NORGES HANDELSHØYSKOLE
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Effects of Flat Tax Reforms on Economic Growth in the OECD Countries

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Master Thesis – International Business

NORGES HANDELSHØYSKOLE

ABSTRACT

This master thesis explores how a transition from progressive tax schemes to flat tax schemes in OECD countries affects economic growth in terms of output, focusing on the period from 1997 to 2007. I present and compare academic and empirical evidence on the relation between taxation and economic growth in order to estimate the most probable effect on the economy of implementing flat tax schemes in the OECD countries. A meta-regression analysis on 18 calibration articles on the subjects of tax reforms provides robust results of the mean tax elasticity from the studies, and also the transformation into long run growth is robust. The average growth potential is summarized to 6.75 percent, translating into a growth potential of 9.16 percent in real output for the OECD area based on the 2006/2007 level of tax progressivity and tax elasticity. Controlling for estimation bias in parameter coefficients and prediction model, the conclusions remain robust.

ACKNOWLEDGEMENTS

I would like to thank Armando Pires for inspiring and constructive guidance throughout the process of initiating and completing this master thesis. I would also like to thank Kristine Jensen for fruitful discussions and everlasting patience. Financial support from Civita is gratefully acknowledged.

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For what reason ought equality to be the rule in matters of taxation? For the reason, that it ought to be so in all affairs of government. As a government ought to make no distinction of persons or classes in the strength on their claims on it, whatever sacrifices it requires from them should be made to bear as nearly as possible with the same pressure upon all; which, it must be observed, is the mode by which least sacrifice is occasioned on the whole. If any one bears less than his fair share of the burden, some other person must suffer more than his share, and the alleviation to the one is not, on the average, so great a good to him, as the increased pressure upon the other is an evil. Equality of taxation, therefore, as a maxim of politics, means equality of sacrifice. It means apportioning the contribution of each person towards the expenses of government, so that he shall feel neither more nor less inconvenience from his share of the payment than any other person experiences from his. This standard, like other standards of perfection, cannot be completely realized; but the first object in every practical discussion should be to know what perfection is.

John Stuart Mill in Principles of Political Economy, Book V, Chapter II (1900)

1 INTRODUCTION

1.1 Motivation

What is the role of government in promoting economic growth? Most economists and policy makers agree on the role of government as provider of sound economic policies in terms of optimal framework conditions for growth and prosperity. As Mankiw (1998) states in his 8th principle of economics: "A country's standard of living depends on its ability to produce goods and services." However, highly different opinions arise when this is brought down to government policies in action, in terms of level of interaction or measures to be used. Fiscal policy is no exception.

How to design and implement a tax scheme has been an important governmental activity ever since the origin of tax. In the well established Western European countries, as well as in the US, the governments have over time added to and amended the tax system for redistributive and other well-meaning purposes, or as plain political statements. Caplan (2007) posts that voters, irrational by rational reason, yields the evident suboptimal policy developments. This is confirmed by Avinash and Londregan (1998) in that they find redistributive politics to favor the middle class at the expense of both rich and poor[1]. As a result most of today's tax schemes in these countries are not easily to understand and comply with, even for professionals. A rationale for this may be the finding by Chetty, Looney, and Kroft (2008) in that salient taxes yield more responsiveness than hidden taxes. Unfortunately, these tax schemes create significant efficiency gaps in the economies[2].

One benefit of globalization is the removal of the government monopolies; as labor and capital become increasingly mobile across country borders, governments have to face competition from other countries in terms of framework conditions (Vietor (2007)), such as climate, infrastructure, social security, employment, liberty, and taxation. Edwards and de Rugy (2002) apply the public choice theory put forward by Charles Tiebout on competition between countries, reasoning that competition between countries increases government efficiency. As Bohacek and Kejak (2005) find; even if the aggregates are important, the behavioral effects on individuals are crucial in obtaining the aggregates (in a fiscal sense). Whereas some of these framework conditions are outside of the governments' sphere of influence (climate), the others are in many countries considered as regulatory framework and dictated without hesitation. However, most of the OECD countries are reluctant to alter the tax conditions in order to attract labor and capital, under the assumption of that reducing taxes is bad for the economy. There are however signs of improvements. Devereux, Lockwood, and Redoano (2002) find evidence for corporate tax competition between OECD countries in terms of statutory tax rates, effective average tax rates, and effective marginal tax rates. This is confirmed by an exposition for the Norwegian Parliament (Gotaas (2007))

[1] Intuitively this is easily illustrated by the median voter hypothesis, which posts that political parties will make an effort to get as close as possible to satisfy the median voter in order to win the election, while simultaneously maintaining diversity from competitors. For the OECD countries the median voter is found in the middle class.

[2] A less moderate understanding of the impact of taxes is found in Adams (2001) where he explains world history from a taxation perspective.

stating that the tax reforms in OECD countries are to improve the countries' competitiveness. An increasing number of non-OECD countries have lowered the price of residing and making money (i.e. tax), pressuring the high-tax OECD countries to respond in order to retain labor and capital.

Under the current global conditions with crisis in the financial, banking and real economy sectors one of the aids pleaded by workers and businesses is tax cuts. This could be a very good time for introducing a flat rate tax scheme in all OECD countries. Businesses and citizens want relief from the governments, and introducing a fundamental tax reform will give all relief that lasts. Lower tax burden, reduced compliance costs, increased incentives, and not least, fair treatment will be the benefits for the tax payers, whereas the benefits for the governments are reduced compliance control costs and possibly increased tax income. A long term recession demands a long term solution. According to the OECD Secretary-General,

How and from whom tax is raised matters, not just how much. One can easily imagine that a broad-based but low rate tax system is effective in resource terms. And a simple, fair and transparent system that operates with broad social consensus is important for good governance and compliance.

Angel Gurría, OECD Secretary-General at the International Conference on Financing for Development, Doha, 29 November 2008[3].

Introducing flat tax schemes in the OECD countries is a proper response to this statement.

[3] Source: OECD – Mobilising domestic financial resources for development. [http://www.oecd.org/document/35/0,3343,en_2649_201185_41765091_1_1_1_1,00.html] (Accessed 30.11.2008)

1.2 Research Question

The focus of this thesis is the *de facto* relation between taxation and economic growth in terms of incentive and disincentive effects from tax schemes. The research question is:

What will be the long run economic growth effects from an introduction of flat tax schemes in the OECD countries in terms of output?

Studies and statistics indicate that flat tax schemes boost growth. To retain competitiveness and to overcome the global recession a viable fiscal policy enhancement for the OECD countries still having progressive tax schemes might be to follow suit and implement flat tax schemes.

1.3 Objective

The objective for the master thesis is to present and compare academic and empirical evidence on the relation between taxation and economic growth in order to estimate the most probable effect on the economy of implementing flat tax schemes in the OECD countries. Of current interest is the increasing number of countries implementing flat tax schemes, the notion of tax competition, and a stagnating global economy. These issues will be discussed with regards to the thesis objective.

1.4 Report Design

Section 2 presents recent issues and trends within the field of taxation. Section 3 describes the methodology for this thesis, and section 4 presents theory and model framework, including the Hall-Rabushka flat tax. Section 5 reviews academic literature derived with the purpose of a meta-regression analysis by which the differences between the articles are studied in terms of output growth effects by changes in tax progressivity.. In section 6 the meta-regression analysis is performed, and in section 7 the results are extended into

qualified estimations on an OECD flat tax scenario as opposed to the current progressive tax schemes. Section 8 concludes and suggests further research.

2 BACKGROUND

In this section I define central terms used in this paper. I provide a brief overview of current tax structure in the OECD countries, and in countries in the flat tax club. Current scenarios and trends within taxation are discussed where I also present some studies proving the case for flat tax reforms.

2.1 Definitions

Economic growth is the increase in a country's production of goods and services from one period to the next. In this paper economic growth is measured as real gross domestic product.

Proportional tax schemes levy one single tax rate on all income for all taxpayers regardless of income level. No deductions are granted, and all loopholes are extinguished. Most value added tax and social security schemes are proportional.

Flat tax schemes levy one single tax rate on all income for all taxpayers regardless of income level. The flat tax is however not a strictly proportional tax scheme, as some progressivity exist in that a basic deduction for persons is granted to limit the tax burden of the poor. All other deductions and loopholes are however extinguished. Some OECD countries and several non-OECD countries has switched from highly progressive tax schemes to flat tax schemes, often accompanied by low tax rates.

Progressive tax schemes levy low tax rates on small incomes and high tax rates on large incomes. Hence the share of tax burden is increasing. In addition numerous deductions are

often implemented for distributive or behavior-directing policy reasons. Most OECD countries still use this type of tax scheme.

The OECD countries (i.e. OECD – Total in tables and figures) covers the 30 OECD Member countries; Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States[4].

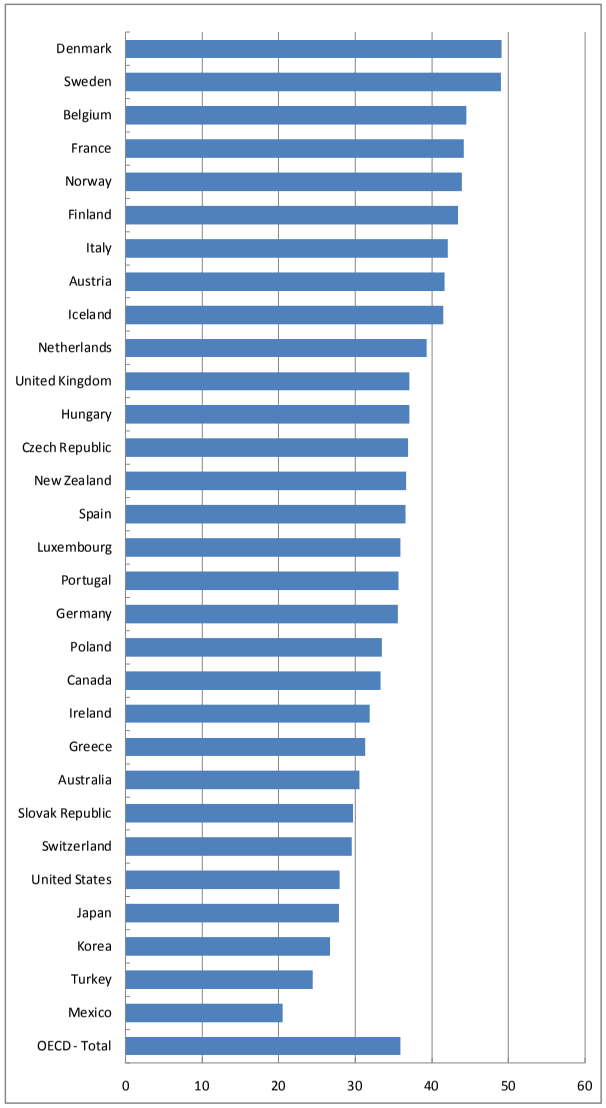
The Flat Tax Club consist of the countries and jurisdictions Albania, Belarus, Bulgaria, Czech Republic, Estonia, Federation of Bosnia and Herzegovina, Georgia, Guernsey, Hong Kong, Iceland, Illinois (US), Indiana (US), Iraq, Jamaica, Jersey, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Massachusetts (US), Mauritius, Michigan (US), Mongolia, Montenegro, Pennsylvania (US), Pridnestrovie, Romania, Russia, Serbia and Montenegro, Slovak Republic, Trinidad, Ukraine, and Uri (Switzerland)[5].

2.2 Current Tax Structure in the OECD Countries

Most OECD countries have as mentioned progressive tax schemes. KPMG's Individual Income Tax Rate Survey 2008 shows that the tax levels have been slightly reduced over the past 5 years. For 13 countries the effective income tax and social security rates have been reduced. The flat tax countries Czech Republic and Slovak Republic has now half of the initial rates, whereas Iceland has seen a 20 percent increase (which the flat tax reform barely reduced). For 12 countries the effective income tax and social security rates have not changed at all. Figure 5 to figure 5 shows the tax structure based on OECD statistics.

