Lukas Preitler, B.A. (Econ.)

Taxes and Revenues for Austria

Estimation of the Laffer Curve and Simulation of an Equilibrium Model

to be awarded the degree of

Master of Science

in Political and Empirical Economics – Politische und Empirische Ökonomik

at the University of Graz

Supervised by

Dr. Michael Scholz

Department: Institute of Economics – Institut für Volkswirtschaftslehre

Graz, December 2018

Author's Declaration

Unless otherwise indicated in the text or references, or acknowledged above, this thesis is entirely the product of my own scholarly work. Any inaccuracies of fact or faults in reasoning are my own and accordingly I take full responsibility.

This thesis has not been submitted either in whole or part for a degree at this or any other university or institution.

This is to certify that the printed version is equivalent to the submitted electronic one.

Table of Content

List of Figures

List of Tables

List of Abbreviations

Short forms

VAT	Value-added tax
MTU	Model of Trabandt and Uhlig (2010)
NAR	National Account Report
GDP	Gross domestic product

Common Abbreviations

T	(Total) tax revenue
X	Tax base
Y	Tax base
τ	Tax rate
τ	Average tax rate
ß	Estimation parameter
u	Error term, independent, identical, distributed

National Account data

CP	Private final consumption expenditure
CG	Government final consumption expenditure.
CGW	Government final wage consumption expenditure.
OS	Gross operating surplus of the overall economy
OSPUE	Unincorporated business net income (including imputed rentals on owner-occupied housing)
PEI	Interest, dividends and investment receipts
KI	Capital income[1]
W	Wages and salaries of dependent employment.
WSSS	Compensation of employees
Afa	Consumption of fixed capital

Revenue statistics

1100	Taxes on income, profits and capital gains of individuals or households.
1200	Taxes on income, profits and capital gains of corporations
2000	Total social security contributions (2100 is paid by employees; 2200 by employers; 2300 by the self-employed and persons outside of the labour force; 2400 is unallocated)
3000	Taxes on payroll and workforce
4000	Taxes on property
5110	General taxes on goods and services (5111 VAT)
5120	Taxes on specific goods and services (5121 excise taxes; 5122 profits of fiscal monopolies; 5123 customs and import duties; 5126 taxes on specific services; 5128 other taxes)
5200	Taxes on use of goods and performances

[1] KI (Capital income) is not reported by the OECD; this is the additional combination of OSPUE and PEI.

Trabandt and Uhlig model

c	Consumption
n	Labour
k	Capital
x	Investment
b	Government bonds
u	Utility function of private good consumption
v	Utility function of public good supply
g	Public good supply
w	Wage rate
d	Dividends
δ	Depreciation rate
k	Capital stock
R^b	Received interest earnings
s	Lump-sum transfer
m	Constant money stream, captures the net imports
y	Output of production
ξ	Total productivity of production factors
θ	Capital share of production
κ	Weight on labour
φ	Constant Frisch Elasticity (CFE)
ψ	Growth rate

Subscripts

h	Household
c	Consumption
k	Capital
n	Labour
nc	Combination of labour and consumption
t	Time

1 Introduction

Benjamin Franklin once stated, “In this world, nothing can be said to be certain, except death and taxes”. Taxation takes place in every (economic) activity in a market economic society. Therefore, in my opinion, taxation is one of economic research’s central topics. Taxes influence market processes by changing relative prices. In modern economics, numerous activities are influenced by taxation even if they are not taxes themselves, as the relative price of taxed alternatives increases via taxation.

Modern states have two main reasons for taxation:

i) Gain revenue to fund state activities, such as social welfare, the education system, the promotion of culture and public transport systems.

ii) To correct market failures (externalities) and reduce the consequences of recession (build-in flexibility).

The correction of market failure in a market economy is the reason why taxation is important, even to those who oppose state activities. Consequently, there is no way for a market system that aims to allow everyone to pursue happiness to avoid taxes.

In Austria there is wide consensus that the state should be strong and that the government should supply a variety of services. However, funding these expenditures represents a problem that remains unsolved. The Austrian state has a state debt higher than 79% of its GDP and government expenditures have been higher than tax revenues in every year since World War II.[2] In order to meet the Maastricht criteria and achieve a zero budget, the Austrian government has two possibilities: increase tax revenue or reduce expenditure.

My Master’s thesis focuses on the possibility of raising tax revenue to fund the actual level of services and potentially increase money transfers to citizens. The economic theory behind my search for additional tax revenue for the Austrian government is the Laffer Curve theory. Laffer (2004) tells the story of a dinner in December 1974 with Jude Wannsiki, Donald Rumsfeld and Dick Cheney. During this dinner, Laffer illustrated on a napkin his view of the relationship between tax rate and tax revenue. Thus, the Laffer Curve theory was born.

Laffer (1981) argues that there is a simple relationship between tax rate and tax revenue. A high tax burden on income is disadvantageous for working and investment and hence the wealth of a nation. The disadvantage leads to higher unemployment and this to a lower tax base and tax

[2] Perhaps in 2001 the state achieved a zero budget, but it sold some assets and today it is still not statistically clear whether the budget was negative or not.

revenue. Ultimately, the increase in unemployment that may accompany high income taxes rates may also result in an augmented federal transfer level to pay for the unemployed.
Following the Laffer Curve idea, taxes can reach a level at which governments can increase their revenues by cutting taxes instead of increasing them.
Laffer illustrates his claim using the functional form of a function of second degree, where tax revenue depends on the tax rate and tax rate squared, known as the Laffer Curve. He further argues that taxes have a revenue-maximising tax rate. Tax rates above the tax revenue-maximising level lead to less tax revenue, although they are higher and should therefore bring higher revenues. Laffer (1981) terms this area the "prohibitive range".
For the Austrian government, the tax rate that constitutes the tax revenue-maximising tax rate represents a question of interest, because if the actual tax rate is lower, a tax rate rise would bring additional revenue to fund state activities. A tax rate within the prohibitive range would be intriguing to the government, as it would permit a reduction in taxes while increasing services. Indeed, it would be a governmental campaign that can satisfy two parties: those who benefit from the transfers, as well as the major state revenue contributors.

When I started my Master's thesis, the purpose was to estimate the simple relationship between tax rate and tax revenue using Austrian data in order to find the Austrian Laffer Curve. The issues are that macroeconomic values for taxation are reported for a one-year interval and therefore the total number of observations is limited, as well as the fact that they are time series. Least squares estimation with few observations and time series must be treated with caution, because estimation results can easily be biased.
Having run an interpretation of the least squares estimation, it was clear that such a simple method would not help in ascertaining where Austrian revenue-maximising tax rates are situated for labour and capital income taxation and consumption tax.
Having failed to estimate the revenue-maximising tax rate using a simple least squares estimation, I searched for a model to attain some tax rates. Trabandt and Uhlig (2010) have presented such a model, which seeks to estimate the Laffer Curve's effects and the revenue-maximising tax rate. With the model of Trabandt and Uhlig (MTU), I present some results.

The focus of this paper is to find these revenue-maximising tax rates. In Chapter 3 I discuss some important issues related to taxation that do not form part of the empirical work of my Master's thesis, and are not included in the model simulation. Therefore, the revenue-maximising tax rates presented in this paper can only be considered a starting point or argument in the optimal taxation discussion, rather than as direct political recommendations.

Before establishing the empirical part of my thesis, I must define the objective of my research, as well as its intersections with other subjects. These considerations provide the following structure:

In Chapters 2 and 3 I present and discuss some general ideas and questions concerning taxation, which build the frame of tax theory in which the Laffer Curve theory is implemented. In Chapter 2 the focus is on the terms and definition of taxation, alongside a brief discussion of the targets of taxation and a definition of a fair and useful tax base and system. Furthermore, the issues caused by measuring tax rates and tax revenue will be briefly discussed.

Chapter 3 subsequently focuses on the economic effects caused by taxation. In this chapter, the basis of the Laffer Curve theory will be presented alongside other important economic consequences and opportunities of taxation. The paper then deals with tax revenue-maximising and not with the other effects of taxation for an economy.

Following brief discussion of general tax ideas in Chapter 4, the Laffer Curve theory will be discussed. The ideas of Laffer and some historical examples that Wanniski (1978) considers to found a successful Laffer Curve tax reform will be presented. The least theoretical part in this paper is the overview of the criticism of the Laffer Curve theory.

I then present the estimation method of Hsing (1996) and the MTU.

Chapter 5 presents the different sources of the data sets used and the ways in which they were prepared for least squares estimation and the MTU.

An attempt at least squares estimation using Austrian data are presented in Chapter 6, detailing why this does not work.

The results of the MTU are presented in Chapter 6. I use this model to determine the tax revenue-maximising tax rate for labour and capital income tax. I simulate a tax reform (separately) for the labour tax and capital tax as well as a reform for both in one step.

In a further simulation I introduce new kinds of taxes: i) The results of the tax rate of capital and labour income being taxed with a unified tax rate; ii) A robot tax that affects the deprecation rate and therefore changes the relative price of labour and capital as production factor input.

2 Tax definition and general tax theory

The answer to the question “What is a tax?” seems simple. However, Homburg (2015) argues that the question is not in fact as easy as it may appear, as there is not just one true answer. To understand the approach used in this thesis, I need to explain my views regarding taxes, the definitions I wish to follow, and how I use technical terms of general tax theory.

Every state must finance its expenditures, which is why taxes are introduced to the economy. There are many factors behind taxation, from funding a war, providing healthcare and social programmes, as well as education, and as an example for recent but currently unimplemented ideas, a general basic income without conditions. In a general sense, governments use taxes, contributions, fees and debts (which are essentially a form of tax suspended to the future) to finance their programmes. Haller (1971) demonstrates the consequences to a state of only being financed by debts. He claims that such a system would not work, and that inflation is also a type of tax. Inflation reduces the personally available consumption level for a given amount of money while reducing the debt burden of the state. Although economists such as Henderson (1981) argue that inflation is a kind of tax, it will not be considered in this paper.

Prior to the introduction of a monetary economy, citizens and subjects contributed to sovereign and/or governmental wealth via barter, i.e. agricultural work, stock rearing and military service. Brümmerhoff (2001) argues from a juridical point of view that natural produces are not taxes; rather, taxes must be a kind of money transfer. However, from an economic stance this is not true, as monetary taxes reduce the wealth of citizens in an indirect way, whereas barter reduces their wealth directly. Each wealth-reducing transfer from a subject to the sovereign can in fact be viewed as a tax (Haller, 1971).

Another source of public income is monetary penalties, and so they may be incorporated into a wider definition of “tax”. Following Homburg (2015), who advocates a broader view, they could be included especially when revenue surpasses levying costs. Many car drivers would support this idea because they often feel that speed limit controls are introduced to finance state expenditures.

A different perspective on monetary penalties as well as strangulation taxes (which are taxes that are so high that nobody would do the taxed activity) is provided by Brümmerhoff (2001). In his view, monetary penalty and strangulation taxes are non-taxes, because (at least in theory) they are not created to gain any revenue, but rather are used to prevent certain activities. Indeed, if they gain revenue, it is by mistake and not by intention.

Homburg (2015) defines three main classes of state incomes: taxes, contributions and fees. Homburg's idea is to classify state income with the relationship of the produced service to the payer.

However, dividing payments under these categories of revenue sources is not an easy task. Fees are paid for (the option to use) a service, which is directly supplied to the fee-payer. The exclusion of agents who are not paying the fee is possible and the service is directly chargeable to the user, e.g. waste collection. On the other hand, contributions do not permit determination of who uses a contribution to what extent, e.g. social secure services or development fees.[3] Homburg (2015) argues that the difference between fees and contributions is that return service cannot be directly chargeable to the payer. In contrast, taxes are not contingent on a direct service for the taxpayer; they are used to finance state expenditure, and the services supplied by the state through tax payments cannot be directly linked to the taxpayer. An excellent illustrative example of the use of tax revenue is national defence: it is impossible to protect only some citizens while excluding those who do not pay taxes.

Homburg's (2015) definitions follow a German legal text, and he notes that this is only an attempt to draw a line between taxes, contributions and fees.

Adding to the complexity is the fact that these terms are treated synonymously: fees are called taxes, contributions are called fees (see: development fees) and so on. The denominations of the payments to the government often have a historical reason, but even though the forms of collection and usage have changed, their names have often remained the same. Sometimes governments use different labels to introduce revenue sources: people may be unwilling to pay more taxes, and so a tax becomes termed a "contribution" even where it is in fact a genuine tax. Dickertmann and Voss (1979) use the example of the "Kohlepfennig"[4] to demonstrate how such a non-tax is established. The "Kohlepfennig" was officially introduced in Germany in the 1970s under the premise of supporting the stone coal industry, gaining a greater share of "home-made" energy and increasing energy security. However, the real reason seems to have been social, regional and labour market policy action; the individual taxpayer did not receive a direct reward, rendering the "Kohlepfennig" a tax. The constitutional court decided that the "Kohlepfennig" was contrary to the constitution. The constitutional court followed the legal definition and argued that contributors were not recipients of benefit. In 1995, the "Kohlepfennig" was duly removed.

[3] Homburg (2015) uses the German term "Erschließungsgebühr", whereas "Gebühr" is translated as "contribution". As can be seen, the name of a payment to the state can differ from the definition of the payment.
[4] Translated to English, "der Kohlepfennig" means "the carbon cent".

In attempt to reduce the confusion, Homburg (2015) developed a general rule to differentiate between fees, contributions and taxes, not based on name but rather on the economic classes of goods. Fees are paid for government service, which are supplied as private goods by the government of the federal state, state or community. Contributions are used to finance group use and are also considered club goods that can be used by a group. In Austria, the social security system is separated into more than 20 security insurance carriers. Each security insurance carrier can decide on the contribution payment and the services to be supplied.

Taxes are spent by the state on public utility services for all citizens without the possibility of exclusion. Usage is often non-competitive and therefore they are treated as public goods.

Schneider (1992) also derives his definition of a tax from a German legal text and reaches a different conclusion: first, a tax is a money transfer and not a payment in kind. Second, there is a "sacrifice" principle. The taxpayer should waive a part of his or her wealth without receiving a direct reward. Third, the payment goes to financial administration. Fourth, the target of the tax is to produce revenue for the state, which may constitute a secondary aim.

As Atkinson (1977) argues, the economic view is of course different from the legal view. When analysing taxes, contributions and fees it is more interesting to investigate economic reaction to the introduction of a new tax or a change of tax.

Homburg (2015) raises several questions: Who pays? What are the costs for an individual and the society? Is there a deadweight loss? What are the losses between taxpayer and treasury? Who bears the burden of a tax? What is a tax based on?

2.1 Roles in taxation

Taxes influence a multitude of economic agents. Homburg (2015) provides an overview of the different roles that natural and juridical persons can play in a tax system. The first role is the tax debtor, who is indebted to the treasury. For some taxes, the tax debtor is an unequal liability debtor of the tax. For example, in the case of value-added taxes (VAT) in Austria, the consumer is the tax debtor, but the liability debtor of the tax is the trader who sells the goods. In Austria, the two taxes with the greatest revenue are income-of-wage-earners and VAT. Neither is paid by tax debtors. In the first case, the tax is paid by the employers, while the intended debtors are the employees; in the second case, the tax is paid by the traders as substitutes of their customers. If the taxpayer and tax debtor are different, the possibility exists that the tax burden will be transferred to a different group than that intended by the government.

Those who genuinely bear the burden of a tax are called tax bearers (effective incidence), see Schneider (1992) and Brümmerhoff (2001). Their identification constitutes one of the major tasks required for an economic perspective on taxes. The rollover process may be manifested in different ways. One is that the market position of the tax debtor is strong. Therefore, he or she can roll over the tax to the contract partner, who becomes the tax bearer. For example, if the government tries to tax landowners, the latter may attempt to raise rent on their land in order to pay. If their market position is sufficiently strong they may roll over a part or the whole tax to the user of their land, who becomes the tax bearer. In Austria employers must contribute to the security insurance of their employees, but the issue is that employers pay this contribution. The amount of the contribution is dependent on the wage, and so it is part of the wage costs. Employers may seek to roll over the contributions by reducing the net wage.

Concerning some taxes, the sheer multitude of bearers may lead to a debt transfer of up to 100% of the debt from the debtor to the bearer. An example is that employer contributions to social security may roll over to the employee. This rollover is possible if the employer has greater market power than the employee. In order to identify the real bearer of a tax, it is essential to be able to design a tax without unwelcome and unintended social consequences.

Changes in economic behaviour are determined through average and marginal tax rates. Therefore, it is useful to consider different forms of tax scales.

2.2 Different forms of tax scales

The form of tax scales can differ between different taxes (and of course between different countries). The simplest form of a tax scale is a constant tax rate, without any deductions and tax-free amounts. This constant average tax rate is called a proportion or flat tax. The amount of collected tax revenue increases (T) constantly with the tax base (X), see Figure 2.2. The tax revenue is zero if the tax base is zero and grows constantly by the tax rate for each new unit of the tax base. A tax system based on such assumptions is termed a flat tax system. In Austria, the capital tax on incomes out of interest is a flat tax. Moreover, gains of corporal entities such as public limited companies or foundations are assessed on fixed tax rates. If these gains are transferred to natural persons, the receiver must pay additional taxes based on the interest tax rate.

Austria's income system is a dual tax system because incomes out of labour, as well as those of a sole proprietor, are taxed on a progressive tax in contrast to the capital incomes of interests and dividends. A progressive income tax means that the marginal tax rate rises with the tax base and therefore the average tax rate. Figure 2.2 displays how a progressive tax revenue (T) is zero if the tax base (X) is zero. The tax rate and therefore the average tax rate rises with the tax base. If the tax base alters from X_f to X_h, (meaning that the tax base doubles), the tax revenue changes from T_f^P to T_h^P, more than double the tax revenue.

Brümmerhoff (2011) states that the scale of a tax is the relationship between tax payment and the tax base. There are three forms of tax scales: proportional, progressive and regressive.

They are characterised by a tax payment function, average tax rate function, and marginal tax rate function.

Tax payment function $$\boldsymbol{T = \tau(X)X} \quad \textbf{(2.1)}$$

Average tax rate $$\boldsymbol{\overline{T}(X) = \frac{T(X)}{X}} \quad \textbf{(2.2)}$$

Marginal tax rate $$\tau(\boldsymbol{X}) = \boldsymbol{\frac{\partial T}{\partial X}} \quad \textbf{(2.3)}$$

Where X is the tax base and τ is the tax rate.

A tax is proportional if the marginal tax rate and the average tax rate are the same for the whole range of the tax base. If the marginal tax rate is higher than the average tax rate for all levels of

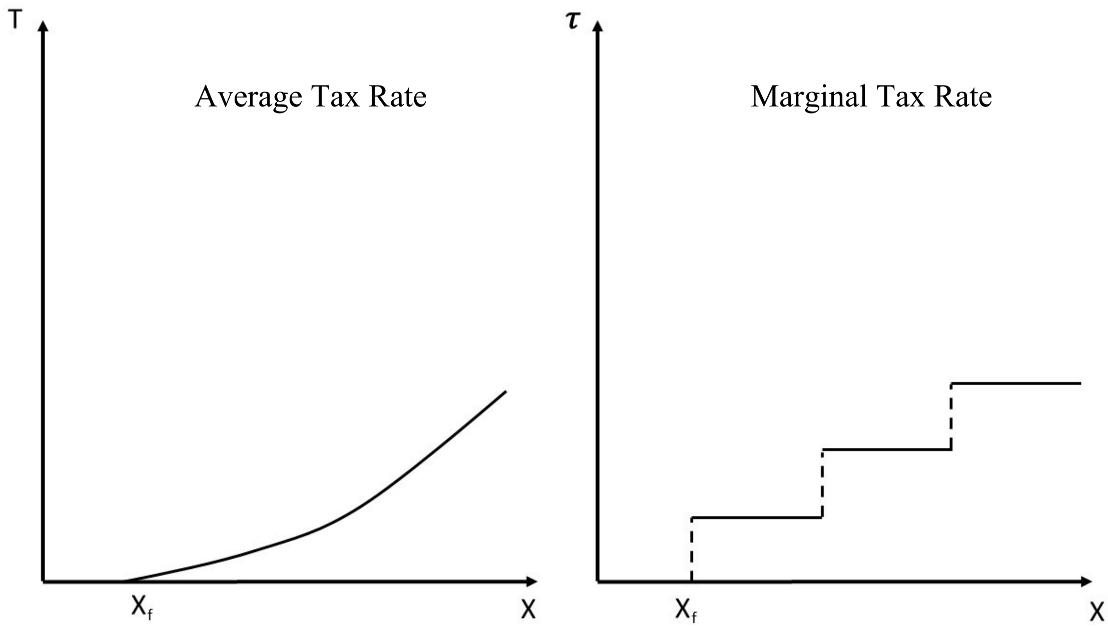


Figure 2.1: Marginal step scale; based on Brümmerhoff (2011)

Form of scale	Difference between tax rate and average tax rate $\alpha = \tau(X) - \bar{T}(X)$	Derivative of the average tax rate with respect to tax base $\frac{\partial \bar{T}(X)}{\partial X}$	Ratio of tax rate and average tax rate $\tau(X) / \bar{T}(X)$	Derivative of tax rates with respect to tax base $\frac{\partial \tau(X)}{\partial X}$
Progressive	> 0	> 0	> 1	> 0
Proportional	= 0	= 0	= 1	= 0
Regressive	< 0	< 0	< 1	< 0

Table 2.1: Different forms of tax scales; source: Brümmerhoff (2011)

tax base, it is called a progressive tax rate. If the average tax rate is higher than the marginal tax rate, the tax has a regressive scale form. Table 2.1 summarises the characteristics of different forms of tax rates.

The characteristics of a progressive or regressive tax may appear even if the marginal tax rate is constant for the whole tax range. This happens when deductions and allowances are introduced into the tax system. Scales deducted in this way can be either indirect progressive (if the marginal tax rate rises more than the average tax rate) or indirect regressive (if an increase in the average tax rate is accompanied by a reduction in the tax base) (Brümmerhoff, 2011). An overview of tax scales is displayed in Figure 2.2.

The opposite of the aforementioned progressive tax is the regressive tax. The average tax rises higher than the marginal tax rate. If the tax base doubles, such as from X_f to X_h, the tax revenue increases but does not double from T_f^r to T_h^r.

The final type of tax scale shown in Figure 2.2 is a proportional tax with a free tax threshold. A free tax threshold such as an allowance leads to a tax base area where no tax must be paid. However, above this free tax threshold the tax must be paid for the whole tax base.

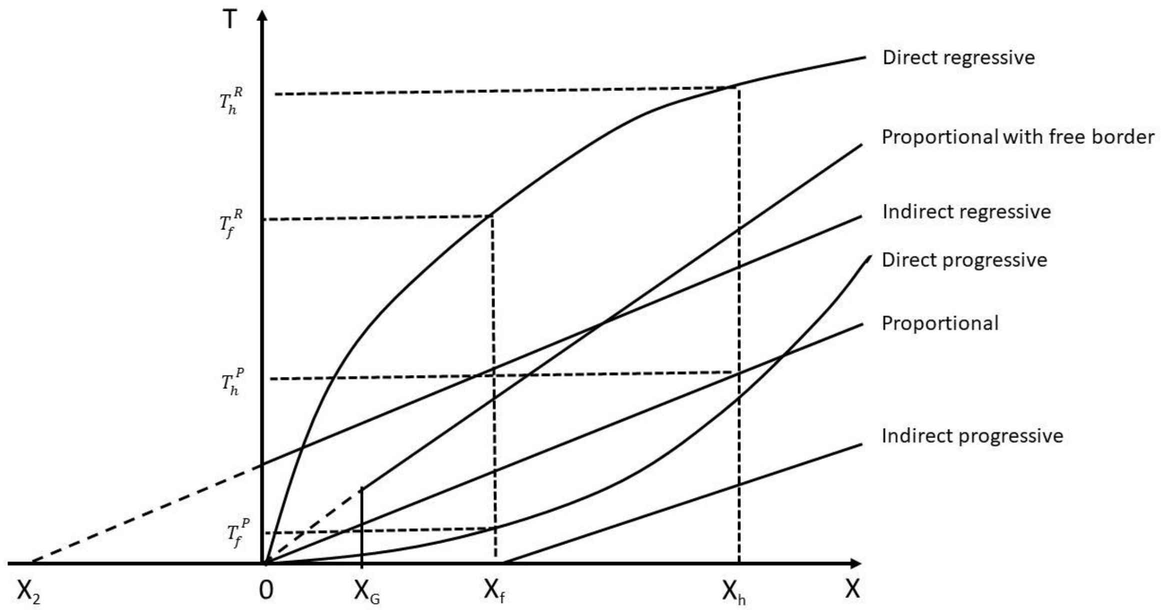


Figure 2.2: Different tax scales; based on Brümmerhoff (2011)

In observed tax systems, scales are often combined and there is not always a clear scale throughout the whole range of the tax base for most taxes. This is true of the Association of Austrian Social Security Institutions (Hauptverband der österreichischen Sozialversicherungsträger (2015), where the tax base has a tax exemption limit of €415.72 and a proportional tax rate of 39.6% of gross wages (aside from an unemployment insurance tax rate displaying a discontinuity of jumps). Another free tax threshold operates until the tax base reaches €1,311. From €1,311 to €1,430 social contributions increase by 1%, from €1,430 to €1,609 by 2%, and for €1,609 and above exists a rate of 3%. Within this area, social contributions are progressive, but given that incomes above €4,860 are exempt from social security contributions (which constitute an upper tax allowance), the scale becomes regressive. Brümmerhoff (2011) explains further that the tax exemption limit, in contrast to deduction, does not lead to a regressive form because there is no taxation under the tax-free threshold amount. In this case, the whole tax base would be assessed, and not merely the amount above the tax-free threshold as would be the case using a tax base-reducing deduction.

