# The local income tax Laffer curve in Sweden*

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**Abstract**

In this study we estimate the effects from a tax increase on local tax revenue, in an estimation of the Laffer curve for the local income tax in Sweden. With data over the years 2000-2013 for 285 Swedish municipalities we estimate a fixed effects 2SLS model. To take the potential endogeneity of tax rates into account we use tax competition as instrument for the tax rate. This instrument is constructed by a spatial inverse distance weight matrix. We also test for more complex shapes of the Laffer curve. Our findings suggest that the Laffer curve of Swedish municipality income tax does not have the traditional inverted U shape.

*Keywords: Laffer curve, taxes, regional governments*

## 1. Introduction

* Special thanks

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Can more tax revenue be raised? For Greece this question became urgent very fast in 2010. For Swedish municipalities, with aging populations and increasing demand for public services, it is a question asked with growing urgency. In both cases the elasticity of tax rates on tax revenues is at the heart of the analysis. Yet, explicit empirical estimations of tax revenue elasticities are not as common as might be expected. The objective of this paper is to investigate the revenue elasticity of Swedish local income tax.

The relation between tax rates and tax revenue is often referred to as the Laffer curve. One of the key features of the traditional Laffer curve is that it is downwards sloping for sufficiently high tax rates. The curve is thus shaped as an inverted U. A decreasing negative relationship for higher tax rates appears intuitive but, as discussed by Malcomson (1986), a negative relationship is not a theoretical necessity. Workers might fully turn to the unofficial market and the tax revenues would be based on those workers that are detected. However, support for an inverted U-shaped Laffer curve in capital tax and VAT, respectively, has previously been found (Haughwout, Inman, Craig, & Luce, 2004; Ireland, 1994). But empirical support for a U-shaped Laffer curve for income tax is less common (e.g. Agell and Persson (2001)). In cross country studies Sweden is often found to be close to or beyond the peak (Feige & Mcgee, 1983; Heijman & Van Ophem, 2005; Jonsson & Klein, 2003; Trabandt & Uhlig, 2011) making it an interesting case to study.

We complement previous research on Swedish data (Bastani & Selin, 2014; Blomquist & Selin, 2010; Gelber, 2014; Hansson, 2007; Holmlund & Söderström, 2011; Ljunge & Ragan, 2007; Selén, 2002) by looking at the local income tax, something that to our knowledge has not been done before in the Swedish context, and only sparsely at all (Haughwout et al., 2004). Using aggregated data and the local income tax, which is a flat tax, we can estimate a Laffer curve and thereby the tax revenue elasticity from a tax rate change. We see potential policy implications, that our result can be useful for prognoses and evaluations at local governments. Previous studies on income elasticities in Sweden are based on individual-level data. But even if the Laffer curve is single peaked for each individual, the aggregated Laffer curve is according to Spiegel and Templeman (2004) likely to be multiple-peaked due to the skewness of the income distribution and different peaks for different individuals. From the local council's point of view, the aggregated effect is of main interest since it determines the outcome, i.e., tax revenues that can be used to finance the provision of services for the residents. By using aggregated data we can also test the theoretical possibility of multiple peaks.

To account for the potential endogeneity problem between tax rates and taxable income we use an instrument variable approach where we tax competition between municipalities is used as an instrument. Our data set, consisting of 285 municipalities over 14 years, allowed us to use fixed effects. Our findings suggest that the local level income tax Laffer curve for Sweden does not have the inverted U-shape, and that the income elasticity varies over tax rates. Most municipalities can still increase revenue by raising the tax rate, but municipalities with tax rates between 17 and 20 percent might be on a downward slope.

The paper is organized as follow. The next section summarizes previous studies. Section 3 gives a background to the Swedish tax system. In Section 4 the theoretical and empirical specification is provided. In Section 5 the data is presented followed by the results in Section 6. The paper ends with concluding remarks in Section 7.

## 2. Previous studies

According to the setup of the traditional Laffer curve an increase in the tax rate decreases labor supply. The size of the negative effect from a tax increase will depend on the elasticity of supply of the input with respect to returns (Laffer, 2004). Early empirical studies on the effect of a tax rate change on income investigated the effect on labor supply only. However, other possible reactions are that individuals turn to the unofficial markets, engage in tax evasion, or alter their income source. Using labor supply will therefore potentially underestimate the effects from a tax change on income (Feldstein, 1995). The first paper that summarized these effects into the elasticity of taxable income was Lindsey (1987). Lindsey used a cross-section sample and was criticized for not taking into account the growing gap in income distribution. By analyzing the tax reform act of 1986 in the USA, where the marginal tax rates were reduced for the high-income groups, Feldstein (1995) addressed this problem and was the first to use panel data to investigate the sensitivity of taxable income to changes in tax rates. Since then there have been multiple studies on the effect of a tax change on income. Most of these have used micro data and natural experiments as identification strategies; see Saez, Slemrod, and Giertz (2012) for a review.

To our knowledge there are only a few papers that have examined Laffer curves of local taxes. Buettner (2003) used a GMM approach to investigate the effect changes in capital tax rates has on the tax base among a selection of German municipalities. In this paper the spatial correlation among tax rates and the effect changes to capital tax rates in neighbouring municipalities have on the tax base is also analysed. As the relationship between tax rate and tax base is what Laffer refers to as the economic effect, this is essentially an estimation of a Laffer curve. Using an endogenous growth setting Haughwout et al. (2004) looked at Laffer curves (tax income hills) for four cities in the USA: Houston, Minneapolis, New York City, and Philadelphia. The findings in this paper was that income or wage taxation has a significant negative effect on the tax base in New York, meaning that there could be an inverted U-shaped Laffer curve.

In studies of the Laffer curve, Sweden is often put forward as one of the developed countries that is closest to, or even beyond, the Laffer curve peak (Feige & Mcgee, 1983; Heijman & Van Ophem, 2005; Jonsson & Klein, 2003; Trabandt & Uhlig, 2011). But considering Sweden as one unit when it comes to income tax is problematic. Income tax revenue is in Sweden primarily collected at the local level which leads to variation in income tax rates. In the Swedish context there is a literature that investigates the elasticity of income with respect to income tax. These estimates of the income elasticity could then be used to calculate the dead weight loss of taxes and thereby the tax revenue elasticity (Feldstein, 1999). These papers have either used Swedish tax reforms, particularly the one in 1990/91, as a natural experiment (Blomquist & Selin, 2010; Gelber, 2014; Hansson, 2007; Ljunge & Ragan, 2007; Selén, 2002), or changes to the national income tax (Bastani & Selin, 2014; Holmlund & Söderström, 2011). Both tax reforms and the national income tax primarily affected high income earners. However, previous studies have shown that income elasticities differ between income groups (Saez et al., 2012). A focus on high income earners can result in estimations of average tax elasticities that suffer from selection bias. In addition, these studies are based on a sample of individuals. There is evidence suggesting that such estimates are sensitive to sample selection (Giertz, 2004). Our study relates to the work of Sørensen (2010), who provides an estimate of the tax base elasticity if all the employment income tax rates were simultaneously increased. We develop this further by considering the consequences of tax changes in a single municipality.

## 3. Institutional background

Sweden consists of 290 municipalities. These are primarily funded through a flat tax on employment income. Figure 1 shows the distribution of income to the sum of all municipal budgets according to income source in 2014. Tax provides 68 percent of total income.

(Figure 1 about here)

Each municipality sets its own income tax rate. All tax is collected by the central tax authority and then distributed to the municipalities. The income tax payment is automatically deducted from the employee's gross income and gross income is reported by the employer. Income tax is paid to the municipality where the tax payer was registered on 1 November the year prior to taxation. Municipalities' main expenditure is schooling, followed by elderly care. Distribution of total municipal expenditure in Sweden for 2014, distributed according to activities, are presented in Figure 2.

