31	3.3; 7.4	5.56; –4.13	< 0.01; 0.01	< 0.01	0.74
2012–2017	13	–18	2.6; 6.3	5.10; –2.92	< 0.01; 0.03	< 0.01	0.94
2000–2008	2.7	8.3	7.3; 17	0.36; 0.48	0.73; 0.65	< 0.01	0.94
2009–2017	6.3	–3.2	2.8; 6.3	2.29; –0.51	0.05; 0.62	< 0.01	0.94
2000–2017	11	–12	7.0; 16	1.55; –0.74	0.14; 0.47	< 0.01	0.97

Table 3. The columns labelled b_1 and b_2 lists the regression estimates for β_1 and β_2, respectively, in the model (6), and the columns labelled p_t and p_F lists the probabilities determined by the t and F statistics, respectively. The estimates and the standard errors are reported with two significant figures. The standard errors are robust to heteroscedasticity and autocorrelation. In the columns with two numbers, the number to the left refers to b_1, and the number to the right refers to b_2. The column labelled R^2 lists the R-squared "within" values.

	b_3	b_4	b_5	b_6	b_7
2000–2002	6.1×10^{-2}	3.4×10^{-3}	0.56	-5.5×10^{-3}	1.1×10^{-3}
2003–2005	-2.0×10^{-2}	7.5×10^{-4}	0.30	4.3×10^{-3}	
2006–2008	4.8×10^{-2}	3.1×10^{-3}	0.15		1.0×10^{-2}
2009–2011	4.3×10^{-2}	1.6×10^{-3}	0.36	9.8×10^{-4}	6.9×10^{-4}
2012–2014	3.5×10^{-2}	-1.2×10^{-3}	0.33	-6.8×10^{-4}	1.1×10^{-3}
2015–2017	-3.1×10^{-3}	-2.9×10^{-3}	0.15	1.0×10^{-3}	-1.4×10^{-2}
2000–2005	7.8×10^{-2}	4.0×10^{-3}	0.73	-8.5×10^{-3}	-1.3×10^{-3}
2006–2011	4.5×10^{-2}	-1.1×10^{-4}	0.62	2.0×10^{-4}	-7.7×10^{-4}
2012–2017	-2.2×10^{-2}	-4.7×10^{-3}	0.60	-1.9×10^{-4}	4.3×10^{-5}
2000–2008	6.2×10^{-2}	1.0×10^{-3}	0.67	-6.8×10^{-3}	-4.9×10^{-3}
2009–2017	-1.2×10^{-2}	-3.7×10^{-3}	0.92	-3.0×10^{-4}	6.7×10^{-4}
2000–2017	6.4×10^{-2}	-2.5×10^{-3}	1.0	-6.0×10^{-3}	-5.9×10^{-3}

Table 4. The column labelled b_i lists the regression results for β_i in the model (6).
For two of the three-year periods, the political dummy variables were
collinear, and Stata therefore omitted one of them.

	b_3	b_4	b_5	b_6	b_7
00–02	8.9×10^{-3}; 6.90^2	6.2×10^{-4}; 5.43^2	0.13; 4.36^2	3.1×10^{-4}; -17.75^1	3.1×10^{-4}; -3.48^3
03–05	1.9×10^{-2}; -1.07	3.7×10^{-4}; 2.01	0.14; 2.10	1.5×10^{-3}; 2.84	
06–08	2.6×10^{-2}; 1.88	6.5×10^{-4}; 4.74^2	0.25; 0.59		6.0×10^{-3}; 1.70
09–11	1.6×10^{-2}; 2.74	6.2×10^{-4}; 2.62	0.15; 2.51	5.0×10^{-4}; 1.97	1.3×10^{-3}; 0.51
12–14	7.0×10^{-3}; 5.02^2	2.5×10^{-4}; -5.07^2	0.15; 2.17	2.3×10^{-4}; -2.97^3	4.7×10^{-4}; 2.28
15–17	2.0×10^{-2}; -0.16	8.5×10^{-4}; -3.36^3	9.8×10^{-2}; 1.55	7.9×10^{-4}; 1.31	6.2×10^{-4}; -23.00^1
00–05	1.7×10^{-2}; 4.67^1	7.0×10^{-4}; 5.75^1	9.3×10^{-2}; 7.81^1	1.2×10^{-3}; -7.21^1	3.7×10^{-4}; -3.67^2
06–11	4.6×10^{-3}; 9.70^1	5.5×10^{-4}; -0.20	0.12; 5.03^1	6.9×10^{-4}; 0.29	1.3×10^{-3}; -0.58
12–17	9.2×10^{-3}; -2.35^3	5.9×10^{-4}; -7.84^1	6.1×10^{-2}; 9.80^1	3.3×10^{-4}; -0.58	7.8×10^{-4}; 0.06
00–08	2.4×10^{-2}; 2.57^2	1.0×10^{-3}; 0.90	9.6×10^{-2}; 7.01^1	1.5×10^{-3}; -4.54^1	1.8×10^{-3}; -2.71^2
09–17	1.9×10^{-2}; -0.62	9.1×10^{-4}; -4.04^1	8.5×10^{-2}; 10.81^1	4.9×10^{-4}; -0.62	4.3×10^{-4}; 1.55
00–17	2.2×10^{-2}; 2.94^1	1.1×10^{-3}; -2.30^2	6.7×10^{-2}; 15.24^1	1.7×10^{-2}; -3.51^1	1.3×10^{-2}; -4.45^1