[4] Source: OECD country Web sites: Country Web Pages [http://www.oecd.org/countrieslist/0,3351,en_33873108_33844430_1_1_1_1_1,00.html] (Accessed 10.11.2008)
[5] Source: Edwards and Mitchell (2008), Alvin Rabushka: Flat Tax – Essays on the Adoption and Results of the Flat Tax Around the Globe. [http://flattaxes.blogspot.com/], Wikipedia: Flat tax [http://en.wikipedia.org/wiki/Flat_tax] (Accessed 14.10.2008)

Figure 1: Total Tax Revenue as Percentage of GDP, 2006



Source: OECD Centre for Tax Policy and Administration, Revenue Statistics 1965-2007, 2008 Edition. [http://www.oecd.org/ctp/revenuestats]

Chart A.

OECD – Total is author's own estimate (unweighted average) based on data from OECD.Stat.

Figure 2: Changes in Tax to GDP Ratio (in percentage points)

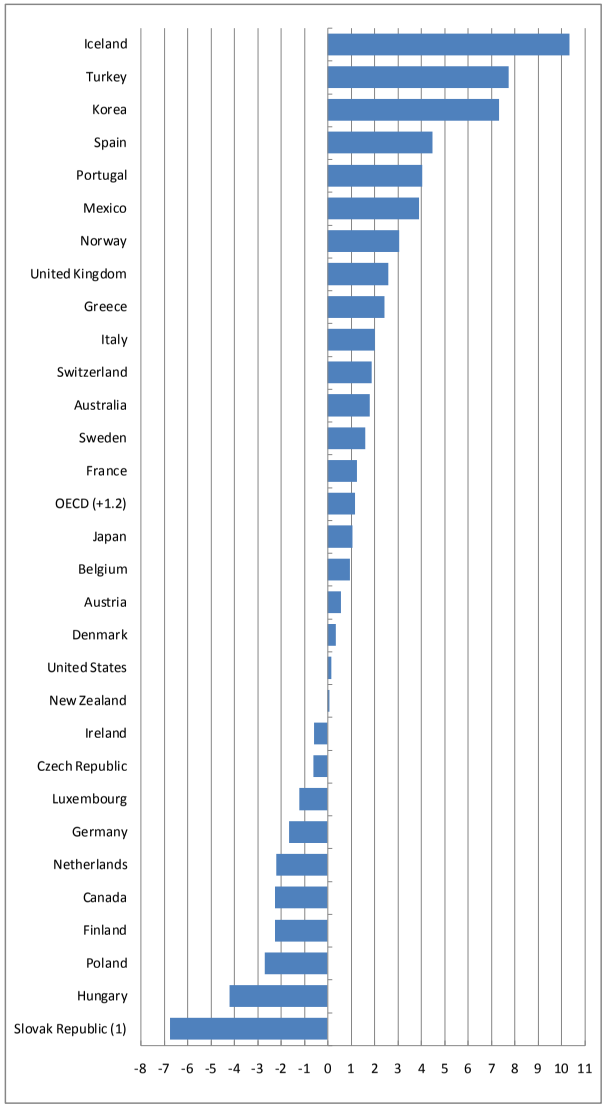


Chart E.

Figure 3: Tax Revenue: Source as Percentage of Total Tax Revenue

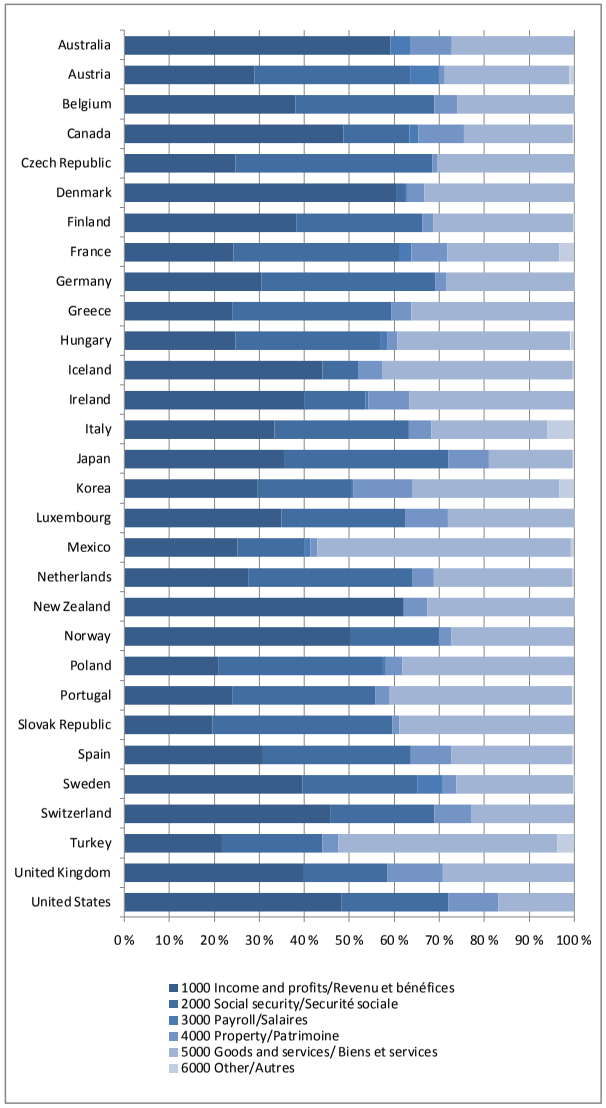


Chart 2.

2.3 Current Flat Tax Structures Worldwide

The number of jurisdictions joining the Flat Tax Club and implementing flat tax schemes is steadily increasing. Latest members of the flat tax club are Belarus and the Federation of Bosnia and Herzegovina, introducing 12 and 10 percent flat rate taxes, respectively, effective as of 2009; as well as the Swiss Canton of Uri, introducing a 15.4 percent flat rate tax[6]. The countries and jurisdictions are however highly diverse, as are the flat tax schemes implemented. Figure 4 shows the 2008 income tax rates for 25 flat tax jurisdictions.

Figure 4: The Flat Tax Club – Income Tax Rates, 2008

Table 4.1
THE FLAT TAX CLUB: INCOME TAX RATES, 2008

Jurisdiction	Year Individual Flat Tax Adopted	Individual Flat Tax Rate	Corporate Tax Rate
Jersey	1940	20.0%	20.0%
Hong Kong	1947	15.0%	16.5%
Guernsey	1960	20.0%	20.0%
Jamaica	1986	25.0%	33.3%
Estonia	1994	21.0%	21.0%
Lithuania	1994	24.0%	15.0%
Latvia	1995	25.0%	15.0%
Russia	2001	13.0%	24.0%
Slovakia	2004	19.0%	19.0%
Ukraine	2004	15.0%	25.0%
Iraq	2004	15.0%	15.0%
Romania	2005	16.0%	16.0%
Georgia	2005	12.0%	15.0%
Kyrgyzstan	2006	10.0%	10.0%
Pridnestrovie	2006	10.0%	10.0%
Trinidad	2006	25.0%	25.0%
Iceland	2007	35.7%	18.0%
Kazakhstan	2007	10.0%	30.0%
Mongolia	2007	10.0%	25.0%
Macedonia	2007	10.0%	10.0%
Montenegro	2007	15.0%	9.0%
Albania	2007	10.0%	10.0%
Mauritius	2007	15.0%	15.0%
Czech Rep.	2008	15.0%	21.0%
Bulgaria	2008	10.0%	10.0%
Average of 25 jurisdictions		16.6%	17.9%

SOURCE: Authors' compilation. Estonia's corporate tax rate for retained earnings is zero.

Source: Edwards and Mitchell (2008)

[6] Source: Alvin Rabushka: Flat tax – Essays on the Adoption and Results of Flat Tax Around the Globe. [http://flattaxes.blogspot.com/]

Evans and Aligica (2008) study the implementation of the flat tax in Central and Eastern Europe (several versions, none pure Hall-Rabushka flat tax or strictly proportional tax schemes) using a comparative study. They find that ideas, interests and consequences are prerequisites for all cases. For some preceding cases ideas are sufficient. E.g. Mart Laar, Prime Minister of Estonia, based the flat tax reform on the thoughts of Hayek and Friedman (Evans (2006)). The conditions for implementing flat tax might hence be transferrable to the OECD countries. Evans (2006) argues that belief in the normative approach to flat tax was a key in many of the now flat tax countries. After some time, when econometric and operational experience from the flat tax is obtained, this has been the foundation for the other countries for implementing the flat tax. In Fraser Forum (February 2008) Patrick Basham describes political obstacles hindering the introduction of flat tax schemes in Western countries, namely interest groups who are willing to keep it complicated for own benefit.

2.3.1 Effects from Flat Tax Reform on Economic Growth

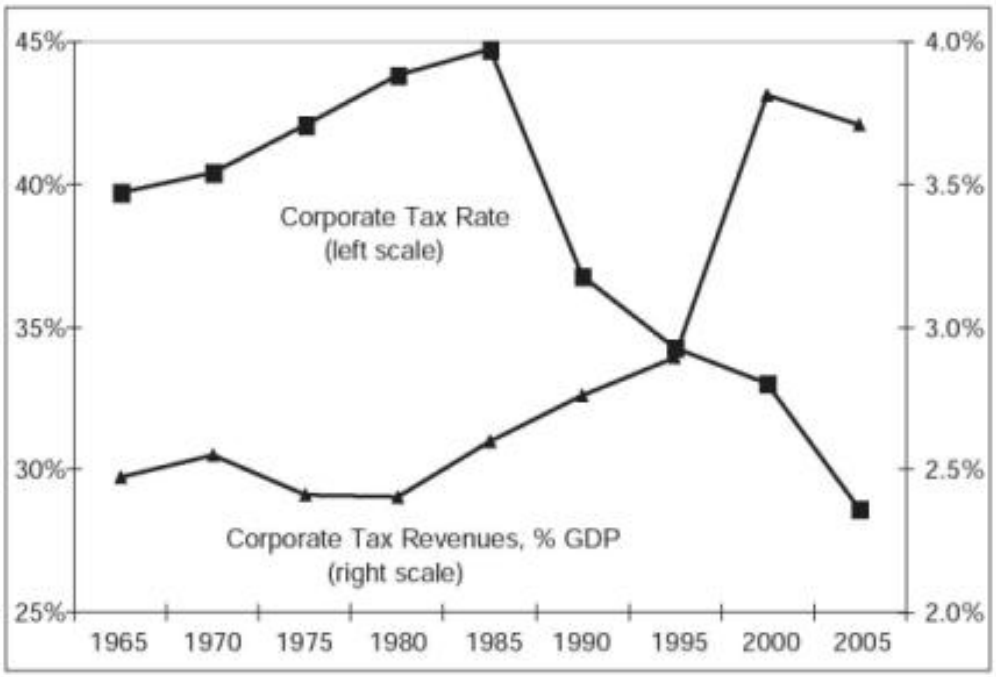
Forbes (2005), Heath (2006), and Edwards and Mitchell (2008) highlight the subsequent growth from introducing flat tax in several countries. In Gotaas (2007) the statistics for Estonia show that whereas pre-tax reform GDP growth was negative, post-tax reform GDP growth has ranged between 0.3 and 11.4 percent annually, averaged at 7.5 percent. As the flat tax was implemented along with several other reforms it is however difficult to determine the isolated tax-reform effect. This is also the case for many other tax reforms; they are combined with other efficiency-improving reforms. However, the mere fact that most of these countries experience significant increasing economic growth provides solid fundament for expecting similar effects for the OECD countries.

2.4 Current Scenarios and Trends

OECD reports a 0.1 percent decline in output for 3rd quarter of 2008[7]. In this period two OECD countries have a 1 percent or larger *increase* in output. The two countries are Slovak Republic and Czech Republic, which both have flat tax schemes. Is this a coincidence? The indication of the potential effects of flat tax reforms is anyway intriguing.

The OECD countries have the later years reduced corporate taxes substantially, and now the individual income taxes are also in a downward trend. There is also a global trend that income taxation is reduced in favor of indirect taxation; value added taxes, sales taxes, customs fees etc. The reason might be partially due to the experience of increasing tax income as shown in figure 5.

Figure 5: Corporate Tax Rates Fall and Revenues Rise, Average of 19 OECD Countries



Source: Edwards and Mitchell (2008): Figure 6.1

[7] OECD Quarterly National Accounts: OECD area GDP down 0.1% in the third quarter of 2008. News release 20.11.2008 [http://www.oecd.org/dataoecd/53/27/41700068.pdf] Accessed 29.11.2008

The effect is equivalent to what Niskanen and Moore (1996) find with regards to the Reagan tax cuts, that lower tax rates improved the US economy on 8 out of 10 key economic variables. Similar effects can be found for the Thatcher supply-side policies in UK.