(Figure 2 about here)

Sweden is also divided in 21 different regions. The regions are also funded by a flat tax rate on employment income. They share the tax base with the municipalities within the region. Like the municipality the regions are free to decide the tax rate. The regions' major obligations are healthcare and public transportation.

Employment income tax is collected on income from labor, grants, and pensions. In 1991 Sweden completed "the tax reform of the century" to simplify the system and widen the tax base. The employment income tax is primarily collected on the municipal and regional levels. Tax rates are decided separately by the local and regional councils as part of a rule of local self-governance. The municipal tax rates for the years in this study ranges from 16.18 percent to 23.9 percent. The rate is the same for all inhabitants in a municipality that have an income above a minimum threshold[3]. Regional tax rates for the same period range from 9.13 percent to 12.27 percent. In addition to the local and regional income taxes there is also a national tax rate at 20 percent on labor incomes above a threshold (430 200 SEK or approx. 45 000 EUR for 2015) and an additional 5 percent (total 25 percent) on incomes above a second threshold (616 100 SEK or approx. 66 000 EUR for 2015).[4] Finally a tax on income was also collected by The Church of Sweden up until 2000 when this tax was removed, and partly replaced by a funeral fee (on average 0,22 percent for 2015).

[3] This threshold where 18739 SEK or approx. 2000 EURO in the year 2016

[4] The national tax was first introduced as a 20 percent tax on incomes above a threshold. In 1995 the rate was raised to 25 percent and since 1999 Sweden has had the system with two thresholds

Since 2008 Swedish municipalities also collect a property fee. The fee, set by the central government, is at most 0.75 percent on property value for detached houses, but with a maximum level (7 112 SEK or approx. 760 EUR per year for 2015). Municipalities are also funded by fees on services and by government grants. Employment income taxation in Sweden is also affected by the earned income tax credit. The earned income tax credit was gradually introduced between 2007 and 2012 and is a tax credit on income from labor.[5] Furthermore, employers are obliged to pay payroll taxes.[6]

## 4. Theoretical and empirical specifications

Following the theoretical results from Malcomson (1986) we do not make an a priori assumption that the relationship between tax rate and tax revenue is continuous for all tax rates. This means that we do not assume that the relationship is decreasing for high tax rates. Instead we employ a U-test to see if our data supports an inverted U-shaped Laffer curve. Based on the findings by Spiegel and Templeman (2004) that even if an individual Laffer curve has one single peak an aggregated Laffer curve can have multiple peaks due to income inequalities between individuals, we will also test for more complex shapes. Also here we use the U-test, if we find an ordinary U-shape in our data this implies a more complex shape, as the curve must start in the origin. We will control for some of the dynamic effect of a change in tax rate by including a lagged tax rate variable in the model as well.

Tax revenue is the product of tax rate and the tax base. Here the tax base is employment income. What makes the Laffer curve potentially downward sloping is that income is a function of the tax rate.

$$Rev = f(Tax) * Tax \quad (1)$$

Where $Rev$ is tax revenue and $Tax$ is the municipal tax rate. The correct specification of the functional form will depend crucially on the specification of $f(Tax)$. If income is linearly decreasing in the tax rate it implies that the Laffer curve has the traditional inverted U-shape.

[5] It is based on the municipal income tax rate and on employment income, but with a maximum amount of around 2000 SEK / approx. 215 EUR per month.
[6] The payroll tax is around 31 percent of the salary

From this simple analysis it is evident that the Laffer curve is multiplicative. A correctly specified functional form should thus be nonlinear.[7] However, our data does not cover the whole range of possible returns and tax rates. Multiplicative specifications force the estimation to consider the origin. As we can only estimate the relationship within the data range we attempt the conventional approach and estimate a reduced form with a specification linear in its arguments. Though this will not give the correct model, it will describe the rate of change in tax revenue from a change in the tax rate found in the data. Thus it will give us an estimate of the elasticity. To adjust for the possibility of nonlinearities we will also include higher order polynomials of the tax rate in the specification.

To test if there are nonlinearities the standard way is to include a quadric term. A negative and significant coefficient on the quadric term indicates an inverted U-shape (given that the coefficient on the non-quadric term is positive and significant). However, as pointed out by Lind and Mehlum (2010), these conditions are not sufficient to conclude that the data supports an inverted U-shape. Typically a squared term could be significant for any convex relationship, even if it is monotone. Lind and Mehlum (2010) state that even if the extreme point is within the data set, that is not sufficient to conclude that there is an inverted U-shape. A test for the U-shape needs to prove that the function is increasing in low values of the data and decreasing in high values.

In our setting, according to Lind and Mehlum (2010), to get necessary and sufficient conditions for an inverted U-shape we need to test the hypotheses

$$H_0^L\colon \beta_1 - \beta_2 f'(Tax_l) \geq 0 \; vs. H_1^L\colon \beta_1 - \beta_2 f'(Tax_l) < 0$$

$$H_0^H\colon \beta_1 - \beta_2 f'(Tax_h) \leq 0 \; vs. H_1^H\colon \beta_1 - \beta_2 f'(Tax_h) > 0$$

With the assumption of only one extreme point, we test if the slope is positive in the beginning and negative at the end of an interval $[Tax_l, Tax_h]$, where the interval is the data range $[\min(Tax), \max(Tax)]$.

Our baseline specification is:

$$\ln(Rev_{i,t}) = a_{i,t} + \beta_1 Tax_{i,t} + \beta_2 Tax^2{}_{i,t} + \beta_3 Tax_{i,t-1} + \beta_4 \boldsymbol{W} ln\big(DIncome_{j,t}\big) + \beta_5 \boldsymbol{X_{i,t}} + m_i + year + \varepsilon_{it} \quad (2)$$

[7] Also it cannot be linearized through the logarithm as that makes all power functions linear.

where $Rev_{i,t}$ is municipal tax revenue per capita and $Tax_{i,t}$ is the municipal tax rate. In response to Spiegel and Templeman (2004) we are also testing for multiple peaks, so our model will be extended to include higher order polynomials as well. $\boldsymbol{W}$ is an inverse distance weight matrix that takes into account that disposable income in neighbouring municipalities affects tax revenues in the municipality. The weight matrix gives higher weights to municipalities closer to the municipality's density core, if the municipality is in the same job market region[8]. $\boldsymbol{X_{i,t}}$ is a vector that includes control variables that will be explained below, and $\varepsilon_{it}$ is a municipal specific error term that varies across time.. To control for municipal-specific, time-constant, heterogeneity, such as location of the municipality and natural resources, we use fixed effects regression and include a municipality dummy variable $m_i$.

Year dummies (*year*) are added to filter out macro-economic changes that are equal across municipalities for a given year, such as national GDP growth, government bond rates, and different macro shocks. Perhaps even more importantly it will control for changes in central government policies, such as changes in government taxes. Cross-tax elasticities are often cited as a factor affecting income.[9] By including year dummies we control for national government tax rate changes, as long as they are equal for all municipalities. One remaining source of heterogeneity exists if the tax base relative to population is unevenly distributed among municipalities. For most taxes this is not an issue, but changes in the central government income tax rate apply only to those with sufficiently high income. To control for this we include the share of population that pays national income tax ($State\ tax\ share_{i,t}$). This should also capture effects associated with the relative distribution of high income earners. We also control for the unemployment rate ($Unemp_{i,t}$), as changes in payroll taxes will only affect those who are employed.