Austria's income tax is a stepwise marginal tax scale, which means that the tax base is separated into intervals, each with a different marginal tax rate. Intervals of higher incomes have higher marginal tax rates. Within the tax intervals, the marginal rate is constant, and the tax rate increases with the same rate (Brümmerhoff, 2011), as displayed in Figure 2.1.

The current Austrian income tax system has seven intervals following the most recent reform introduced on 1 January 2016. It had previously been built on four intervals (see Table 7.10).

2.3 Targets of taxation

The first and main target of taxation is to finance state expenditure. However, taxes can influence the behaviour of taxpayers and other agents. Therefore, taxes can be used to reduce activities that are not beneficial to social welfare (Homburg, 2015; Schneider, 1992), such as smoking cigarettes (additional tax on buying cigarettes) or driving a car (additional tax on buying gasoline). How the steering effect works will be discussed in Chapter 3. An additional use of taxes is (and often in combination with subsidies) the redistribution of income and wealth. A powerful tool to redistribute income is a progressive tax structure for the income tax. A progressive income tax and a lump-sum transfer lead to a smaller range between high and low incomes. Primary incomes (income before tax, and subsidies) of persons with a high income face greater reductions than persons with a low income. If the transfers are paid as subsidies, even if it is a lump-sum transfer, has a greater effect on the secondary incomes (incomes after taxes and subsidies) of those with lower primaries incomes because the same amount of money forms a relatively larger part of the entire disposable income. Austria has considerable potential for redistribution due to its huge state quota, but Rocha-Akis (2016) argues that this potential remains unused. This is largely because the greatest part of the payments from households to the state comprise social contributions. These have a regressive average tax rate form, and are therefore lower than the effect of the progressive income tax. Since the year 2000, primary incomes as well as secondary incomes are rising in Austria. Primary incomes are rising due to declining wage rates for small wages and a wage increase for high wage employees. Secondary incomes are growing owing to the rising number of persons (i) without a job, which is declarable for social security contributions, and (ii) those who receive no market or primary income. Rocha-Akis (2016) further argues that redistribution is not useless, even if it leads to an increase of inequality. Transfers independent of wealth and income position, like education, childcare and healthcare, are over-proportionally used by those with lower incomes. Furthermore, their financial situation also benefits from subsidies depending on the income in question.

Correction of market failures

In addition, taxes and subsidies may be used to include social cost (revenue) into private cost (revenue) structures. Brümmerhoff (2001) states that this may constitute a strategy to finding a Pareto optimal solution for markets, where the allocation of resources is not optimised. Examples include monopolistic markets or markets where (high) social costs are not included in the cost structure of market agents, or where not solely sellers and buyers of goods enjoy a benefit (see Chapter 3 for more details).

Stabilisation of the economy

The income tax may be used to stabilise the economy if the income tax grows with increased income level, as described by Brümmerhoff (2011), or if the income tax has a revenue elasticity greater than one (Musgrave and Kullmer, 1974). In boom times, the economy grows more slowly within a progressive tax system than within a proportional tax system. As gross wages rise faster than net wages, higher income levels also stimulate the expansion of the tax wedge between net and gross wages. The consequence is that the costs employers face rise at a higher rate than the income of their employees. This leads to a lower demand for labour than in a proportional tax system at the same level of employee income. In an economic bust, recession is not exacerbated. Given that gross wages decrease at a greater rate than net wages, labour in relation to payment becomes cheaper, and the level of employment falls to a lesser extent (or perhaps does not decrease at all when only a labour cost reduction within gross wages occurs) relative to a flat tax system.

According to Brümmerhoff (2011), a more progressive tax rate increases this effect. This can be supported by unemployment insurance or other social security programmes and transfers where a revenue is generated during a boom and household income remains close to the general growth path of the economy. In times of recession, the state treasury stabilises household income levels with the growth path and spends savings or takes loans to finance transfers to mitigate income reductions. A state's financial position balanced throughout the economic cycle is termed "cyclical budgeting", while cases where the government does not need to stabilise the economy (considering long-term trends) because tax and social security systems regulate themselves is called "built-in flexibility" (Musgrave and Kullmer, 1974).

Dolls, Fuest, and Peich (2010) have sought to calculate the built-in flexibility effect. For Austria, their results reveal a substantial impact. If the Austrian economy is hit by a shock, then the consequences are mitigatedfor incomes by 44% and 67% for employment compared to a flat tax system.

2.4 Optimal tax system

All of these tax targets are more or less products of the utopian concept of a fair, stable, safe and wealthy economy and society. Again, however, tough questions are raised: What is a fair, stable, safe economy that leads to a wealthy society? How can a tax system be built to support this?

In *An Inquiry into the Nature and Causes of the Wealth of Nation*, Adam Smith created four maxims regarding taxes in general.
The first maxim is:

> *The subject of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state. The expense of government to the individuals of a great nation, is like the expense of management to the joint tenants of a great estate, who are all obliged to contribute in proportion to their respective interests in the estate. In the observation or neglect of this maxim consists, what is called the equality or inequality of taxation. Every tax, it must be observed once for all, which falls finally upon one only of the three sorts of revenue above-mentioned,*[5] *is necessarily unequal, in so far as it does not affect the other two. In the following examination of different taxes I shall seldom take much further notice of this sort of inequality, but shall, in most cases, confine my observations to that inequality which is occasioned by a particular tax falling unequally even upon that particular sort of private revenue which is affected by it.*

Smith and Sutherland (2008, p. 451)

The first part of his first maxim is close to the definition of the "ability-to-pay" principle used by economists today. This principle is separated into two key parts. Homburg (2015) and Brümmerhoff (2001) describe these as a horizontal "ability-to-pay", which means that two citizens who have the same income and wealth (and are equal in all other characteristics) must be taxed in the same way. Taxpayers who are different should be treated differently: those able to pay more taxes should do so.
Adam Smith describes how the state supplies a frame (law, social security, infrastructure and so on) in which taxpayers can achieve wages, rents and profits. Tax payments represent the entry pass in this "frame". This idea is today captured in the "assurance" principle: those who use federal services should contribute more to the system.
This is different from the "ability-to-pay" principle, which neglects the number of services consumed by an individual, if the ability to pay remains (Brümmerhoff, 2001).

[5] Smith and Sutherland (2008) claim that for Adam Smith "[w]ages, profits, and rent, are the three original sources of all revenue as well as of all exchangeable value".

The "benefit" principle (Homburg, 2015) sees a tax as only admissible if the welfare losses of utility produced by the tax are at least equalised by the utility that all citizens gain from the services provided by the tax revenue.
The second part of Smith first maxim addresses a problem that to this day remains unsolved: What is the optimal, fair and efficient tax base? Smith claims that the tax debtor should know how, when and what amount taxpayers must pay, and everyone else should know that too:

> *The tax which each individual is bound to pay ought to be certain, and not arbitrary. The time of payment, the manner of payment, the quantity to be paid, ought all to be clear and plain to the contributor, and to every other person. Where it is otherwise, every person subject to the tax is put more or less in the power of the tax-gatherer, who can either aggravate the tax upon any obnoxious contributor, or extort, by the terror of such aggravation, some present or perquisite to himself. The uncertainty of taxation encourages the insolence and favours the corruption of an order of men who are naturally unpopular, even where they are neither insolent nor corrupt. The certainty of what each individual ought to pay is, in taxation, a manner of so great importance, that a very considerable degree of inequality, it appears, I believe, from the experience of all nations, is not near so great an evil as a very small degree of uncertainty.*
>
> Smith and Sutherland (2008, p. 452)

Stated more simply, a tax system should be transparent to everyone and the government should change taxations without warning. One of the main conditions of a perfect competitive market is certainty growth. A government should reduce the development of any uncertainty, and if possible avoid it entirely.
The third maxim is that tax payments should be due when tax debtors receive their settlement from the tax base.

> *Every tax ought to be levied at the time, or the manner in which it is most likely to be convenient for the contributor to pay it. A tax upon the rent of land or of houses, payable at the same term at which such rents are usually paid, is levied at the time when it is most likely to be convenient for the contributor to pay; or, when he is most likely to have wherewithal to pay. Taxes upon such consumable goods as are articles of luxury, are all finally paid by the consumer, and generally in a manner*

that is very convenient for him. He pays them by little and little, as he occasion to buy the goods. As he is at liberty too, either to buy, or not to buy as he pleases, it must be his own fault if he ever suffers any considerable inconveniency from such taxes.

Smith and Sutherland (2008, p. 452)

Most modern taxes are built following this maxim, such as income tax for employees in Austria, which is deducted from wages on a monthly basis, or VAT, which is paid by the tax debtor by the transaction.

The fourth maxim is a discussion of inefficiencies that occur from introducing taxes.

Every tax ought to be so contrived as both to take out and to keep out of the pockets of the people as little as possible, over and above what is brings into the public treasury of the state. A tax may either take out or keep out of the pockets of the people a great deal more than it brings into the public treasury, in the four following ways. First, the levying of it may require a greater number of officers, whose salaries may eat up the greater part of the produce of the tax, and whose perquisites may impose another additional tax upon the people. Secondly, it may obstruct the industry of the people, and discourage them from applying to certain branches of business which might give maintenance and employment to great multitudes. While it obliges the people to pay, it may thus diminish, or perhaps destroy some of the funds, which might enable them more easily to do so. Thirdly, by the forfeitures and other penalties which those unfortunate individuals incur who attempt unsuccessfully to evade the tax, it may frequently ruin them, and thereby put an end to the benefit which the community might have received from the employment of their capitals. An injudicious tax offers a great temptation to smuggling. But the penalties of smuggling must rise in proportion to the temptation. The law, contrary to all the ordinary principles of justice, first creates the temptation, and then punishes those who yield to it; and it commonly enhances the punishment too in proportion to the very circumstances which ought certainly to alleviate it, the temptation to commit the crime. Fourthly, by subjecting the people to the frequent visits, and the odious examination of the tax-gatherers, it may expose them to much unnecessary trouble, vexation, and oppression, and though vexation is not, strictly speaking, expense, it is certainly equivalent to the expense at which every man

> *would be willing to redeem himself from it. It is in some one or other of these four different ways that taxes area frequently so much more burdensome to the people than they are beneficial to the sovereign.*
>
> Smith and Sutherland (2008. p. 452)

The final maxim is divided into four stages, each describing one source of inefficiency, starting with the claim that every tax is taken or kept from the pockets of citizens. Therefore, taxation should be conducted with care, because taxes always lead to a loss and this may surpass the gains of the state treasury. This maxim is close to the definition of the benefit principle, which includes the notion that the tax burden should be at least equivalent to the benefit created by the state.
The first source is that new taxes need administration. The administration is not costless, which means that a certain proportion of the tax revenue must be used to finance this new cost.
Second, taxes obstruct normal market processes, leading to excess burdens for the economy. Taxes create incentives to switch activities from a formal to an informal market. The state must punish this illegal behaviour, but in so doing it destroys wealth, which can no longer be used as a production factor. This is the third source of inefficiency.
The fourth source is that the process of paying taxes is costly for taxpayers. They are required to invest time to complete forms, there are certain costs involved in transferring money, and so on.
These four maxims of taxation include most of the factors identified by Brümmerhoff (2001) as being important for a good tax system (transparency of the tax burden, stabilised tax framework, low costs of compliance and administration, taxation with consideration of the "benefit" principle and the "ability-to-pay" principle). Supplementary factors mentioned by Brümmerhoff comprise the importance of individual preferences, a secured subsistence level and fairness, or at the very least comprehensibility of taxes.
Attention to individual preferences is a kind of fairness measurement. It means that a tax system should use the preferences of each person to reduce their utility with the exact same amount. Two ways exist in theory. The first reduces the utility for each person by the same total amount, while the second reduces the relative amount or imposes individual taxes to create an equal marginal utility (Brümmerhoff, 2001). However, this is only a theoretical construct because preferences are not measurable.
In order to preserve a certain level of subsistence, subsidies as well as general tax allowances are used. According to Rocha-Akis (2016), Austria has a mixed system with a surplus on the subsidiary side.

Whether the Austrian tax system is fair or not remains unclear. Given that the number of tax consultants has increased from 3,900 in 1995 to 7,400 in 2016, it would appear that at the very least it is non-transparent and inconvenient. The true complexity of the tax system is demonstrated by a statement of the speaker of the tax consultant branch, see Zahrl (2016), who asks for an easier tax law system. This surprises me because the existence of this branch is connected to a tax system that is complex and comprehensible to non-experts.

2.5 Direct and indirect taxation

The investigation of taxes in an economic context often begins by distinguishing between direct and indirect taxes. However, as Atkinson (1977) argues, an enormous range of definitions exists. Atkinson discusses certain definitions by different authors. One definition is based on the idea that direct taxes are designed in a way that they cannot be shifted to another person, unlike the case of indirect taxes. However, this definition is not helpful because almost any tax might be shifted to another person (Brümmerhoff, 2001), and so nearly all taxes would be considered indirect. According to Brümmerhoff (2001), most definitions of indirect and direct taxes are limited by their attempts to classify the tax before it is even clear who really bears the tax burden. When introducing a tax, certainty regarding who will bear the tax burden is almost impossible, rendering classification based on this criterion useless and merely theoretical.

Historically, the taxpayer only paid taxes for the purchase of goods indirectly, and taxes based on income to the fiscal authorities directly (Atkinson, 1977). This form of administration may enable a distinction supported by Brümmerhoff (2001). He claims that only income tax should be called direct tax, with VAT the only indirect tax.

In my opinion, the most useful concept of indirect and direct taxes is provided by Atkinson (1977), Brümmerhoff (2001) and Homburg (2015). Direct taxes pertain to the characteristics of taxed persons or households: the tax subject. In contrast, indirect taxes are unrelated to the tax subject and only depend on the tax object. For example, the Austrian income tax system involves numerous characteristics of the tax subject. The marginal tax rate is related to income, and other characteristics such as number of children and costs of education and training lead to tax deductions and deductibles.

The VAT for every taxed subject in Austria is the same. Therefore, the person who pays for a good such as a pair of shoes is irrelevant, as they will pay the same rate of tax.

Therefore, direct taxes can be used directly to redistribute income and wealth.

Fromm and Taubman (1973) argue that direct taxes are more efficient than indirect taxes. They claim that the tax system is efficient if the excess burden is minimised. To minimise this burden for a consumption tax, a demand function must be estimated to determine the appropriate tax rate for each commodity. This procedure would be continuous given the constant introduction of new goods and changes in preferences. The calculation of demand functions leads to high costs of administration, as numerous computers, economists and statisticians are required.

Furthermore, this form of taxation instigates an equality problem. Individuals who prefer commodities with a more elastic demand than the market average would be treated better by the tax given the lower tax rates and tax burden. High administration costs (the improbability of such calculations) and lack of guaranteed equality provide strong support for a different taxation method.

Lump-sum taxes are excluded due to the impossibility of integrating them into a real economy and the "ability-to-pay" principle. Thus, only direct tax remains a possibility. Fromm and Taubman (1973) argue that direct taxes serve equality, efficiency and administrative cost criteria more effectively than indirect taxes, helping reduce inefficiencies in the market process. Following the arguments of Fromm and Taubman (1973), this issue is not only a theoretical problem but is also relevant for tax reform, because increasing excess burdens may instigate severe damage to an economy.

2.6 Hidden incomes

An additional problem of income taxation is represented by entertainment and other benefits. Each person gains a different level of joy (utility) of activities paid by their companies. For instance, business trips represent a free holiday for some people but are unwanted by others. This issue of business trips, networking, sporting and cultural events and so on are not countable in a matter that can be processed.

Two types of tax avoidance are listed by Goode (1976). First, self-employed persons and officers use their companies to pay for certain private bills, leading to a reduction in their income tax. Second, employees can receive non-taxable compensation, like theatre tickets, to take care of business partners or for networking. They also receive a non-taxable income in the form of free entertainment. The problem of taxing this non-payment income is that for some people attending a concert at the opera along with clients is a matter of joy, while for others the same situation is a nightmare. It is nearly impossible to evaluate and tax these factors efficiently (in the sense of a reduction in utility to the same amount for everyone). A definition of what is deductible and what is not is provided by legislation.

In this thesis, I use effective average tax rates (explained in Subsection 5.1), and so most questions are excluded, such as fairness, scale, role, incidence, stabilisation, correction of market failures and direct and indirect taxation. Therefore, interpretation is limited.

3 Behavioural changes caused by taxation

As has been described, taxes affect the activities of taxed agents. The two most important economic effects of taxation, which appear in an equilibrium model, are the income effect and the substitution effect.
Further effects that should be briefly discussed are the steering effect, the incidences of taxation, the feedback effect and the consequences of hidden incomes for fair tax systems.

3.1 Income effect

A tax reduces the potential income of the real tax bearer, and therefore his or her potential consumption. This means that taxes reduce spending capacity in the private sector. This loss of income caused by taxation is called the "income effect".
Laffer (1981) claims that the income effect operates to the average tax rate (Equation 2.2), which leads to the income effect growing alongside the average tax rate. With a higher average tax rate, the income effect grows and the income that might be spent falls.
With a substitution-neutral tax, which means to tax all of the activities of every agent without creating a change in relative prices, a tax would only have an income effect because nobody would change their behaviour.
A tax that fulfils this condition is only a theoretical concept. The main reason for this is that there are too many variables that affect people's preferences. Caring to individual preferences would mean to care to every single individual, consider every preference and evaluate every single activity. Brümmerhoff (2001) argues that even if there were an individual tax for every activity, the administration of such a tax would be costlier than most other taxes and would consume a considerable share of the revenue.
In economic theory there also exists the "lump-sum tax", which is per definition allocation neutral. The closest genuine tax to the lump-sum tax is a tax per capita, in which everyone must pay the same amount, regardless of actions. This kind of tax may be efficient (it does not produce any excess burden), but it is the direct opposite of the "ability-to-pay" principle of taxation. Furthermore, a free choice of residence beyond the nation would create the possibility of avoiding taxes. Consequently, taxpayers may depart the country to avoid the tax, leading to cost. These costs are allocation costs caused by the tax that would contradict an allocation-neutral tax idea.
For the analysis of taxes, we must exclude the idea of taxes, which are allocation-neutral and only change the income level. We must instead introduce the substitution effect, which plays an important part in the Laffer Curve theory.

3.2 Substitution effect, direct and indirect feedback effect

The substitution effect occurs owing to the existence of different tax rates for different activities, as well as activities that are not taxed at all, such as free time or black market activities. The (marginal) tax rate affects the relative prices of the activities (Bronfenbrenner, 1942), thus changing the allocation of resources. For example, a tax on labour income (or consumption) causes working hours to become more expensive and therefore less attractive relative to free time. As a result, if the tax burden is borne by labour, labour supply reduces, usual market processes are blocked, and an efficient allocation of resources is not achievable.
This substitution effect represents the main driver of the Laffer Curve theory (Chapter 4). Laffer terms the substitution effect the "feedback effect", covering the reaction to a tax rate change. For his theory, Laffer claims that if a tax rate is increased, taxed activities become less attractive and agents avoid them (substitution effect/direct feedback effect). This theory is simple and briefly stated, but this leads to a problem as such a change has an influence on other activities as well. In a simplified sector market model can be identified two factors: labour and capital. The taxation of one factor generates an arithmetic and economic effect that influences the taxed factor, but it also creates a feedback effect influencing the other factor (indirect feedback effect). Laffer provides an example for the different effects accompanying an increase in labour.

> *The increase in the tax wedge on labor will have the following effects:*
> *1. More revenue will be collected per worker; this will tend to increase revenue. Some people call this effect the naïve treasury estimate. However, we prefer to call it the arithmetic effect.*
> *2. Fewer workers will be employed; this will tend to lower revenue. We label this effect the direct feedback effect.*
> *3. Less capital will be employed; this will tend to lower revenue. This effect we label the indirect feedback effect.*
>
> Laffer (1981, p. 4)

Both factors, which are related to each other via the production (function), must be observed in order to maximise the tax revenue. Therefore, tax design has numerous links to the activities of the agents in an economy, and taxes could be used to steer their behaviour. As such, Brümmerhoff (2001) argues that if the allocation was not Pareto optimal before a tax, a smart tax design may reduce social inefficiency by reflecting social marginal costs.

3.3 Pigou Tax

A famous tax in the context of supporting the allocation process of resources is the Pigou tax. The basic idea is that products and services have external effects, both positive and negative. A classical negative effect is air pollution owing to production, which lowers the quality of life (or utility in economic terms) of all neighbours. Air is a free good (or was a free good), and so its use is costless, resulting in the use of the resource “air” within production being higher than would be optimal for a society. This overuse of the air leads to social costs.

A further example is that the ability to read facilitates communication. Therefore, not only those who were taught how to read benefit from this skill, but society as a whole does as well. Communication is facilitated in a society in which everyone can read. Therefore, not only a person who learns to read gains, but everyone else as well Pigou (1962) separates cost and benefit into two parts: private cost (benefit) and social cost (benefit). In a market economy, private demand and supply ignore social costs and benefits. If social costs are at the market equilibrium, the consumption of the good or service is too great. If there are social benefits, the consumption is too little.

For example, education leads to social benefits: a better educated workforce is more productive, producing benefits for their employers as well. Consequently, education in Austria is free until university level, and universities are inexpensive relative to other countries.

An example of social costs is driving. Cars produce pollution and harm everybody in the region. Without any tax, driving would exceed the socially efficient amount. With a tax on driving or petrol, the government may attempt to include the social costs into the private decision and therefore into the market process. In Austria, nearly one third of the total price of gas is a special tax.

3.4 Steering effect

The Pigou tax uses the steering effect of taxation. Taxes change relative prices, rendering higher taxed activities less attractive and in turn leading to a reduction in such activities, at least theoretically. An example of steering effects is cigarette smoking. Carpenter and Cook’s (2008) and Hansen, Rees and Sabia’s (2013) studies used data from the United States of America (USA) regarding the objective of taxes to reduce adolescents’ proclivity to smoke. However, the reduction was small due to secondary or black markets where the tax had no effect, enabling the young people to find cigarettes at lower prices (substitution effect).

In Austria, there is no measurable steering effect of cigarette taxation. From a long-time view, cigarette sales are rising steadily, as claimed by Ludwig-Boltzmann-Institut für Suchtforschung

(2016). Puwein and Wüger (1998) have found that prior to an increase in cigarette tax, demand also increases. For a short period following the introduction of the tax reform, stored cigarettes are consumed, leading to decreased demand. However, once all pre-introduction cigarettes are consumed, demand continues to follow the rising trend.

This is not surprising because, smoking is an addiction: smokers need their cigarettes, causing price elasticity for cigarettes to be very low. In 1997, 74% of the price a customer paid for cigarettes comprised taxes (Puwein and Wüger, 1998), which following the demand form of a normal good ought to have led to a considerable reduction in smoking.

In 2005 the German Government introduced a successful steering tax on alcopops. Köhler-Azara and Gaßmann (2007) note that youths consumed half the amount of alcohol in 2005 than in 2004, and when asked why they drink fewer alcopops, nearly two thirds of youths claimed that they had become too expensive.

In Austria a successful steering tax is seen in the lower tax on diesels than gasoline engine cars. Different taxes were introduced on the basis that diesels are less harmful to humans and the environment.