Increasing focus is paid to the distortionary effects of taxation. An OECD study on the effects of taxation on economic growth finds that both business and individual taxes reduce economic growth (Arnold (2008)). King and Rebelo (1990) find that national taxation can substantially affect long-run growth rates. Similarly, Hall and Jones (1999) find that a country's long-run economic performance is determined primarily by the institutions and government policies that make up the economic environment, of which physical capital and educational attainment is only a partial reason. Romer and Romer (2007) use a narrative methodology in analyzing the relation between legislation and changes in output. They find that tax increases are highly contractionary. A Norwegian government exposition by Stølen, Gjems-Onstad, Rasmussen, Røtnes, Mathisen Sletteberg, Torp, Winsnes, Berner, Gerdrup, Moen, and Andersen (1999) states that there exist costs for the real economy associated with high tax rates when citizens find tax planning profitable even when accompanied by transaction costs. They also recommend that the tax scheme be less progressive.

The Pareto's Principle, or the rule of 80/20, was derived from wealth inequality, and there is a probability that it is still present in income distribution, and more important, in income creation. Stokey (1980) states that while the high-income groups may be a minority in headcount, their economic importance is not. The high-income groups also have higher tax elasticity due to better knowledge and hence high marginal tax rates which mostly apply to high-income groups will have severe distortionary effects on the economy.

Auerbach, Kotlikoff and Skinner (1983) study the efficiency gains from a dynamic tax reform based on general equilibrium rational expectations growth path of life cycle economies. The model incorporates effects of changes in tax progressivity and tax base, and is applied to a switch from the US tax system (proportionally approximated) to proportional tax on either consumption or labor income. They find that a flat consumption tax will increase lifetime welfare of all future generations by 2 percent, whereas a flat labor income tax will decrease welfare by similar amount. However, applying an initial progressive tax structure yields increases in both reforms by 7.08 and 4.24 percent, respectively. This illustrates that even

minimal progressivity in the income tax structure has a large efficiency cost, and that tax progressivity may be as important as the tax base.

Prescott (2004) finds that when the US and European tax rates were comparable the labor supply was also comparable, and that most differences between US labor supply and Germany and France 1970 – 1974 are due to differences in tax schemes. For Italy on the other hand institutional constraints in the labor market and unemployment benefits are more important.

Grecu (2004) suggests a dual fiscal system taxpayers would be able to choose between the progressive tax system with all its reliefs and deductions, and a simple flat tax scheme with only a basic deduction.

Kukk (2007) differ substantially from other literature on the relation between taxation and economic growth, in that he finds that all government revenue categories have positive effects on growth. This result is obtained by simultaneously controlling for government expenditure and budgetary deficits. This approach is somewhat problematic however, as revenue and expenditure in general cancels out, the result being budgetary surplus or deficit. Implicit the growth is determined by the budget balance, regardless of government revenue and expenditure being 10 or 90 percent of GDP – this is not very likely. Hence the relation between government revenue and growth has to be analyzed separately in order to infer on the associations, similarly for government expenditure. The finding in Kukk (2007) is also contrary to the OECD study by Leibfritz, Thornton, and Bibbee (1997) which states that "the increase in the average (weighted) tax rate of about 10 percentage points over the past 35 years may have reduced OECD annual growth rates by about 0.5 percentage point".

The amount of academic effort on the subject of flat tax, and the increasing number of real life examples shows a trend in tax competition between countries in order to attract capital and labor, which inevitable paves way for more Western countries to grasp the flat tax opportunity for increased growth.

3 METHODOLOGY

The fundament for the further progress of the paper is the review of academic and empirical literature on the current topic. A search for "flat*tax*", "proportional*tax*", “linear*tax*”, "tax reform" in JSTOR retrieves 7805 references. Limiting to articles only, still 4373 references are available. A similar search in NBER for the same subjects produces 1090 working papers. This amount will however require a more extensive research than appropriate for this paper. Excluding “tax reform”, which obviously will remove some articles regarding flat tax, still I find 1042 JSTOR articles on the flat tax issue. Including “economic efficiency”, “efficiency effects” in the search results in 488 references, which is a viable amount for reviewing, assuming that not all articles will be relevant. I have based the meta-analysis on the JSTOR articles and other relevant resources found through the articles.

To include a study in the meta-regression analysis there are two conditions which must be fulfilled. First, the study must concern fiscal effects on economic efficiency. Second, the study must present an econometric or simulated estimate of the economic output or sufficient information to calculate it. In effect, most of the studies reviewed appear unsuitable for a meta-regression analysis. They are either reviews on the topic, or they are based on models not described or referred to in the article, or the effects on output are not reported and not possible to calculate for the estimates presented.

Most of the articles I use in the meta-regression analysis present more than one measure. Stanley and Jarrell (1998) provide a useful discussion on this matter. Multiple measures from one article are used only when representing different model frameworks. If the author(s) have preferred one particular measure this is chosen. Otherwise I have estimated the elasticity extremes and the used the average elasticity for the concerning article. I have summarized the literature research in table 1, describing properties of 18 studies (n = 19) on flat tax.

The evidence is then compared in a meta-regression analysis to infer whether the model specifications bias the evidence. Based on the relation between taxation and economic growth determined in the regression model I estimate the most probable effect on the economy of implementing flat tax schemes in the OECD countries.

For data collection, structuring, calculations and reporting I use Microsoft Excel, Office 2007 version. For statistical reporting I use Minitab, release 15, a statistical software package.

4 THEORETICAL FRAMEWORK

This paper combines the areas of taxation and regression. Taxation comprises microeconomic and macroeconomic theories; for the purpose of this paper the notions of tax wedge and deadweight loss, tax elasticity, and growth models are described here. The notion of supply side economics is also compared with the more common demand analysis framework. Then the Hall-Rabushka flat tax proposal is discussed, before this section concludes with a description of the regression model deployed; a multiple regression using both binary indicator variables as well as interval variables.

4.1 Tax Wedge and Deadweight Loss

To illustrate the efficiency loss of taxes some fundamentals are explored. From the microeconomic theory the general equilibrium in a market is the intercept between supply and demand ($Q_S^* = Q_D^*$). Quantity supplied (Q_S) depends on the price (P) to the supplier; quantity demanded (Q_D) depends on the price to the customer. Assume linear supply and demand functions. Introducing a proportional tax τ in this stylized model will alter this equilibrium to

$$\alpha + \beta P_S = Q_S = Q_D = \gamma - \delta P_S(1+\tau), \qquad 0 < \tau < 1 \tag{1}$$

where α, γ denote intercept for the supply and demand functions, β, δ denote slope, and $P_D = P_S(1+\tau)$, i.e. the price to the buyer exceeds the price to the seller by the fraction of tax τP_S. The tax wedge is then given by

$$W = \tau P_S Q_{S,D} + 0.5\tau P_S\left(Q^*_{S,D} - Q_{S,D}\right)$$
$$= 0.5\tau P_S\left(Q_{S,D} + Q^*_{S,D}\right) \quad (2)$$

where $Q_{S,D} = \alpha + \beta\left(\frac{\gamma-\alpha}{\beta+\delta(1+\tau)}\right)$ is equilibrium supply, $Q^*_{S,D} = \alpha + \beta\left(\frac{\gamma-\alpha}{\beta+\delta}\right)$ is non-tax equilibrium supply, $\tau P_S Q_{S,D}$ $(= (P_D - P_S)Q_{S,D})$ is government revenue, and where

$$0.5\tau P_S\left(Q^*_{S,D} - Q_{S,D}\right) \quad (3)$$

is the deadweight loss. The market may be e.g. goods, services (τ is a value added tax), or labor (τ is an income tax). In Feldstein (1999) an equivalent formula for deadweight loss is augmented to include tax avoidance and to be based on taxable income elasticities. In macroeconomics the tax wedge is mostly referred to in terms of the difference between labor costs and net wage, either the tax is paid by the employer (payroll tax) or the employee (wage tax)[8], hence omitting the deadweight loss. OECD define tax wedge as the "sum of personal income tax and employee plus employer social security contributions together with any payroll tax less cash transfers"[9]. However, e.g. Mankiw (1998) provides an entire chapter devoted to the costs of taxation.

From the deadweight loss implied by the tax wedge we may hence predict that there are efficiency gains from reducing taxes. As the stylized model was analyzed in terms of a proportional tax, progressive taxes are likely to yield even larger deadweight loss. This is confirmed in Feldstein (1999), and Hansen and Verdelin (2007), both of which also find effects on increased deadweight loss from increasing tax progressivity. Extending the deadweight loss formula to also include disincentives may yield higher effects, but as Hansen and Verdelin (2007) find the effects varies with the level of income. The notion of a deadweight loss implies that the other part of the tax wedge – government revenue – is spent as efficiently as would suppliers and buyers. Additional efficiency costs arise when this

[8] Who pays is actually irrelevant, as the tax burden depends on the elasticity of supply and demand (Mankiw (1998), Pindyck and Rubinfeld (2005)). The shares of tax burden is found by the pass-through fraction formula $\frac{-E_D}{(E_S-E_D)}$ for the seller and $\frac{E_S}{(E_S-E_D)}$ for the buyer, where the elasticities are of the form $E = \left(\frac{P}{Q}\right)\left(\frac{\Delta Q}{\Delta P}\right)$.

[9] OECD Glossary of Statistical Terms - Tax wedge Definition [http://stats.oecd.org/glossary/detail.asp?ID=7273] (Accessed 15.12.2008)

is not the case; however this is not captured by the deadweight loss formula[10]. Ding (2008) finds however that a one percentage increase in the tax wedge can lead to about 0.09 percentage decrease in labor productivity growth rate for the OECD countries.

4.2 Tax Elasticity

To compare the articles regardless different measures of output tax elasticities are estimated for each article, utilizing the methodology described by Philips and Goss (1995) where they refer to Bartik's tax elasticity estimations[11]. Assume tax elasticity as the percentage change in real output caused by a one percent change in tax progressivity, where tax progressivity is defined as the ratio $\Theta = \frac{1-\tau_s}{1-\tau_c}$, where τ_s is the lowest effective marginal tax rate and τ_c is the highest[12]. Then the average tax elasticity is

$$Y_i = \frac{1}{M}\sum_{m=1}^{M}\left(\frac{\Delta\gamma}{-\Delta\Theta}\right)_m \tag{4}$$

where $\Delta\gamma$ is efficiency gain, and m is the number of elasticity estimates. Using the tax progressivity ratio allows for inferring whether changes in output is due to changes in tax level or tax progressivity.

4.3 Growth Models

The relationship between taxation and economic growth has been studied through numerous growth models. A brief summary of the basic models are presented next. Some of

[10] See Edwards and Mitchell (2008) for an analysis of how competitive governments are more efficient than monopolist governments.

[11] Bartik, Timothy J. (1991): Who Benefits from State and Local Economic Development Policies? W.E. Upjohn Institute, Kalamazoo, Michigan. In this book Bartik estimated tax elasticities for economic activity based on 61 studies.

[12] Tax progressivity ratio is a modified version of the ratio in Caucutt, Imrohoroglu and Kumar (2000). Vedder (1985) uses the definition $\tau_c - \tau_s$. Other studies use the Lorentz curve as basis for tax progressivity indices (Suits (1977), Stroup (2005)).

the calibration studies deploy the models directly, others use modified (adjusted or augmented) versions for improved interpretations. See the studies for complete model descriptions, also Farmer (1999), Romer (2001), Gärtner (2006), McCandless (2008), or other macroeconomic literature.

4.3.1 The Solow Growth Model

The neoclassical Solow growth model provides a basic fundament for growth analysis. Although the model has severe simplistic limitations (assuming exogenous growth, closed economy with no government, constant returns to scale) it is a good starting point for developing and interpreting models. The model assumes production of one single good determined by labor and capital (savings) supplied by households. The basic production function is of the form

$$Y_t = A_t F(K_t, L_t) \tag{1}$$

where Y_t denotes output at time t, A is the scale parameter, K is capital, and L is labor. Net change in capital stock is given by $sF(K_t, L_t) - \delta K_t$, where total savings is determined by output and a savings rate assumed fixed at a level $s = 1 - c$ (c = consumption rate), and capital depreciate at a rate δ. Steady state output and capital stock is found where total savings equals capital depreciation, i.e. where actual investment equals required investment. The golden rule of capital accumulation hence yields the highest steady state level of consumption at a savings rate

$$s = \frac{\delta K_0^*}{A_0 F(K_0^*, L_0)} \tag{2}$$

A conceptual defect of the basic Solow model is that the model only explains differences in observed levels of output. Plosser (1992) emphasize that the Solow growth model, despite being a useful fundament, has severe limitations in understanding growth. By extending the model to not be bound by diminishing marginal productivity by expanding the capital term

and by endogenizing technology development, public policies which affect savings and investment in physical and human capital, and technology development are central to long run growth. Gärtner (2006) states that the Solow model does not really explain economic growth, but treats growth exogenously "as a residual which the model does not even attempt to understand".