Unlike the national tax rates, regional tax rates will not be controlled for by year dummies. Regional tax rates $\left(Regional\, Tax_{i,t}\right)$ are included following Aronsson, Lundberg, and Wikstrom (2000), who find that municipal expenditures can in part be explained by the expenditures of the region. The reason is that the region and municipality use the same tax base. An expenditure decision at one level will therefore have an income effect on the other level. Given the structure of the Swedish income tax system such a relation could exist between municipal and regional income taxes. The same argument applies to the funeral

[8] Municipalities are divided into job market regions according to commuting patterns across municipalities

[9] (Holmlund & Söderström, 2011) used this to investigate the elasticity of income from tax rates.

fee ($Funeral\ fee_{it}$). Both of these are expected to have a negative effect on municipal tax revenue.

Grants are both vertical and horizontal, meaning that local governments receive (or pay) grants from (to) the national government and other municipalities, which are captured in the variable $Grants_{i,t}$. The variable is the sum of both the vertical and horizontal grants. These constitute about 30 percent of the total income for municipalities. Grants affect income only indirectly, as grants make it possible for municipalities to lower taxes without lowering the provision of publicly provided goods and services. As higher spending typically leads to higher income, since the municipality is usually the largest employer, the municipality could also maintain a tax rate and increase tax revenue because of grants. (Dahlberg, Mork, Rattso, & Agren, 2008) find that grants primarily affect municipal spending. We will therefore include grants in our regression.[10] Further, a municipality can also increase spending by taking on more debt. As increased spending will have a direct effect on income and thus on tax revenue debt ($Debt_{i,t}$) is included in the estimation. Note that we do not say anything about the long term effect of increasing investments by taking on debt.

Additional controls included in the model are variables that affect average income. The average income is expected to be negatively correlated with the unemployment rate ($Unemp_{i,t}$) as well as the share of the population who are elderly ($old_{i,t}$) and share of the population who are underage ($young_{i,t}$). We also include level of education ($Education_{i,t}$) which is assumed to have a positive effect on productivity and therefore on tax revenue. We ensure that controls are predetermined by using one year lags. To control for shocks during the year we use unemployment during the year.[11]

Since tax rates are decided at the end of the year before they are implemented there is a natural lag between income and tax rate. This reduces the risk of endogeneity. But tax rates will typically be decided based on prognosis of future revenue. As this prognosis will be related to future revenue there could be an endogeneity problem, in spite of the lag. To control for this

[10] In a robustness check we exclude *Grants* , but this does not alter our main results

[11] Including this year's unemployment rate means that a change from work to unemployment due to a tax increase is not allowed in the model, this is why we also test to include only the lagged unemployment rate. This leads to slight change in the point estimates for the income elasticity from -0.25 to -0.311 (Table 5 column 2) and from -0.353 to -0,442 (looking at table 5 column 5) This is an expected result as individuals now can go to unemployment reducing their income. However it might also be due to some exogenous chock to the different municipalities, as a large factory closing down etc. To read more about yardstick competition see e.g. Besley and Case (1995)

endogeneity we use an instrument variable approach. The instruments used in this study is tax competition $TC_{it}$ as well as yardstick competition $YC_{it}$. According to Edmark and Ågren (2008) neighboring municipalities in Sweden adapt tax rates to each other. This is consistent with the result found by Buettner (2003) for German municipalities. One way to incorporate such spatial dependence is by using a spatial matrix (Anselin, 1988). In this study we use two different weight matrixes, both based on the distance between the municipalities density core. The difference lies in the distribution of weights between municipality types. For the instrument on tax competition the weight matrix only gives weight to municipalities that are in the same job market region while municipalities not in the same job market region are given zero weight. The other weight matrix is based on the type of municipality, where municipalities categorized[12] as the same type are given a weight corresponding to the inverse distance to the density core. All municipalities that are not in the same category are given a zero weight. When we use the tax rate of the same year from neighboring municipalities as an instrument variable there is however still an income effect from neighboring municipalities as the population receives lower (or higher) disposable income when tax rates increase (decrease). To control for this we include a spatial income variable as a control variable ($\boldsymbol{W}ln(DIncome_{j,t})$). The tax decision is simultaneous among municipalities and we assume that the tax rate that is set in one municipality will affect the tax rate set by its neighbors.[13] This implies an assumption of asymmetric information between budget departments in municipalities and residents regarding future tax rates.

## 5. Data

We use panel data from Statistics Sweden over the years 2000-2013 for 285 out of 290 Swedish municipalities.[14] All municipalities in Sweden are affected by the same laws and institutions. They are free to set their own tax rate, which implies that tax rates vary between municipalities

[12] We use the classification of municipalities according to type used by The Swedish Association of Local Authorities and Regions. In this classification the following ten different types are identified (with number of municipalities given within parentheses): large cities with more than 200 000 residents (3); suburban municipalities (38); larger cities between 50 000-200 000 residents(31); commuter municipalities where 40 percent of the residents commute to work (51); tourism industry municipalities where the number of hotel nights over 21 per resident (20); manufacturing municipalities (54); sparsely populated municipalities (20); municipalities in densely populated region (35); municipalities in sparsely populated regions (16).

[13] We also test to include the lagged tax competition variable as a robustness check. This does not affect the results remarkably.

[14] Gotland is excluded due to that the county region and local government is one unit. We also exclude four other municipalities due to changes in their borders: Södertälje, Knivsta, Nykvarn, Heby.

for the same year and within the municipalities for different years. When analysing tax revenue elasticities one possible problem of estimating the full effect of a tax rate change can be that individuals may switch tax base and tax revenues may increase from another type of tax base. When we use local tax revenues, and only focus on the effects for the local government, we do not need to account for that an increase in the tax rate can cause individuals to switch income source - leading to an increase in another tax base (Saez et al., 2012). Since municipalities only rely on the employment income tax base, this will not affect their tax revenues.

The variable $old_{i,t-1}$ , is the share of the population who are above 74 years old.[15] The variable $young_{i,t-1}$ include people under the age of 15, which is the minimum age for employment. $Education_{i,t-1}$ is the share of people with at least three years of Post upper secondary education. $Funeral\ fee_{it}$, is a fee payed by everybody who is registered in Sweden and has a taxable income. The variable $Grants_{it}$ contains the net grants paid to, or taken from the municipality. There are three different types of grants, income grants, cost grants, and structural grants. The aim of the grants is to ensure that municipalities have equivalent financial opportunities to provide welfare to inhabitants irrespective of the structural conditions, such as the population structure, and the location. We also include a lagged dependent variable in our estimations.

Since people pay income tax in the municipality where they were registered on 1 November the year prior to taxation, i.e. in *t*-1, we do not capture the effect on tax revenues caused by residents that decide to move due to the tax rate change. We will thus be estimating a lower bound. However, this will make our tax competition variable valid. All monetary variables are deflated using the consumer price index and are then transformed in logs to normalize the distribution. However, because Grants can be either positive or negative, the variable has first been transformed to be positive only by defining it in hundred thousand SEK per capita and then adding the number one. This transformation affects the interpretation of the point estimates. An explanation of all variables used in the estimation is found in Table A1 in Appendix.

The taxable income per capita also has a larger variation, from 18475 SEK/1987 EUR to 57998 SEK/6236 EUR over the years.

[15] The purpose is to capture a share of the population who are not working and who often require more of local resources. Using 74 as a cut of is fairly standard internationally, but not obvious in Sweden where the pension age is 64. However, the share of people working after 64 is about half the number working just before 64 the share of people working after 74 are typically zero, which also is likely to reflect a less healthy population.

(Table 1a about here)

As we use fixed effects the variation within the municipalities over the time interval studied is an interesting measure, see Table 1b.

(Table 1b about here)

The within variation of the tax rates ranges from 19.9 percent to 22.9 percent, a variation of 3 percent. However, this is still a 15 percent increase in tax rate.