VCÖ - Mobilität mit Zukunft (2017) used EUROSTAT data to find that Austria had the third highest number of diesels per citizen in the European Union (EU) in 2017; moreover, per 1,000 citizens there are 311 diesels in Austria compared to just 180 in Germany.

3.5 Incidence of taxes

The incidence of a tax describes who will burden the tax. When a government introduces a tax it should consider who will burden it, as the taxpayer and the person who burdens the tax may differ. Indeed, the target group of the taxpayer may roll over the tax burden to other groups. When a tax can be rolled over is dependent on the price elasticity of demand and supply.

If the price elasticity of supply and demand are the same, the burden of a newly introduced tax will be shared at the same value between supplier and customer. This equal share of the burden is independent of the question of the taxpayer’s identity. The taxpayer rolls over half of the tax burden, as shown in Figure 3.1.

In both cases, the amount of traded goods is reduced from x_0 to x_1. The supplier only receives the net price (p_n) instead of the market price (p_0), and the consumer has a higher price (p_1) than the actual market price (p_0). The tax is thus $(p_1-p_n)*x_1$. The share of the tax burden of the customer is $(p_1-p_0)*x_1$ compared to $(p_0-p_n)*x_1$ for the producer, while $(p_1-p_n)*(x_0-x_1)/2$ is the deadweight loss.

If the price elasticity of demand and supply differ, those who are comparably inelastic must bear more of the tax burden. If the consumer has a higher price elasticity than the producer, he or she will be less willing to buy if the price including taxes is rising.

Brümmerhoff (2011) provides an example using the four extreme cases, shown in Figure 3.2. First, total inelastic demand is where the producer receives the same price for the same amount of goods before and after the introduction of a new tax. In this case, the consumer must bear the whole tax. Second, if the supply is elastic to a maximum, the consumer must bear the tax burden while reducing his or her consumption. The producer receives his or her former price but sells fewer goods. Third, if the demand is elastic to a maximum, the consumer receives the same price but a lower amount of goods, and the producer bears the tax burden and receives lower prices. Fourth, inelastic supply leads to lower net prices for the producer with the same amount of sales, while the consumer gets the same price and amount of goods.

The incidences of taxes should be considered by every tax planner. Indeed, a tax planner needs to consider the object and base of a tax carefully, as the tax subject reacts to the new tax (or new tax level). If the aim of a tax is to gain a certain amount of money for the state, this reaction must be planned or at least taken into consideration. In case (a) of Figure 3.2, the tax is $(p_1-p_0)*x_0$. If that was the planned amount, there is no problem (in (d) there is also no substitution

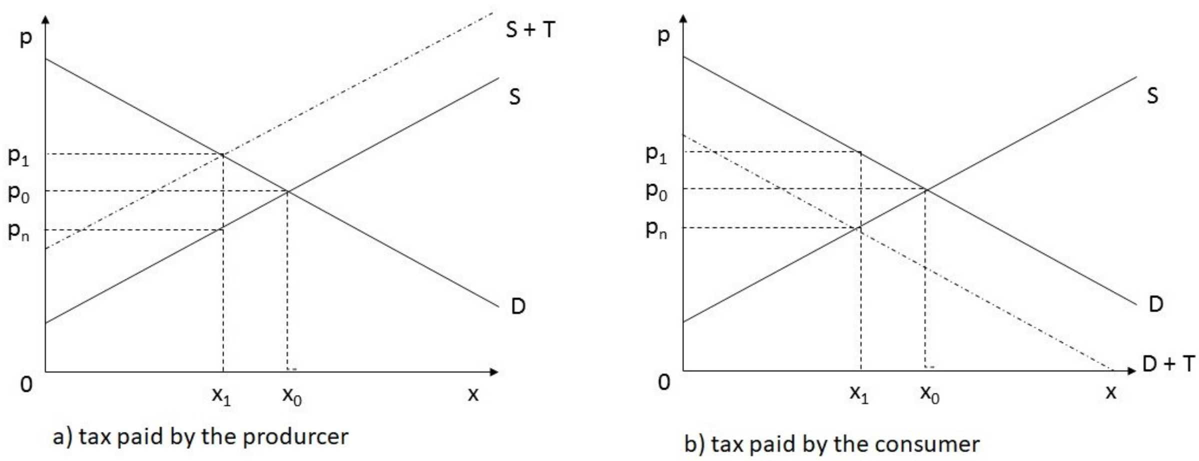


Figure 3.1: Introducing a tax by perfect competitive markets; source: Brümmerhoff (2001)

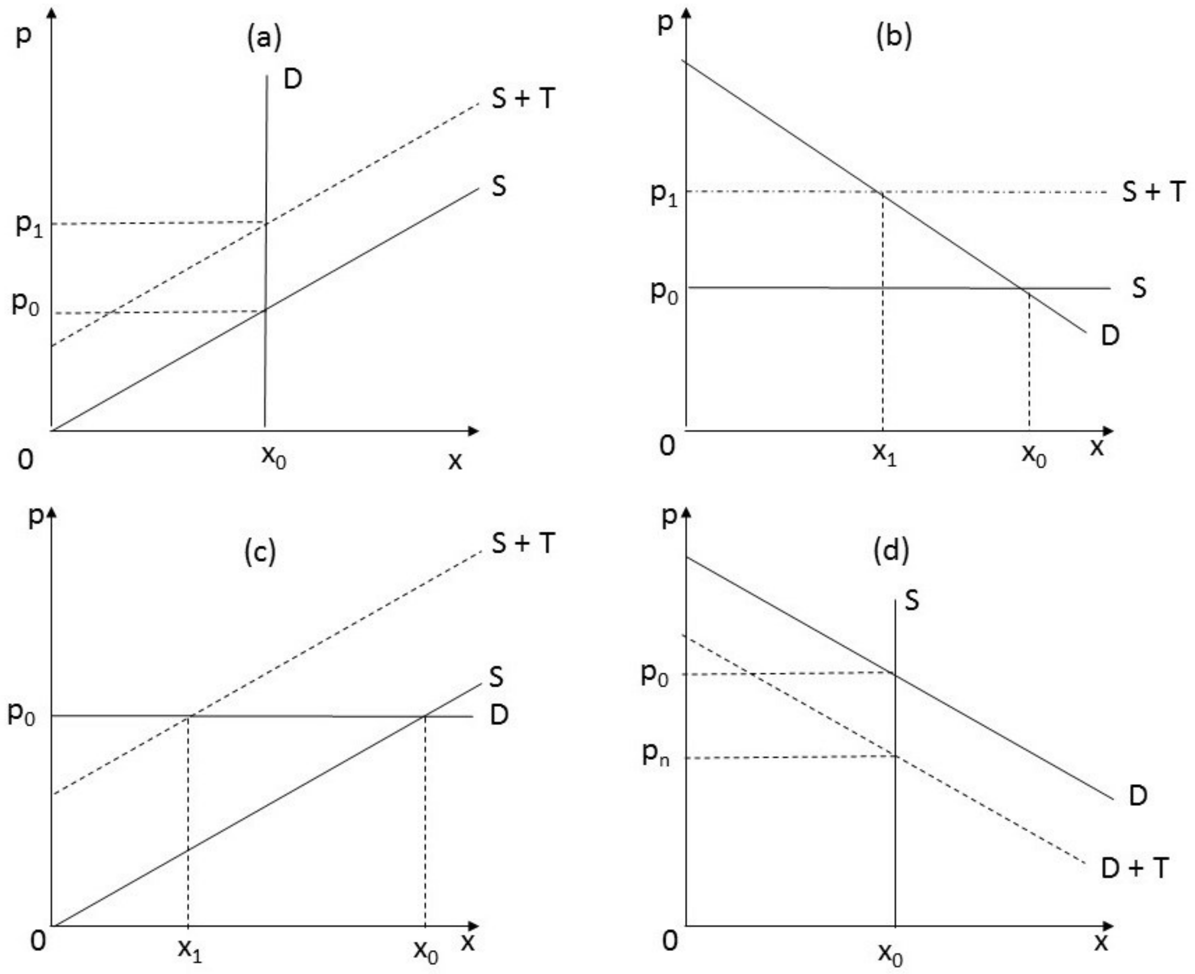


Figure 3.2: Tax incidences with extreme price elasticities; source Brümmerhoff (2001)

effect). In case (b), the tax revenue is only $(p_1p_0)*x_1$ owing to the altered amount of traded good (substitution effect) instead of x_0 (also in (c) with $(p_0\text{-}p_n)*_{x1}$).
If the substitution effect is not considered, the tax revenue will be lower than intended. If this is the case, the tax rate or tax base must be increased (tax as an additional good), leading to greater distortions on the market (Brümmerhoff, 2001).

3.6 Feedback effect of taxes on other factors and goods or indirect feedback effect

A further problem when attempting to predict the effects of a tax cut or increase is that the change in one tax influences other taxes. For example, a tax cut in capital taxes should increase the capital supply, and so the stock of capital increases and labour becomes more productive (assuming a Cobb-Douglas production function), or at the very least more capital increases the productivity of labour.
Another feedback effect occurs within consumption taxes. When the price of a good is raised by a new tax, it is possible that the sales of other goods will rise and therefore the tax revenue related to the second good will also increase (Bronfenbrenner, 1942). For instance, if the price of butter is increased by a new tax, we can expect that sales of butter will reduce, and perhaps

sales of margarine will increase. Therefore, the state has three tax revenue effects: (1) revenues rise by the new tax rate on butter; (2) tax revenues are lowered by lower sales of butter; (3) tax revenues rise with extra sales of margarine. Whether the new tax on butter leads to a higher or lower total tax revenue constitutes a question that is difficult to answer.
Therefore, a political recommendation for a tax reform that considers only one good or factor of production is unhelpful.

Based on this definition (Chapter 2) and economic ideas (Chapter 3) regarding taxation, I want to introduce the Laffer Curve theory in the following chapter.

4 The Laffer Curve theory and the model of Trabandt and Uhlig

The tax revenue (T) is the tax base (Y) times the tax rate (τ) (the price wedge between payer and receiver):

$$T(Y,\tau) = Y(\tau) * \tau \qquad (4.1)$$

The basic idea of the Laffer Curve is that a change in the tax rate does not only has a numerical[6] effect, but also has an economic effect i.e. a change in the tax base or the substitution effect. Therefore, the tax base (Y) is contingent on the tax rate (τ); the arithmetic effect of a tax change creates a new hypothetically tax revenue, as the given tax base is multiplied by a new tax rate. However, the tax base (Y) alters with the new tax rate (τ), a change called a "feedback effect" or "economic effect". Laffer (2004) argues that if the tax base (Y) shrinks considerably in reaction to the tax rate (τ) increase, it might lead to a lower tax revenue (T) compared to the previous and smaller tax rate (τ).

Stated more formally: if the revenue is a function that depends on the tax base and tax rate, a change in tax rate does not only change the tax revenue (arithmetic effect), but also changes the tax base, which has an indirect effect on the tax revenue (economic or feedback effect):

$$\frac{dT}{d\tau} = T_Y^{`} * \frac{dY}{d\tau} + T_\tau^{`} \qquad (4.2)$$

If the tax rate is raised (do>0), the tax base change $\left(\frac{dY}{d\tau}\right)$ must be negative and vice versa. If the change in tax base $\left(T_Y^{`} * \frac{dY}{d\tau}\right)$ is greater than the change in tax rate $\left(T_\tau^{`}\right)$, then and only then will a tax cut or tax rate raise increase the tax revenue.

Given that the tax revenue is tax base times tax rate, there is of course one point where the state receives no tax revenue at all: when the tax rate is 0. If the tax rate is defined as the wedge between what is paid and what is received, a 100% tax rate means that the whole value of an activity goes to the state, and those who created the value or want to buy it gain nothing. Rational people would avoid such an activity, ultimately creating no revenue for the state as well.

[6] Laffer calls this the "arithmetical effect".

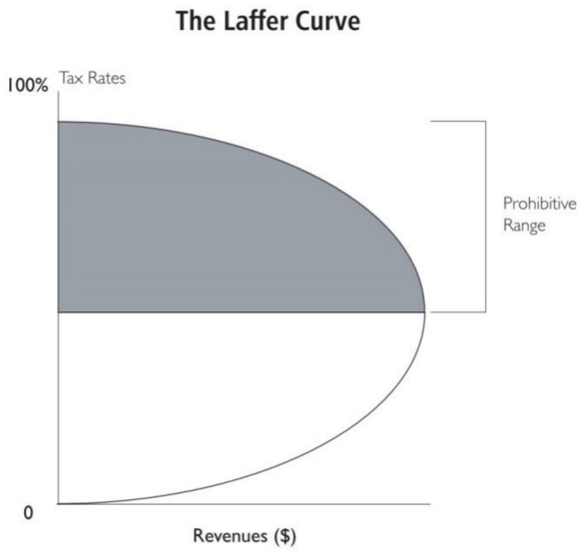


Figure 4.1: Illustration of the Laffer Curve theory; source: Laffer (2004)

The two points of no revenue form the starting points of the Laffer Curve because every tax rate between 0% and 100% creates a positive revenue. Furthermore, Wanniski (1978) argues that for each amount of revenue, there are two ways to archive them: one is to combine a low tax rate with a large tax base, and the other is to combine a high tax rate with a small tax base. The situation is like a monopolist who can choose between a small price accompanied by a high number of sales and a high price accompanied by a small number of sales.

Therefore, the government can realise the same amount of tax revenue with a high tax rate and small tax base and a low tax rate and a large tax base. Only a single point can be achieved with only one tax rate; this is also the maximised tax revenue. From this point onwards, the tax revenue declines for each higher and smaller tax rate. Following this idea, the Laffer Curve has a bell-shaped form (Figure 4.1).

The Laffer Curve has two areas: the normal range, where an increase of tax rate leads to higher revenues (in Figure 4.1 the white area), and a prohibitive range (grey area), where a tax cut would increase the revenue.

As described in Chapter 3.2, the drivers of the Laffer Curve theory are the substitution/feedback effect and the indirect feedback effect. Therefore, a tax rate change in one production factor influences the other factors. Consequently, Laffer (1981) assumes a diminishing marginal rate of substitution between factor tax rates and draws isoquants of the combined revenue of labour and consumption.

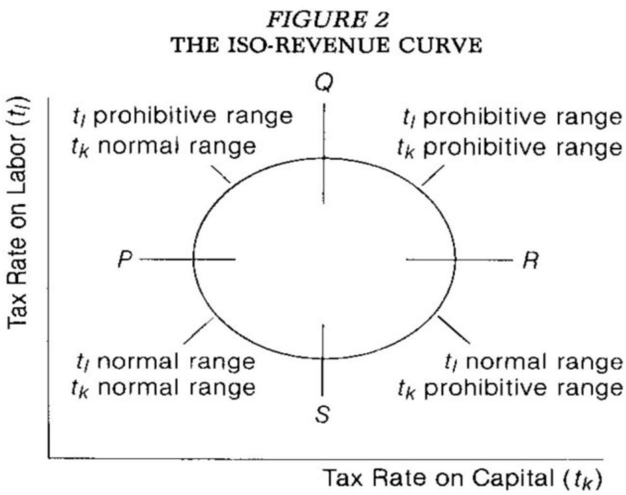


Figure 4.2: Laffer ISO-Revenue Curve; source: Laffer (1981)

He defines four possible areas, displayed in Figure 4.2. The first area is between P-S: both taxes are in the normal range. A tax cut will reduce revenue. In the P-Q area the capital tax is in the normal range, but with a tax cut on labour tax the total revenue would increase. The opposite situation is present in area S-R. In the final area Q-R, a cut on each or both tax rates would increase the tax revenue.

What could be a consequence of a change of one tax rate is summarised by Laffer (1981) in the following five bullet points:

> *1. Changes in tax rates affect output in a direct fashion. Lower tax rates correspond to higher output.*
> *2. Changes in tax rates directly affect the employment of both factors of production. Lower tax rates on either factor increase employment for both factors.*
> *3. With government spending held constant, the constellation of tax rates affects output. How taxes are collected is important, as is the total amount of taxation and spending.*
> *4. Lowered tax rates on any factor may or may not lower total revenue.*
> *5. With revenue held constant, changes in the pairing of tax rates may shape the distribution of after-tax spending power, but only indirectly. As often as not, when one factor's tax rate is raised and the other's is lowered, the second factor will end up in worse economic shape.*

Laffer (1981, p. 8)

The key message of the Laffer Curve is that if a tax is in the prohibitive range, the state can increase its tax revenue by lowering the tax rate. This property seemingly contradicts the definition of the arithmetic effect, where lower taxes mean lower revenue, which is true if the arithmetic effect is regarded as separate from other factors. Laffer argues that the economic effect after a tax cut could lead to higher tax revenue as the tax revenue loss through the arithmetic effect.

Moreover, if a tax is within the prohibitive range, the government is in the comfortable situation of being able to increase its revenue by cutting taxes, increasing the wealth of both the government and the people.

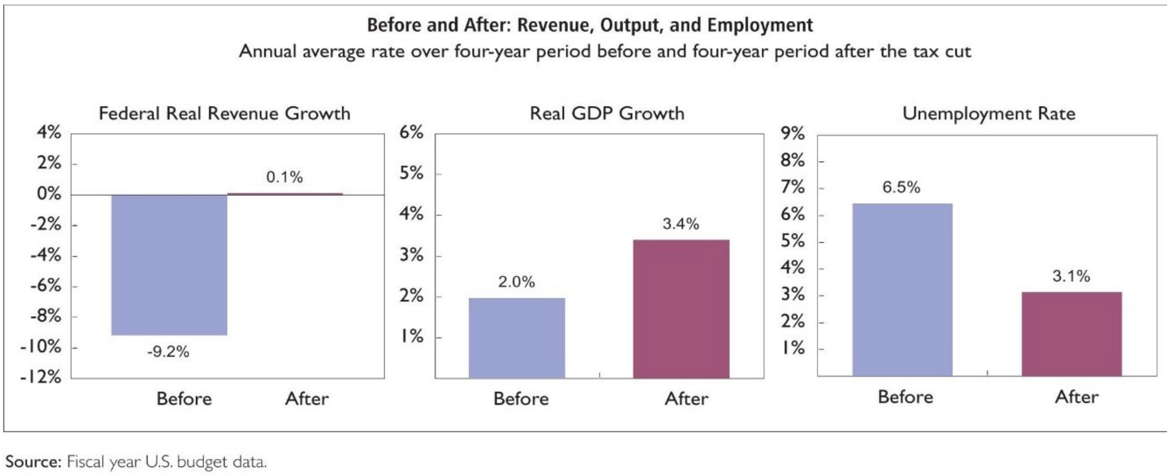


Figure 4.3: Harding-Collidge cut; source: Laffer (2004)

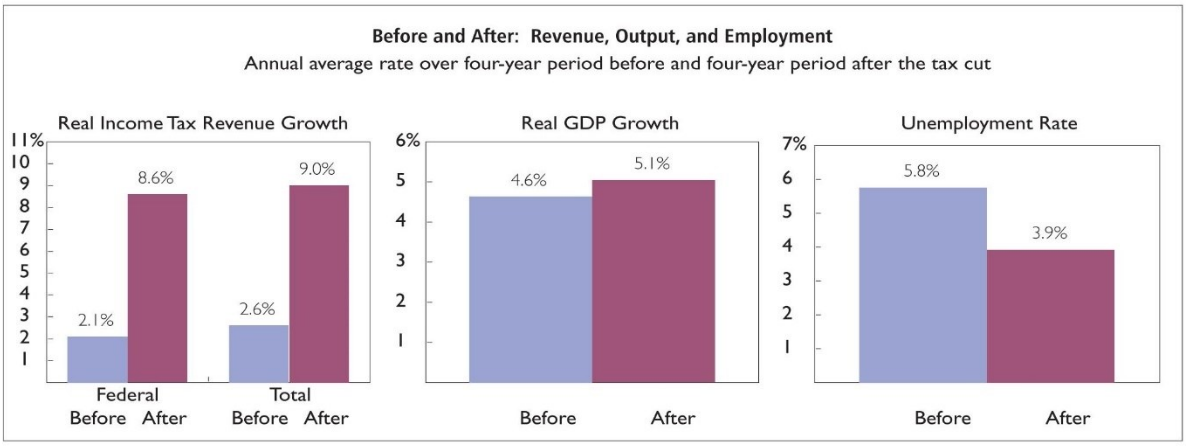
4.1 Historical examples of a successful tax cut

Laffer and other supply-side economists provide historical examples of successful tax cuts. They claim that before these cuts taxes, the tax system was in the prohibitive range. In "The Laffer Curve: Past, Present, and Future," Laffer (2004) offers three examples of American tax cuts – Harding-Coolidge (1925), Kennedy (1965) and Reagan (1981) – that he considers successful due to the Laffer Curve effect. Laffer (2004) also briefly discusses the history of American capital taxation.

Harding-Coolidge tax cut of 1925

Laffer (2004) explains that in 1913 the US top marginal personal income tax rate was 7%, rising dramatically to 77% at the end of World War I. The Harding-Coolidge tax cut reduced the top marginal personal income tax rate to 25% in 1925. An overview of the results, which are presented by Laffer, is provided in the Appendix (Table 10.8). Laffer compares the four years before and after the tax cut. On average, the federal tax revenue declined (inflation-adjusted) by 9.2% each year from 1921 to 1925, while after the tax cut the tax revenue stabilised, reaching an average growth of 0.1% per year.

Laffer claims that he was even more impressed by the decline of unemployment (from 6.5% to 3.1%) and annual gross domestic product's (GDP) real growth from 2% to 3.4%, as shown in Figure 4.3. Furthermore, Laffer (2004) argues that the quality of life in the USA in terms of owning assets increased from 1920 to 1930 due to the tax cut. Indeed, the percentage of Americans owning a car rose from 26% to 60%, owners of a radio from 0% to 46%, accommodations with electric lighting from 35% to 68%, washing machines from 8% to 24%, vacuum cleaners from 9% to 30% and water closets from 20% to 51%.



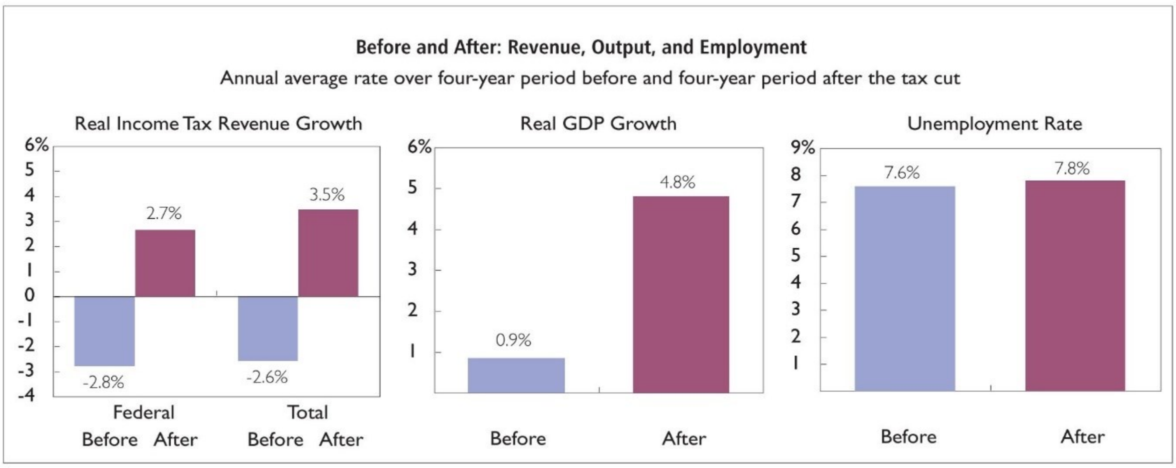
Source: U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts dataset.

Figure 4.4: Kennedy tax cut; source: Laffer (2004)

Kennedy tax cut in 1965

As a reaction to the Depression and World War II, the top marginal personal income tax rate rose to a peak of 94% in 1944 and the rate remained above the 90% benchmark until the Kennedy tax cut in 1965 (Laffer, 2004). The tax cut reduced the top marginal personal income tax rate from 91% to 70%, as well as the tax rates for lower income brackets.

Again, Laffer compares the four years before and after the tax cut (Table 10.10). Akin to the situation in 1925 an average real revenue increase from 2.6% to 9.0% was seen, alongside an average real GDP increase from 4.6% to 5.1%, as shown in Figure 4.4. The unemployment rate also declined from 5.8% to 3.9%. Bartlett (1977) argues that the US government created a surplus of 3 billion dollars until the middle of 1965, when the Vietnam War began.



Source: U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts dataset.