Extensions of the Solow growth model may however increase its explanatory value. First include Cobb-Douglas production function and human capital, taking the form

$$Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta}, \qquad \alpha > 0, \beta > 0, \alpha + \beta < 1 \tag{3}$$

where α and β is the physical and human capital share of income parameter, and H denotes human capital. Then further inclusion of government will alter the net change in physical capital stock into

$$\Delta K_t = s_K Y_t + (1 - s_K) T_t - G_t - \delta_K K_t \tag{4}$$

where $T_t - G_t$ denotes the budget balance, i.e. government revenue less government expenditure, and government expenditure is assumed non-human capital demanding. Assuming that the human capital sector is untaxed yields

$$\Delta H_t = s_H Y_t - \delta_H H_t. \tag{5}$$

Finally, let changes in scale parameter and labor be explained by $\Delta A_t = g A_t$ and $\Delta L_t = n L_t$ where g denotes technological progress and n is population growth[13]. The augmented model now captures more parts of the economy, but still only income levels are explained, not why income grows.

[13] Extensions may also be done through the intensive form of the Solow growth model.

4.3.2 The Ramsey Model

The Ramsey model assumes many identical competitive firms. The production function is similar to the Solow model (1), however in this model the function is for each individual firm, assuming many firms in competitive markets. The firms are owned by a large number of identical households with infinite lives. A household divide its income from labor, capital and profits between consumption and saving. Each household member supplies 1 unit of labor at each point in time. The household utility function is

$$U = \int_{t=0}^{\infty} \left(e^{-\rho t} \left(\frac{C_t^{1-\theta}}{1-\theta} \right) \frac{L_t}{H} \right) dt \qquad \theta > 0, \quad \rho - n - (1-\theta)g > 0 \tag{6}$$

where ρ denotes time discount rate, θ is relative risk aversion, C_t is consumption of each household member at time t, L_t is total population, and H is the number of households. The household's budget constraint is

$$\lim_{s \to \infty} e^{-R_s} \frac{K_s}{H} \geq 0 \tag{7}$$

where the real interest rate (r) variation is captured by $R_t = \int_{\tau=0}^{t} (r_\tau) d\tau$, and K_s is total capital at time s. Let $\frac{C_t}{A_t} = c_t$ denote consumption per unit of effective labor. Households then maximize lifetime utility by

$$\frac{\Delta c_t}{c_t} = \frac{r_t - \rho - \theta g}{\theta} \tag{8}$$

where g is the growth rate of A. Augmentation of the Ramsey model may further include Cobb-Douglas production function, leisure, variable labor, and tax.

4.3.3 The Overlapping Generations Model

The basic overlapping generations model is a dynamic lifecycle model which captures heterogeneity among agents. An improvement from the Solow model is that the savings rate is endogenous. Population grows exogenously by a rate n, hence $L_t = (1+n)L_{t-1}$. Agents live for two periods; at time t the model assumes an infinite set of agents L in generation t is born, an infinite set of agents L in generation $t-1$ is retired. Young agents supply 1 unit of labor each, income is divided between intraperiod consumption (C_{1t}) and saving. Retired agents consume savings and interest earned (C_{2t+1}). Agents' lifetime utility given by

$$U_t = \frac{C_{1t}^{1-\theta}}{1-\theta} + \frac{1}{1+\rho}\frac{C_{2t+1}^{1-\theta}}{1-\theta} \qquad \theta > 0, \qquad \rho > -1 \tag{9}$$

where θ denotes relative risk aversion, and ρ is the agent's time discount factor. The lifetime budget constraint is the sum of initial wealth and the present value of lifetime labor income

$$C_{1t} + \frac{1}{1+r_{t+1}} C_{2t+1} = A_t w_t \tag{10}$$

where r is real interest rate, and $A_t w_t$ is labor income. In equilibrium agents maximize utility (6) subject to (7) which yields

$$\frac{C_{2t+1}}{C_{1t}} = \left(\frac{1+r_{t+1}}{1+\rho}\right)^{1/\theta} \tag{11}$$

or that agents' consumption over time depends on whether the real interest rate is higher or lower than the time discount factor.

The production function is similar to the Ramsey model. In equilibrium firms earn zero profit, and capital and labor earn their marginal products.

The augmented versions of this basic model provide significant improvements; I will only refer them here. The number of periods is infinite; agents may have different endowments (inherited capital, productivity, skills), and may even inherit from the previous generation;

each generation may consist of heterogenous agents; agents' preference for leisure, taxation and government expenditure, and open economy features are included. Hence this overlapping generations model framework may provide good approximations to real-life economies.

4.3.4 New Growth Theory

The basic versions of the Ramsey model and overlapping generations model have similar defects as the Solow growth model in terms of exogenous growth in capital and labor. Their advantage is however that saving is endogenous and may be variable. The implicit effect of treating growth exogenously is that growth is temporary and will converge over time. This is hardly the case considering technological development, economies of scale and scope, and population growth. Hence, to capture the fundamentals behind growth, models with endogenous growth must be employed. As mentioned, augmenting the basic versions may yield models with endogenous growth, exemplified by most of the studies. Here the simplest endogenous growth model is presented; the AK model, an extension of the Solow model.

Assume a human capital-augmented production function $Y_t = A_t K_t (H_t L_t)$ where human capital and capital endowment per worker is related by $H = K/L$, hence reducing the production function to

$$Y_t = A_t K_t \tag{12}$$

which implies constant marginal productivity of capital. Net change in physical capital is then

$$\Delta K_t = s A_t K_t - \delta K_t \tag{13}$$

where $sA_t K_t > \delta K_t$ yields permanent growth. This is contrary to the converging long run growth from the previous described models. Furthermore, policies will affect growth, in that changes in the savings rate have direct and indirect effects on growth.

The four basic models described are the basis for all calibration studies used in the meta-regression analysis. Methodologies used are either augmentations as described for each model, or extended/included into general equilibrium models or real business cycle models.

4.4 Supply Side Economics

Supply side economics is all about providing sound economic policies in terms of optimal framework conditions for growth and prosperity. Incentives (and disincentives) for individuals and businesses to supply capital and labor are recognized by this approach[14]. There has been extensive criticism towards this economic approach; however theory and empirics provides substantial support – as do common sense. People do not consume in order to work, they work in order to consume. As most proponents of supply side economics support the market as the way to organize society, most effort has been put into the reduction of impeding government interference in terms of regulations and fiscal policies. Taxation and tax reforms have received extensive attention, one of the propositions is the Hall-Rabushka flat tax which is presented later.

Although most economists agree on the role of government as provider of sound economic policies in terms of optimal framework conditions for growth and prosperity, little attention is paid to this when it comes down to economic modeling and research. In most macroeconomic literature Keynesian demand side economics receives substantially more attention, where the focus is on the role of government as provider of stabilizing fiscal policies in terms of demand adjusting measures. However history proves the countercyclical fiscal policy flawed due to a) decision lags; b) implementation lags; and c) impact lags of fiscal policies (Taylor (2000)). Hence the time from a countercyclical measure would have had the effect predicted by theory to the measure is effective may be long; so long that in some cases the measure turns into effect after the through (or peak in an overheating economy), amplifying the normalizing path of the economy (Bernoth, Hallett, and Lewis (2008)). The result is then similar to driving a car from one ditch to the other. It seems as

[14] Source: James D. Gwartney: Supply-Side Economics: The Concise Encyclopedia of Economics | Library of Economics and Liberty. [http://www.econlib.org/library/Enc/SupplySideEconomics.html] (Accessed 18.12.2006)

monetary and automatic stabilizers are better chauffeurs than the government providing (de)stabilizing fiscal policies.

That government interference on demand factors only indirectly affects supply is also flawed. Supply is inevitably associated with demand, but is not a linear function of demand (as demand is not a linear function of supply). This is easily demonstrated by the fact that less than 50 percent of new businesses survive beyond 5 years after establishment[15]. Supply depends on price (as a function of demand), costs, technology, expectations, framework conditions, capital stock, population growth, living standards, total factor productivity (Mankiw (1998), Miles and Scott (2005)). For labor supply there are also trade unions involved. Hence, and corresponding with the growth models presented above, the relation between aggregate supply and aggregate demand is not always easily observed.

The obvious relation is however the cost of supply. If costs exceeds income the supply disappears, i.e. the producer files for bankruptcy. As a major cost component for businesses is tax the obvious linkage extends to taxation (figure 5 shows total tax revenue for the OECD countries; this is the tax burden for businesses and individuals). Recalling the discussion on tax wedge and deadweight loss, this implies that if governments want to affect the economic growth, there is a linear relationship between taxation and supply. Because of this relationship governments must consider the supply side effects beyond the indirect effects of demand-side policies, if that is their path of choice. As stated initially, taxes should be levied fairly and in the least intrusive possible way.

4.5 The Hall-Rabushka Flat Tax Proposition

Hall and Rabushka (1995) propose an integrated flat tax which applies to both individuals and businesses. The main point is that taxing consumption is the least interruptive way of taxation. As value-added taxes do not allow for deductions for the poor this is considered less feasible. The indirect consumption tax (income less investment) allows for deductions,

[15] Source: OECD: Measuring entrepreneurship: a digest of indicators. [http://www.oecd.org/document/31/0,3343,en_2649_34233_41663647_1_1_1_1,00.html] and OECD: Workshop On Firm-Level Statistics, 26-27 November 2001. [http://www.oecd.org/dataoecd/32/62/2669736.pdf] (Accessed 17.12.2008)

and is also more predictable upfront. They suggest in their flat tax reform a flat marginal tax rate of 19 percent applicable to both business and individuals, and a fixed deduction of USD 22,500 for a family of four (Social Security is abstracted from the reform). All other deductions, exemptions and tax credits are eliminated. The integrated flat tax form an airtight tax system, and is fair in that all income is taxed in the same proportion and only once, extinguishing the current double or even triple taxation of income, loopholes, and tax evasion. Fairness is thus maintained for both horizontal and vertical equity. The efficiency gain from removing disincentives of current tax schemes and introducing a flat tax reform is estimated to a 6 percent upward shift in output. Resources will also be allocated away from unproductive tax compliance expenditures, and tax planning (own effort, tax advisers, tax attorneys) for the taxed subjects, and from tax compliance control and investigation for the government. Tax compliance would be much easier; each of the tax forms fit on a postcard and is completed using common records. This would yield even larger efficiency effects. E.g. estimations by Robert E. Plamondon and David Zussman (Clemens, Emes, and Scott (2001)) show that administrative and compliance cost associated with business taxes to be 1.5 percent of total tax revenue.

The Hall-Rabushka flat tax has been used as basis for several reform proposals, such as the flat tax proposals by US Congressmen Dick Armey and Richard Shelby (majority leader and senator, respectively; see Bartlett (1994)), and by Steve Forbes (Forbes (2005)) in his candidature for the 1996 presidential primaries. Hall and Rabushka also provide advisory services to countries interested in adopting flat tax, including several of the Eastern European countries[16].

Robert Eisner and Herbert Stein (Hall, Rabushka, Armey, and Stein (1996)), and Foster (2002) put forward some criticism by arguing that human capital should be treated like physical capital in the flat tax scheme; if not human capital investments will be less attractive. Contrary to this, Heckman, Lochner, and Taber (1998) find that in general equilibrium skill formation increases as the higher earnings associated with college graduation are no longer taxed away at higher rates. Slemrod (1997) sums up main benefits and objections of the flat tax, and also a stepwise deconstruction from the current US income tax into the Hall-

[16] Robert E. Hall [http://www.hoover.org/bios/hall.html]
Alvin Rabushka [http://www.hoover.org/bios/rabushka.html]

Rabushka flat tax. Robbins and Robbins (1996) provide a summary of the USA (Unlimited Savings Allowance) tax, proposed by Senators Sam Nunn and Pete Domenici; a national sales tax; and the Hall-Rabushka flat tax. Koenig and Huffman (1998) provide insights in the short and long run dynamics of a Hall-Rabushka flat tax reform. The Hall-Rabushka flat tax is also well reviewed in Clemens et al. (2001), Emes, Clemens, Basham, and Samida (2001), and Heath (2006).