## 6. Results

The results from the first estimations are found in Table 2.[16] The Kleibergen-Paap Wald rk F statistic of the relevance of excluded instruments are found at the bottom of the Table.[17]

(Table 2 about here)

The results in column two show that the municipality tax rate has a negative coefficient and the squared tax rate coefficient is positive. This is consistent with a U-shaped Laffer curve, and not with an inverted U-shaped Laffer curve. The U-test supports a U-shape with a minimum point around a tax rate of 20 percent as can be seen in Figure 3.

(Figure 3 about here)

[16] According to the Breusch and Pagan Lagrangian multiplier test for random effects, the null hypothesis is rejected, which indicates that there are significant differences between municipalities. Thus we cannot use a pooled OLS. We also run the Modified Wald test, which rejects the null hypothesis of constant variance and motivates robust standard errors. Using the Wooldridge test for autocorrelation we can reject the null hypothesis that no serial correlation is present and conclude that cluster robust standard errors are needed. The Hausman test indicates that we should use fixed effects rather than random effects. After a Hausman test we conclude that IV is preferred over OLS. We therefore estimate equation (2) by using 2SLS.

[17] The Kleibergen-Paap rk Wald F statistic is the relevant statistic to use when testing for weak instruments if clustered robust standard errors are used, with critical values are taken from Stock and Yogo (2005) and based on the number of endogenous variables and the number of instruments. For to many endogenous variables no critical value is calculated, however the value of the test statistic is then too low to be significant, meaning not reported in the table.

Tax revenue must be zero when the tax rate is zero. This implies that we must have a maximum to the left of our estimated minimum. Following the logic behind the traditional Laffer curve we should also have a maximum to the right of our minimum point as no rational individual would give away their full income (Malcomson, 1986). But as discussed by Malcomson (1986) the curve might not be continuous for high tax rates. We can therefore not conclude that there are multiple peaks without testing the hypothesis. In column two of Table 2 the estimation results of a potentially multiple peaked Laffer curve are found. The coefficient on all four of the Tax rate variables are significant. In Figure 4 the values are plotted, yielding a graph with a minimum point at a tax rate of 20 percent and a possible maximum point at 17 percent. However in this estimations our instruments are weak so caution must be taken in interpreting the results.

(Figure 4 about here)

In figure 4 we see a second peak at 23 percent. This peak lies within the data which means that we estimate a decline in tax revenue elasticity for the highest tax rates in our data. But this does not mean that we can say that we have support for a multiple peaked Laffer curve. The U-test does not support the hypothesis of a peak in this region and based on the results of the test we cannot reject the possibility that the Laffer curve is monotonically increasing above the minimum at 20 percent tax rate.

The lagged tax rate coefficient is only significant in the single peaked Laffer curve estimation; the effect is then positive. One explanation could be that what we capture is that an increase in the tax rate increases revenue - which increases spending in the following period. The control variables in the estimations have the expected results, which gives some justifications for the model. Education has a positive and significant coefficient. This is as expected as people with higher education have higher mean income. The share of young people has a negative effect on tax revenues, as expected. So does the unemployment rate, where unemployed have a lower mean income. Debt has a positive effect on tax revenues, indicating that municipalities can increase tax revenues by increasing its debt. The share of individuals in the municipality paying state tax has a positive correlation with tax revenues as expected.[18] We have used two different instruments in these estimations both based on spatial weight matrixes. In Table A2 in

[18] To control for the influence of extreme values we limit our regression to tax rates between 19 and 23 percent and to control for influential data we exclude the three major Swedish cities, Stockholm, Göteborg, and Malmö. Our key findings holds also under these restrictions. We also run the estimations without the lagged dependent variable, and this does not affect our results. We try to increase the number of liberties by using regional fixed effects, but a hausman test suggests that we should use municipal fixed effects.

Appendix the result from the estimations with a single weight matrix is shown. The results does not change depending on weight matrix for our single peaked Laffer curve estimations. Turning to multiple peaks estimations when the yardstick competition matrix is used all four coefficients on the tax rate are insignificant, and the instrument is too weak as before, in both estimations of the multiple peaked Laffer curve.

### 6.1. Income elasticities

To be able to compare our results to previous studies using Swedish data we want to estimate the income elasticity of tax rate changes as well as the net of tax rate[19] elasticity. When estimating a single measure of the elasticity it either implies that the elasticity is the same across individuals or that the average elasticity across individuals has a meaningful interpretation. Given this assumption we can use our aggregated data and measure the average elasticity across municipalities, by the constant elasticity specification:

$$\ln(Income) = a_{i,t} + \beta_1 \ln(Tax_{i,t}) + \beta_2 \ln(Tax_{i,t-1}) + \beta_4 \boldsymbol{W} ln\left(DIncome_{j,t}\right) + \beta_5 \boldsymbol{X_{i,t}} + m_i + year + \varepsilon_{it} \quad (3)$$

Also here we take the lagged effect from a tax increase into account and calculate the elasticity by taking $(\beta_1 + \beta_2)$ to obtain the total elasticity. Table 3 presents the results of the estimated average income elasticities, using the tax rate as a percentage.

(Table 3 about here)

First we estimate the income elasticity with respect to the tax rate, see column 1 of Table 3. The estimated coefficient is -1.061 and it is significantly different from zero. If we take into account the lagged effect the elasticity is -0.30, which means that a one percentage increase in the tax rate will reduce income with 0.3 percent. Second we estimate the income elasticity of the net of tax rate. Table 3 column 2 shows that the elasticity is 1.164 percent with the lagged effect included, meaning that a decrease in the tax rate would increase the income with 1.164 percent.[20]

[19] Net of tax rate is 1-tax rate.

[20] As with the Laffer curve estimations we also test to run the different instruments by themselves. The results can be found in Table A3 in Appendix and the estimates of the income elasticity does not change remarkably.

We conduct a test of the validity of our instruments by including a second instrument that is based on how people have voted in the local elections.[21] This does not alter the results much. The tax revenue elasticity is now at around -0.271, as can be seen in column 3 of Table 3. We also test using only the policy instrument, without the tax competition instruments, but the instrument is too weak, resulting in an insignificant coefficient for the net of tax elasticity. Still, the estimate of the income elasticity does not change remarkably depending on which instruments that are used. This speaks in favor of the results and our instruments. The Hansen J test statistic does not reject the hypothesis that our instruments are valid. As the instruments are based on different factors moving the tax rate, this also speaks in favor for the validity of our tax competition instrument (Murray, 2006)

If the Laffer curve of Swedish municipal income tax does not have the traditional U-shape there is reason to be careful when using average elasticities to calculate Laffer curves. To describe the implications of our results for Swedish municipalities we look at the implied revenue elasticities. If we first analyze the income elasticity estimated earlier at -0.3 percent, this result implies a tax revenue elasticity of 0.7[22] at the average tax level. Hansson (2007) uses the approach from Feldstein (1999) to calculate the implied Laffer curve of an elasticity of similar size. The result is a right skewed inverted U-Shaped Laffer curve. Turning to our Laffer curve estimations, to calculate the elasticity of tax revenue we first need to transform it to get the elasticity of tax revenues suppressing indexes, and replacing all control variables by a constant ($C$). This yields:

$$Rev = e^{a+\beta_1 Tax+\beta_2 Tax^2+C} \tag{4}$$

Taking the derivative of Equation 4 yields

[21] The instrument ($Right\ wing_{i,t}$) is a dummy variable equal to one if the ruling party in the local government is from any of the right wing parties. The instrument is relevant if right wing parties are more in favor of lower taxes. The instrument is invalid if changes in political power are affected by changes in mean income, e.g. if individuals change their voting behavior along with their income, or if there is migration of individuals with similar political views and income. Drawing on Holmberg, Näsman, and Wännström (2012) we do not perceive the first issue to cause a significant problem. The second is potentially more problematic if migration is large enough. Endogeneity will also arise if people punish actual poor management. According to (Holmberg, 1993) little weight is generally put on municipal considerations in Swedish elections.