Figure 4.5: Reagan tax cut; source: Laffer (2004)

Reagan tax cut in 1981-1983

President Ronald Reagan reduced the top marginal personal income tax from 70% to 50% and cut the marginal tax rates for lower incomes (Laffer, 2004). As before, Laffer compares the four years before and after the tax cut. For the Reagan tax cut, he selects 1 January 1984 as the tax cut point, because this was the date on which the entire tax cut was introduced (Table 10.12). Laffer observes an increase in the average real tax revenue (-2.6% to 3.5%) as well as average real GDP (0.9% to 4.8%), as shown in Figure 4.5. However, unlike tax cuts, the unemployment rate did not decline, instead rising from 7.6% to 7.8%.

Capital tax rates cuts in the USA

In addition to the cuts in private income tax, Laffer (2004) presents a history of the capital tax in the USA.

Laffer argues that the change in the tax rate for capital gains represents a better indicator of taxpayer behaviour than changes in labour taxation, given that the temporal availability of one's capital gains constitutes a more controllable form of income than wages. Furthermore, capital gains show an "incredible consistent pattern", rendering changes in tax rates easier to observe.

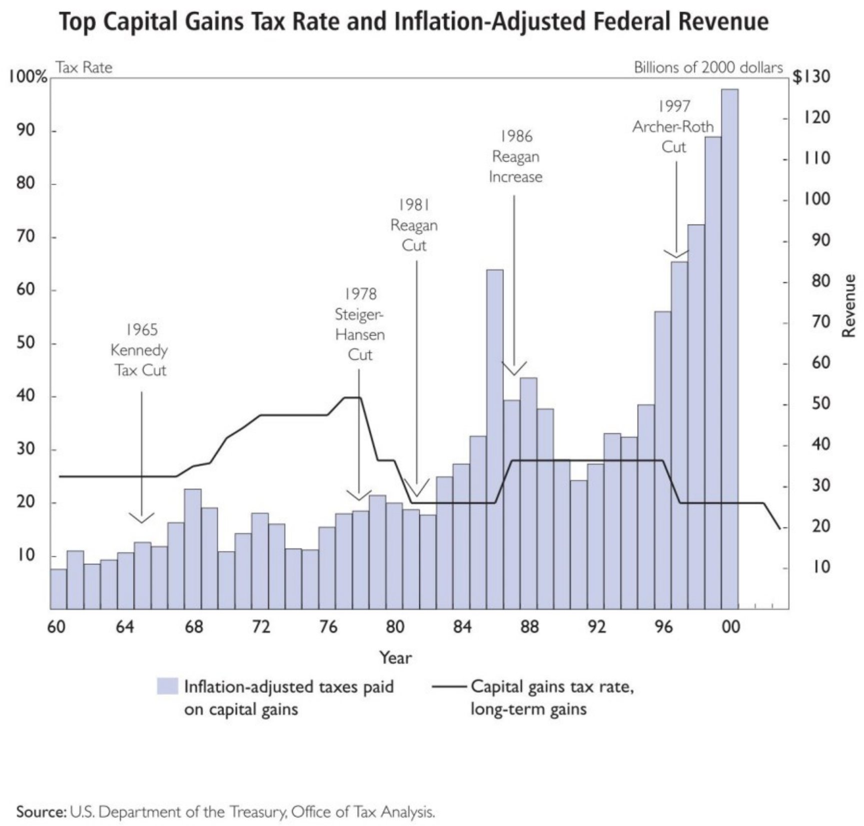


Figure 4.6: Top capital gains tax rate and inflation-adjusted federal revenue; source: Laffer (2004)

Laffer (2004) describes the development of the capital tax revenue and tax rate as follows: in the 1960s and 1970s the capital gains tax receipts were around 0.4% of the GDP, with surges following the Kennedy (labour) and Steiger-Hansen (capital) tax cuts. In 1981, the tax rate for capital was cut from 28% to 20%.
This led to an increase in the capital gains tax revenue of 50% between 1980 (12.5 billion dollars) to 1983 (18.7 billion dollars), an approximate 0.6% of the GDP. An increased tax rate in 1986 (back to 28%) led to a collapse in revenue (in 1986 the revenue was 328 billion dollars, compared to 112 billion dollars in 1992). In 1996 the tax was cut again to a 20% tax rate. The receipts of capital tax revenue have steadily been rising ever since (Laffer, 2004).
Note that Laffer uses tax revenue measured in nominal dollars for his description and real (base 2000) dollars for his graphic.
Laffer (2004) claims that a change in capital gain tax rate affects the behaviour of taxpayers, and hence a lower tax rate leads to a higher tax revenue.

Germany and Japan after World War II

Wanniski (1978) argues that after World War II, the German and Japanese economies suffered from wartime tax rates, whereas the American economy smoothly transformed from a wartime to a peacetime economy due to an early tax cut. The economies of both Japan and Germany began to grow after tax cuts were conducted, and their tax revenues increased as well.
Wanniski (1978) argues that in 1948, the post-war German tax system with a marginal 50% for income above $600 and 95% above $15,000 precluded economic growth. In 1948, Finance Minister Ludwig Erhard introduced a tax reform, raising the tax brackets, with 50% tax rates for incomes above $2,200 and 95% above $63,000. This kind of tax reform occurred for the following 10 years, so the German tax system in 1958 exempted the first $400 of income, the bracket for the 50% income began with $42,000, and the top marginal tax rate was reduced to 53% for incomes over $250,000.
In Wanniski's (1978), opinion this tax reform gave the German government the ability to build the "welfare state", with Ludwig Erhard and not the Marshall Plan ultimately saving Europe from communism.

Mirowski (1982) argues that even if Laffer found evidence for his Laffer Curve theory, he has not been able to determine the location of the revenue-maximising point, even though he was able to describe its characteristics. However, other authors have tried to determine revenue-optimising tax rates.

4.2 Examples for Laffer Curve estimations

Wannsiki wrote:

The "Laffer Curve" is a simple but exceedingly powerful analytical tool.

Wanniski (1978, p. 11)

Following Wanniski, it would be beneficial to make use of this tool and ascertain which countries' taxes fall within a prohibitive or normal range.

Most empirical works based on the Laffer Curve seek to calculate the optimal point, where the tax revenue is maximised. According to Hsing's (1996) calculations, the revenue-maximising rate of US personal income tax was between 32.67% and 35.21% for the years 1959 to 1991. Trabandt and Uhlig (2011) have calculated a revenue-maximising tax rate of 14 for the USA and EU from 1975 to 2000. This calculation sees Austria exhibits an optimal tax rate on labour of 61% and capital 35%. For the USA, the respective figures are 63% for both labour and capital. The only countries observed within the prohibitive area are Denmark and Sweden. Heijman and van Ophem (2005) have estimated the point of the maximal willingness-to-pay taxes for Austria at 60% of the GDP for the year 1996. Although they use different methods, the wide range (from 32.67% to 63%) between their results for the revenue-maximising tax rate for the US income tax rate is surprising. The estimated revenue-maximising tax rate should be independent of the estimation method and converge to the same value if the estimation method is effective. For this paper I use the least squares estimation from Hsing (1996) and the model of Trabandt and Uhlig (2010).

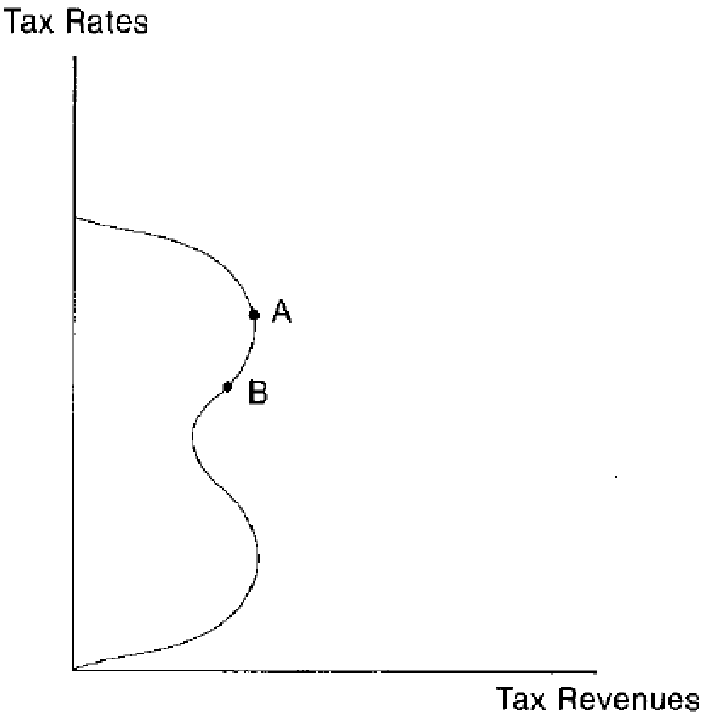


Figure 4.7: Alternative Laffer Curve; source: Henderson (1981)

4.3 Criticism of the Laffer Curve theory

Although it has been supported by empirical data, the Laffer Curve theory is not undisputed. Mirowski (1982) argues that the existence of a point with a 100% tax rate and 0 tax revenue is unproven. He argues that at such a point, the state would gain all revenues, like in a communist

society. History shows us that people in communist states worked without wages (primary income), receiving only a secondary income. Mirowski (1982) argues that if a 100% tax rate does not lead to a rejection of work, the entire premise of the Laffer Curve collapses, as there would be no reason for a downward-sloping range.
For the consumption tax, in contrast to the capital and labour tax, Trabandt and Uhlig (2011) found no peak. In their model, the consumption tax is only a scalar of the labour tax curve. Households pay consumption taxes, while the state uses the additional payment stream for transfers to households, extending their consumption. This creates a circle where no peak is expected. Moreover, in the MTU the consumption tax is built as surplus, which means that the tax is built as a price increase, and capital and labour income are built as a share of the price. Therefore, Trabandt and Uhlig (2011) argue that consumption tax has no Laffer Curve peak.

This points towards the lack of a downward range and an absence of a Laffer Curve for consumption taxes.

The second area of criticism pertains to the bell-shaped form of the Laffer Curve. Even if there exist two 0 revenue points (0% and 100% tax rate), this does not mean that the curve has only one peak. Indeed, Mirowski (1982) and Henderson (1981) (see Figure 4.7) argue that there can be more than one extreme point and more than one downward-sloping areas.
It is useful to examine alternatives to the bell-shaped form, such as by applying the Laffer Curve to only some parts of the tax rate range or to use a different relationship between tax rates and tax revenue.

In Chapter 2.2, progressive tax scales are briefly discussed. If the tax system is progressive as in the case of Austrian income tax, this scale raises certain question regarding the Laffer Curve theory. First, is the elasticity of labour supply constant for all income groups? Following Henderson (1981) and Fullerton (2008), higher-income groups display greater elasticity of labour compared to lower-income groups. If the former are more elastic to a tax rate rise at the same amount for all income groups, this would lead to a greater shift from working to untaxed activities. Second, do the scales of progressivity influence the tax revenue-maximising tax rate? Feige and McGee (2005) have observed that with a greater scale of progressivity, the average tax rate that leads to the revenue-maximising amount must be increased. Third, Feige and McGee (2005) argue that a tax cut in marginal tax rates may lead to a higher average tax rate. A tax cut in the marginal tax rates might result in a higher factor input and therefore higher productivity and an extension of the tax base. Taxpayers review higher wages and therefore encounter higher tax rates due to the progress scale. The average tax rate rises. This contradicts the way in which the Laffer Curve theory connects average tax rate and tax revenue, and may produce an alternative Laffer Curve form as Henderson (1981) has suggested.

The third point of criticism applicable to all neoclassical frameworks of the labour market is that workers choose their own working hours.
Stuart (1981) and Mirowski (1982) claim that laws, unions and the demand for labour (most job offers already include working hours) constrain workers' options. Adjustments to their work-free time balance are either unrealistic or are accompanied by transaction costs (e.g. searching for a new job or negotiating with an employer).

The tax revenue is not only contingent on the formal tax system. Following Feige and McGee (1983), tax payments are influenced by the expectation of furthering government action, and following a tax reform, tax payers require some time to adjust their work effort and may not react if adjustment costs are excessive. Stuart (1981) estimates the tax reform time lag on the labour market as being 9 to 10 years.

The fourth point is that the government influences households' income with their spending. The elasticity of labour supply is dependent on household income and so as Fullerton (2008) argues, if the government transfers tax revenue to households, the latter adjust their labour supply. Feige and McGee (2005) argue that the government uses transfers to equalise income, and these transfers may have the effect that households do not work in low-paid jobs. This affects the average tax rate and tax revenue because lower-taxed jobs are not occupied. By the same marginal tax rates, the average tax rate and tax revenue could be altered through government spending. Again, these transfers might lead to an alternative Laffer Curve form.

A sixth point is that the tax burden has an effect on growth (see Feige and McGee, 1983), as Pecorino (1995) argues in terms of human capital formation. Therefore, the tax revenue-maximising tax rate is not the socially optimal tax rate. Feige and McGee (2005) argue that this difference between social optimal and revenue-maximising tax rates is important if tax revenue-maximising is discussed.

4.4 Least squares estimation of the Laffer Curve introduced by Hsing (1996)

Hsing (1996) has defined a polynomial formula for the bell-shaped form of the Laffer Curve:

$$T_t = \beta_1 \tau_t + \beta_2 \tau_t^2 + u_t \qquad (4.3)$$

Where T is the revenue, τ is the tax rate and u is the standard error term. t is the time index, β_1 and β_2 are the estimation parameters.

To obtain a Laffer Curve, the parameters must be $\beta_1 > 0$ and $\beta_2 < 0$. There is no intercept because according to the Laffer Curve theory a tax rate of 0 corresponds to a revenue of 0 (Hsing, 1996). Hsing offers no information regarding what happens when the 100% tax rate corresponds to zero revenue.

If the parameters are as expected by the Laffer Curve theory, the optimal tax rate could be determined as any extreme point by the first derivative of the tax revenue function with respect to the tax rate set to 0.

$$\tau^{\mathrm{Opt}} = \frac{-\beta_1}{2 * \beta_2} \qquad (4.4)$$

Hsing (1996) conducted his calculation using data from National Income and Product Accounts (NIPA) for 1959 to 1991 (32 years) regarding the US economy. He ran four estimations: linear, log-log, linear-log and log-linear. As mentioned above, his results displayed an optimal labour income tax rate between 32.67% (liability-based, linear estimation) and 35.21% (payment-based, log-log estimation). He also attained the expected sign of the parameters for the log-linear estimation, but not for the linear-log (both parameters positive).

He did not report the log-linear results, arguing that the R^2 value (liability-based R^2 being 0.84 and payment-based 0.798) is smaller than the linear-linear (0.919 and 0.931) and log-log estimation (0.928 and 0.934), and therefore it is not used to calculate the optimal tax rate. I conducted such a calculation, and using Hsing's parameters I obtained an optimal tax rate of 20.94% (liability and payment base 21.9%). There is no reason why Hsing did not report the result of this calculation, especially given that the R^2 criterion requires an intercept to be interpreted (see Auer, 2005).

In the same way as Hsing (1996) for US data, I aim to conduct a least squares estimation with Austrian data. I use the same estimation equation as Hsing (4.4), where T is the tax revenue relative to GDP, τ is the tax rate, measured using the effective average tax rate method, where i = {capital (k), labour (l), consumption (c), and combination of labour and consumption (lc)}, t is the time index, and u is an independent, identically distributed error term. If the tax rate is 0,

Laffer's theory expects a tax revenue of 0, and therefore the regression line goes through the origin (no intercept), which is part of the Laffer Curve theory.
The determination of the tax rate, as the ratio of tax revenue and tax base, leads to the problem that the tax revenue appears as a dependent variable (in my case T) and an independent variable (τ) on both sides of the estimation equation.
To solve this issue, I modified the equation to:

$$T_t = ß_1 \tau^i_{t-1} + ß_2 \left(\tau^i_{t-1}\right)^2 + u_t \tag{4.5}$$

This little trick should solve the endogeneity problem.
As shown before, Hsing (1996) also calculated log-log, log-level and level-log versions:

$$\log T_t = ß_1 \log \tau^i_{t-1} + ß_2 \log\left(\tau^i_{t-1}\right)^2 + u_t \tag{4.6}$$

$$\log T_t = ß_1 \tau^i_{t-1} + ß_2 \left(\tau^i_{t-1}\right)^2 + u_t \tag{4.7}$$

$$T_t = ß_1 \log \tau^i_{t-1} + ß_2 \log\left(\tau^i_{t-1}\right)^2 + u_t \tag{4.8}$$

My aim is to find the level of the tax rate that maximises tax revenue based on the Laffer Curve theory. This is the interpretation of equation (4.5) where the level is regressed on the level. The log-log model (4.6) estimates the average change of tax revenue regarding the change of the tax rate. The optimal tax rate change could be retransferred to the optimal level of the tax rate. Both semi-log models, in my opinion, have a different interpretation. The log-level equation (4.7) estimates the tax rate level at which the tax revenue change is maximised. The level-log equation (4.8) presents the tax rate change where the tax revenue level is maximised. There is no simple transformation to express the tax rate that maximises the tax revenue, rendering both semi-log models useless when working to find the tax revenue-maximising tax rate.
I prefer the level-level model, but some authors like Karas (2012) prefer the log-log model. Therefore, I apply both to the Austrian data in Chapter 6.

4.5 Model of Trabandt and Uhlig

As an alternative to a direct estimation using macroeconomic values, a model can be built. For the determination of the Laffer Curve and the revenue-maximisation tax rate, Trabandt and Uhlig (2010) present an equilibrium model in "How far are we from the slippery slope; The Laffer Curve revisited".
In the model represented, active households maximise utility over life time.
Time is discrete, t=0,1,.., ∞ one step represents one year. Future utilities are discounted by a constant rate ß. Therefore, the households maximise their intertemporal utility (4.9) with respect to the budget they receive (4.10):

$$c_t n_t k_t x_t b_t max\, E_0 \sum_{t=0}^{\infty} ß^t [u(c_t, n_t) + v(g_t)] \tag{4.9}$$

s.t.

$$(1 + \tau_t^c)c_t + x_t + b_t$$
$$= (1 - \tau_t^n)w_t n_t + \left(1 - \tau_t^k\right)(d_t - \delta)k_{t-1} + \delta k_{t-1} + R_t^b b_{t-1} + s_t + \Pi_t + m_t \tag{4.10}$$
$$k_t = (1 - \delta)k_{t-1} + x_t \tag{4.11}$$

Where t is a subscript for time, consumption c_t, hours worked n_t, capital k_t, investment x_t and government bonds b_t and an exogenous stream of payments m_t. The government supplies a public good g_t to the households, which provides utility $v(g_t)$. The households receive utility u from consumption c_t and disutility from working hours n_t.

Households must fulfil restriction (4.10): to finance the consumption ct, private investment xt, as well as to buy government bonds bt, the households use their hourly wages w_t, dividends dt, profits Π_t and stream payments m_t and then receive interest earnings R_t^b and lump-sum transfers s_t from the government.

The capital stock for each period depends on the investment k_t and the capital stock of the period before being reduced by a depreciation rate δ. This is built into the side condition (4.11).

Labour incomes are taxed at the rate τ^n, capital incomes τ^k and consumption with τ^c.

The asset payment stream m_t is constant and can be either negative or positive. The asset payment stream captures the net imports. This constant represents international trade. The net imports are independent form the production costs in this model. Therefore, taxes do not influence international trade. This assumption of independence of international trade and gross production costs contradicts the typical neoclassical perspective regarding international trade. Especially in the case of extreme tax rates, the estimation may be biased by failure to adjust to international trade.

Trabandt and Uhlig assume labour immobility between the USA and EU, and so I must assume that this situation applies to Austria, too. European workers are less mobile than their American counterparts. To leave a country like Austria to work in other countries like Hungary, Italy or Spain is not common. The constant immigration of Eastern European workers to Austria is captured by the number of workers in the labour force. This shift to the west in Europe seems not to have been caused by taxes, because people tend to settle in high-tax countries. Rather, it seems that European workers leave their countries due to the quality of living. Therefore, I follow the assumption of labour immobility. This assumption of labour immobility is important for the estimation and models used. Indeed, without this assumption, the model would require a complex simulation of the production factor movement between states with respect to taxation, additionally including the political decisions behind tax rates in foreign countries.

For capital, Trabandt and Uhlig (2010) follow Feldstein and Horioka's (1980) observation that savings and investments are highly correlated. Alternatively, the model can be interpreted as owner-based capital taxation rather than source-based taxation. Therefore, fiscal policy changes have a minor cross-border effect.

The representative firms using Cobb-Douglas production technology (4.13) seek to maximise their profits as presented in Equation (4.12).

$$max_{k_{t-1},n_t} \;\; y_t - d_t k_{t-1} - w_t n_t \tag{4.12}$$

s.t.

$$y_t = \xi^t k_{t-1}^{\theta} n_t^{1-\theta} \tag{4.13}$$

Where y_t is the production output and ξ^t is the trend of total factor productivity.

The government finances expenditures (public goods g_t, transfers s_t, interest payments for the bonds $R_t^b b_{t-1}$) with taxes received (T_t) and bonds (b_t) should tax payments be lower than expenditures:

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{4.14}$$

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k (d_t - \delta) k_{t-1} \tag{4.15}$$

Trabandt and Uhlig aim to analyse the equilibrium shift that occurs when tax rates are changed. In order to determine the equilibrium, they observe agents' decisions. Households seek to maximise their utility by choosing their labour supply and plan their investments, while companies solve their maximisation problem by employing labour and capital. Moreover, the government sets its public spending based on the maximum of its budget constraint.

Over time, asset payments, bonds and payments for public goods grow at the same rate ψ.

$$\begin{aligned} m_t &= \psi^t \bar{m} \\ b_{t-1} &= \psi^t \bar{b} \\ g_t &= \psi^t \bar{g} \end{aligned} \tag{4.16}$$

Where $\bar{m}$ is average observed exogenous stream of payments, $\bar{b}$ is the average observed government bonds and $\bar{g}$ the average observed public good supply.

Note that hours worked ($\bar{n}_t$), interest rate (R_t^b) and tax rates (τ^n, τ^k, τ^c) alter over time but do not grow with a fixed rate.

The after-tax return on any asset is contingent on the time preference, growth rate and the inverse of the intertemporal elasticity of substitution. Hence it is possible to determine the time preference through observation of the interest and growth rate and the assumption regarding the intertemporal elasticity of substation. With the additional assumption that the interest rate must be greater than one, the balanced growth path of the capital-output ratio is given by the interest rate, capital share of production, depreciation and capital tax rate.

$$\overline{k/y} = \left(\frac{\bar{R}-1}{\theta(1-\tau^k)} + \frac{\delta}{\theta}\right)^{-1} \tag{4.17}$$

Workers' productivity is dependent on the capital stock, and so the capital-output ratio is linked to labour productivity. Therefore, the capital-output ratio (4.17) can be set via the equation for labour productivity (4.18).

$$\frac{y_t}{\bar{n}} = \psi^t\, \overline{k/y^{\frac{\theta}{1-\theta}}} \tag{4.18}$$

The before-tax wage rate must be equal to the worth of labour. To determine the worth of labour, the share of capital in production must be excluded. Production per hours' work is thus the before-tax wage.

$$w_t = (1-\theta)\frac{y_t}{\bar{n}} \tag{4.19}$$

The before-tax wage equation contains labour productivity, hence the equations for capital-output ratio (4.17), labour productivity (4.18) and before-tax wage (4.19) can be represented as one equation.

Capital-output ratio and before-tax wage only depend on a policy-variable capital tax rate and via the interest rate on the preference parameters.

To determine the hours worked in equilibrium, Trabandt and Uhlig use the link between the elasticity of labour supply and consumption.

The first-order conditions of the firms and households, the Constant Frisch Elasticity (CFE) of labour supply (φ) and the inverse of the constant intertemporal elasticity of substitution (η) can build an equation with hours worked on the left and the consumption growth path together with the political variables of consumption and labour tax on the right.

$$\left(\eta\kappa\bar{n}^{1+\frac{1}{\varphi}}\right) + 1 - \frac{1}{\eta} = \frac{1+\tau^c}{1-\tau^n}\frac{1+\frac{1}{\varphi}}{1-\theta}\overline{c/y} \tag{4.20}$$

$$\overline{c/y} = 1 - (\psi - 1 + \delta)\,\overline{k/y} + \left((\bar{m} - \bar{g})\,\overline{k/y}^{\frac{-\theta}{1-\theta}}\right)\frac{1}{\bar{n}} \tag{4.21}$$

Substituting the equation of the feasibility constraint of consumption (4.21) in the consumption growth path hours worked equation (4.20) provides a one-dimensional, non-linear equation system, depending on the variable of hours worked. This system can be processed numerically, given the preference and production parameters, growth path level of the bonds, public good expenditure, money stream, and tax rates as the political decision variable.