Numerous other studies are supportive in terms of reducing tax progressivity and reduce the tax burden[17]. Slemrod (1990) argue that unless including the technology of collecting taxes optimal tax theory has little applicability. Innovative public economics are not always for the better. Mullen and Williams (1994) find that higher marginal tax rates are significantly associated with slower output growth, reducing growth rates by up to 25 percent. Based on a meta-regression analysis similar to the one applied in this paper, Phillips and Goss (1995) find that state and local government tax policy (US) has significant effects on economic development in that the tax elasticity range from -0.216 to -0.346. Aaberge, Dagsvik, and Strøm (1995) find that reducing income tax progressivity removes distortionary effects on labor. They suggest that moving further towards a flat tax scheme increases welfare and efficiency, and that the purely proportional tax scheme may move the economy close to its potential. Niskanen and Moore (1996), and Grecu (2004) provide statistics on US tax cuts and corresponding increase in tax revenue. Milesi-Ferretti and Roubini (1998) find that whereas consumption taxation only affects the choice between productive time and leisure time in favor of the latter and by that is growth reducing, taxation of factor income has additional distortionary effects, and is hence even more growth reducing. Carroll, Holtz-Eakin, and Rosen (1998), and Gentry and Hubbard (2000) find that increasing marginal tax rates reduces both the investment level of existing entrepreneurs as well as the number of entrepreneurs entering the market. This is also confirmed in the review by Keith Godin in Fraser Forum (February 2008). Aaberge, Colombino, and Strøm (2000) study labor supply responses and welfare effects for Italy, Norway and Sweden in flat tax scenarios. By applying

[17] Famous promoters of the flat tax are Adam Smith (1776), John Stuart Mill (1900), David Ricardo (1911), Friedrich A. Hayek (1960), and Milton Friedman (1962;1980). Currently the idea of flat tax and other market-liberal thoughts are promoted by epistemic communities (think-tanks) such as Adam Smith Institute (UK), Cato Institute (US), Center for Freedom and Prosperity (US), Civita (Norway), Fraser Institute (Canada), The Heritage Foundation (US), Hoover Institution (US), Institute for Policy Innovation (US), Ludwig von Mises Institute (US), and Reform (UK).

revenue neutral tax rates (1992 level) at 23, 25 and 29 percent, respectively, they find efficiency gains by shifting to a flat tax in all three countries.

4.6 Meta-Regression Analysis

4.6.1 Ordinary Least Square Regression Model

Multiple regression analysis is the prediction of the value of a dependent variable based on other independent variables. It is the most applied statistical technique, providing information on both whether there is a relationship between the variables and the form of these relationships. The ordinary least squares regression model is of the form

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon \tag{14}$$

where y is the dependent variable, x_1, x_2,..., x_k are the independent variables, β_0, β_1,..., β_k are the coefficients, and ε is the error variable. The standard error of estimate is

$$s_\varepsilon = \sqrt{\frac{SSE}{n-k-1}} \tag{15}$$

where $SSE = (n-1)\left(s_y^2 - \frac{(cov(x,y))^2}{s_x^2}\right)$ denotes sum of squares for error, n is the sample size, and k is the number of variables. The coefficient of determination is given by

$$R^2 = 1 - \frac{SSE}{\sum(y_i - \bar{y})^2} \tag{16}$$

and the coefficient of determination adjusted for degrees of freedom

$$R^2\ adjusted = 1 - \frac{SSE/(n-k-1)}{\sum(y_i - \bar{y})^2/(n-1)} \tag{17}$$

The validity of the model is tested by the hypotheses

H_0: $\beta_1 = \beta_2 = \cdots = \beta_k = 0$

H_1: At least one β_j is not equal to 0.

The null hypothesis' rejection region is $F > F_{\alpha,k,n-k-1}$ where α is the significance level. The F statistic for this test is given by

$$F = \frac{(\sum(y_i - \bar{y})^2 - SSE)/k}{SSE/(n-k-1)} \tag{18}$$

This implies that if the null hypothesis is true none of the moderator or parameter variables are linearly correlated with the dependent variable, and the model is invalid. If on the other hand at least one of the coefficients is not 0, the regression model is valid.

For the coefficients the hypotheses are

H_0: $\beta_i = 0$

H_1: $\beta_i \neq 0$

with the test statistic $T = \frac{b_i - \beta_i}{S_{b_i}}$ which is Student t distributed with ($\nu = n - k - 1$ degrees of freedom). The corresponding P-values denotes whether the null hypothesis is true (high P-value) or not.

The regression model may be used to estimate the expected value of the dependent variable. The confidence interval estimator of the expected value is then

$$\hat{y} \pm t_{\alpha/2,n-2} s_\varepsilon \sqrt{\frac{1}{n} + \frac{(x_g - \bar{x})^2}{(n-1)s_x^2}} \tag{18}$$

where x_g is the given value of x_j, holding $x_j \neq x_g$ constant.

4.6.2 Meta-Regression Analysis Framework

Meta-analysis is the evaluation of empirical studies using statistical analyses of methods and data sets used in the studies. Meta-regression analysis is a form of meta-analysis designed for analyzing econometric economic studies. Using control variables for properties like methodology, variable definition, sample characteristics, and more, it is possible to infer around the obtained results for different studies. Until now the analysis is used for econometric studies only. In the field of interest there are not many econometric studies, and too few to make a robust meta-regression analysis. There are however several calibration studies on the topic of tax reform, not directly comparable with econometric studies as these use a different empirical methodology. Meta-regression analysis of calibration studies is hence a different approach which is presented in section 6 of this paper. As calibration studies are more vulnerable than econometric studies for specification bias, the cross-study analysis is most viable.

The ordinary least square regression model is used to compare control variables – indicator variables for model structure, parameter variables for model parameterizations. The methodology for meta-analysis is based on Stanley (2001) which provides a step-by-step process for conducting an analysis. Card and Krueger (1995), Phillips and Goss (1995), Stanley (1998), Stanley and Jarrell (1998), Görg and Strobl (2001), and Jarrell and Stanley (2004) provides supplementary methodology in action. The meta-regression model is of the form

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j Z_{ij} + \varepsilon_i \qquad i = 1,2,\dots,n \tag{19}$$

where Y_i is the average reported estimate in article i, and Z_{ij} are meta-independent variables characterizing the calibration studies in the sample in order to explain the variation in Y_i s across the articles. β_j is the coefficient of the jth control variable as listed in Table 2, and ε_i is the error term. The articles are presented next.

5 LITERATURE REVIEW

5.1 Calibration Studies

As the literature search illustrate, substantial academic effort has been placed on the flat tax and tax reform subject. To fit a brief summary of these studies into the paper would have put a viable highlight on the differences and similarities for the theoretical approach towards the flat tax issue. I will however have to limit the number of articles reviewed, although numerous additional articles are referred to throughout the paper. For an extensive summary of the academic literature see e.g. Heath (2006) and Clemens et al. (2001).

Altig and Carlstrom (1991) study the interaction between inflation, taxation and macroeconomic performance in an overlapping-generations model as described by Auerbach and Kotlikoff[18]. They find that the distortionary effects from inflation and tax structure interactions are reduced by 0.2 to 1.1 percentage points if a flat marginal tax rate scheme is introduced in place of the 1965 progressive tax structure. Furthermore they found the distortions to origin in labor supply behavior.

Pecorino (1994) studies growth rate effects of US tax reforms based on the Lucas (1990) framework with an extended human capital production function. He finds that removing tax on physical capital earnings (from a 36 percent rate) will increase the wage tax rate from 40 to 45 percent and reduce annual per capita output growth rate by 0.13 percentage points. On the other hand, replacing the progressive 1985 income tax structure with a consumption tax will increase the per capita output growth rate by 1.06 percentage points annually. In this case the distortionary effects of taxation on both growth rate and labor-leisure decisions are reduced.

Jensen et al. (1994) study a tax reform where marginal tax rates are reduced and the tax base is broadened in a unionized labor market. They find that when wage formation is governed by union behavior and unions maximize the after-tax income of their members, the tax reform will be contractionary and welfare-reducing, yielding a long run loss of -4.1 percent in output and -1.3 percent in aggregate welfare. As other aggregate variables shows

[18] Auerbach, Alan and Laurence Kotlikoff (1987): Dynamic Fiscal Policy. Cambridge University Press. In this book the simulation framework is described in detail.

losses, a reform under these conditions is not feasible. On the other hand, when unions take into account the disutility of work of union members, long run output increases by 5.4 percent and aggregate welfare by 4.5 percent.

Stokey and Rebelo (1995) study the implications of preferences, technology and tax policies on potential effects of tax reform on the long run growth rate of the US economy. Modifying four studies they find that eliminating all taxes (which equals reducing tax progressivity to 1) will yield 0 - 0.33 percentage points increases in growth rate. The zero effect is found in their modified Lucas (1990) model (their labor elasticity function implies inelastic labor supply using Lucas' parameterization). They further find that share parameters, intertemporal substitution and labor supply elasticities, depreciation rates, and tax treatment of depreciation and human capital production have significant effect on estimating growth effects.

Ventura (1996) studies the implications of replacing the US income and capital income tax structure with the Hall-Rabushka flat tax. He finds that a revenue-neutral reform will have a flat marginal tax rate ranging from 18.5 to 30.7 percent depending on deduction levels and agents' relative risk aversion. Furthermore, eliminating double taxation on capital income has a significant impact on capital accumulation, resulting in output increases ranging from 12.98 to 17.88 percent. He also finds that aggregate welfare gains from introducing a flat tax range from 2.5 to 4.5 percent.

Jorgensen and Wilcoxen (1997a,b) study the impact of tax reforms on US economic growth; one flat rate consumption tax similar to the Hall-Rabushka flat tax, and one flat rate income-based value-added tax. They find that a revenue neutral flat consumption tax at 21.7 percent yields a 3.3 percent increase in long run output, whereas the income-based tax with a rate at 20.5 percent yields 1.4 percent higher long run output. They also suggest that reductions in compliance costs (USD 100-500 billion annually) would yield even higher gains, however this is not captured by the model.

Rogers (1997) studies the effects of six different US tax reforms; flat marginal tax rate income, consumption, and wage taxes, with and without exemption levels. She finds that the more neutral tax system will have substantial efficiency effects, increasing long run output

by 1.72 – 6.03 percent, depending on the responsiveness in intertemporal and labor-supply decisions.

Auerbach et al. (1997) study the macroeconomic effects of two tax reforms. They find that moving from the current US progressive income tax system to a flat income tax rate at 25 percent with fixed deductions at USD 10 000 and USD 5 000 for each dependent will reduce long run output by 3 percent. All other aggregate variables are also reduced; hence this reform is not feasible. On the other hand, moving to a flat tax rate at 22.4 percent on consumption with capital income exemptions will increase output by 7.5 percent.

Caucutt et al. (2000) study tax progressivity and economic growth. They find that reducing tax progressivity increases growth even when reducing flat marginal tax rates shows no effect. The effects of introducing flat rate taxes are significant, and aggregate welfare is unambiguously higher. Growth effects of eliminating tax progressivity amounts to 0.13 – 0.53 percentage points on growth rate, welfare effects amounts to 0.38 – 1.31 percent.

Altig et al. (2001) study the welfare and macroeconomic effects of transitions to five fundamental alternatives to the US federal income tax. They find significant long-run gains in output and aggregate welfare in all cases. The estimated long run increases in output are: proportional income tax, 4.9 percent; proportional consumption tax, 9.4 percent; flat tax, 4.5 percent, flat tax with transition relief, 1.9 percent; the X tax, 6.4 percent. Even in welfare increase in general, some groups will lose.

Cassou and Lansing (2003) study the growth effects of shifting from the US progressive tax system to a flat tax similar to the Hall-Rabushka version. They find that the growth gain by a flat marginal tax rate at 34.37 percent and a pre-reform deduction level is between 0.009 and 0.143 percentage points per capita depending on labor supply elasticity. Furthermore, if the pre-reform tax progressivity increases, the growth gains from introducing a flat tax will become even larger.