[22] The elasticity is calculated using an average income of 135000 SEK times tax rate of 20 % and a tax revenue of 27000 SEK. A one percent increase yields a tax rate of 20.2 %, an income elasticity of -0.3 yields a new average income of 134595 SEK and a tax revenue of 27188 SEK, Thus ((27188-27000)/27000)*100 = 0.7

$$\frac{dRev}{dTax} = (\beta_1 + 2 * \beta_2 * Tax) * e^{a+\beta_1 Tax + \beta_2 Tax^2 + C} \quad (5)$$

From Equation 2 we have that $a + \beta_1 Tax + \beta_2 Tax^2 + C = \ln(Rev)$ and substituting this into equation 5 and multiplying by $\frac{Tax}{Rev}$ on both sides of Equation 5 yields

$$\epsilon_{TR} = (\beta_1 + 2 * \beta_2 * Tax) * Tax \quad (6)$$

Results from calculating this elasticity for different tax rates are found in Table 4. Note that these elasticities are based on the point estimates from Table 2.

(Table 4 about here)

According to Table 4 the elasticity varies with different tax rates, so using a single measure for income elasticity when calculating the tax revenue elasticity would yield a single tax revenue elasticity as well. The elasticities vary from positive to negative which implies that the tax rate chosen will result in higher or lower tax revenues. Common to all elasticities despite sign is that they are smaller than one, meaning that a one percent increase in tax rates yields a smaller increase in the tax revenues or even a decrease, there is a deadweight loss from raising taxes. Here it is important to remember that we have excluded the migration effect. We are therefore estimating an upper bound for the elasticities.

## 6.2. Discussion

Many previous studies find that the net of tax income elasticity in Sweden is moderately high. Hansson (2007) estimates an elasticity of taxable income of between 0.4 and 0.5 and Bastani and Selin (2014) estimate the corresponding elasticity at 0.39. Blomquist and Selin (2010) report a taxable labor income elasticity estimates of between 0.96 and 1.44 for women and only between 0.19 and 0.21 for males. These results are not too far from our findings regarding an income elasticity of 0.3. The interest in this paper is however primarily on the elasticity of tax revenue and our results regarding the Laffer curve indicate that it is not obvious how to translate the estimates of income elasticities into the elasticity of tax revenue at different tax rates. To translate a point estimate of the income elasticity into a Laffer curve we must be able to model the relationship between tax rates and income. The generalizability of an income elasticity estimated at a particular tax rate or averaged across tax rates can therefore be problematic. We will now briefly discuss what our results might mean for this understanding.

Since the Laffer curve we estimate is no single peaked curve the elasticity of income cannot be monotonic in the tax rate. One way to generate this is by specifying a utility function for the individual that has this property. Income elasticity estimates could then be generalized using the utility function as it would be identical for all individual. However, our result regarding the Laffer curve does not follow from the specifications most often used in the literature (Feldstein, 1999). Following Spiegel and Templeman (2004) our results could also be explained if individuals have single peaked Laffer curves but with peaks at different tax rates. If income distribution is skewed the result would be a Laffer curve with multiple peaks. Our results could then be explained in a setting where individuals differ but the context is equivalent across municipalities. If this is the case our Laffer curve could correctly describe tax revenue elasticity in Sweden and be used to evaluate tax rates. It could be argued that income distribution alone should not be driving our results as we, to some extent, indirectly control for income distribution through the control variables $State\ tax\ share_{i,t}$ and $Unemp_{i,t}$. But these controls can only possibly cover two kinks in income distribution.

Another potential explanation is that municipalities differ from each other. If we people have different sensitivity to tax rates the Tiebout hypothesis could imply that people who are more sensitive to tax rates self-select and move to municipalities where the tax rate is lower. If a municipality with a low tax rate and with a population that is sensitive to tax rates changes the tax rate the response could be greater than a similar tax rate change in a municipality with higher initial tax rate but a less sensitive population. Tax changes are most often small and the within variation is much smaller than the between variation. The difference in willingness to pay tax could therefore produce multiple peaks in our estimation.[23] If difference in the individual Laffer curves depends on income the self-selection would result in skewed distribution of income across municipalities and this could be the explanation to the shape of our Laffer curve.

[23] Such a difference in willingness to pay tax across municipalities should be possible to control for by including the interaction between tax rate and municipality, but this is to demanding for our data set.

## 7. Concluding Remarks

The purpose of this paper was to investigate the revenue elasticity of Swedish local income tax. We estimated the effect tax rate changes has on tax revenue for municipalities in Sweden. We estimate a lower bound of the income effect as we do not include the migration effect. Because we estimate the relations between tax rates and tax revenue for different values of the tax rates our estimation takes the form of a Laffer curve. The key finding is that the graph has a minimum point at about 20 percent. We have briefly discussed –that this could be explained by distribution of income and self-selection. But both explanations are based on differences in individual elasticities and our aggregate data is not suitable to investigate differences between individuals. This question should be studied using individual data.

Our findings regarding the elasticity of income tax rate should be treated with caution. The single peaked Laffer curve cannot represent the true form since the curve must go through the origin and elasticities from the multiple peaked Laffer curve is very sensitive to small variations in the coefficients. It is also important to remember the migration effect, which we have not been able to estimate here. Neither do we control for the long run effect on income growth from a tax increase, where the effects of a tax rate may have an effect on the growth rate. We have estimated a negative direct effect from a tax increase on tax revenues. The lag effect has been positive, which could be an effect from increased consumption for the local government in the following period of a tax increase. Our point estimates suggest that the majority of Swedish municipalities can still raise more revenues by increasing tax rates. For tax rates around the median the deadweight loss is also limited, but this relationship only holds for a small range of tax rates.

The elasticity estimated in this paper is specific to the Swedish context and the municipal income tax rate. To what extent it applies in other settings depends on differences compared to the Swedish context. According to Heijman and Van Ophem (2005) and Kleven (2014) Sweden has a high willingness to pay tax compared to other countries. Arguably then an upper bound in Swedish data should be an upper bound also outside Sweden. Regarding our finding that elasticities vary across individuals we cannot claim that it holds outside our context.

For future studies it would be interesting to complement this study with an estimation of the migration effect. It would also be interesting to investigate the causes of the U-shape in the Laffer curve estimated here. Another interesting topic would be to analyze the labor supply elasticity for the local income taxes. This can then be compared to the total tax elasticity to get even further policy implications. If the labor supply elasticity is low it can be argued that for a municipality to raise more tax revenues they should try to reduce the loop holes in the tax system, reducing tax avoidance and evasion and thereby increase tax revenues. Another result that might be interesting to study further is that tax revenue elasticity is largest in a limited range around the median. This might be understood in the context of tax competition.