Table 5. The column labelled b_i lists the regression results for β_i in the model (6). The numbers in each cell refer to, from left to right, the standard error and the t statistic. The standard errors are robust to heteroscedasticity and autocorrelation. The superscripts 1, 2 and 3 denote significance at the 1, 5 and 10 percent level, respectively. For two of the three-year periods, the political dummy variables were collinear, and Stata therefore omitted one of them.

	Estimate	Standard error	t
2001	7.2×10^{-3}	2.9×10^{-3}	2.47^2
2002	-9.9×10^{-3}	5.5×10^{-3}	-1.80^3
2003	-3.0×10^{-2}	7.6×10^{-3}	-4.01^1
2004	-3.7×10^{-2}	8.9×10^{-3}	-4.14^1
2005	-3.1×10^{-2}	1.1×10^{-2}	-2.88^1
2006	-8.2×10^{-3}	1.2×10^{-2}	-0.66
2007	-5.4×10^{-3}	1.4×10^{-2}	-0.40
2008	-1.2×10^{-2}	1.5×10^{-2}	-0.79
2009	-4.4×10^{-2}	1.8×10^{-2}	-2.42^2
2010	-4.9×10^{-2}	1.9×10^{-2}	-2.61^2
2011	-3.1×10^{-2}	1.7×10^{-2}	-1.76^3
2012	-1.6×10^{-2}	1.8×10^{-2}	-0.87
2013	-2.7×10^{-2}	2.0×10^{-2}	-1.32
2014	-3.9×10^{-2}	2.3×10^{-2}	-1.73
2015	-2.9×10^{-2}	2.5×10^{-2}	-1.17
2016	-3.8×10^{-2}	2.7×10^{-2}	-1.41
2017	-3.6×10^{-2}	2.8×10^{-2}	-1.28

Table 6. The estimated coefficients of the dummy time variables, the reference year being the year 2000. The standard errors are robust to heteroscedasticity and autocorrelation. The superscripts 1, 2 and 3, denote significance at the 1, 5 and 10 percent level, respectively.

7 Conclusion

In summary, we have presented a simple regression model based on the Laffer curve relationship between tax revenue and tax rates and including control variables for public expenditures, unemployment rate, taxable income and the political affiliation of the ruling party or parties. The model was regressed using empirical data on 288 Swedish municipalities spanning the period 2000 to 2017 in order to identify possible shifts in the peak of the Laffer curve during this period, i.e. whether or not the optimal value of the average municipality tax rate has changed.

Our regression results give some indications that the top of the average Laffer curve of Swedish municipalities has moved during the period from 2000 to 2017. However, because of low significance levels of many of the regression estimates, we are unable to reliably conclude whether or not the peak has shifted during that period and, thus, to clearly answer the main question of this study posed in Section 1, i.e. whether or not the optimal value of the average tax rate of Swedish municipalities has changed during the period 2000 to 2017.

Regarding the regression results presented in Section 6, it is problematic to the study that some of the time periods examined do not show a significant relationship between the tax rate and tax revenue, complicating comparisons between time periods. There are several potential explanations for this, both within the model as in factors reflected in the raw data. There could, for example, be a case where other factors than the tax rate effects tax revenue to such a degree that the tax rate becomes insignificant. This would be contrary to our expectations and, in such case, the control variables in the model were not fully functional and additional control variables would be needed. Another potential scenario that could result in insignificant estimates is weaknesses in the regression methods. Specifically if the methods do not match the characteristics of the raw data. In this case, the model is to some degree designed to fit the data and the potential problems that come with it, as discussed Section 4.2.