Li and Sarte (2004) study progressive taxation and long run growth using progressive taxes (as opposed to approximated flat rate taxes) in growth models for the US. They find that the decrease in tax progressivity from the tax reform introduced by Reagan (TRA-86) increased the growth rate of output per capita by 0.12 – 0.34 percentage points.

Conesa and Krueger (2005) study the optimal progressivity of the income tax code in the US with regards to the highest expected utility of individuals (maximum social welfare). They find that the optimal tax code will increase welfare by 1.7 percent and is equivalent with a flat marginal tax rate of 17.2 percent and a fixed deduction of USD 9 400, yielding and a shift in GDP per capita of 0.64 percent. They also find that in the case of a pure proportional tax the shift would amount to 8.86 per cent.

Carroll et al. (2006) study macroeconomic responses to three tax reforms presented by the President's Advisory Panel on Federal Tax Reform using three economic growth models. The panel recommended two reforms which are hybrids of an income and consumption based tax. These are found to yield increases in output from 0.2 to 4.8 percent. The last reform, a progressive consumption tax, was not recommended by the panel, however the growth effects of this was even higher, ranging from 1.9 to 6 percent. This is consistent with other research proposing that taxing consumption rather than income have less distortionary effects on the economy. They also conclude that there are additional gains of tax reforms not included in the models which are likely to yield even larger growth effects.

González-Torrabadella and Pijoan-Mas (2006) study a series of flat tax reforms for Spain. They find that output increases for reforms with flat marginal tax rates up to 28.19 percent and fixed deductions up to 0.40 percent of benchmark average income. Gains in output range from 12.6 percent in the strictly proportional case to 0.6 percent in the most progressive case. Increasing tax progressivity more will yield losses in all aggregate variables and is hence not feasible. Regarding welfare of the flat tax reforms they find that a marginal tax rate at 23.11 percent combined with a fixed deduction of 30 percent of per capita income will reduce the tax payables for the 60 percent with lowest incomes, and still yield a 5.1 percent increase in output.

Díaz-Giménez and Pijoan-Mas (2006) study consequences of two revenue-neutral flat tax reforms in the US. In the lower progressivity case the flat marginal tax rate is 22 percent, fixed deduction is USD 16 000, output increase by 2.4 percent and productivity by 3.2 percent, and a welfare loss at -0.17 percent. On the other hand, in the higher progressivity case the flat marginal tax rate is 29 percent, fixed deduction is USD 32 000, output decrease by -2.6 percent and productivity by -1.4 percent, and a welfare gain at 0.45 percent. The

contractionary results make this reform less feasible. Finally they conclude that flat taxes are better for the poor than progressive tax regimes.

Office of Tax Analysis, US Department of the Treasury (2006) studies the economic effects of extending marginal tax reductions enacted in 2001 and 2003, set to expire ultimo 2010. They find that a continuation will have a significant effect on US long run economic growth. However, how the tax reduction is financed is of great importance – using future tax increases instead of reduced government spending may yield lower increase in output, 0.3 percent comparing to 1.1 percent, and is strongly dissuaded.

Elger and Lindqvist (2007) study the effects of a flat tax reform in Sweden. They find that a strictly proportional tax scheme with marginal tax rate at 31.95 percent increases long run output by 7.65 percent. Increasing the marginal rate and introducing deductions up to 20 percent of benchmark income level will still yield gain in output by 0.69 percent, whereas a flat tax rate at 42.89 percent with 30 percent deduction on labor income reduces output by 3.99 percent. The latter case yields losses in all aggregate variables and is hence not feasible. Aggregate welfare increases in all cases except for the most progressive scheme.

5.2 Econometric Studies

A useful assessment of the calibration results is to make a comparison with econometric findings. A number of articles on flat tax are left out of the meta-regression analysis due to their econometric methodology. These provide a useful benchmark in validating the growth effects on output. Some articles are presented here, others are referred to throughout the paper.

Vedder (1985) studies the relationship between tax rates, tax structure and growth. Using panel data for the period 1963 – 1983 he finds that economic growth is positively associated with the flatness of the income tax, reducing tax progressivity leads to an increase in long run output per capita by 0.85 – 1.28 percent.

Koester and Kormendi (1987) study the impact of tax structure on growth rate and level of economic activity. They use panel data for 63 countries for the period 1970 – 1979. Findings are that revenue neutral reduction of marginal tax rates by 10 percent in developed countries yield 6.1 percent increase in per capita income (an upward shift in the growth path). They find no significant negative relation between tax rates and economic growth, however high marginal tax rates will shift factor utilization from labor to capital.

Colombino and del Boca (1990) study labor supply and income distribution in Italy. Using 1979 cross-section data they find that a linear tax reduces the dead-weight loss of the tax system by 43.75 percent[19], but increases inequality.

Padovano and Galli (2001) study the relationship between effective marginal income tax rates and economic growth. They use panel data for 23 OECD countries covering the period 1951 – 1990. They find that effective marginal income tax rates are negatively correlated with economic growth, contradictory to most econometric literature which use average measures. The effect is estimated to 0 – 1.2 percentage points on growth rate.

Lee and Gordon (2005) study the tax structure and economic growth in 70 countries. Using cross-section and panel data from 1970 – 1997 they find that statutory corporate tax rates are significantly negatively correlated with economic growth, whereas personal tax rates are less clear. They estimate that a 10 percentage point reduction in corporate tax rates will increase annual growth rate per capita by 1.1 – 1.8 percentage points.

The econometric estimates appear to fit well into the range of the calibration study estimates. This is a confirmation both on the validity of the calibration models and the estimated associations between tax level, tax structure and economic growth.

[19] This equals a 3.56 percent output growth (calculation based on 1979 GDP (national currency, constant prices, OECD base year) from OECD.Stat and 1979 total population from World Bank World Development Indicators).

6 META-REGRESSION ANALYSIS

6.1 Sample Description and Modification

For the calibration studies I follow the lead in Phillips and Goss (1995) and choose a set of moderator variables as shown in table 2. These are binary indicator variables (dummies) describing the characteristics of each study regarding measure, data source, and model structure. The meta-regression further includes the study parameterizations which Stokey and Rebelo (1995) find to be significant correlated with output estimations. As all but one article (González-Torrabadella and Pijoan-Mas (2006)) treat labor supply elasticity as endogenous this parameter is not included. Tax treatment of human capital is assumed being well covered by the dependent variable. A total of 20 control variables (k) are analyzed.

In some cases the flat tax is in fact slightly progressive due to basic deductions (e.g. the Hall-Rabushka flat tax), i.e. tax progressivity is larger than 1. In other cases the tax reform studied is not aiming for a flat tax, it only implies a change in the progressivity of the tax structure. For both of these I adjust for tax progressivity in the reform scenario when estimating tax elasticities, assuming the change in output comprises the full potential of tax progressivity change.

The estimated effect on output relative to change in tax progressivity is shown in the dependent variable *AVG_ELASTICITY*. For all articles included in the meta-regression there is a negative correlation between change in tax progressivity and change in output, hence stronger effect is indicated by increasing negative elasticity. The articles are in the regression sorted by calibration benchmark year to be able to take into account differences in model calibrations as the modeled economies change. The descriptive statistics are shown in table 8 and figure 12 (appendix I).

Table 1: Calibration Studies Included in the Meta-Regression Analysis

Author(s)	Year	Measure	Elasticity estimate
Altig and Carlstrom (1991)	1955 - 1988	Inflation effects in different tax regimes	-0.001 - -0.007
Altig, Auerbach, Kotlikoff, Smetters, and Walliser (2001)	1996	Output	-0.076 - -0.174
Auerbach, Kotlikoff, Smetters, and Walliser (1997)	1995	Effects of tax reform	-0.375
Carroll, Diamond, Johnson, and Mackie (2006)	2005	Macroeconomic responses to tax reform using three economic growth models - Solow and Ramsey growth models	-0.040 - -0.436
Carroll, Diamond, Johnson, and Mackie (2006)	2005	Macroeconomic responses to tax reform using three economic growth models - overlapping generations life-cycle model	-0.180 - -0.200
Cassou and Lansing (2003)	1994	Growth effects from adopting Hall-Rabushka flat tax	-0 - -0.005
Caucutt, Imrohoroglu, and Kumar (2000)	1990-1996	Growth and welfare effects of eliminating tax progressivity	-0.003 - -0.005
Conesa and Krueger (2005)	2004	Optimal progressivity of income tax	-0.038
Díaz-Giménez and Pijoan-Mas (2006)	1997	Consequences of revenue-neutral flat tax reforms similar to Hall-Rabushka	-0.171
Elger and Lindqvist (2007)	2005	Effects of flat tax reform in Sweden	-0.010 - -0.059
González-Torrabadella and Pijoan-Mas (2006)	1999	Effects of tax reforms in Spain	-0.011 - -0.137
Jensen, Nielsen, Pedersen, and Sorensen (1994)	1990	Effects from labour tax reform in unionized labor market in Denmark	-0.049
Jorgensen and Wilcoxen (1997a)	1998	The impact of tax reform on economic growth	-0.034 - -0.080
Li and Sarte (2004)	1985 / 1991	Growth effects of the decline in tax progressivity produced by TRA-86	-0.022 - -0.062
Office of Tax Analysis, US Department of the Treasury (2006)	2006	Economic effects of extending marginal tax reductions	-0.367
Pecorino (1994)	1985	Growth rate effects of tax reforms	-0.014 - -0.033
Rogers (1997)	1993	Effects of tax reform	-0.032 - -0.670
Stokey and Rebelo (1995)	1950 - 1985	Growth effects of flat-rate taxes	0 - -0.074
Ventura (1996)	1994	General equilibrium implications of a revenue neutral tax reform as proposed by Hall-Rabushka	-0.416 - -0.590

Table 2: Control Variables

Moderator Variables
CH_GROWTH = 1 if summary statistic is change in growth , = 0 if change in growth rate
CH_PERCENT = 1 if summary statistic is change in percent, = 0 if change in percentage points
CH_PER_CAPITA = 1 if summary statistic is change per capita, = 0 otherwise
COUNTRY = 1 if study uses US data only, = 0 otherwise
HETERO = 1 if study uses heterogeneous agents, = 0 otherwise
PROP_TAX = 1 if study targets a strictly proportional tax structure, = 0 otherwise
FLAT_TAX = 1 if study targets a proportional tax structure with basic deductions, = 0 otherwise
OVERLAP_GEN = 1 if study uses an overlapping generations model, = 0 otherwise
PRODUCTIVITY = 1 if study uses a productivity variable
SKILL = 1 if study measure skilled/unskilled ratios, = 0 otherwise
SOCIAL_SECURITY = 1 if study includes social security structure, = 0 otherwise
POP_GROWTH = 1 if study allows for population growth, = 0 otherwise
GOV_EXP = 1 if study includes government expenditure, = 0 otherwise
INHERIT = 1 if study allows for inheritance between generations, = 0 otherwise
RETIRE = 1 if study allows for retirement of labor, = 0 otherwise
OPEN_ECON = 1 if study uses an open-economy model, = 0 otherwise
Parameter Variables
CAP_SHARE = Physical capital share
CAP_DEP = Depreciation rate of physical capital
TIME_DISC = Intergenerational discount factor
INT_SUBST = Elasticity of intertemporal substitution

Before conducting a regression analysis it is however necessary to deal with the issue of (n < k). As the number of moderator and parameter variables is larger than the number of articles some variables is omitted upon regression. The structure of the data in terms of correlation is shown in table 9 (appendix I). The Pearson correlation show that the number of variables being significantly correlated is relatively high, indicating a multicollinearity problem. There are 34 instances where moderator variables are significantly correlated; of which 8 at the 1 percent level, 14 at the 5 percent level, and 12 at the 10 percent level. Summarized, only 1 parameter variable is not significantly correlated with the other variables. Regression (1) on moderator variables (see table 10 in appendix II) illustrates the multicollinearity issue, where adjusted R-squared is 0, and the variance inflation factors range from 3.3 to 23.5.