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Figure 1: Total municipal income according to income source in 2014.[24]

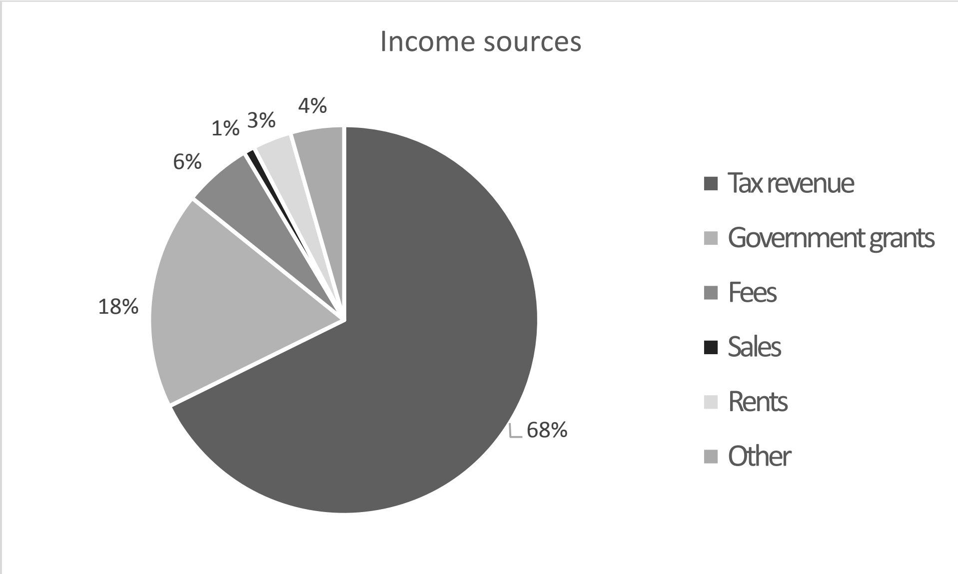


Figure 2: Distribution of total municipal expenditure in Sweden for 2014

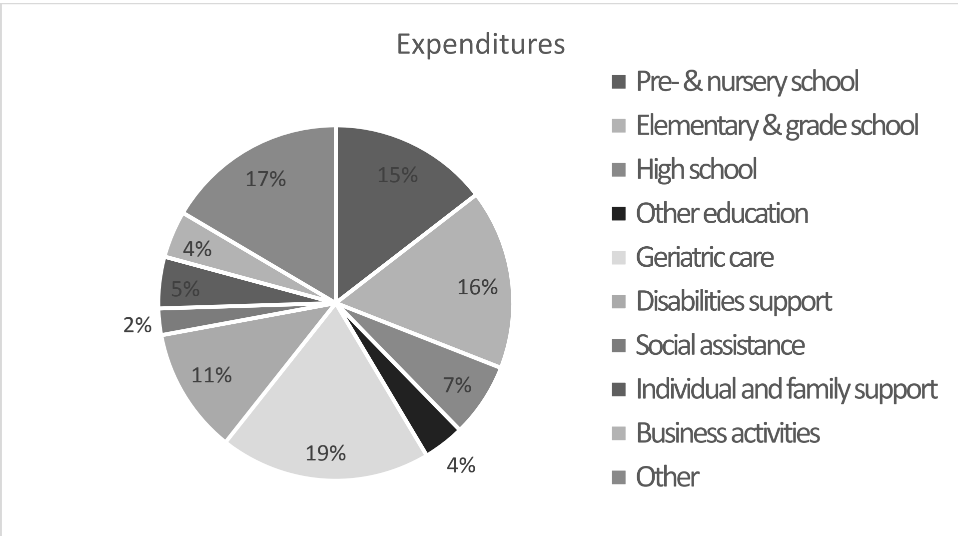


Figure 3: A plot of the Laffer curve from Table 2 Estimation 1

[24] Fees is income from services that carries a fee, Sales is income from services sold for example to other municipalities, Rents is income from property rents.

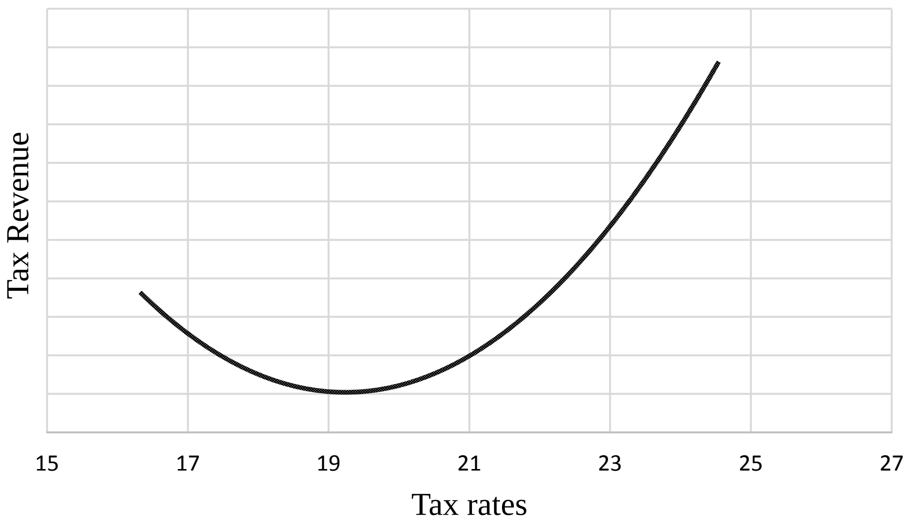


Figure 4: A plot of the Laffer curve from Table 2 Estimation 2

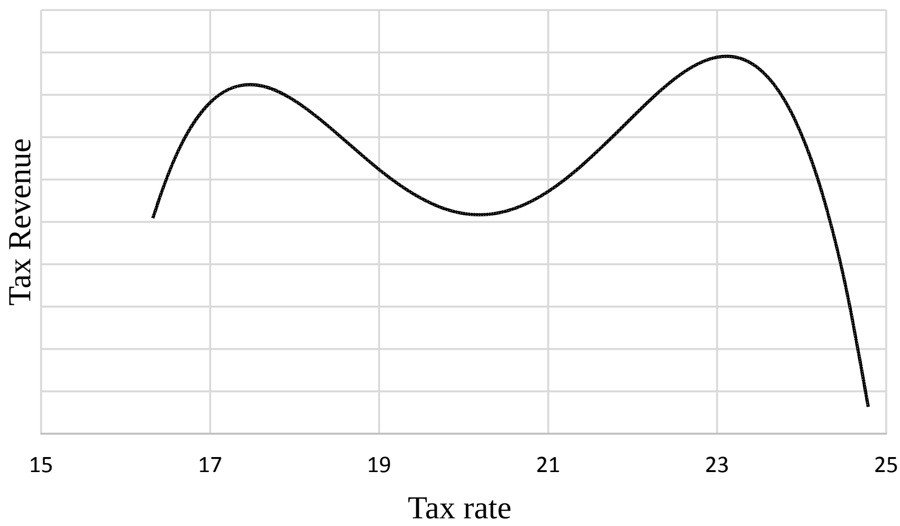


Table 1a: Summary statistics

| Variables | N | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| *Rev* | 3,990 | 31,982 | 5,209 | 18,475 | 57,998 |
| *Tax rate* | 3,990 | 21.39 | 1.155 | 16.18 | 23.90 |
| *Income* | 3,990 | 139,762 | 26,424 | 81,775 | 317,187 |

| | | | | | |
|---|---|---|---|---|---|
| *Grants* | 3,990 | 8,197 | 4,982 | -15,709 | 27,949 |
| *Young* | 3,990 | 0.171 | 0.0221 | 0.113 | 0.246 |
| *Old* | 3,990 | 0.0987 | 0.0219 | 0.0319 | 0.170 |
| *Policy* | 3,990 | 44.19 | 11.66 | 7.200 | 82.30 |
| *Debt* | 3,990 | 21,650 | 13,250 | 1,483 | 95,439 |
| *Funeral fee* | 3,990 | 0.260 | 0.0617 | 0.100 | 0.400 |
| *Education* | 3,990 | 0.140 | 0.0676 | 0.0481 | 0.546 |
| *Financial costs* | 3,990 | 600.4 | 674.4 | -22.72 | 13,898 |
| *Unemp* | 3,990 | 0.0395 | 0.0175 | 0.00800 | 0.137 |
| *Regional Tax rate* | 3,990 | 10.45 | 0.620 | 9.220 | 12.27 |
| *DIncome* | 3,990 | 96,282 | 19,667 | 29,033 | 170,306 |
| *State Tax Share* | 3,990 | 0.0983 | 0.0426 | 0.0275 | 0.327 |