As demonstrated in Equation (4.17), the capital-output ratio relies on the capital tax decreasing monotonically. Therefore, the tax base shrinks with increasing tax rate, as the Laffer Curve theory predicts. Assuming that spending on public goods surpasses the money stream, tax bases decreases for capital and labour taxes. It remains unclear which variable has which sign and size, and so a numerical solution is useful. A more detailed description, as well as proofs and propositions for the model, can be found in Trabandt and Uhlig (2010, p. 9-20): “How far are we from the slippery slope? The Laffer Curve revisited".

5 Data preparation for least squares estimation and the Trabandt and Uhlig model

In order to explain changes in the tax base it is necessary to consider individual parts of the tax revenue. Adam Smith claims that there are only three original sources – rents, profits and wages – from which all taxes are paid (Smith and Sutherland, 2008). However, Heady (2004) claims that it is impossible to determine the incidences of taxes (see Subchapter 3.5). I opt to only analyse counted taxes, which are paid, and not the economic burden of certain taxes. This work can only be used as starting point of a discussion on tax burden and not as a conclusion to the topic.

Therefore, only two income sources are considered in this paper: wages on factor input labour, and profits and rents on factor input capital. Every tax I used was part of one of these categories. Heady (2004) claims that the average worker in Austria receives less than 1% of his or her income from non-wage incomes, hence I assume that all consumption payments are based on labour income.

In a subsequent step I exclude all money penalties, because their objective is not to lead to revenue (see Chapter 2).

Fees are countable to the person who uses them, and hence they are like private goods; even if these services are supplied by the government, they are not taxes according to an economic definition of taxes (see Chapter 2).

A more difficult question is that of contributions. In Austria there are lots of contributions, such as social security payments, church taxes, chamber contributions[7] and union contributions. Only social security is reported separately in the Organisation for Economic Co-operation and Development (OECD) Revenue Statistics, chamber contributions for the chamber of labour supply (as well as for chamber of entrepreneurs) are included in the OECD-variables "Taxes on income, profits and capital gains of individuals or households (1100)" and "Taxes on income, profits and capital gains of corporations (1200)" taxes on income, profit, and capital gains. Chamber contributions are not voluntary; rather, everyone with an income based on labour is obligated to pay them. Therefore, both are more akin to taxes than contributions according to the legal definition. To treat them as taxes is a simplification of course, but the Chamber of Labour supplies a multitude of services free of charge, even to non-members. Personal or group services within social security are less strict compared to other countries

[7] Austrian employees and employers are organised in chambers. The biggest chamber is the "The Chamber of Labour", counting over 3.4 million members. Membership is mandatory.

because the state guarantees a minimum level of income and medical healthcare. Even in retirement, the personal component of contributions is only relevant in the area above the minimum pension. Social security also receives payments out of the governmental budget (which is financed by taxes) to provide retirement payments to those whose contributions during their working lives would be insufficient. This is not the way club goods work, enabling these payments to be treated as taxes.

Data for social contributions are available and are included in this paper. The chamber contributions are not displayed alone; they are included within taxes on income, profits and capital gains.

Union contributions and church tax payments are excluded because the payment is voluntary (it is possible to leave church or union to avoid the payment). The state offers a tax deduction for this kind of payment and in the case of employees, tax offices collect the contributions and transfers them to unions. The contribution to the church could be deducted after they are paid to the churches. Therefore, they are indirectly counted because if someone leaves the union or church, the tax payment rises for the same wage due to the tax deduction. However, this effect should be small and is not counted, and so I ignore it.

Another difference from neoclassical frameworks is that I do not use marginal tax rates as a disincentive for the taxed activity. In Austria there is a highly regulated labour market with strict rules of employment for workers. The assumption that employees are free to choose their work time to optimise their work-life balance, which is assumed in the leisure and work-time framework, is not realistic. More useful is the use of average tax rates, because planning for labour market participation is more dependent on the net wages, they can receive than on the net wage of the next hour worked.

For most capital incomes in Austria operate flat taxes, and so marginal and average tax rates are the same. Nevertheless, there are always exceptions in Austria.

Investors may see possible tax deductions. Owners of capital companies are taxed with the capital tax rate if they obtain profits. The profits of owners of private companies are taxed with the labour income tax system. Therefore, not all capital gains are taxed with the same tax rate, and the capital tax system is not a real flat tax system.

For self-employed persons it is difficult to distinguish between labour and capital income as argued by Carey and Rabesona (2002b). For example, lawyers consider it important to build a reputation for the chancellery, which may bring customers. But is this reputation human capital and therefore labour income, or is it an asset of the chancellery and therefore capital? I deal

with this problem by estimating a self-employed wage, which is hypothetical paid for self-employed businessmen.
Regardless of whether they are based on capital gains or labour income, they are all treated as proportional tax scales. This is consistent with the treatment by Canto et al. (1983).
To treat the tax as proportional tax scales leads to a loss of information because in Austria the tax system is not a flat tax system. Therefore, the interpretation of the results is limited at this point, as discussed in Chapter 4.3, “Criticism of the Laffer Curve theory”.

The only incidence included is the payment of payroll taxes. The tax on labour is the wedge between labour costs and the payment the worker received. In Austria this wedge has different components: (i) the income tax; (ii) the social contributions the workers must pay based on the wage; and (iii) the social contributions the employer must pay for the worker based on the wage, known internationally as “payrolls”. These payrolls are considered labour costs, as demonstrated by Heady (2004), Haan, Sturm and Volkerink (2004), and Mendoza, Milesi-Ferretti and Asea (1997). They are based on the wage: even if the employer is the tax debtor the worker must generate the payrolls because if he or she generates less than his or her cost, he or she will be fired. Therefore, the rollover of the burden from the employer to the worker will be seen in every case, because the employer reduces gross wages to the level they desire. Aside from the case where the worker is employed at the minimum wage rate, Nickell (1997) argues that shifting the tax burden of the payroll to workers is impossible. I use average tax rates and average workers who are not employed at the minimum wage rate. Consequently, the payrolls’ tax burden in my model is borne by the worker with the total amount, which is consistent with the average effective tax rate calculation of Tchilinguirian and Carey (2000).

The tax revenues are the sum of the taxes used to determine the average effective tax rates. I distinguish between taxes on capital, labour and consumption.
They are measured in current values for each year in order to render them comparable over time. Hsing (1996) has argued that for a Laffer Curve estimation, the dependent variable must be the real income tax revenue per capita. To adjust the observed tax revenues, I use the GDP akin to Trabandt and Uhlig (2010). I use 2010 as the base year, which is the current base year of most OECD variables. GDP is useful as a deflator because tax revenue rises in boom times when the tax rates are unchanged. The GDP deflector controls for this change in the revenue.

5.1 Determine the tax rate and tax revenue

For a statistical test of the Laffer Curve theory, I require tax rates that are comparable over a long period in order to gain sufficient data. Therefore, I calculated the tax ratios on labour, capital income and consumption. The method I used was presented by Mendoza, Razin and Tesar (1994) and further developed by Carey and Rabesona (2002a) and McDaniel (2007). Their objective was to present a tax calculation that allows comparison across countries and over time. To achieve this goal, a method is needed to break down historically different and complex tax systems into comparable components. Even though I only used Austrian tax rates, I had to simplify the problem to find a manageable solution for my Master's thesis. The authors mentioned above solved this problem using data from the OECD Revenue and National Account Statistics.

As Carey and Rabesona (2004) demonstrate, OECD Revenue Statistics do not distinguish between labour and capital income. Mendoza, Razin and Tesar (1994) solved this problem by constructing the household tax rate (τ^h) on total income. This means that labour and capital income are calculated based on the same tax rate:

$$\tau^h = \frac{1100}{KI + WSSS - 2100 - 2300} \qquad (5.1)$$

The household income is the tax revenue on taxes on income, profits and capital gains of individuals or households (1100) divided by the total household income, capital income (KI) and compensation of employees (WSSS). The WSSS includes the total social security contributions paid by employees (2100) and self-employed people or persons outside of the labour force (2300). Therefore, the total social security contributions paid by employees (2100) and by self-employed people and persons outside of the labour force (2300) are subtracted from the denominator.

The calculation I used is different from that used by Mendoza, Razin and Tesar (1994), especially given the deductible social security contributions introduced by Carey and Rabesona (2002). Following Haan, Sturm and Volkerink (2004), I argue that labour taxes should be assigned to the total costs of labour. I also used the compensation of employees (WSSS) instead of wages and salaries (W) in the denominator. The compensation of the employees (WSSS) includes total costs on labour, and only the gross wages among wages and salaries (W).

Use of the household income intermediate stage creates the possibility of calculating the tax ratios for labour and capital.

Mendoza, Razin and Tesar (1994) undervalue wages as they fail to calculate a wage for self-employed persons. Carey and Rabesona (2002) solve this using a calculated "wage bill" for the self-employed by using the number of self-employed divided by the employees times the wages paid. I want to introduce an alternative calculation because for Austria the self-security payments of self-employed persons are reported and therefore a ratio to an employee's security payments is possible. This approach is more suitable to the average wage bill for self-employment than the hours spent working.

In order to calculate the wage bill of self-employed persons (WSE), I used the wage and salaries (W) and weighted them with the social contribution payments of the self-employed persons (2300) and the social contribution payments of the employees (2100).

$$WSE = \frac{2300}{2100} * W \tag{5.2}$$

This wage bill of self-employed person (WSE) merely represents an attempt to determine the real wage of the self-employed person because the boundary between wage and capital is very hard to define, as briefly discussed in Subsection 2.6.

To calculate the effective average tax rate of labour, the household income tax rate (τ^h) is multiplied by the net wage of employees and self-employed persons plus the social contributions of employees (2100), employer payments to the social contributions (2200) and the tax on payrolls (3000).

The denominator is built with the total labour cost (WSSS) and tax on payrolls (3000) as well as the wage bill of the self-employed persons (WSE) and their social security contributions (2300).

$$\tau^n = \frac{\tau^h * (W - 2100 + WSE - 2300) + 2100 + 2200 + 3000}{WSSS + 3000 + WSE + 2300} \tag{5.3}$$

This is very close to the Austrian income tax system, where the social security contribution is deductible from the tax.

For the consumption tax, I used Carey and Rabesona's (2002) calculation, where the taxed payments on goods are summed and divided by private consumption (CP) and public consumption without wages (CG – CGW).

The tax payments on consumption are classified by the OECD data as general taxes on goods and services (5110), taxes on specific goods and services, excise taxes (5121), profits of fiscal monopolies (5122), customs and import duties (5123), taxes on specific services (5126), other taxes (5128) and Taxes on use of goods and performances (5200).

$$\tau^c = \frac{5110 + 5121 + 5122 + 5123 + 5126 + 5128 + 5200}{CP + CG - CGW} \tag{5.4}$$

Following Adam Smith (Smith and Sutherland, 2008) every tax must be paid out of one income stream, and so a consumption tax must be allocated to a capital or labour income. Given that consumption is based on labour incomes, the consumption tax will be combined with the labour tax:

$$\tau^{nc} = \tau^{n} + (1 - \tau^{n}) * \tau^{c} \qquad (5.5)$$

According to Carey and Rabesona (2002), this is important for the incentive work instead of having leisure time.

Carey and Rabesona (2002) improved the formula presented by Mendoza, Razin and Tesar (1994) by avoiding the simple addition of both tax rates. Simply summing up these two rates would mean that households could further spend the income taken away by taxes.

To avoid this issue, the consumption tax was weighted by 1 minus the income tax rate.

The tax ratio on capital income was refined by McDaniel (2007), but the author makes numerous assumptions due to the weakness of available data. Therefore, I decided to stick with Carey and Rabesona's (2002) formula.

The effective average tax rate for capital is the household income tax rate (τ^{h}) multiplied by the capital income, which is reduced by the wage of the self-employed persons and the taxes on income, profits and capital gains of corporations (1200) and the taxes on property (4000) added. As a denominator, the gross operating surplus of the overall economy (OS) minus the taxes on payroll and workforce (3000) and wage of self-employed persons (WSE) and their social security contributions (2300), representing the total capital income, was used.

$$\tau^{k} = \frac{\tau^{h} * (\mathrm{KI} - \mathrm{WSE}) + 1200 + 4000}{\mathrm{OS} - 3000 - \mathrm{WSE} - 2300} \qquad (5.6)$$

The calculation of the tax revenues is simply the sum of reported tax revenues, which are used in the formulas calculating effective average tax rates:

$$\mathrm{T}^{n} = \tau^{h} * (\mathrm{W} - 2100 + \mathrm{WSE} - 2300) + 2100 + 2200 + 3000 \qquad (5.7)$$

$$\mathrm{T}^{c} = 5100 + 5121 + 5122 + 5123 + 5126 + 5128 + 5200 \qquad (5.8)$$

$$\mathrm{T}^{nc} = \mathrm{T}^{n} + \mathrm{T}^{c} \qquad (5.9)$$

$$\mathrm{T}^{k} = \tau_{h} * (\mathrm{KI} - \mathrm{WSE}) + 1200 + 4000 \qquad (5.10)$$

$$\mathrm{T} = \mathrm{T}^{n} + \mathrm{T}^{c} + \mathrm{T}^{k} \qquad (5.11)$$

Using this calculation for tax rates and tax revenues, it is possible to conduct estimations of the Laffer Curve theory.

For the additional macroeconomic values required for the model of Trabandt and Uhlig (2010), no complicated preparation is necessary: the average over the 15th year is sufficient.

5.2 Data sources, data preparation and variable definition

In order to determine the effective average tax rates, I used OECD Tax Revenue Statistics and OECD National Accounts as explained in Subsection 5.1.

Revenue statistics data were all exported from OECD Revenue Statistics on the OECD (2016) website.[8] They are reported for the whole period, so I only had to select the relevant values.

National account data are not entirely available online, at least not for the whole period (1965-2012). The OECD National Accounts data are provided from different sources, as shown in Table 5.1, Table 5.2 and Table 5.3. The OECD National Accounts used were: OECD (1983, 1995, 1997) and the website of the OECD (2016).

All data from the National Accounts are measured in current prices. The change from Schilling to Euro and the different reporting methods (some values being reported in billions, others in millions) required me to convert the data accordingly. For the Schilling/Euro exchange I used the rate in the OECD (1999) Economic Report: 13,7603 AtS = €1.

Data	1965 – 1969	1970 – 1975	1976 – 2012
Private final consumption expenditure (CP)	National Account Report from OECD (1983)	OECD (2016) website	
Government final consumption expenditure (CG)			
Gross operating surplus of the overall economy (OS)[9]			
Compensation of employees (WSSS)			
Consumption of fixed capital (Afa)			
Wages and salaries of dependent employment (W)	estimated[10]	NAR from OECD (1983)	OECD (2016) website

Table 5.1: Table I of OECD sources

[8] *http://stats.oecd.org/: Follows the buttons: Public Sector, Taxation and Market Regulation, Taxation, Revenue Statistics - OECD Member Countries, Details of Tax Revenue – Austria.*

9 The previous name (*Operating surplus and the consumption of fixed capital*) was not included (McDaniel, 2007)

10 The estimation of the W was made by the ratio of W/WSSS (0.808), stable over the whole period. There have been only three occasions on which the fluctuation was greater than 1%, and it has never surpassed the 1.5% mark. The ratio of W/WSSS multiplied by the WSSS was used for unreported values.

	1965 - 1969	1970 - 1980	1981 - 1991	1992 - 1994	1995 - 2012
Government final wage consumption expenditure (CGW)	estimated[11]	NAR OECD (1983)	NAR OECD (1995)	NAR OECD (1997)	OECD (2016) website

Table 5.2: Table II of OECD sources

	1965 - 1969	1970 - 1982	1983 - 1994	1995 – 2012
Unincorporated business net income (including imputed rentals from owner-occupied housing) (OSPUE) Interest, dividends and investment receipts (PEI)	NAR OECD (1983)	NAR OECD (1995)	NAR OECD (1997)	OECD (2016) website

Table 5.3: Table III of OECD sources

Unlike the data used by Carey and Rabesona (2002), the data for Austria were not entirely available for the years 1965-2012. According to McDaniel (2007, p. 29):

> *The household accounts for Austria for the period 1950-1995 do not separately report Operating surplus of private unincorporated enterprises and property and entrepreneurial income.*

For McDaniel's method, this was a problem. For my calculations, this problem could be solved without substantial effort because both variables only occur together in my determinations. This allowed me to sum both variables for the data from 1995 onwards. The combination of these two variables created a new variable for capital income (KI).

In order to use the Trabandt and Uhlig model, I was required to collect additional data. The macroeconomic values, aside from the annual hours worked per worker, were taken from the AMECO-Database of the European Commission. They are available on the website.[12]
The annual hours worked per worker were derived from The Conference Board (2016), available online.[13]

[11] To estimate the missing data, I chose the average ratio of the five adjoining years of CGW/CG.
[12] *https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic- databases/macro-economic-database-ameco/download-annual-data-set-macro-economic- database-ameco_en*
[13] *https://www.conference-board.org/data/economydatabase/index.cfm?id=27762*

The working age population was again taken from the OECD website.[14]

The data for the Trabandt and Uhlig model are reported for the whole period in the data sources, therefore no further databases were used.

Tax revenue adjustment

In order to undertake a meaningful least squares regression, I sought to come as close as possible to a ceteris paribus situation.
The tax revenues are cash-based on national accounts, and therefore according to Carey and Rabesona (2004) it is impossible to compare two points within a timeline. Hsing (1996) uses the real tax revenue per capita to render the time series comparable. Trabandt and Uhlig (2010) simply adjust using the GDP deflator, which is the approach I follow in my thesis.

[14] http://stats.oecd.org/ / *Follows the buttons: Labour, Labour Force Statistic, Annual Labour Force Statistic, Population and Labour Force*

6 Empirical application of the Laffer Curve theory and the model of Trabandt and Uhlig to Austrian data

In order to apply the method presented in Subchapter 4.4 I had to ascertain whether a least squares estimation is possible. Following Wooldridge (2013), a least squares estimation with a small data set (as in my case) is prone to outliers. Therefore, I was obligated to identify any outliers in the data sets (Subchapter 6.1).

A least squares estimation conducted using time series data may lead to an endogenous problem or unit root process. Therefore, I had to test for non-stationarity or cointegration for my data set (Subchapter 6.2).

In Subchapter 6.3 I calibrated the model of Trabandt and Uhlig (2010), presented in Subchapter 4.5, with the Austrian data from Chapter 5. I can subsequently present some results in Subchapter 6.4.

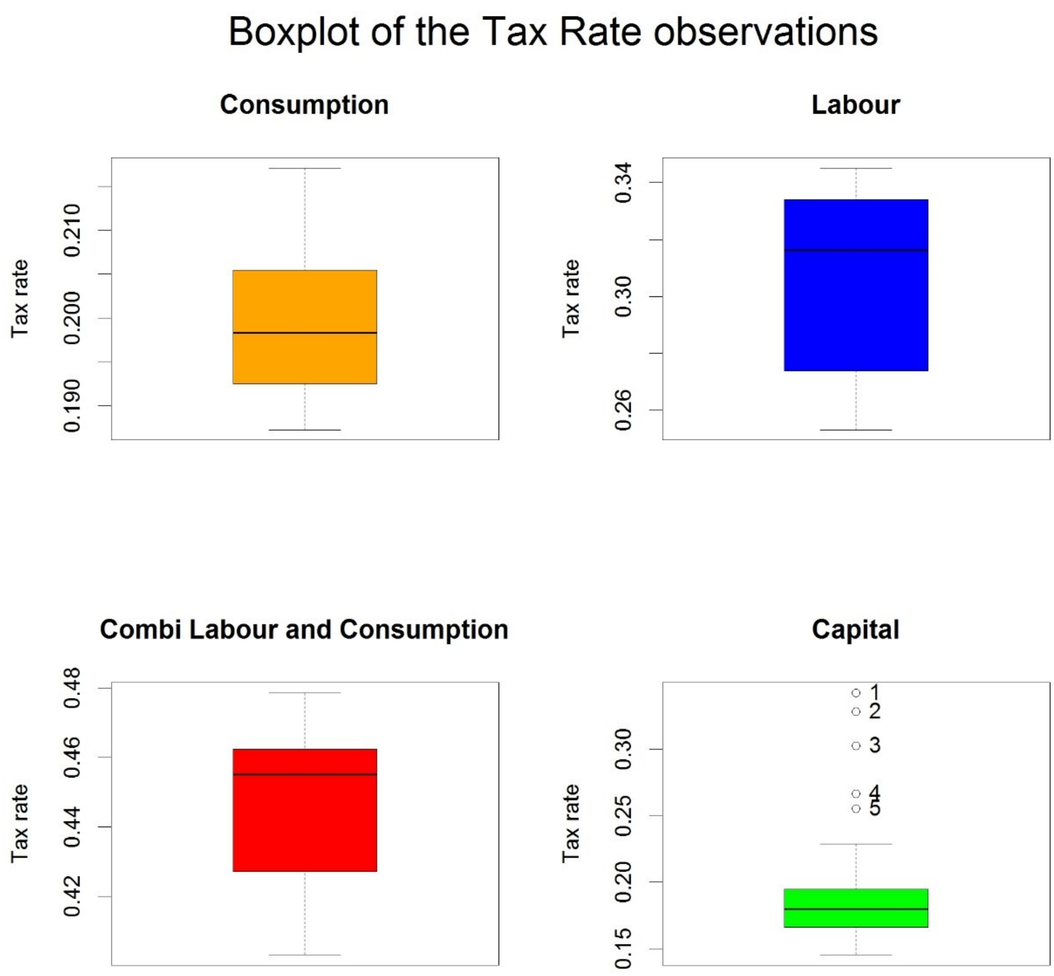


Figure 6.1: Box plot of the observed tax rates from 1965-2012

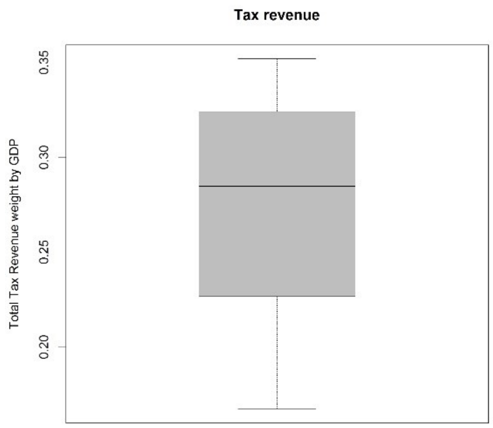


Figure 6.2: Box plot of the total tax revenue

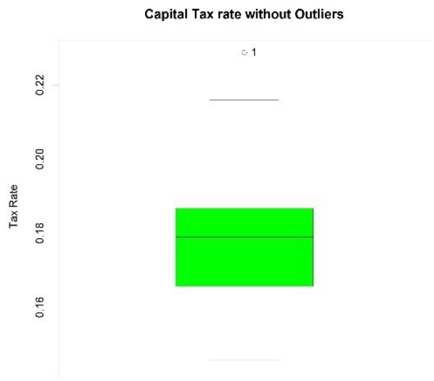


Figure 6.3: Observed capital tax rates 1970-2012

6.1 Outlier detection

A simple means of detecting outliers is to exclude suspect points and compare the model results with and without them. If R^2 has changed significantly then the outlier should be excluded. By estimation through the origin, following Auer (2005), there is no meaningful R^2, and so I had to create a different method to control for outliers. One way was to use box plots.

For the tax rate observations, there was no outlier for consumption, labour or the combination of both; only the capital tax rate had outliers, as displayed in Figure 6.1. The first five observations (1965-1969) are outliers I excluded.

If the first five observations are excluded as shown in Figure 6.3, there is a new outlier (the year 1969), but the distance to the mean value is smaller than the distance between the mean value and the lowest observation times (1.1), hence I decided to accept this point and exclude the first five observations.

For the total tax revenue, the box plot (Figure 6.2) exhibits no outliers.

In order to verify these results, the observation distance to the median weighted with the median absolute deviation of the median can be tested. Each observation with a test statistic smaller or equal to 3 could be included.