6.2 Meta-Regression Analysis

To manage these issues a backward stepwise regression is performed to exclude redundant moderator variables until a satisfactory model fit is reached. The backward stepwise regression takes the following path: First the moderator variables having most weighted instances of significant correlation is removed from the regression model, assuming the statistical properties of these are covered by correlated variables remaining. More weight is put on correlation at the 1 percent level than at the 10 percent level. Second, the parameter variables are initially biased towards the mean by replacing missing values by mean values. Each parameter variable contains from 2 to 8 missing values for different articles, which would result in 12 eliminated studies if not using the mean value or omitting the variables. The estimation bias is then controlled for in 18 regressions with different setups, where the preliminary model parameter variable coefficients are compared with parameter variable coefficients estimated under altering conditions. Finally, the least significant moderator variables are iteratively omitted until a satisfactory model fit is reached.

Note that none of the moderator variables directly attached to measure (i.e. whether the change in output is measured at level or growth rate, in percent or percentage points, overall or per capita) will be omitted, even though both *CH_GROWTH* and *CH_PER_CAPITA* are significantly correlated with *CH_PERCENT*. Doing so would bias the regression model since these variables are crucial determinants of the measure, and as a result there is a probability of inferring other moderator variables to have too much or too little effect. This argument is verified in the following contradiction: The correlation between *AVG_ELASTICITY* and the three variables is significant at the 10 percent level for *CH_GROWTH* and *CH_PER_CAPITA*, and at the 5 percent level (close to the 1 percent level) for *CH_PERCENT*. Regression (2) shows on the other hand that none of the three variables have significant explanatory effect on *AVG_ELASTICITY* (see table 11 in appendix II). Furthermore, the variance inflation factors range from 1.3 to 2.7, which indicate a moderate correlation. These contradictory results verify the aforementioned multicollinearity.

The following moderator variables are the most correlated with other moderator variables (count of instances at the 1 percent level; the 5 percent level ; the 10 percent level): *CH_PERCENT* (3, 4, 1 - not omitted), *FLAT_TAX* (2, 6, 0), *SOCIAL_SECURITY* (2, 4, 2),*INHERIT*

(2, 2, 3), and *RETIRE* (3, 0, 3). They all have at least 2 instances of correlation at the 1 percent level, see table 10 in appendix I. The initial regression model (3) is hence

$$\begin{aligned} AVG\_ELASTICITY_i &= \beta_0 + \beta_1 CH\_GROWTH_i + \beta_2 CH\_PERCENT_i + \beta_3 CH\_PER\_CAPITA_i \\ &+ \beta_4 COUNTRY_i + \beta_5 HETERO_i + \beta_6 PROP\_TAX_i + \beta_7 OVERLAP\_GEN_i \\ &+ \beta_8 PRODUCTIVITY_i + \beta_9 SKILL_i + \beta_{10} POP\_GROWTH_i + \beta_{11} GOV\_EXP_i \\ &+ \beta_{12} OPEN\_ECON_i + \beta_{13} CAP\_SHARE_i + \beta_{14} CAP\_DEP_i + \beta_{15} TIME\_DISC_i \\ &+ \beta_{16} INT\_SUBST_i + \varepsilon_i \end{aligned} \tag{20}$$

where $AVG\_ELASITICTY_i$ is the estimated average tax elasticity of article i, $\beta_j x$ is the coefficient of the jth moderator or parameter variable as listed in table 2, and ε_i is the error term.

The initial regression model fits the data extremely well. There are however two indications of that there is a high degree of multicollinearity still being present. First, from the Pearson correlation test (table 9) 9 moderator and parameter variables are significantly correlated with the dependent variable at either the 1, the 5 or the 10 percent level, which contradicts the regression model. In addition 3 instances have correlation close to but above the 10 percent level. This test also shows that both *CH_GROWTH* and *CH_PER_CAPITA* are significantly correlated with *CH_PERCENT* at the 1 and the 5 percent level. Second, the variance inflation factors are still rather high, ranging from 3.6 to 22.2.

In addition there might be a problem that the number of independent variables is almost equal to the sample size (16 and 19, respectively), even after removing the most correlated variables. Additionally omitting the variables *PRODUCTIVITY* and *HETERO* solves both this and the multicollinearity issues to a large extent. The final meta-regression model is of the form

$$\begin{aligned} AVG\_ELASTICITY_i &= \beta_0 + \beta_1 CH\_GROWTH_i + \beta_2 CH\_PERCENT_i + \beta_3 CH\_PER\_CAPITA_i \\ &+ \beta_4 COUNTRY_i + \beta_5 PROP\_TAX_i + \beta_6 OVERLAP\_GEN_i + \beta_7 SKILL_i \\ &+ \beta_8 POP\_GROWTH_i + \beta_9 GOV\_EXP_i + \beta_{10} OPEN\_ECON_i \\ &+ \beta_{11} CAP\_SHARE_i + \beta_{12} CAP\_DEP_i + \beta_{13} TIME\_DISC_i + \beta_{14} INT\_SUBST_i \\ &+ \varepsilon_i \end{aligned} \tag{21}$$

The variance inflation factors are now in the range from 2.6 to 10.7, still indicating a degree of multicollinearity yet much more moderate than in the initial model. All variables are now significant, and the explanatory factor is still high. The model fit may however, as previously mentioned, be biased due to the use of means for missing values. To control for estimation bias each parameter variable is controlled in a total of 12 regressions. Missing values is used first to avoid bias, then maximum and minimum values are used to control for extremes. Subjecting the final regression model to altering parameter variables the results in table 14 and figure 13 (appendix III) show that the estimated coefficients for *CAP_SHARE*, *TIME_DISC* and *INT_SUBST* holds relatively well. For *CAP_DEP* the testing shows high volatility in coefficient estimates. As the variable only has 11 observations this is reasonable. The bias towards the mean for all parameter variables must however be accounted for when drawing any conclusions. The results of the meta-regression analysis are shown in table 3.

Table 3: Results of Meta-Regression

Dependent: Y_i				
			Regression	
Variable	(1)	(2)	(3)	(4)
Intercept (β_0)	0.099	-0.057	-1.090	-1.215
	(0.29)	(-0.70)	(-5.97)**	(-6.74)***
CH_GROWTH	0.259	0.023	0.286	0.310
	(0.59)	(0.20)	(7.23)**	(6.97)***
CH_PERCENT	-0.073	-0.169	0.185	0.111
	(-0.18)	(-1.51)	(3.42)*	(2.49)*
CH_PER_CAPITA	0.335	0.061	0.134	0.112
	(1.20)	(0.69)	(4.76)**	(3.51)**
COUNTRY	-0.163		0.350	0.266
	(-0.75)		(4.74)**	(4.21)**
HETERO	0.126		-0.053	
	(0.46)		(-2.02)	
PROP_TAX	-0.132		0.091	0.105
	(-0.69)		(4.04)*	(4.42)**
FLAT_TAX	-0.373			
	(-1.16)			
OVERLAP_GEN	-0.097		0.137	0.082
	(-0.38)		(3.67)*	(2.71)*
PRODUCTIVITY	0.046		0.009	
	(0.33)		(0.36)	
SKILL	0.134		0.245	0.240
	(0.59)		(9.12)**	(7.55)***
SOCIAL_SECURITY	-0.020			

	(-0.07)			
POP_GROWTH	-0.019		-0.171	-0.145
	(-0.12)		(-6.63)**	(-5.80)***
GOV_EXP	-0.170		-0.394	-0.341
	(-0.72)		(-7.76)**	(-6.73)***
INHERIT	0.205			
	(1.01)			
RETIRE	-0.018			
	(-0.06)			
OPEN_ECON	-0.102		0.174	0.138
	(-0.49)		(5.53)**	(4.37)**
CAP_SHARE			-2.430	-2.230
			(-8.46)**	(-6.81)***
CAP_DEP_PH			-4.563	-6.224
			(-2.78)	(-3.60)**
TIME_DISC			1.012	1.287
			(4.63)**	(6.15)***
INT_SUBST			0.787	0.712
			(8.18)**	(7.35)***
R-Square (percent)	87.1	33.1	99.7	99.1
F-statistic	0.85	2.48	42.76**	32.06***

Coefficients (T-statistic in parentheses)
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively

6.3 Model Testing and Interpretation

Comparing the standard error of residual from the analysis of variance with the mean of *AVG_ELASTICITY* it appears that the standard error of estimate is relatively large (S = 0.031 versus μ = -0.141). On the other hand both unadjusted and adjusted coefficients of determination are high, indicating a good model fit. An F-test will show whether the null hypothesis may be rejected, implying the regression model be valid. At the 5 percent level the rejection region is $F > F_{0.05,14,4} \approx 5.86$. As the analysis of variance shows that $F = 32.06$ with a corresponding P-value of 0.002, there is strong evidence to infer that the model is valid. The multicollinearity is however still present. The residual plots show that the required conditions are met to a reasonable extent; the residuals are approximately normal distributed with constant variance, and yet they seem somewhat autocorrelated there is inconsistency in the plot order. Another test for autocorrelation is the Durbin-Watson test.

The critical values for $d_{0.05,19,14}$ are $d_L = 0.070$ and $d_U = 3.642$ (see table 3 in Savin and White (1977)). Testing the Durbin-Watson statistic (1.586) against these for positive and negative autocorrelation and the combination of these, the test is inconclusive. A Pearson test shows no evidence of correlation between average benchmark year and *AVG_ELASTICITY*. Summarized the statistics show that the model's fit is good.

It is worth mentioning that the final regression model's statistics show slightly less fit than the initial model, even though the variance inflation factor is reduced by more than half. This indicates that the final model is more robust against interdependence between variables without losing explanatory value.

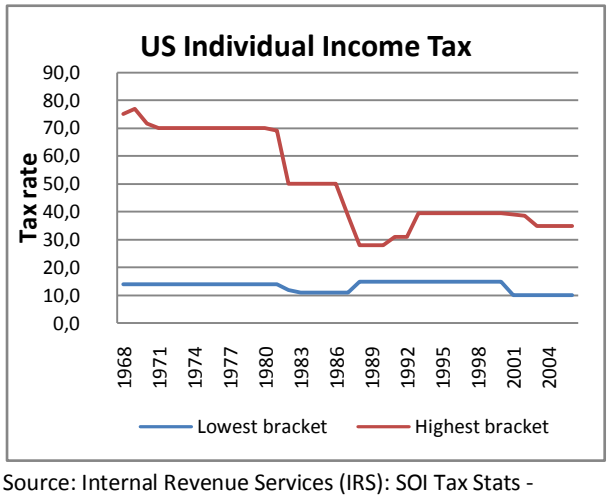
For the coefficients the corresponding P-values denotes whether the null hypothesis is true (high P-value) or not. The latter case is denoted in the regression tables with the significance level of the T-statistic. At the 10 percent level all variables are significantly different from 0.

The intercept is -1.215 and represents the predicted tax elasticity when all moderator and parameter variables are 0. The size and negativity of the intercept is not to be strictly interpreted, however it fits well with the direction given by the articles studied. The measure moderator variable coefficients are as one should expect but for *CH_PERCENT* and *COUNTRY*. The decreasing effect of using percent as opposed to percentage points is surprising, as the data clearly shows that the elasticities estimated for articles using percentage points are overall much lower than for the articles using percent. The coefficient may however be biased due to multicollinearity as its variance inflation factor is 8.7. Using US data will reduce the predicted elasticity by 0.266, however due to the low number of non-US studies in the regression this is not robust. If the overlapping generations model was utilized the predicted tax elasticity is reduced by 0.082. When the study includes population growth and government expenditure, the predicted tax elasticity increases by -0.145 and -0.349, whereas differences in skills and modeling an open economy reduce the elasticity by 0.240 and 0.138.Not to draw any conclusions for the variables, this illustrates that more complex economic models do not necessarily alter the conclusions. The effects gained through some of the elements included may be eliminated by the losses from other elements. For the parameters the regression predicts that studies using high physical capital share and capital depreciation rate, and low intergenerational discount factor and elasticity

of intertemporal substitution, will estimate high tax elasticities. The preliminary model also indicates that including heterogenous agents will yield higher elasticities, whereas a productivity variable will have modest effects.