Table 1b: Summary statistics Tax rates

| Variable | | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| *Tax rate* | Overall | 21.39 | 1.155 | 16.18 | 23.9 |
| | Between | | 1.12 | 17.37 | 23.57 |
| | Within | | 0.28 | 19.86 | 22.87 |

Table 2: Laffer curve estimation

| Dependent variable: ln(Rev) | (1) | (2) |
|---|---|---|
| $Tax$ | $-0.230^{***}$ | $34.907^{**}$ |
| | (0.06) | (13.58) |
| $Tax^2$ | $0.006^{***}$ | $-2.619^{***}$ |
| | (0.00) | (1.02) |
| $Tax^3$ | | $0.087^{***}$ |
| | | (0.03) |
| $Tax^4$ | | $-0.001^{**}$ |
| | | (0.00) |
| *Lag Tax* | $0.013^{*}$ | 0.007 |
| | (0.01) | (0.01) |
| *ln(lag Rev)* | $0.492^{***}$ | $0.496^{***}$ |
| | (0.06) | (0.08) |
| $Young$ | $-0.415^{***}$ | $-0.427^{***}$ |
| | (0.09) | (0.11) |
| *Old* | -0.041 | -0.096 |
| | (0.09) | (0.10) |
| *Education* | $0.205^{***}$ | $0.236^{***}$ |
| | (0.07) | (0.09) |
| *Unemp* | $-0.258^{***}$ | $-0.275^{***}$ |
| | (0.04) | (0.05) |
| *Debt* | $0.003^{**}$ | $0.004^{***}$ |
| | (0.00) | (0.00) |
| *State Tax Share* | $1.170^{***}$ | $1.235^{***}$ |
| | (0.12) | (0.15) |
| *Grants* | -0.004 | 0.024 |

| | | |
|---|---|---|
| | (0.06) | (0.06) |
| *Regional Tax* | -0.002* | 0.000 |
| | (0.00) | (0.00) |
| *Funeral Fee* | 0.016 | 0.033 |
| | (0.04) | (0.04) |
| *DIncome* | -0.000 | -0.002 |
| | (0.01) | (0.01) |
| *N* | 3990 | 3990 |
| adj. $R^2$ | 0.982 | 0.981 |
| *AIC* | -24702.7 | -24443.7 |
| *Instruments* | Tax comp<br>*Yardstick comp* | Tax comp<br>*Yardstick comp* |
| *Hansen J Statistic* | 7.941 | 9.980 |
| *P-value* | 0.1595 | 0.1897 |
| *Underidentification test* | 38.572 | 22.974 |
| *P-value* | 0.0000 | 0.0034 |
| *Kleibergen-Paap rk Wald F statistic* | 12.811 | 2.883 |
| *Critical value 10%* | 9.01 | - |
| *U-test minimum point* | 19.56 | |
| *P-value* | 0.000 | |

Note: Cluster robust standard errors in parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bothe time and year fixed effects are used (not reported)

Table 3: Income tax elasticities

| *Dependent variable ln(income)* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *ln(Tax)* | -1.061*** | | -1.022*** | -0.417 |
| | (0.13) | | (0.13) | (0.59) |
| *Ln(Lag Tax)* | 0.761*** | | 0.751*** | 0.664 |
| | (0.11) | | (0.11) | (0.50) |
| *ln(lag Rev)* | 0.653*** | 0.655*** | 0.653*** | 0.639*** |
| | (0.02) | (0.03) | (0.02) | (0.03) |
| *ln(1-Tax)* | | 4.361*** | | |
| | | (0.57) | | |
| *ln(1-lag Tax)* | | -3.197*** | | |
| | | (0.49) | | |
| *Young* | -0.338*** | -0.324*** | -0.338*** | -0.351*** |
| | (0.08) | (0.08) | (0.07) | (0.07) |
| *Old* | -0.046 | -0.041 | -0.046 | -0.052 |
| | (0.08) | (0.08) | (0.08) | (0.08) |
| *Education* | 0.060 | 0.046 | 0.065 | 0.165** |
| | (0.04) | (0.04) | (0.04) | (0.08) |
| *Unemp* | -0.221*** | -0.221*** | -0.226*** | -0.318*** |
| | (0.03) | (0.04) | (0.03) | (0.06) |
| *Debt* | 0.004*** | 0.004*** | 0.004*** | 0.000 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *State Tax Share* | 0.942*** | 0.941*** | 0.943*** | 0.964*** |

| | | | | |
|---|---|---|---|---|
| | (0.11) | (0.11) | (0.11) | (0.09) |
| *Grants* | $0.107^{**}$ | $0.109^{**}$ | $0.113^{**}$ | $0.220^{**}$ |
| | (0.04) | (0.05) | (0.05) | (0.09) |
| *Regional Tax* | $-0.005^{***}$ | $-0.005^{***}$ | $-0.005^{***}$ | $-0.005^{***}$ |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *Funeral Fee* | 0.011 | 0.009 | 0.012 | 0.025 |
| | (0.03) | (0.04) | (0.03) | (0.04) |
| *DIncome* | $-0.017^{*}$ | $-0.016^{*}$ | $-0.016^{*}$ | -0.002 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| *N* | 3990 | 3990 | 3990 | 3990 |
| adj. $R^2$ | 0.976 | 0.974 | 0.977 | 0.982 |
| *AIC* | -24321.5 | -23945.2 | -24450.6 | -25384.2 |
| *Instruments* | Tax competition<br>Yardstick comp | Tax competition<br>Yardstick comp | Tax competition<br>Yardstick comp<br>Right wing | Right wing |
| *Hansen J Statistic* | 3.339 | 3.597 | 6.918 | - |
| *P-value* | 0.1883 | 0.1656 | 0.1403 | - |
| *Underidentification test* | 41.051 | 43.983 | 47.418 | 12.209 |
| *P-value* | 0.0000 | 0.0000 | 0.0000 | 0.0005 |
| *Kleibergen-Paap rk Wald F statistic* | 20.178 | 20.068 | 14.592 | 6.590 |
| *Critical value 10%* | 11.04 | 7.56 | 9.48 | 7.03 |

Note: Cluster robust standard errors in parenthesis, $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$. Bothe time and year fixed effects are used (not reported)

Table 4: Analyses of elasticities of tax revenue for different tax rates

| Model | | Single peaked | Multiple peaks |
|---|---|---|---|
| Tax rate | *Percentiles of Tax rate distribution* | $\epsilon_{TR} = \frac{d(Rev)}{dTax} * \frac{Tax}{Rev}$ | $\epsilon_{TR} = \frac{d(Rev)}{dTax} * \frac{Tax}{Rev}$ |
| 17 | | -0.57 | 0.66 |
| 18 | | -0.40 | -0.46 |
| 19 | | -0.20 | -0.61 |
| 20 | | 0.02 | -0.13 |
| 20.84 | 25 | 0.22 | 0.45 |
| 21 | | 0.26 | 0.55 |
| 21.56 | 50 | 0.41 | 0.81 |
| 22 | | 0.53 | 0.86 |
| 22.25 | 75 | 0.60 | 0.81 |
| 23 | | 0.82 | 0.17 |