Year	Capital tax rate	Labour tax rate	Consumption Tax rate	Combi tax rate	Revenue
1965	8.0	2.1	0.3	2.2	
1966	7.3	1.9	1.1	1.8	3.5
1967	6.0	1.8	0.2	1.9	3.4
1968	4.3	1.8	1.4	1.6	3.4
1969	3.7	1.7	1.9	1.3	3.1
1970	1.7	2.2	1.3	2.0	3.2
1971					2.9

Table 6.1: Test of outliers 1965-1970 for independent variables and 1966-1971 for depended variable

Critical values	1%	5%	10%
Constant	-3.43	-2.86	-2.57
Constant and trend	-3.96	-3.41	-3.13

Table 6.2: Critical values for the unit-root test (adf-test); based on Davidson and MacKinnon (1993)

The outliers are presented in Table 6.1. The test statistics for the capital tax rate observations for 1965 to 1969 are greater than 3. Therefore, for further investigation a reduced set of data was used including the years 1970 to 2012. Given Equation 4.6, the first revenue used was 1971.

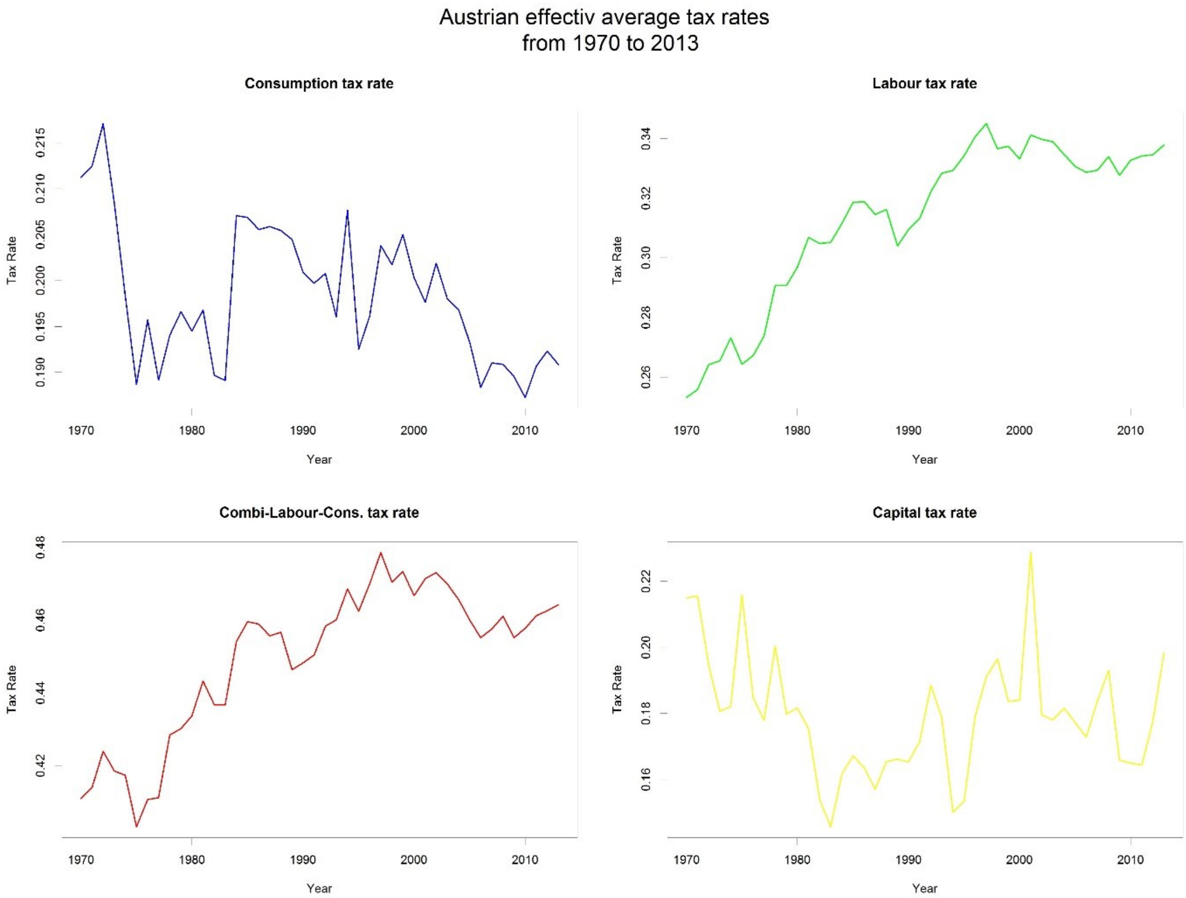


Figure 6.4: Tax rate changes over time

6.2 Test of non-stationarity and cointegration

An OLS estimation based on data gained by observation of a time series must be followed by a test of stationarity of the residual. To this end I used the Augmented Dickey-Fuller Test (adf-test) on the included observations. The H0-hypothesis for the adf-test is non-stationarity. The critical values are different from the standard critical values, and the H0 can be rejected if the test statistic is smaller than the critical value.

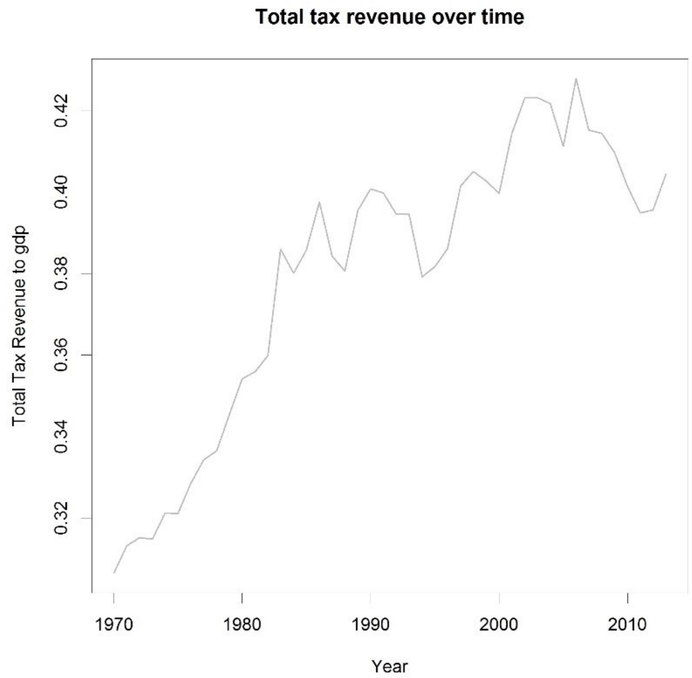


Figure 6.5: Development of the total tax revenue over time

The adf-test can be undertaken without a constant, using a constant or using a constant and trend. Following Hill, Griffiths and Lim (2008), I plotted the time series to observe their behaviour and to decide on the means to apply.

The time series for the tax rates are plotted in Figure 6.4. All have a constant time series for labour and the combination of labour and consumption include a trend. Thus, I applied the adf-test for consumption and capital using a constant, while for labour and the combination of labour and consumption I used a constant and trend. The development of the total tax revenue over time is shown in Figure 6.5. The time series of the total tax revenue has a trend and a constant. The critical values are shown in Table 6.2 The adf-test statistic values are reported in

	Time series of		The tax rate time series of		
	Revenue	Capital	Labour	Combi	Consumption
Test statistics observations	"-2.27"	"-3.71"	"-1.67"	"-1.55"	"-2.82"
Trend	Yes	No	yes	Yes	no"
Test statistics log observations	"-2.33"	"-3.66"	"-1.76"	"-1.56"	"-2.79"
Trend	Yes	No	yes	Yes	No

Table 6.3: Test statistics for the observations and log values of the time series for the adf-test

Regression model	1%	5%	10%
Constant, trend, two independent variables	-4.6451	-4.1567	-3.8429

Table 6.4: Critical value for DW Test with intercept k=2, n=27; based on Savin and White (1977)

Table 6.3. I find that the capital tax rate (1%) and consumption (10%) are not stationary at the usual significance levels, but instead are stationary. Therefore, a least squares estimation is meaningless, rendering a Laffer Curve estimation impossible as a means of identifying the optimal tax rate for the level-level model. This is not changed by using the log version of the time series variables.

The tax revenue time series is non-stationary in both the level-level and the log-log version, hence the next step required is a unit root process. If a least squares regression includes a variable that is non-stationary, the estimated parameters are biased.

Only capital and consumption tax rates can be treated as stationary, engendering the problem that a least squares estimation is biased in the parameters, leading to an incorrect optimal tax rate point.

I tried the differential method as well, but it failed to change the results in a useful way.

If one ignores the problem and estimates the parameters for the Laffer Curve with the least squares method, a spurious regression is observed. This would lead to seemingly good t-statistics for the parameters and a high R^2, which is wrong (a short discussion of the problem can be found in Wooldridge, 2013). Such a spurious regression may explain the high R^2 and t-statistics that Hsing (1996) and Karas (2012) have reported for their estimations. Karas (2012) has tested for spurious regression, comparing a Durbin-Watson statistic and the determination index R^2, on the basis that if the determination index exceeds the Durbin-Watson statistic, the regression is likely to be spurious. The issue in conducting estimation via the origin is that the R^2 is biased.

Karas (2012) has estimated a linear model with a constant, not a Laffer Curve, and found strong t-statistics and high R^2 values. His regressions may thus be spurious. Karas quoted a paper by Granger and Newbold (1974) as the source of his method. Giles (2012) advises caution in using a large determination index and a small Durbin-Watson statistic.

	Critical value d_u	Critical value d_l
Alpha = 0.01	1.019	1.318
Alpha = 0.05	1.240	1.556

Table 6.5: Critical value for test of cointegration (adf-test), based on Phillips and Ouliaris (1990)

The common interpretation of the Durbin-Watson statistic (which has a potential range from zero to four) as a test of autocorrelation is:

- A value close to two means no autocorrelation;
- A value smaller than 1.5 and greater than 2.5 means autocorrelation.

Karas (2012) has reported his models 1.128 (model I) and 0.954 (model II) as DW statistics. Compared to the critical values in Table 6.4 for DW statistics with an intercept, two independent variables and 27 observations (1993-2010), there is no support for the null hypotheses of no autocorrelation. If the lower critical value (dl) is greater than the DW statistic, the H0 of no autoregression must be rejected. For both models, the H0 must be rejected at the 5% level. For the 1% level, model I also rejects the H0, while for model II the DW statistics is located between the lower and upper critical values, rendering the test inconclusive.

As Wooldridge (2013) claims, if one or more variables are non-stationary within the estimation, there is the possibility that when combined they are stationary, termed “cointegration”.
Again, I follow Hill, Griffiths and Lim’s (2008) explanation.
To test if they are cointegrated, one could use an OLS regression. The vector gained from the estimated residuals could then be tested for unit roots.

$$\hat{e} = T_t - b_1\tau_{t-1} - b_2\tau_{t-1}^2 \qquad (6.1)$$

If the variables are cointegrated then the estimation parameters could be interpreted as normal. To check whether the cointegration holds, the estimated residuals are tested for unit roots via the adf-test. For this test, the critical values depend on the number of variables on the right-hand side of the regression equation as well as whether the regression contains a constant or time trend. In my case, the relevant values are tax rate and tax rate squared, and so I need the values for two independent variables; moreover, because of the dependent variable (a time series with constant and trend), I also need critical values with a trend and constant.
If the test statistic is smaller than the critical value, reported in Table 6.5, the null hypothesis of non-cointegration can be rejected.
None of the estimates show signs of cointegration (Table 6.6). The H0 cannot be rejected for any of them at the 10% level.

	Regression on total tax revenue with the independent			
	Capital	Labour	Combi	Consumption
Level-level	-2.4633	-3.2514	-2.5038	-1.5222
Log-log	-2.1695	-3.2571	-2.7494	-1.9140

Table 6.6: Test statistic for test of cointegration

Description	Symbol	Value
Gov. debt to GDP	$\overline{b/y}$	0.730
Gov. cons+inv. to GDP	$\overline{g/y}$	0.097
Net imports	$\overline{m/y}$	0.031
Capital to output ratio	$\overline{k/y}$	3.440
Consumption to output ratio	$\overline{c/y}$	0.453
Priv. investment to output	$\overline{x/y}$	0.201
Gov. transfer to GDP	$\overline{s/y}$	0.005
Hours worked	$\bar{n}$	0.232

Table 6.7: Macroeconomic variables for model calibration

Again, the residuals are not stationary. This leads to the problem that a determination of the tax revenue-optimising tax rate is not possible with a least squares estimation.
To establish a tax revenue-optimising rate, a model must be used.

6.3 Model calibration and parameterisation

Trabandt and Uhlig (2010) use annual post-war data from the USA and EU for the period 1995-2007 to calibrate their model. In addition to the calibration of US and EU data, they calculated the optimal tax rates for most EU countries as well.
I used the same source data for Austria from 2001 to 2012, the period with the most recent data available when I commenced my research. An overview of the macroeconomic variables can be found in Table 6.7
The tax rates are calculated using average effective tax rate methods introduced by Mendoza, Razin and Tesar (1994), and modified as described in Section 5.1. This leads to the initial tax rates, reported in Table 6.8.

Tax rate of	Symbol	Effective average tax rates
Labour income	τ^n	33.4%
Capital income	τ^k	18.1%
Consumption	τ^c	19.4%

Table 6.8 Effective average tax rate.

Description	Symbol	Value
Gross real interest rate	$\bar{R}$	1.04
Inverse IES	η	2.00
CFE	Φ	1.00
Initial technic level of prod.	Γ	1.00
Growth rate	Ψ	1.010
Weight of labour	Κ	4.976
Depreciation	Δ	0.049
Capital share on prod.	Θ	0.335

Table 6.9: The used parameter

To run the model, the parameters must be determined. Trabandt and Uhlig (2010) used an entire chapter to discuss CFE preferences, with the result of setting the benchmark CFE preferences at 1 and the inverse of the intertemporal elasticity of substitution at 2. Trabandt and Uhlig (2010) also set the gross real interest rate and the initial technical level of production. I used their parameter values. The other parameters varied from country to country, resulting in Trabandt and Uhlig calculating them from the data gained. I followed their example and determined the parameters for the growth rate, weight of labour, depreciation rate and capital share on production. The parameters used are summarised in Table 6.9.

Using the variables and parameters, it was possible to calibrate the model.

The benchmarks and actual measured values for the economy are reported in Table 6.10.

My model predicts the values as precisely as the Trabandt and Uhlig Model. A prediction of hours worked yielded a value of 0.232.

Description	Symbol	Actual measured	Predicted
Hours worked	$\bar{n}$	0.232	0.232
Consumption to output	$\overline{cy}$	0.453	0.453
Capital-output ratio	$\overline{ky}$	3.447	3.427
Labour tax revenue to output	T^n	0.246	0.222
Capital tax revenue to output	T^k	0.043	0.030
Consumption tax revenue to output	T^c	0.102	0.088

Table 6.10 The predicted benchmark values of the economy

$$\bar{n} = \frac{\frac{hours\ work\ per\ year}{work\ age\ population}}{365\ day * 14.55\ hours\ max.dayli\ working\ time} \tag{6.2}$$

A $\bar{n}$ of 0.232 means an average weekly working time of 23 hours and 42 minutes.

$$predicted\ weekly\ working\ time = \bar{n} * 14{,}55 * 7 \tag{6.3}$$

The consumption and capital-output ratio are also predicted perfectly. In contrast to the valid predictions for hours worked, capital-output ratio and consumption to output, labour tax revenue, capital tax revenue and consumption tax revenue remain underpredicted.

Labour tax revenues in Trabandt and Uhlig (2010) are overpredicted, while capital and consumption tax revenues are underpredicted. Measured as the gap between prediction and the measured value, my prediction for the tax revenue is at least as small as Trabandt and Uhlig's (2010).

The economic values are predicted well and the tax revenue matches Trabandt and Uhlig's (2010) benchmark, enabling me to simulate different tax rates and regimes.

6.4 Tax revenue-maximising simulations

Using the model, I can simulate different tax-optimising cases: (i) classical ones, where labour and capital tax rate are set to maximise tax revenue, and (ii) as an advantage compared with estimations with models, I can introduce new taxes as well. There I simulated in the model a unique tax rate for labour and capital and the introduction of a robot tax.

Capital tax revenue optimisation

In the first case, I aim to predict the consequences if the government were to maximise its capital tax revenue without altering the 33.2% tax on labour. The optimal capital tax rate is set at 59% and provides the government with an additional total tax revenue of 6.5%.

As expected, the capital stock falls to 54.9% of the benchmark (direct feedback effect). The average weekly working time increases (indirect feedback effect) from 0.232 to 0.234, equivalent to 12 more minutes per week. Therefore, GDP shrinks to 82.3% of the benchmark value.

Consumption decreases to 81.2% of the benchmark, a loss of nearly one fifth. Transfers increase to 483.3% of the benchmark. The high increase in the

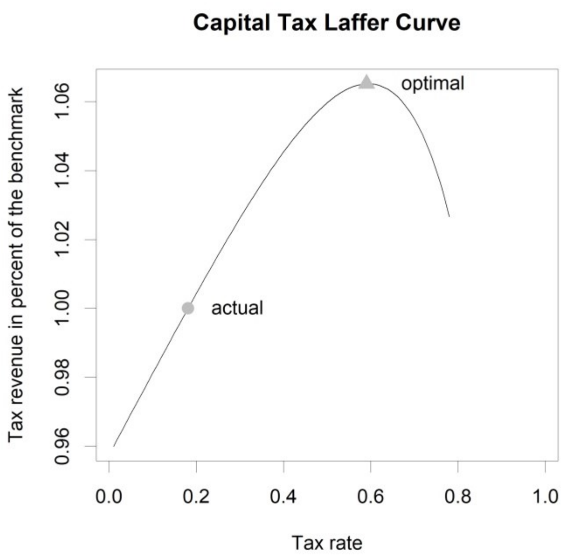


Figure 6.6: Predicted Laffer Curve for Capital

transfers is driven by the fixed amount of government consumption. Therefore, the whole amount of additional tax collection goes to the transfers. In the benchmark, less than 5% of the government expenditures are transfers.

According to Trabandt and Uhlig (2011) and Trabandt and Uhlig (2010), the optimal capital tax rate is 35%, 24% lower than that calculated here.
The sources for this huge difference could be an increase in capital-output-ratio or a decline in depreciations and the weight of capital in production. The smaller depreciation rate leads to greater capital for GDP, hence the capital stock is less elastic compared to the capital tax, and if the government increases the tax rate, the tax base reacts more slowly.

Labour tax revenue optimisation

The second case is that the government only changes the tax rate of the labour tax. The capital tax will remain at 18.1%. The labour tax-optimising tax rate is 69%, affording the government a maximal tax revenue of 122.7% compared to the benchmark: a potential of nearly five times the maximal additional capital tax revenue.
As predicted by the theory, labour input decreases, following the direct feedback effect. The average working time shrinks to 0.174, or 17 hours and 46 minutes. The capital-output ratio is not affected by the labour tax and therefore a reduction in production due to reduced working time cannot be prevented by an alteration in the capital factor. If production falls and the ratio stays constant, the capital stock begins to shrink, becoming 82.3% of the benchmark capital stock (indirect feedback effect).
Production suffers from the lost labour and capital input, leading to a decrease to 75.2% of the benchmark.
More than one third of consumption is lost, and only 61.7% can be consumed. Transfers increase over fifteen-fold compared to the benchmark (1,569.8%).
Trabandt and Uhlig (2011) have predicted an optimal tax rate of 61%, which is 8% lower than my prediction, which could be explained by a relatively higher labour share of production.

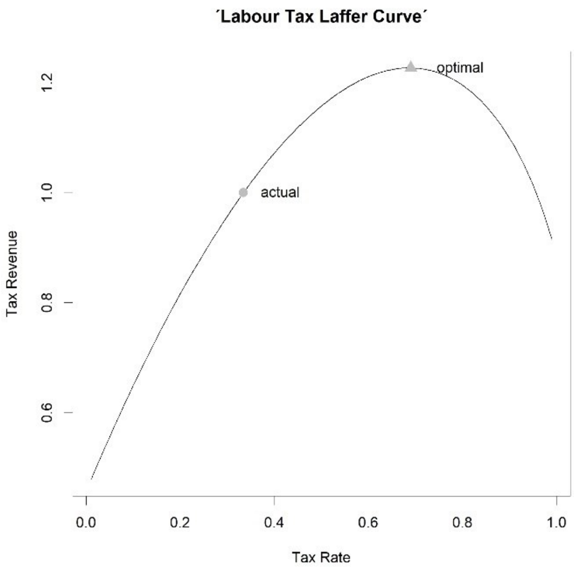


Figure 6.7: Total tax revenue to labour tax

Revenue tax optimisation with simultaneously setting labour and capital tax

The government is not limited to changing only one tax rate; indeed, it can change the labour and capital taxes simultaneously.

In the model, I optimised the tax rate using two loops. The capital tax consequently changed by 1% step as the outer loop, and the labour tax rate at the same rate as the inner loop, yielding a total tax revenue matrix of 99 x 99 values, where it is possible to select the highest combination yielding the largest tax revenue. Above the 74% capital tax rate there are no real solutions to the equation system. I can ignore this problem because the plot of the indifference curves of the tax revenue shows that they are in the prohibitive range on the far right.

This method leads to an optimal labour tax rate of 67% and capital tax rate of 37%, creating a maximal tax revenue of 123.2% of the benchmark, which is less than 1% greater than the optimal labour tax rate's result.

The factor employment of labour (0.179) and capital stock (54.9% of the benchmark) decrease and therefore production shrinks to 71.9%. The average working time falls to 18 hours and 2 minutes.

The consumption decreases to nearly half of the benchmark (54.9%). The transfers increase by more than 14 compared to the benchmark (1,464.7%).

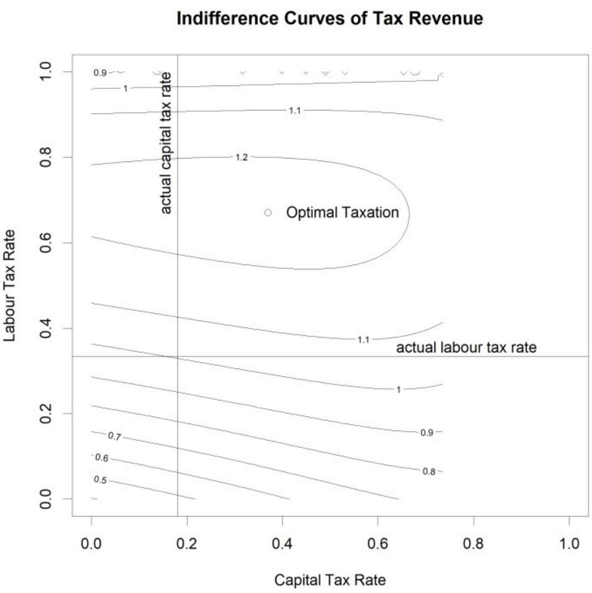


Figure 6.8: Indifference curves of tax revenue with respect to labour and capital tax rate

Tax revenue optimisation with unit tax rate for capital and labour income

One of the targets of taxation is that the tax system be fair. Left-wing politicians often argue that a different tax rate for labour and capital income is a source of (social) injustice. The problem in using the same tax rate for capital and labour is that capital is the more mobile factor input, and so it is expected that the outflow of capital is greater than that of labour. Supporters of separate tax rates argue that the outflow of capital is so dramatic that the economy deteriorates; workers would lose so much that the benefits of taxation are lost.

To build a single tax rate for all kinds of income instead of capital (7.11) and labour (7.12) tax revenue equations, I created a single tax for the entire income. In Equation 6.4 the entire income is taxed with a unique tax rate (τ^s). The incomes of labour and capital are combined to form the tax base.

$$T^s = \tau^s(\left(1-\theta\right) + (\theta - \delta * \overline{k/y})) * y \tag{6.4}$$

I next replace all capital and labour tax rates in the model by this single tax rate.
This small change results in a maximal tax revenue of 120.9% of the benchmark given a tax rate of 60%. The maximal tax revenue is quite close to the simultaneous optimisation revenue of 123.2 and much higher than the benchmark.
The hours worked decrease to 0.195 or 19 hours and 49 minutes, and again the capital stock declines dramatically (as expected) to 44.6% of the benchmark.
The fall in factor inputs leads to a decrease in production (68.1% of the benchmark). Moreover, consumption in the economy falls to 54.3%. These figures provide support for separate tax rates.
Transfers increase to 1,604% of the benchmark. This model only works with average persons, i.e. the taxed person and the person who receives a transfer are the same. If we assume that transfers are (at least in this case) redistributions from persons with high incomes to persons with low incomes, we can empathise with left-wing politicians' calls for higher standards of living for the poor via higher redistributions.