A limitation of this study is that the sample size only covers eighteen years, and all of the regressions except one are on even shorter time periods (three, six and nine years). Using a larger sample that includes more years might improve the significance levels of the estimates. By

comparison, Stener and Wintenstråle (2016) used a sample size that covers twenty-four years. Also, including a larger sample size with additional election years and, hence, additional political power shifts, might result in more precise estimates of the impact of the political affiliation of the ruling party.

Another limitation of our model is that it does not consider the varying demographic composition of different municipalities, unlike the model used by, Edmark and Ågren (2008), for instance. It would be interesting to extend our model to reflect the demography of the municipalities, as different age groups may, in general, not only vote differently but also have different attitudes towards taxes, something which may affect the shape of the Laffer curve. Also, in our data, the ruling parties are classified using only three categories (left-wing rule, center-right rule and coalition rule). Future studies could use a more differentiated classification, which includes more than three categories, and perhaps capture effects that our model is unable to detect.

Yet another limitation of our model is the assumption that the Laffer curve is parabolic. As noted in Section 2, several studies (Malcomson 1986; Guesnerie & Jerison 1991; Gahvari 1989) have shown that this assumption may not always hold. The assumption could be relaxed by expressing the tax revenue as a more general function of the tax rate than a quadratic polynomial as in equations (5) and (6), such as adding a cubic term in the tax rate. However, this approach is problematic since the Laffer curve no longer has a unique maximum, which is a premise for this study. Nevertheless, we performed a series of test regressions in which a third-order term in the tax rate was added to the model (6). We found that the significance of the estimates generally improved, but not to a satisfactory level.

To conclude, we hope that, despite the limited conclusions that can be drawn from this work, it will inspire further empirical investigations.

References

Becsi, Z. (2000). The Shifty Laffer Curve. *Economic Review*, third quarter 2000, pp. 53–64. Atlanta: Federal Reserve Bank of Atlanta.

Driscoll, J. C. & Kraay, A. C. (1998). Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *The Review of Economics and Statistics*, 80(4), pp. 549–560.

Edmark, K. & Ågren, H. (2008). Identifying strategic interactions in Swedish local income tax policies. *Journal of Urban Economics,* 63(3), pp. 849–857.

Feige, E. L. & McGee, R. T. (1983). Sweden's Laffer curve: Taxation and the Unobserved Economy. *The Scandinavian Journal of Economics*, 85(4), pp. 499–519.

Fullerton, D. (1982). On the possibility of an inverse relationship between tax rates and government revenue. *Journal of Public Economics*, 19(1), pp. 3–22.

Gahvari, F. (1989). The nature of government expenditures and the shape of the Laffer curve. *Journal of Public Economics*, 40(2), pp. 251–260.

Guesnerie, R. & Jerison, M. (1991). Taxation as a social choice problem. The scope of the Laffer argument. *Journal of Public Economics*, 44(1), pp. 37–63.

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal*, 7(3), pp. 281–312.

Hsing, Y. (1996). Estimating the Laffer Curve and Policy Implications. *The Journal of Socio-Economics*, 25(3), pp. 395–401.

Laffer, A. B. (2004). The Laffer Curve: Past, Present, and Future. *Backgrounder*, no. 1765, June 1, pp. 1–16. Washington, DC: The Heritage Foundation.

Malcomson, J. M. (1986). Some analytics of the Laffer curve. *Journal of Public Economics*, 29(3), pp. 263–279.

Perloff, J. M. (2014). *Microeconomics with Calculus*. Third edition, Global edition, Pearson Series in Economics.

RKA (2018). https://www.kolada.se [December 2018]

SCB (2018). http://www.statistikdatabasen.scb.se [November 2018]

Smith, Adam. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. First Edition, W. Strahan and T. Cadell.

Stener, V. & Wintenstråle, T. (2016). På Lafferkurvans Sluttning: En ekonometrisk studie av vilken den pekuniära effekten är av förändringar i svenska kommuners skattesatser. Bachelor thesis, Department of Economics. Gothenburg: School of Business, Economics and Law, University of Gothenburg. http://hdl.handle.net/2077/54214

Stuart, C. E. (1981). Swedish Tax Rates, Labor Supply, and Tax Revenue. *Journal of Political Economy*, 89(5), pp. 1020–1038.

Wanniski, J. (1978). Taxes, Revenue, and the "Laffer Curve". *The Public Interest*, winter 1978, 50, pp. 3–16.

Wooldrigde, Jeffery. M. (2016). *Introductory Econometrics: A Modern Approach*. 6th Edition, South-Western Cengage Learning.