## Appendix

Table A1: Description of the variables included in the estimations

| Variable | Description | Source |
|---|---|---|
| $DIncome$ | Disposable income for residents in municipality i year t. | Official statistics from Statistics Sweden |
| $Income$ | Mean taxable income for residents in municipality i year t | |
| $Rev$ | The per capita tax revenues for municipality i in year t. Calculated by taking the average taxable income for individuals living in the municipality the 31 of December year t times the tax rate for the municipality. | Official statistics from Statistics Sweden |
| $Right\ wing$ | A dummy variable equal to one if the ruling is the right wing parties | Official statistics from Statistics Sweden |
| $Pop$ | Total population of municipality *i* in year *t* | Official statistics from Statistics Sweden |
| $Policy$ | Share of people in the municipality voting for the left wing parties. | Official statistics from Statistics Sweden |
| $Unemp$ | Average annual unemployment rate for municipality *i* in year *t* | The Swedish employment office |
| $Tax$ | Total tax rate: the sum of local and regional taxes for municipality *i* in year *t* | Official statistics from Statistics Sweden |
| $Education$ | Proportion of the population (ages 25-74) with at least three years of university education for municipality *i* in year *t* | Official statistics from Statistics Sweden |
| $Grant$ | Total intergovernmental grants, measured in SEK per capita, for municipality *i* in year *t* | Official statistics from Statistics Sweden |

| | | |
|---|---|---|
| ***Funeral Fee*** | The funeral fee tax rate payed in municipality i year t. | Official statistics from Statistics Sweden |
| ***Regional Tax*** | The county tax rate payed in municipality i year t. | Official statistics from Statistics Sweden |
| ***State Tax Share*** | Share of people in the municipality that have a high enough income to be obligated to pay state tax. | Official statistics from Statistics Sweden |
| ***Young*** | Share of the population between ages zero to fifteen for municipality *i* in year *t* | Official statistics from Statistics Sweden |
| ***Old*** | Share of the population older than 65 years of age for municipality in *i* year *t* | Official statistics from Statistics Sweden |

Table A2 Laffer curve estimation

| Dependent variable: ln(Rev) | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $Tax$ | -0.368*** | 34.163** | -0.297*** | 31.414 |
| | (0.07) | (16.60) | (0.11) | (23.44) |
| $Tax^2$ | 0.009*** | -2.578** | 0.007*** | -2.344 |
| | (0.00) | (1.25) | (0.00) | (1.76) |
| $Tax^3$ | | 0.086** | | 0.077 |
| | | (0.04) | | (0.06) |
| $Tax^4$ | | -0.001** | | -0.001 |
| | | (0.00) | | (0.00) |
| *Lag Tax* | 0.011 | 0.011 | 0.024** | 0.028** |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| *ln(lag Rev)* | 0.444*** | 0.478*** | 0.385*** | 0.295** |
| | (0.07) | (0.07) | (0.13) | (0.15) |
| $Young$ | -0.416*** | -0.441*** | -0.495*** | -0.551*** |
| | (0.10) | (0.11) | (0.13) | (0.16) |
| *Old* | -0.026 | -0.084 | -0.055 | -0.130 |
| | (0.11) | (0.10) | (0.10) | (0.14) |
| *Education* | 0.271*** | 0.235*** | 0.269** | 0.384*** |
| | (0.08) | (0.08) | (0.11) | (0.14) |

| | | | | |
|---|---|---|---|---|
| *Unemp* | -0.262*** | -0.288*** | -0.290*** | -0.302*** |
| | (0.05) | (0.06) | (0.06) | (0.08) |
| *Debt* | 0.003* | 0.004*** | 0.003* | 0.004 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *State Tax Share* | 1.242*** | 1.251*** | 1.316*** | 1.522*** |
| | (0.12) | (0.15) | (0.21) | (0.24) |
| *Grants* | -0.040 | 0.010 | -0.076 | -0.126 |
| | (0.06) | (0.06) | (0.09) | (0.11) |
| *Regional Tax* | -0.000 | 0.000 | -0.002 | 0.001 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *Funeral Fee* | 0.021 | 0.028 | 0.013 | 0.030 |
| | (0.05) | (0.04) | (0.05) | (0.06) |
| *DIncome* | 0.007 | -0.004 | 0.007 | 0.017 |
| | (0.01) | (0.01) | (0.01) | (0.02) |
| *N* | 3990 | 3990 | 3990 | 3990 |
| adj. $R^2$ | 0.980 | 0.980 | 0.979 | 0.970 |
| *AIC* | -24341.9 | -24340.9 | -24034.0 | -22670.2 |
| *Instruments* | Tax comp | Tax comp | *Yardstick comp* | *Yardstick comp* |
| *Hansen J Statistic* | 0.002 | 2.257 | 1.147 | 0.445 |
| *P-value* | 0.9674 | 0.1330 | 0.2841 | 0.5047 |
| *Underidentification test* | 24.438 | 13.449 | 8.015 | 9.891 |
| *P-value* | 0.0000 | 0.0012 | 0.0182 | 0.0071 |
| *Kleibergen-Paap rk Wald F statistic* | 8.202 | 2.611 | 2.180 | 3.874 |
| *U-test minimum point* | 19.74 | | 20.07 | |
| *P-value* | 0.000 | | 0.006 | |

Note: Cluster robust standard errors in parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bothe time and year fixed effects are used (not reported)

Table A3: Income tax elasticities

| *Dependent variable ln(income)* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *ln(Tax)* | -1.120*** | | -0.969*** | |
| | (0.13) | | (0.14) | |
| *Ln(LagTax)* | 0.767*** | | 0.719*** | |
| | (0.12) | | (0.11) | |
| *ln(lag Rev)* | 0.655*** | 0.657*** | 0.652*** | 0.654*** |
| | (0.02) | (0.03) | (0.02) | (0.02) |
| *ln(1-Tax)* | | 4.698*** | | 3.958*** |
| | | (0.59) | | (0.62) |
| *ln(1-lagTax)* | | -3.326*** | | -2.983*** |
| | | (0.53) | | (0.50) |
| *Young* | -0.336*** | -0.323*** | -0.338*** | -0.325*** |
| | (0.08) | (0.08) | (0.07) | (0.07) |
| *Old* | -0.045 | -0.041 | -0.045 | -0.040 |
| | (0.08) | (0.08) | (0.07) | (0.08) |

| | | | | |
|---|---|---|---|---|
| *Education* | 0.050 | 0.034 | 0.070* | 0.058 |
| | (0.04) | (0.04) | (0.04) | (0.04) |
| *Unemp* | -0.211*** | -0.212*** | -0.230*** | -0.230*** |
| | (0.04) | (0.04) | (0.03) | (0.03) |
| *Debt* | 0.004*** | 0.005*** | 0.004*** | 0.004*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *State Tax Share* | 0.940*** | 0.939*** | 0.943*** | 0.942*** |
| | (0.11) | (0.11) | (0.11) | (0.11) |
| *Grants* | 0.096** | 0.098** | 0.118** | 0.120** |
| | (0.04) | (0.05) | (0.05) | (0.05) |
| *Regional Tax* | -0.005*** | -0.005*** | -0.005*** | -0.005*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| *Funeral Fee* | 0.009 | 0.006 | 0.014 | 0.012 |
| | (0.03) | (0.04) | (0.03) | (0.03) |
| *DIncome* | -0.018** | -0.018* | -0.015* | -0.015* |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| *N* | 3990 | 3990 | 3990 | 3990 |
| adj. $R^2$ | 0.975 | 0.972 | 0.978 | 0.976 |
| *AIC* | -24120.3 | -23642.7 | -24622.1 | -24301.1 |
| *Instruments* | Tax comp | Tax comp | Yardstick comp | Yardstick comp |
| *Underidentification test* | 26.490 | 27.053 | 35.313 | 38.494 |
| *P-value* | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| *Kleibergen-Paap Wald F statistic* | 19.369 | 17.396 | 37.025 | 37.139 |
| *Critical value10%* | 7.03 | 7.03 | 7.03 | 7.03 |

Note: Cluster robust standard errors in parenthesis, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bothe time and year fixed effects are used (not reported)