Robot tax

Technological shifts in the production of goods and services have destroyed many jobs. This did not create a problem in the past as total employment was rising, but today it represents a threat to the social system. Austria's current former Chancellor, Christian Kern, is campaigning for the taxation of robots because many workers are losing their jobs or can only work in roles that provide much lower wages. Bill Gates, the wealthiest man alive, has also supported a robot tax in an interview with Delaney (2017), desiring that each robot provide the same tax volume as a human worker.
The meaning of the term "robot tax" is not entirely clear. There are different definitions, but they share a common target: to enlarge the tax base for social contributions as a reaction to a decreasing labour income share. I found a tax-based definition by Quin (2016), who claims that profit and loss accounts of companies plus personal cost, cost of outside capital and depreciation build the tax base, forming part of the discussion of the tax base for the "Familienlastenausgleichsfond".[15]

[15] Familienlastenausgleichsfond is a form of transfer from employees and employers to families.

In my opinion, this tax base fails the main target of a robot tax, and so for my model I choose only the depreciation rate as a tax base.

In the model, the depreciation rate appears within the capital-to-output ratio and private investment.

$$\overline{k/y} = \left(\frac{1-\bar{R}}{1-\tau^k} * \theta + \frac{\frac{\delta}{(1-\tau^r)}}{\theta}\right)^{-1} \tag{6.5}$$

$$\overline{x/y} = (\varphi - 1 + \delta/(1-\tau^r) * \overline{k/y} \tag{6.6}$$

The term $1/(1-\tau^r)$ alters the price for reinvestment of depreciated capital. This tax rate is in line with a Laffer Curve theory definite tax rate because a rate of 100% would mean that the whole value is captured by the state. The tax rate is calculated as a share of the investment.

The tax revenue is thus captured in a new equation:

$$T^r = \tau^r * \overline{k/y} * \delta * \bar{y} \tag{6.7}$$

Again, this revenue will be added to the total revenue.

This small modification to the model provides the desired effect for the hours worked. An increase in the tax and decrease in capital stock causes the production factor to be shifted from capital to labour. Again, the capital in the model is dependent on savings. The MTU has no capital flow to other countries.

The tax revenue-optimising tax rate is 35%, and again the other taxes are fixed with the measured values, as shown in Table 6.8. The maximised tax revenue of 7.1% is greater than the average tax rate. With the robot tax rate of 35%, the labour input increases to 0.248, an average weekly working time of 25 hours and 15 minutes. This is an increase of one hour and 45 minutes compared to the benchmark, or 6.3% more labour input in production. The robot tax raises the price of reinvestment in the capital stock, hence the capital stock shrinks to 75% of the benchmark. The shift from capital input to labour input caused by the robot tax leads to a shrinking economy (minus 5% compared to the benchmark).

With decreasing production, consumption also diminishes (85.4% of the benchmark). Again, the transfers increase considerably, by 614%.

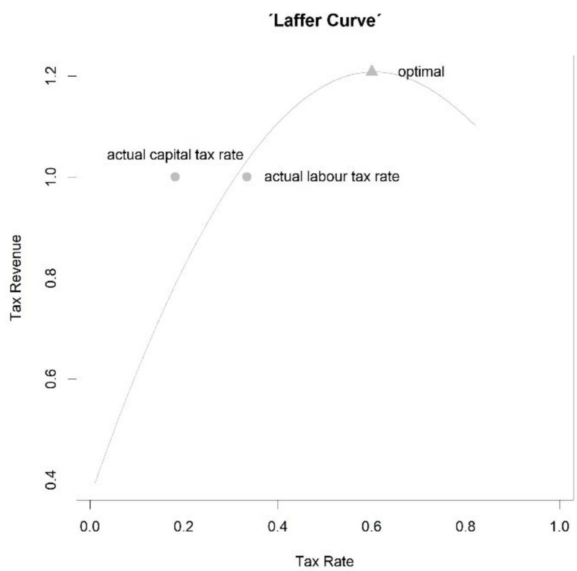


Figure 6.9: Total tax revenue to robot tax rate

7 Conclusion

The aim of my Master's thesis is to find the Laffer Curve peaks of Austria's income taxation. It will consequently be possible to identify if tax rates are in the normal or prohibitive range and thus whether the state debt could simply be reduced by a tax cut or not.

The theoretical background of the empirical estimation is derived from the Laffer Curve theory. The initial target of estimating the Laffer Curve theory with a least squares estimation, using tax revenue as the dependent variable and the tax rate as the independent variable, was not possible. Due to problems concerning the autoregression of time series, the estimated parameters are biased and could not be used. Even with the implementation of the cointegration method, I was not able to run a meaningful Laffer Curve estimation.

An alternative approach was to choose an equilibrium model. I decided to use the model presented by Trabandt and Uhlig (2010).

With the MTU I could present revenue-maximising tax rates for i) capital income tax, ii) labour income tax, iii) a unified income tax for capital and labour income, and iv) a robot tax for the depreciation rate.

For the capital income tax, the revenue-maximising tax rate was determined in the model at 59% (measured average tax rate for the period 1995-2007: 19.8%). The potential additional revenue was determined at 6.5%.

The labour income tax was measured at 33.4% and the tax revenue-maximising tax rate at 69%. The potential additional revenue was 22.7%.

In an additional simulation, I implanted a tax reform where labour and capital income tax rates are set simultaneously to maximise the tax revenue. This kind of tax reform would lead to tax revenue-maximising tax rates for labour income of 67% and capital income of 37%. The Austrian government would thus gain 23.2% more tax revenue.

Via a simple modification to the model, I simulate the consequences of tax revenue maximisation with the normative target of the same income tax for all sources of income: labour and capital. The tax revenue-maximising tax rate for the unified tax rate was 60% and the additional revenue was 20.9%.

The final simulation was to introduce a new kind of tax. The robot tax – a tax on the depreciation of capital – leads to a tax revenue-maximising tax rate of 35% and 7.1% greater tax revenue.

The maximal tax revenue can be achieved with the simultaneous optimisation of the capital and labour tax rates, achieving 123.2% of the benchmark calibration. Nearly the same revenue could be achieved if only the labour tax is optimised (122.7% of the benchmark revenue).

The unified tax can be optimised to a tax revenue of 120.9%, and only optimising the capital tax rate would lead to a tax revenue of 106.5% compared to the benchmark.

Trabandt and Uhlig (2011) have calculated a revenue-maximising tax rate of 35% for capital income tax and 62% for labour income tax in the period 1995-2007.
Given other studies, the results are in the expected range. Heijman and van Ophem (2005) found a maximal willingness to pay taxes as high as 60% of the GDP. In optimising the capital tax, the state share of GDP would be approximately 44%, 56% for labour tax rate optimisation, 59% for simultaneous tax, 60% for unified tax cases and 38% for robot tax simulation. Willingness to pay taxes seems to be contingent on the tax base, with none of my predictions exceeding the 60% threshold predicted by Heijman and van Ophem (2005). Compared to the benchmark share of the state on the GDP of 39%, every form of tax optimisation increased the state sector aside from the robot tax.

Other factors also influence tax revenue but are not included in the model.
In Subchapters 2.2 and 4.3 I briefly discussed the issue of the tax scale. The Austrian labour income tax rate is directly progressive, while the capital income tax rate is indirectly progressive. This is not incorporated as part of the model, but it constitutes an additional area of error. Holter, Krueger and Stepanchuk (2014) claim that progressivity leads to a 7% lower maximal tax revenue compared to a flat tax. On the other hand, Guner, Lopez-Daneri and Ventura (2016) found no substantial differences in tax revenue when using an average or progressive tax. Therefore, more empirical work with respect to a progressive tax scale should be undertaken.
Sanz-Sanz (2016) has analysed Spanish tax reform for different income classes in a progressive tax system and determined the mathematical and economic effects of different income classes. Perhaps his paper is of interest to an analysis of Austria’s most recent tax reform, shown in Table 10.7. Nevertheless, the prediction of an optimal tax rate based on their work is not possible without income class tax revenue statistics before and following the tax reform.

Further points of interest for new empirical work regarding the Laffer Curve should also deal with the heterogeneity and utility of households.
Brümmerhoff (2001) argues that taxation-optimising analyses often depend on the assumed utility function.

Holter, Krueger and Stepanchuk (2014) have developed a version of the Trabandt and Uhlig (2010) model for heterogeneous households. Although they endeavoured to create a complex model, they also made many assumptions and omitted the final step, in my opinion: a heterogeneous household that is different in its effective labour should also be different in its capital endowment.
Rocha-Akis (2016) uses similar arguments, claiming that new data imply that the distribution of wealth is more disparate than assumed to date. Therefore, capital endowments and incomes should not be assumed to be the same for all households. I believe it is more important to model capital income heterogeneous than labour income.

Fève, Matheron, and Sahuc (2013) estimated Laffer Curves for incomplete markets and got higher optimal tax rates due to the lower elasticity of the factor of supply. They argue that their results would also apply to complete markets if the government budget were adjusted through transfers. If the adjustment were driven by state debts, the Laffer Curve would change dramatically, with the bell shape becoming a horizontal 's'. States do not have a constant debt-GDP ratio, and so a bell-shaped Laffer Curve may not exist. When providing political advice, the issue of incomplete markets should be considered.
Furthermore, the stabilisation effect is totally ignored in most tax revenue-maximising literature. This is not a problem for an equilibrium model but could have dramatic consequences for the Austrian economy during future economic crises, should the progressive tax be eliminated by a tax reform.

In my opinion, a central problem of all of the models for a Laffer Curve calculation is that they do not include state institutions, except for as a public good in the utility function of households. They should also be represented in the production function when estimating the optimal tax rate, as factors like streets, (high-speed) internet, energy circuits, property rights, (fundamental) research and education systems have an influence on production. As Adam Smith claims, the state sets the frame in which individuals can generate their wealth. The same route is identified by Malcomson (1986), arguing that a model to estimate a meaningful Laffer Curve must be sufficiently rich in the labour supply function in order to allow signs of a marginal tax rate to increase differently from those of a reduction of the clear wage tax in the case of a progressive income tax economy.

Furthermore, as briefly discussed in Sections 2 and 3, the actual economic burden remains unknown. The model works with representative households and companies, only observing one (private) good. This means that there is no market power implemented and no rollover effects can be simulated or interpreted. Therefore, the interpretation is limited to the question of who really bears the tax costs for the tax revenue-maximisation of Austrian taxation: the capital-holder or the workers.

The model I used exhibited additional problems. The first issue was that the data used are 13-year average values, meaning that the effects of tax changes in this period are minimal on average values. The average measurement smoothens the effects of a tax reform in the pre-reform years.

Another issue of the MTU is that the parameter calibration for the capital share of production includes the capital tax rate, but Trabandt and Uhlig (2010) no longer update the parameter.

The interpretation of the Laffer Curve effect as the main factor of historical income tax revenues and tax rate data is problematic, too. The problem is observable in the Harding-Coolidge tax cut example, reported by Laffer (2004) himself. He claims that the huge increase in living standards for Americans was caused by the tax cut, yet an increase due to extraordinary technological progress during these years was at least as likely.

Returning to my MTU results, I do not discuss household utility levels. The production, consumption and transfers are measured in euros and can therefore be easily interpreted. All kinds of tax revenue-maximisation reduce production and consumption while increasing transfers. Their impacts on wealth and utility remain unclear. Two pieces of information might be gained from the model pertaining to consumption, production and transfers, as shown in Table 7. First, a unified tax rate for labour and capital cannot be recommended as a means of maximising revenue. The achievable revenue maximisation is smaller than the labour income

	Tax revenue	Production	Consumption	Transfer
Labour income	122.7%	75.2%	61.7%	1,569.5%
Capital income	106.5%	82.3%	81.2%	483.3%
Simultaneous labour and capital	123.2%	71.9%	54.9%	1.464.8%
Unified tax rate	120.8%	68%	54.3%	1,324.8%
Robot tax	107.6%	95%	85.3%	521.4%

Table 7.1: Tax reform compare; all values relative to the benchmark

tax and the simultaneous labour and capital income tax reform with greater reduction in consumption and production. Second, a robot tax gains more maximised revenue and harms the economy to a lesser extent than the capital tax reform. Therefore, to introduce a robot tax based on this model's results is more useful than a capital income tax reform aimed at maximising tax revenue.

Focusing on the factor input in production in Table 7.2, which are also the tax sources for the simulated taxes reforms, i) the capital stock shrinks after each tax reform where tax revenue is maximised, ii) and for the factor input of labour a higher tax on labour reduces the average weekly hours of working time, yet with the same labour tax and a higher capital tax or robot tax, the labour supply increases.

Based on the model, a tax based on the labour income has greater potential to maximise the tax revenue than capital income. If the target is to maximise the tax revenue, the government should work on labour taxation.

For normative targets like "fair" taxes on all sources of income, a new tax base such as the robot tax is more useful than increasing classical capital income taxes. Furthermore, the additional tax revenue generated would be enough to develop a surplus for the state treasury and reduce the state's debts.

To summarise, this paper has not been able to fulfil the target of providing a fail-safe, optimised tax rate that could be executed by the government because the consequences of a tax reform are so complex that a Master's thesis could never cover all aspects. In order to attain useful political advice, additional research must be undertaken.

	Average weekly working hours	Capital stock
Labour income	75%	82.9%
Capital income	101%	54.9%
Simultaneous labour and capital	77%	62.5%
Unified tax rate	84%	44.7%
Robot tax	107%	74.8%

Table 7.2: Factor input after tax revenue maximisation, compared to the benchmark

The conclusion to be taken from this paper is that it seems that Austria falls within the normal range for all mean taxes and might increase its tax revenue by increasing tax rates and reducing state debts in this way.

Atkinson, A. B. 1977. "Optimal Taxation and the Direct versus Indirect Tax Controversy." *The Canadian Journal of Economics*, 10(4): 590–606.

Auer, Ludwig v. 2005. *Springer-Lehrbuch, Ökonometrie. Eine Einführung. 3rd ed*. Berlin: Springer.

Bartlett, Bruce. 1977. "Revolution of 1978." *National Review*, 30(43): 1333–36.

Bronfenbrenner, M. 1942. "Diminishing Returns in Federal Taxation?" *Journal of Political Economy,* 50: 699–717.

Brümmerhoff, Dieter. 2001. *Oldenbourgs Lehr- und Handbücher der Wirtschafts- und Sozialwissenschaften*, *Finanzwissenschaft*. 8th ed. München: Oldenbourg.

Brümmerhoff, Dieter. 2011. *Lehr- und Handbücher der Wirtschafts- und Sozialwissenschaften*, *Finanzwissenschaft*. 10th ed. München: Oldenbourg.

Canto, Victor A., Douglas H. Joines, Arthur B. Laffer, and Paul Evans. 1983. *Foundations of Supply-side Economics. Theory and Evidence*. New York & London: Acad. Press.

Carey, David, and Josette Rabesona. 2002a. Vol. 258. *Average Effective Tax Rates on Capital, Labour and Consumption*.

Carey, David, and Josette Rabesona. 2002b. "Tax Ratios on Labour and Capital Income and on Consumption." *OECD Economic Studies*, 35(2): 129–74. https://www.researchgate.net/profile/David_Carey7/publication/227461318_Tax_Ratios_on_Labour_and_Capital_Income_and_on_Consumption/links/5630df6708ae506cea67493e.pdf.

Carey, David, and Josette Rabesona. 2004. "Tax Ratios on Labor and Capital Income and on Consumption." In *CESifo seminar series, Measuring the tax burden on capital and labor*, ed. Peter B. Sørensen, 213–62. Cambridge, Mass: MIT Press.

Carpenter, C., and P. J. Cook. 2008. "Cigarette Taxes and Youth Smoking: New Evidence from National, State, and Local Youth Risk Behavior Surveys." *Journal of Health Economics*, 27(2): 287–99.

Delaney, Kevin J. 2017. The Robot that Takes your Job Should Pay Taxes, says Bill Gates. https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/ (accessed March 26, 2017).

Dickertmann, Dietrich, and Antonius Voss. 1979. "Der Kohlepfennig. eine getarnte Steuer." *Wirtschaftsdienst 1979*(1): 287–92.

Dolls, Mathias, Clemens Fuest, and Andreas Peich. 2010. “Wie wirken die automatischen Stabilisatoren in der Wirtschaftskrise? Deutschland im Vergleich zu anderen EU-Staaten und den USA.” *Perspektiven der Wirtschaftspolitik*, 11(2): 132–45.

Feige, Edgar L., and Robert T. McGee. 1983. “Sweden’s Laffer Curve. Taxation and the Unobserved Economy.” *The Scandinavian Journal of Economics*, 85(4): 499.

Feige, Edgar L., and Robert T. McGee. 2005. “The Unobserved Economy and the UK Laffer Curve.” EconWPA.

Fromm, Gary, and Paul Taubman. 1973. *Public Economic Theory and Policy*. New York: The Macmillan Company.

Fullerton, Don. 2008. “Laffer Curve.” In *The New Palgrave Dictionary of Economics*. 2nd ed., ed. Steven N. Durlauf, 839–41. Basingstoke: Palgrave Macmillan.

Giles, Dave. 2012. More about Spurious Regressions. http://davegiles.blogspot.co.at/2012/05/more-about-spurious-regressions.html.

Goode, Richard. 1976. *Studies of Government Finance*, *The Individual Income Tax*. Washington, DC: Brookings Institution.

Granger, C.W.J., and P. Newbold. 1974. “Spurious Regressions in Econometrics.” *Journal of Econometrics*, 2(2): 111–20.

Haan, Jakob de, Jan-Egbert Sturm, and Bjorn Volkerink. 2004. “How to Measure the Tax Burden on Labor at the Marco Level.” In *CESifo seminar series, Measuring the Tax Burden on Capital and Labor*, ed. Peter B. Sørensen, 289–318. Cambridge, Mass: MIT Press.

Haller, Heinz. 1971. *Die Steuern. Grundlinien eines rationalen Systems öffentlicher Abgaben*. 2nd ed. Tübingen: Mohr.

Hansen, Benjamin, Daniel I. Rees, and Joseph J. Sabia. 2013. “Cigarette Taxes and How Youth Obtain Cigarettes.” *National Tax Journal*, 66(2): 371–94.

Hauptverband der österreichischen Sozialversicherungsträger. 2015. Beitragsrechtliche Werte 2016 (Stichtag 1. Jänner 2016). https://www.sozialversicherung.at/portal27/portal/esvportal/content/contentWindow?contentid=10008.626564&action=b&cacheability=PAGE&version=1450778053 (accessed June 2, 2016).

Heady, Christopher. 2004. “The "Taxing Wages" Approach to Measuring the Tax Burden on Labor.” In *CESifo Seminar Series, Measuring the Tax Burden on Capital and Labor*, ed. Peter B. Sørensen, 263–87. Cambridge, Mass: MIT Press.

Henderson, David. 1981. “Limitations of The Laffer Curve As A Justification For Tax Cuts.”

Hill, Rufus C., William E. Griffiths, and Guay C. Lim. 2008. *Principles of Econometrics*. 3rd ed. Hoboken, NJ: Wiley.

Homburg, Stefan. 2015. *Vahlens Handbücher der Wirtschafts- und Sozialwissenschaften*, *Allgemeine Steuerlehre*. 7th ed. München: Vahlen.

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

Karas, Michal. 2012. “Tax rate to maximize the revenue: Laffer curve for the Czech Republic.” *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 60(4): 189–94.

Köhler-Azara, Christine, and Raphael Gaßmann. 2007. “Finanzen und Steuern 2007.” Arbeitsplatz des Monats.

Laffer, Arthur B. 1981. “Government Exactions and Revenue Deficiencies.”

Laffer, Arthur B. 2004. “The Laffer Curve: Past, Present, and Future.” *Executive Summary Backgrounder*(1765).

Ludwig-Boltzmann-Institut für Suchtforschung. 2016. Rauchverhalten in Österreich. Ergebnisse unterschiedlicher aktueller Quellen einschließlich der österreichweiten repräsentativen Bevölkerungsumfrage BMGF/LBISucht/market 2008. http://www.bmg.gv.at/cms/home/attachments/1/8/7/CH1038/CMS1166785817949/factsheet__rauchverhalten_in_oesterreich.pdf (accessed May 27, 2016).

Malcomson, James M. 1986. “Some analytics of the laffer curve.” *Journal of Public Economics*, 29(3): 263–79.

McDaniel, Cara. 2007. “Average Tax Rates on Consumption, Investment, Labor and Capital in the OECD 1950-2003.” Arizona.

Mendoza, Enrique, Gian Milesi-Ferretti, and Patrick Asea. 1997. “On the Ineffectiveness of Tax Policy in Altering Long-run Growth. Harberger’s Superneutrality Conjecture.” *Journal of Public Economics*, 66(1): 99–126.

Mendoza, Enrique, Assaf Razin, and Linda L. Tesar. 1994. “Effective Tax Rates in Macroeconomics Cross-country Estimates of Tax Rates on Factor Incomes and Consumption.” *Journal of Monetary Economics,* 34: 297–323.

Mirowski, Philip. 1982. “What's Wrong with the Laffer Curve?” *Journal of Economic Issues,* 16: 815–28.

Musgrave, Richard A., and Lore Kullmer. 1974. *Studienausgabe*, *Finanztheorie*. 2nd ed. Tübingen: Mohr.

Nickell, Stephan. 1997. "Unemployment and Labour Market Rigidities: Europe versus North America." *The Journal of Economic Perspectives*, 11(3): 55–74.

Organisation for Economic Co-operation and Development (OECD). 1983. *National Accounts of OECD 1983. Volume II, Detailed Tables*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 1995. *National Accounts. 1981-1993*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 1997. *National Accounts. Detailed Tables, Vol. II*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 1999. *OECD Wirtschaftsberichte: Österreich*, *OECD Wirtschaftserichte, Österreich 1999*. Paris: OECD Publishing.

Organisation for Economic Co-operation and Development (OECD). 2016. National Accounts. Volume II. http://stats.oecd.org/.

Pecorino, Paul. 1995. "Tax Rates and Tax Revenues in a Model of Growth through Human Capital Accumulation." *Journal of Monetary Economics*, 36(3): 527–39. https://www.sciencedirect.com/science/article/pii/0304393295012249/pdf?md5=4f52d7519f74b3ffb640b1c85f763658&pid=1-s2.0-0304393295012249-main.pdf.

Pigou, Arthur C. 1962. *A Study in Public Finance*. New York: London: Macmillan.

Puwein, Wilfried, and Michael Wüger. 1998. "Tabaksteuer und Zigarettenabsatz in Österreich." *WIFO Monatsberichte*(3): 173–85.

Quin, Eckehard. 2016. "Wertschöpfungsabgabe oder Maschinensteuer. Gedanken zu einem politischen Kampfbegriff." *gymnasium. Zeitschrift der AHS-Gewerkschaft in der Gewerkschaft Öffentlicher Dienst*(6): 4–7. http://www.goed-ahs.at/wp/wp-content/uploads/2016/09/gymnasium_5_16.pdf.

Rocha-Akis, Silvia. 2016, *Umverteilung durch den Staat in Österreich*. Wien.

Schneider, Dieter. 1992. *Investition, Finanzierung und Besteuerung*. 7th ed. Wiesbaden: Gabler Verlag.

Smith, Adam, and Kathryn Sutherland. 2008. *Oxford World's Classics*, *An Inquiry into the Nature and Causes of the Wealth of Nations*. Oxford: Oxford University Press.

Stuart, Charles E. 1981. "Swedish Tax Rates, Labor Supply, and Tax Revenues." *Journal of Political Economy*, 89(5): 1020–38.

Tchilinguirian, Harry, and David Carey. 2000. *Average Effective Tax Rates on Capital, Labour and Consumption*.

Trabandt, Mathias, and Harald Uhlig. 2010. “How Far are we from the Slippery Slope? The Laffer Curve Revisited.” *European Central Bank Working Paper Series*, 1174: 1–59.

Trabandt, Mathias, and Harald Uhlig. 2011. “The Laffer Curve Revisited.” *Journal of Monetary Economics*, 58(4): 305–27.

VCÖ - Mobilität mit Zukunft. 2017. Österreich hat dritthöchste Diesel-Pkw-Dichte in der EU. Österreichs Bevölkerung besonders stark von erhöhten Abgasausstoß betroffen. https://www.vcoe.at/news/details/vcoe-oesterreich-hat-dritthoechste-diesel-pkw-dichte-in-der-eu (accessed April 10, 2018).

Wanniski, Jude. 1978. “Taxes revenues and the laffer curve.” *The Public Interest*(50).

Wooldridge, Jeffrey M. 2013. *Introductory Econometrics. A Modern Approach*. 5th ed. Mason, Ohio: South-Western Cengage Learning.

Zahrl, Jürgen. 2016. Steuer-Dschungel als Geschäft. Komplizierte Gesetze kurbeln Jobmotor an und bringen Wirtschaftstreuhänder zur Verzweiflung. http://kurier.at/wirtschaft/steuer-dschungel-als-geschaeft/178.232.360 (accessed May 27, 2016).

Appendix

Year	Labour	Consumption	Combined labour	Capital
1965	0.2715287	0.2034642	0.4197466	0.3442386
1966	0.2785092	0.2105504	0.4304194	0.3286518
1967	0.2818173	0.2024849	0.4272385	0.3082784
1968	0.2792188	0.2136483	0.4332124	0.2730290
1969	0.2851219	0.2178284	0.4408426	0.2628009
1970	0.2709581	0.2122014	0.4256618	0.2211724
1971	0.2742448	0.2132153	0.4289869	0.2220856
1972	0.2839196	0.2178072	0.4398871	0.2033736
1973	0.2869323	0.2094846	0.4363090	0.1878900
1974	0.2955425	0.1989956	0.4357264	0.1901780
1975	0.2862571	0.1892958	0.4213656	0.2182371
1976	0.2856240	0.1964608	0.4259709	0.1899402
1977	0.2947074	0.1900948	0.4287798	0.1810324
1978	0.3158439	0.1949699	0.4492337	0.2018808
1979	0.3152903	0.1975097	0.4505271	0.1842116
1980	0.3214619	0.1953636	0.4540236	0.1871840
1981	0.3325964	0.1976331	0.4644975	0.1820716
1982	0.3291121	0.1905004	0.4569165	0.1631610
1983	0.3292650	0.1899123	0.4566458	0.1553711
1984	0.3363411	0.2082155	0.4745252	0.1716572
1985	0.3435213	0.2079981	0.4800676	0.1779354
1986	0.3434839	0.2066550	0.4791563	0.1747635
1987	0.3389027	0.2070277	0.4757682	0.1677591
1988	0.3403081	0.2066079	0.4766057	0.1760350
1989	0.3255298	0.2056297	0.4642209	0.1734236
1990	0.3308833	0.2020791	0.4660977	0.1742894
1991	0.3353031	0.2008212	0.4687883	0.1808285
1992	0.3449024	0.2018181	0.4771130	0.1978311
1993	0.3528834	0.1970290	0.4803841	0.1889226
1994	0.3526833	0.2090895	0.4880304	0.1614682
1995	0.3592171	0.1944227	0.4837998	0.1655640
1996	0.3675852	0.1981008	0.4928671	0.1901249
1997	0.3751146	0.2058119	0.5037234	0.2019989
1998	0.3710414	0.2038007	0.4992236	0.2038050
1999	0.3721046	0.2070725	0.5021245	0.1938874
2000	0.3672351	0.2026250	0.4954491	0.1920352

Year	Labour	Consumption	Combined labour	Capital
2001	0.3772419	0.2002934	0.5019762	0.2304872
2002	0.3759378	0.2048263	0.5037622	0.1898129
2003	0.3752956	0.2009301	0.5008175	0.1884319
2004	0.3719807	0.1994349	0.4972297	0.1896925
2005	0.3667513	0.1956585	0.4906518	0.1844305
2006	0.3647480	0.1907243	0.4859061	0.1805087
2007	0.3648733	0.1932584	0.4876169	0.1897996
2008	0.3694740	0.1927793	0.4910264	0.1989630
2009	0.3646870	0.1914116	0.4862933	0.1748784
2010	0.3695254	0.1891222	0.4887622	0.1749612
2011	0.3725162	0.1925356	0.4933291	0.1748399
2012	0.3735236	0.1940852	0.4951134	0.1861577

Table 7.3: Effective average tax rates for Austria

Year	1100	1200	2100	2200	2300	3000	4000	5110	5121	5122	5123	5126	5128	5200	5212
1965	1240	334	686	721	141	472	246	1160	610	37	332	129	0	46	13
1966	1432	332	761	799	161	529	271	1262	684	39	382	144	0	53	14
1967	1545	320	829	865	168	590	291	1288	765	37	354	159	0	58	15
1968	1533	324	905	941	182	625	304	1528	830	41	370	164	0	66	15
1969	1734	381	999	1038	199	681	345	1622	982	38	371	185	0	69	16
1970	2015	429	1098	1146	236	753	365	1807	1073	44	418	206	0	74	17
1971	2339	478	1265	1322	267	865	387	2094	1157	46	471	235	0	80	16
1972	2854	529	1439	1496	296	981	416	2474	1307	49	535	264	0	91	16
1973	3317	499	1670	1737	354	1145	444	2912	1340	54	542	148	0	110	27
1974	4038	680	1934	2089	393	1324	482	3247	1435	51	551	164	0	108	19
1975	3987	801	2128	2502	453	1478	571	3655	1456	46	458	182	0	116	19
1976	4398	706	2385	2775	508	1631	633	4391	1621	54	424	205	0	150	26
1977	4992	789	2701	3170	607	1826	671	4715	1800	56	397	229	0	218	37
1978	5963	840	3124	3831	720	1826	771	5012	1907	55	298	252	0	280	38
1979	6303	957	3383	4137	780	1949	816	5571	2076	59	311	269	0	349	40
1980	6899	1049	3792	4563	845	2097	858	5984	2219	57	354	297	0	373	41
1981	7714	1080	4136	5127	881	2106	932	6578	2457	53	355	328	0	418	43
1982	7985	998	4416	5405	943	2195	932	6820	2593	55	371	359	0	418	46
1983	8192	1073	4675	5723	1006	2258	998	7455	2750	57	410	382	0	441	48
1984	8840	1252	5058	6280	1087	2281	1031	8543	2866	56	450	467	0	616	72
1985	9671	1458	5558	6700	1158	2404	1031	8856	2955	49	466	713	0	653	75

Year	1100	1200	2100	2200	2300	3000	4000	5110	5121	5122	5123	5126	5128	5200	5212
1986	10361	1509	5914	6991	1216	2550	1048	9172	3055	52	494	715	0	679	78
1987	10347	1494	6171	7262	1289	2668	1027	9506	3152	57	544	702	0	709	83
1988	10710	1580	6559	7686	1362	2768	1225	9855	3260	60	627	675	0	761	87
1989	9847	1963	7010	8175	1430	2992	1325	10525	3269	55	667	778	0	819	92
1990	11326	1930	7512	8768	1482	3259	1473	11229	3290	52	677	854	0	865	97
1991	12733	2114	8133	9469	1571	3536	1606	11893	3411	55	736	926	0	893	100
1992	13827	2607	9047	10460	1709	3776	1742	12570	4049	74	770	992	0	895	102
1993	14501	2356	9740	11181	1874	3923	1743	12790	4064	92	746	1021	0	896	98
1994	13836	2149	10708	11947	2043	4605	1104	14721	4002	95	742	1119	0	1059	152
1995	15127	2381	11006	12792	2186	5017	1081	13468	4425	57	314	1407	9	1075	206
1996	16471	3364	11264	13243	2398	5117	1107	14706	4583	92	237	1460	33	1062	228
1997	17986	3686	11497	13593	2640	5263	1088	15336	5114	86	326	1508	30	1073	232
1998	18913	4083	11696	13821	3166	5432	1123	15772	5276	87	0	1620	32	1155	246
1999	19821	3533	12123	14331	3283	5621	1167	16757	5448	88	7	1612	34	1177	251
2000	19890	4157	12524	14707	3382	5788	1206	16894	5484	130	-5	1720	34	1430	298
2001	21866	6519	13000	14891	3630	5998	1258	17301	5728	74	-6	1758	22	1624	357
2002	21870	4831	13180	15098	3717	6137	1206	18012	5934	111	-2	1754	23	1731	403
2003	22361	4848	13480	15457	3861	6258	1263	17944	6220	118	-1	1817	13	1770	415
2004	22781	5277	13896	15928	4267	6379	1309	18630	6535	125	4	1854	17	1699	379
2005	22763	5446	14421	16631	4382	6574	1375	19466	6586	118	1	1738	26	1752	369
2006	24006	5625	14997	17330	4627	6866	1510	19757	6508	119	0	1944	5	1829	376
2007	25741	6622	15671	18162	4750	7266	1572	20988	6760	122	-8	1967	-3	1858	370
2008	28008	6953	16439	18928	4934	7922	1534	21957	6866	124	-21	2039	18	1884	328
2009	26151	4683	16534	19023	5214	8143	1511	22231	6714	130	0	2059	4	1948	327
2010	27098	5519	16909	19496	5155	8359	1555	22764	6921	129	0	2005	4	1990	334
2011	28546	6180	17596	20377	5514	8756	1576	23498	7472	318	0	2475	4	2110	342
2012	30289	6379	18169	21158	5732	9156	1765	24601	7562	332	0	2551	8	2207	340

Table 7.4: OECD Revenue Report, measured in millions €

Year	CP	CG	CGW	OS	W	WSSS	KI	AFA
1965	10595	2393.1	1551.2	6975.9	6805.6	8475.8	3716.5	2121.3
1966	11307.2	2665.6	1728.7	7413.4	7501.2	9342.1	3927.2	2305.9
1967	12152.4	3021	1957.6	7756.4	8121.5	10114.6	4008.6	2497.8
1968	12948.8	3288.4	2129.9	8321	8609.9	10722.9	4265.9	2641.7
1969	13767.9	3668.5	2364.9	9113.9	9392.4	11697.4	4518.1	2809.5
1970	15665.6	4262.2	2779	10934	10938.7	13793.5	5521	3932.8
1971	17551.2	4783.9	3110.4	11619.9	12656.7	15940.7	5776	4441.3
1972	19826	5410.7	3492.7	13135.2	14399.4	18113	6062.4	5040.5
1973	22265.7	6322.2	4084.9	13963.7	16917.5	21211.9	6066.7	5593.8
1974	25228.8	7520.1	4733.2	15810.2	19671.8	24714.8	6668.5	6410
1975	28101.8	8725.8	5490.4	15844.1	21905.8	27740.7	7058.7	6943.6
1976	31300.7	9863.5	6190.3	17848.6	24835.3	30554.7	8000.6	7400
1977	35112.8	10794.9	6706.2	19708.6	27428.9	33691.7	8568.1	8358.6
1978	35917.8	11850.9	7547.1	20003.4	29750.1	36862.4	8803.6	9052.2
1979	39143.8	12900.7	8122.6	23146	31676.5	39233.1	10148	9791.7
1980	42561.5	13866	8696	24715	34117.1	42309.8	11164	10797
1981	46193.6	15138.8	9559.7	25870.7	36690.5	45531.5	10968.9	11863.4
1982	49779.8	16616.3	10427.7	29463.6	38319	47522.1	13303.7	12867.8
1983	54173.3	17704.2	11096.8	32664.3	39601.4	49236.8	14656.6	13530.7
1984	55833.4	18633	11694.9	33359	41520.7	51825.8	15940.6	14194.3
1985	58801.7	19866.7	12480.3	35361.7	43967	54835.8	17241.2	14842.9
1986	61066.4	21157.5	13292.6	37574.4	46793.4	58113.6	18521.2	15631.8
1987	63245.3	21928.2	13912.5	38902.2	48724.5	60427.3	19391.1	16339.7
1988	65700.6	22704.2	14230.5	40943.8	50355.4	62765.3	21232.5	16987.3
1989	69876.6	23856.4	14926.3	44165	53585.7	66690.5	23333.6	18203.4
1990	74978.9	25343.3	15880	47636.3	57943.7	71865.9	25849.1	19415.5
1991	79610	27445.5	17353.8	50496.1	62959.1	77920.1	27759.3	20869
1992	85135.5	29525.3	18277	52449.8	66960.6	83155.6	29326.7	22485.7
1993	87774.8	31836	19590	53343.2	69546.3	86709.7	28991.5	23722.1
1994	91573.8	33673.2	20555	55622.6	72166.5	90461.7	31726.7	24836.5
1995	94367.9	35461.7	22018.1	60805.1	74599.2	93668.4	36457.1	25580.8
1996	98867.5	36454.8	22243.5	63869.6	75116.5	94711.6	38790.3	26500.1
1997	100702.5	35624.4	21148.9	66012.6	76309.9	96292.4	40844.1	27542.7
1998	103535	36867.8	21718.2	69952.9	79444.9	99814.5	42405.8	28650.6
1999	106025.2	39010.7	22499.1	72359.2	82400.6	103369.9	44651.6	29797.2
2000	111498.1	39609.7	22866	77419.7	85476.5	106886.7	47115.3	31412.3
2001	115038.4	40009.1	20954.2	80833.9	87269.1	108878.4	47509.9	32954.3
2002	116919.2	40657.1	21041.1	84447.6	88960.3	110694.9	47077.7	34166
2003	120338.7	42045.2	21558.8	86946.2	90911.7	113112.7	48732.2	35312.9
2004	125255	43286	21911.7	93454.8	92912.2	115355.5	54365.8	36636.2
2005	131430.4	45068.2	22884	99082	96179.1	119524.1	59077.2	38137.2
2006	136776.9	47337.6	23998.6	106756.7	100898.7	125134	63698.3	39605
2007	141244.6	49398.9	24782.7	113534.2	106263	131535.7	69616.4	41382.3
2008	145384.3	52757.8	25950.4	114587.5	112152.2	138469.5	71345.3	43465.5
2009	147153.3	54577.3	27169.6	106551.4	113069.2	139692.8	65069.6	44536
2010	152826.9	55534	27805.7	111584.4	115346.5	142621.4	63604.5	45729.5

Year	CP	CG	CGW	OS	W	WSSS	KI	AFA
2011	159606.7	56773.7	28264.5	118690	119794.1	148153.1	65482.3	47390.4
2012	164436	58361.7	29063.2	119316.1	124608.5	154253.8	68983.4	49422.8

Table 7.5: OECD National Accounts data, measured in millions €

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968
Working-age population	4632.6	4617.1	4615.1	4620.3	4618.9	4614.6	4613.5	4615.1	4608.4
Year	1969	1970	1971	1972	1973	1974	1975	1976	1977
Working-age population	4597.5	4596.8	4610.4	4639.4	4675.1	4692.9	4691.1	4706.6	4740.5
Year	1978	1979	1980	1981	1982	1983	1984	1985	1986
Working-age population	4771.4	4800.8	4845.1	4913.3	4977.7	5031.5	5080.1	5107.4	5120.8
Year	1987	1988	1989	1990	1991	1992	1993	1994	1995
Working-age population	5126	5129	5148.4	5185.7	5233.3	5284.3	5319.5	5329.9	5330
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004
Working-age population	5336	5347.2	5361.4	5383.3	5410.3	5446.2	5489.3	5530.4	5559.7
Year	2005	2006	2007	2008	2009	2010	2011	2012	
Working-age population	5573.1	5585.9	5596.4	5615.8	5626.9	5644.2	5675.5	5693.4	

Table 7.6: Table of working-age population (15 to 64 years), measured in 1,000 persons

Year	Private consumption	Government investment	Private investment	Nominal gross domestic product	Real gross domestic product, base year 200	Net capital stock	Net export	Government consumption	Government expenditure	Government expenditure, except interest payments	Government debts
2001	119.4	5.3	49.3	220.1	257.1	874.2	3.8	41.8	103.8	95.9	146.3
2002	121.5	5.9	47.4	226.3	261.4	892.2	8.3	42.7	106.3	98.5	150
2003	125.5	5.8	50.1	231	263.4	911.4	6.2	44	109.9	102.5	151.3
2004	130.7	5.8	51.3	241.5	270.5	930.2	7	45.8	112.1	104.9	156.5
2005	136.9	7.4	51	253	276.3	948	7.8	49.2	119.2	111	172.8
2006	142.7	7.7	52.7	266.5	285.5	965.7	9.1	51.6	123.5	115.1	178.7
2007	147.8	8.5	56.5	282.3	295.9	985.7	11.7	53.2	127.1	118.3	183
2008	152.3	9.5	58.7	291.9	300.5	1005.7	12.2	56.6	133.3	124.6	200
2009	153.9	9.7	54.6	286.2	289.1	1019.8	8.5	59.6	139.8	130.7	228.2
2010	158	9.6	54.2	294.6	294.6	1031.9	9.8	60.6	142.8	134.3	242.7
2011	165.2	9.4	60	308.6	302.9	1047.6	7.8	61.7	144.9	136.3	253.7
2012	170.1	9.4	62.6	317.1	305.2	1063.1	8.2	63.3	149.3	140.6	260.1

Table 7.7: AMECO macroeconomic values

All values measured in Mrd €.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
hours worked	6790	6774	6786	6840	6833	6882	6968	7070	6814	6845	6982	6960

Table 7.8: Total annual hours work

Total annual hours worked are measured in millions of hours worked.

Year	Capital tax rate	Labour tax rate	Consumption Tax rate	Combi tax rate	Revenue
1965	8.0	2.1	0.3	2.2	3.7
1966	7.3	1.9	1.1	1.8	3.5
1967	6.0	1.8	0.2	1.9	3.4
1968	4.3	1.8	1.4	1.6	3.4
1969	3.7	1.7	1.9	1.3	3.1
1970	1.7	2.2	1.3	2.0	3.2
1971	1.8	2.1	1.4	1.9	2.9
1972	0.7	1.8	1.9	1.4	2.7
1973	0.0	1.8	1.0	1.7	2.6
1974	0.1	1.5	0.1	1.7	2.3
1975	1.8	1.8	1.1	2.4	1.9
1976	0.3	1.7	0.3	2.0	1.7
1977	0.1	1.5	1.0	2.0	1.5
1978	1.0	0.9	0.5	1.2	0.5
1979	0.0	0.9	0.3	1.1	0.7
1980	0.1	0.7	0.5	1.0	0.5
1981	0.2	0.3	0.2	0.5	0.0
1982	1.3	0.4	1.0	0.8	0.5
1983	1.7	0.4	1.0	0.8	0.7
1984	0.9	0.1	0.8	0.0	0.0
1985	0.6	0.1	0.8	0.2	0.2
1986	0.8	0.1	0.7	0.2	0.2
1987	1.1	0.0	0.7	0.0	0.0
1988	0.7	0.0	0.7	0.1	0.0
1989	0.7	0.4	0.6	0.4	0.6
1990	0.7	0.2	0.2	0.3	0.5
1991	0.4	0.1	0.1	0.2	0.3
1992	0.4	0.2	0.2	0.1	0.3
1993	0.0	0.5	0.3	0.2	0.4
1994	1.5	0.5	0.9	0.6	0.4
1995	1.3	0.7	0.7	0.3	0.2
1996	0.0	0.9	0.3	0.7	0.9
1997	0.6	1.1	0.5	1.1	1.2
1998	0.8	0.8	0.3	0.7	1.2
1999	0.2	0.8	0.6	0.8	1.2
2000	0.2	0.6	0.1	0.5	0.7
2001	2.4	0.9	0.1	0.7	1.4
2002	0.0	0.9	0.3	0.8	0.9
2003	0.1	0.8	0.1	0.7	0.9
2004	0.1	0.7	0.2	0.5	0.7
2005	0.1	0.5	0.6	0.2	0.4
2006	0.3	0.5	1.1	0.0	0.1
2007	0.2	0.5	0.8	0.1	0.1
2008	0.7	0.7	0.8	0.3	0.5
2009	0.7	0.4	1.0	0.0	0.3
2010	0.7	0.6	1.2	0.1	0.4
2011	0.8	0.7	0.9	0.3	0.4
2012	0.1	0.7	0.7	0.3	0.7

Table 7.9: Test of outliers for least squares estimation

Income Tax bracket measured in Euro	**Marginal tax rates 2009-2015**	**Marginal tax rates from 2016**
11,000 and lower	0%	**0%**
11,000 to 18,000	36.5%	**25%**
18,000 to 25,000	36.5%	**35%**
25,000 to 31,000	43.2143%	**35%**
31,000 to 60,000	43.2143%	**42%**
60,000 to 90,000	50%	**48%**
90,000 to 1,000.000	50%	**50%**
over 1,000,000	50%	**55%**

Table 7.10: Table of marginal tax rates of the Austrian Income Tax System

A Look at the Harding–Coolidge Tax Cut

Before and After: Federal Government Receipts (in $billions)

	Fiscal Year	Federal Government: Revenue	Year-to-Year % change	Inflation-Adjusted Revenue	Year-to-Year % change
4-Year Average Before Tax Cut	**FY1920**	$6.6		$6.6	
	FY1921	$5.6	-16.2%	$6.2	-6.1%
	FY1922	$4.0	-27.7%	$4.8	-23.0%
	FY1923	$3.9	-4.3%	$4.5	-6.0%
	FY1924	$3.9	0.5%	$4.5	0.0%
			-12.6%		**-9.2%**
4-Year Average After Tax Cut	**FY1925**	$3.6	-5.9%	$4.2	-8.2%
	FY1926	$3.8	4.2%	$4.3	3.3%
	FY1927	$4.0	5.7%	$4.6	7.8%
	FY1928	$3.9	-2.8%	$4.5	-1.7%
			0.2%		**0.1%**

Table 7.11: Harding-Coolidge tax cut; source: Laffer (2004)

A Look at the Kennedy Tax Cut

Before and After: Total Income Tax Revenue (Personal and Corporate) (in $billions)

		Federal Government				**Total Government (Federal, State, and Local)**			
	Fiscal Year	Revenue	Year-to-Year % change	Inflation-Adjusted Revenue	Year-to-Year % change	Revenue	Year-to-Year % change	Inflation-Adjusted Revenue	Year-to-Year % change
4-Year Average Before Tax Cut	**FY 1960**	$63.2		$63.2		$67.0		$67.0	
	FY 1961	$64.2	1.6%	$63.5	0.5%	$68.3	1.9%	$67.6	0.9%
	FY 1962	$69.0	7.5%	$67.5	6.2%	$73.7	7.9%	$72.1	6.6%
	FY 1963	$73.7	6.8%	$71.2	5.5%	$78.7	6.8%	$76.0	5.5%
	FY 1964	$72.1	-2.2%	$68.8	-3.4%	$78.0	-0.9%	$74.4	-2.1%
			3.3%		**2.1%**		**3.9%**		**2.6%**
4-Year Average After Tax Cut	**FY 1965**	$80.0	11.0%	$75.1	9.2%	$86.4	10.8%	$81.1	9.0%
	FY 1966	$90.0	12.5%	$82.0	9.2%	$97.7	13.1%	$89.1	9.8%
	FY 1967	$94.4	4.9%	$83.7	2.1%		5.6%	$91.5	2.8%
	FY 1968	$112.5	19.2%	$95.7	14.3%		19.8%	$105.1	14.9%
			11.8%		**8.6%**		**12.2%**		**9.0%**

Table 7.12: Kennedy tax cut; source: Laffer (2004)

A Look at the Reagan Tax Cut

		Before and After: Total Income Tax Revenue (Personal and Corporate) (in $billions)							
		Federal Government				Total Government (Federal, State and Local)			
	Fiscal Year	Revenue	Year-to-Year % change	Inflation-Adjusted Revenue	Year-to-Year % change	Revenue	Year-to-Year % change	Inflation-Adjusted Revenue	Year-to-Year % change
4-Year Average Before Tax Cut	**FY1978**	$260.3		$260.3		$307.4		$307.4	
	FY1979	$299.0	14.9%	$268.7	3.2%	$350.8	14.1%	$315.3	2.6%
	FY1980	$320.3	7.1%	$253.5	-5.7%	$377.4	7.6%	$298.7	-5.3%
	FY1981	$356.3	11.2%	$255.6	0.8%	$419.6	11.2%	$301.0	0.8%
	FY1982	$344.0	-3.5%	$232.5	-9.0%	$410.0	-2.3%	$277.1	-7.9%
			7.2%		**-2.8%**		**7.5%**		**-2.6%**
4-Year Average After Tax Cut	**FY1983**	$347.5	1.0%	$227.6	-2.1%	$421.7	2.9%	$276.2	-0.3%
	FY1984	$376.6	8.4%	$236.5	3.9%	$462.9	9.8%	$290.7	5.2%
	FY1985	$412.3	9.5%	$250.0	5.7%	$504.6	9.0%	$306.0	5.3%
	FY1986	$433.9	5.2%	$258.2	3.3%	$534.0	5.8%	$317.8	3.9%
			6.0%		**2.7%**		**6.8%**		**3.5%**

Table 7.13: Reagan tax cut; source: Laffer (2004)