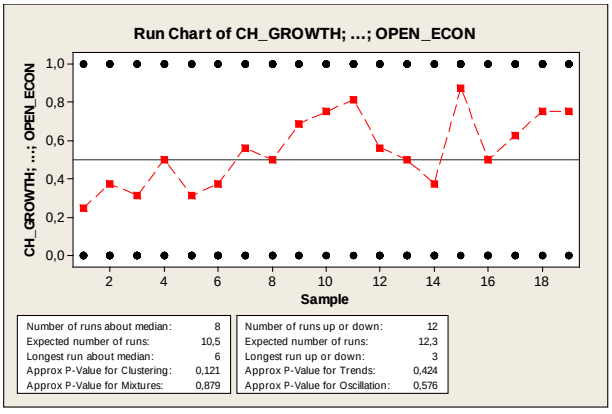
The consistently good fit of the meta-regression analyses illustrates that calibration model specification and parameterization has significant effect on outcome. For the articles studies this imply that depending on the model structure and consequently parameterization the growth effects from reducing tax progressivity range from 0 percent (Stokey and Rebelo (1995)) to 17.88 percent (Ventura (1996)). The benchmark data set has less importance in terms of time. As tax policies in fact evolve over time in terms of tax progressivity, this indicates a model specification problem. See figure 6 for an illustration of tax progressivity in the US for the period covered by the articles. Intuitively, the effects of introducing a flat tax should be declining until 1988, increasing 1988 – 1993, and then stable until 2006, except for the lag between 2000 and 2002. For the articles studied no such conclusions can be drawn. Comparing with the run chart in figure 7 there is a trend in broadening of model specification. This suggests that the earlier studies were more strict and static than the later-coming, ignoring important effects of reducing tax progressivity.

Figure 6: US Individual Income Tax 1968 - 2006



Source: Internal Revenue Services (IRS): SOI Tax Stats - Historical Table 23: U.S. Individual Income Tax: Personal Exemptions and Lowest and Highest Bracket Tax Rates, and Tax Base for Regular Tax (1913 - 2006) [http://www.irs.gov/taxstats/article/0,,id=175910,00.html] (Accessed 09.11.2008)

Figure 7: Run Chart of Moderator Variables, US articles



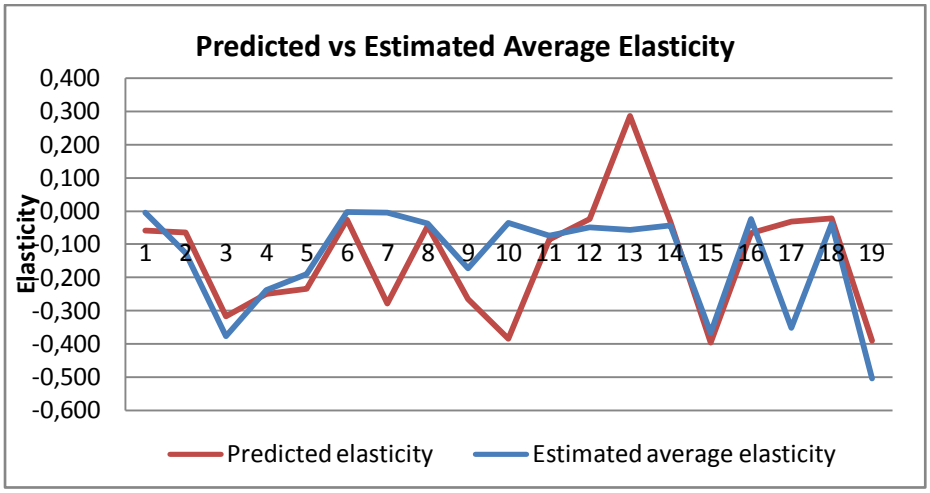
The model specification and parameterization bias may be reduced using the sufficient statistics methodology as put forward by Chetty (2008) as a way of bridging structural and reduced-form methodologies. As already mentioned, more complex models do not necessarily yield any differences in outcome. The notion of constructing models which are transparent and credible and at the same time are useful for aggregate predictions is intriguing. Also the use of econometric derived sufficient statistics for calibration models will improve the prediction quality.

The meta-regression analysis is concluded by a control of whether the final regression model yields a range similar to the growth effects from reducing tax progressivity in the calibration and econometric studies. The average elasticity for each study is estimated using equation (21). Means are used for missing values. Figure 8 shows that there is reasonable fit between predicted and estimated average elasticities. The predicted mean elasticity is -0.141 with boundaries -0.220 and -0.063 (95 percent confidence interval). This equals the mean of estimated average elasticity, but the boundaries are slightly wider (upper bound of estimated average is -0.211, lower bound is -0.072). Equation (4) is then reduced to

$$\Delta\gamma = -\Delta\Theta Y_i \tag{22}$$

in order to derive efficiency gains from elasticities and changes in tax progressivity. The mean reduction in tax progressivity in the articles used in the meta-regression is 0.48. This implies that the average increase in long run growth is 6.75 percent for the articles analyzed, with upper and lower boundaries at 10.06 and 3.44 percent, respectively. The prediction is equivalent with the average of the range of study estimates, with boundaries at 10.51 and 2.99 percent.

Figure 8: Predicted Elasticities versus Estimated Average Elasticities



Source: Author's own calculations.

7 INTRODUCTION OF FLAT TAX IN THE OECD COUNTRIES

The marginal income tax rates in 2007 and the corresponding tax progressivity for the OECD countries are listed in Table 5. The personal allowance implies as before a lower marginal tax rate of zero. The total tax burden for persons is shown in figure 5, further comprising business taxes, value added taxes, and duties; including these would drive up the effective marginal tax rates extensively. E.g. according to the OECD Economic Survey of Sweden in 2007, combining "social contributions, income and consumption taxes drives the effective marginal tax rate above 70% for over a third of the full-time employed, helping to explain why working hours for those employed are below the OECD average"[20]. For comparison the top marginal income tax rate is 56.5 percent according to the OECD Tax Database. As the effective marginal tax rates are not readily observable (Padovano and Galli (2001)) these are not included in this analysis.

[20] OECD Policy Brief: Economic Survey of Sweden, 2007 [http://www.oecd.org/dataoecd/25/53/38081720.pdf] Accessed 29.11.2008

Table 4: Taxation of Wage Income in the OECD Countries (2007)

Country	Personal allowance / Tax credit*	Marginal rate*	Top marginal rates (all-in)**	Tax progressivity
Australia		0.0 %	46.5 %	1.87
Austria		0.0 %	42.7 %	1.75
Belgium	6,040	25.0 %	59.3 %	2.46
Canada	1,440	15.0 %	46.4 %	1.87
Czech Republic	7,200	12.0 %	40.5 %	1.68
Denmark	39,500	5.5 %	63.0 %	2.70
Finland		0.0 %	56.1 %	2.28
France		0.0 %	49.8 %	1.99
Germany		0.0 %	47.5 %	1.90
Greece	12,000	29.0 %	49.6 %	1.98
Hungary		18.0 %	71.0 %	2.83
Iceland***	385,800	22.8 %	34.3 %	1.52
Ireland	1,760	20.0 %	47.0 %	1.89
Italy	18,400	23.0 %	50.7 %	2.03
Japan	3,800,000	5.0 %	47.8 %	1.92
Korea	1,000,000	8.0 %	38.3 %	1.62
Luxembourg		0.0 %	48.3 %	1.93
Mexico	7,083.84	3.0 %	22.6 %	1.29
Netherlands	2,043	2.5 %	52.0 %	2.08
New Zealand		15.0 %	39.0 %	1.39
Norway	100,800	12.6 %	47.8 %	1.92
Poland	572.54	19.0 %	42.7 %	1.74
Portugal	221.65	10.5 %	48.4 %	1.94
Slovak Republic***	95,616	19.0 %	27.8 %	1.39
Spain	5,050	15.7 %	43.0 %	1.75
Sweden	11,900	0.0 %	56.5 %	2.30
Switzerland		0.0 %	47.9 %	1.92
Turkey		15.0 %	35.6 %	1.32
United Kingdom	5,225	10.0 %	41.0 %	1.69
United States	8,750	10.0 %	42.7 %	1.75

Source: OECD Tax Database, Taxation of Wage Income Part I (2007)
*) Table I.5. Central government personal income tax rates and thresholds. Personal allowance/ tax credit in local currency.
**) Table I.4. Top marginal personal income tax rates for employee
***) Flat tax scheme

Bottom marginal tax rates are zero for all countries[21] except Hungary and New Zealand. Note that non-tax revenues – such as court fees, driving license fees, harbor fees, passport fees, and radio and television license fees where public authorities provide the service – are not included in the figures.

[21] Zero tax rate, or equivalent deduction, according to OECD.Stat National Accounts.

7.1 Effects of Flat Tax Reforms on Economic Growth in the OECD Countries

All articles used in the meta-regression analysis in section 6 are related to an OECD country. Also the econometric articles reviewed concern one or more (all) OECD countries. Comparing the results from the final regression model with estimations for the OECD countries will hence yield relevant estimates, if not directly transposable. The estimations are based on the relation between tax elasticity, tax progressivity, and economic growth which the meta-regression analysis find robust. As most of these studies consider long run growth effects this is also the emphasis in the following. The studies yielding efficiency gain as increase in growth rate are however consistent with the remaining and the effects on economic growth will be even larger if using this approach in a long-run analysis.

The estimations on economic growth could for simplicity be based on the assumption that all OECD countries have similar average tax elasticity. When considering the wide range of tax burden in the OECD countries as shown in figure 1 this is however a too restrictive measure which would yield overestimated growth effects. On the contrary the tax burden might be partially interpreted as the realization of tax elasticity – higher tax elasticity will yield downward pressure on governments' fiscal policies, and lower tax burden; whereas lower tax elasticities implies less restraint on the government from the society. This relation may also be interpreted by a Laffer curve (Blinder (1981), Mankiw (1998), Laffer (2004), Miles and Scott (2005)). The inverse U-shaped curve illustrates that increasing tax rates up to a certain point yields increased government revenue; beyond this tax revenue will decrease due to disincentive effects, i.e. reduced input and increased effort in tax avoidance. Tax elasticity defines the curve's path (steepness and maximum), effective marginal tax rates define the current position at the curve, the sum being tax burden. Modeling and measuring this relationship is outside the scope of this paper, hence the more simple linear relationship between tax burden and tax elasticity is assumed[22]. Still, increased tax revenue may be expected, as a simplified and less intrusive tax scheme provides less incentive for evasion and avoidance (Hall and Rabushka (1995)). Schneider (2005) estimates the average shadow economy for 21 OECD countries to 16.3 percent.

[22] Trabandt and Uhlig (2007) find that EU-15 is moving closer to peak of Laffer curve, yet is still at the left side of the curve. The US is also at the left side of the curve. Hence the approximation seems viable for most OECD countries.

Although the three non-US articles show elasticities well below the mean of the US articles (-0.158), they are within the similar range (-0.503 – -0.003). A regression using the mean elasticity for the US, the elasticities for Sweden, Spain and Denmark, and the respective tax burdens in figure 1 indicates however that using the tax burden as proxy for tax elasticities is a reasonable approximation, see table 15 in appendix IV. This is also confirmed by a Pearson correlation test showing a correlation of 0.941 with a corresponding P-value of 0.059. The results are shown in table 5. Comparing the elasticity estimations using the regression equation for the US, Spain, Sweden and Denmark with the estimated average elasticities shows only small deviations.

Table 5: Approximated Tax Elasticities for the OECD Countries

Country	Tax versus GDP Ratio	Estimated elasticity	Approximated elasticity
Australia	30,60		-0,130
Austria	41,74		-0,074
Belgium	44,52		-0,060
Canada	33,33		-0,116
Czech Republic	36,92		-0,098
Denmark	49,14	-0,049	-0,037
Finland	43,47		-0,065
France	44,17		-0,062
Germany	35,58		-0,105
Greece	31,32		-0,126
Hungary	37,08		-0,097
Iceland	41,52		-0,075
Ireland	31,88		-0,123
Italy	42,15		-0,072
Japan	27,90		-0,143
Korea	26,77		-0,149
Luxembourg	35,90		-0,103
Mexico	20,57		-0,180
Netherlands	39,32		-0,086
New Zealand	36,71		-0,099
Norway	43,94		-0,063
Poland	33,51		-0,115
Portugal	35,70		-0,104
Slovak Republic	29,77		-0,134
Spain	36,64	-0,074	-0,099
Sweden	49,08	-0,035	-0,037
Switzerland	29,61		-0,135
Turkey	24,52		-0,160
United Kingdom	37,12		-0,097
United States	28,00	-0,158	-0,143
OECD - Total	35,95		-0,103

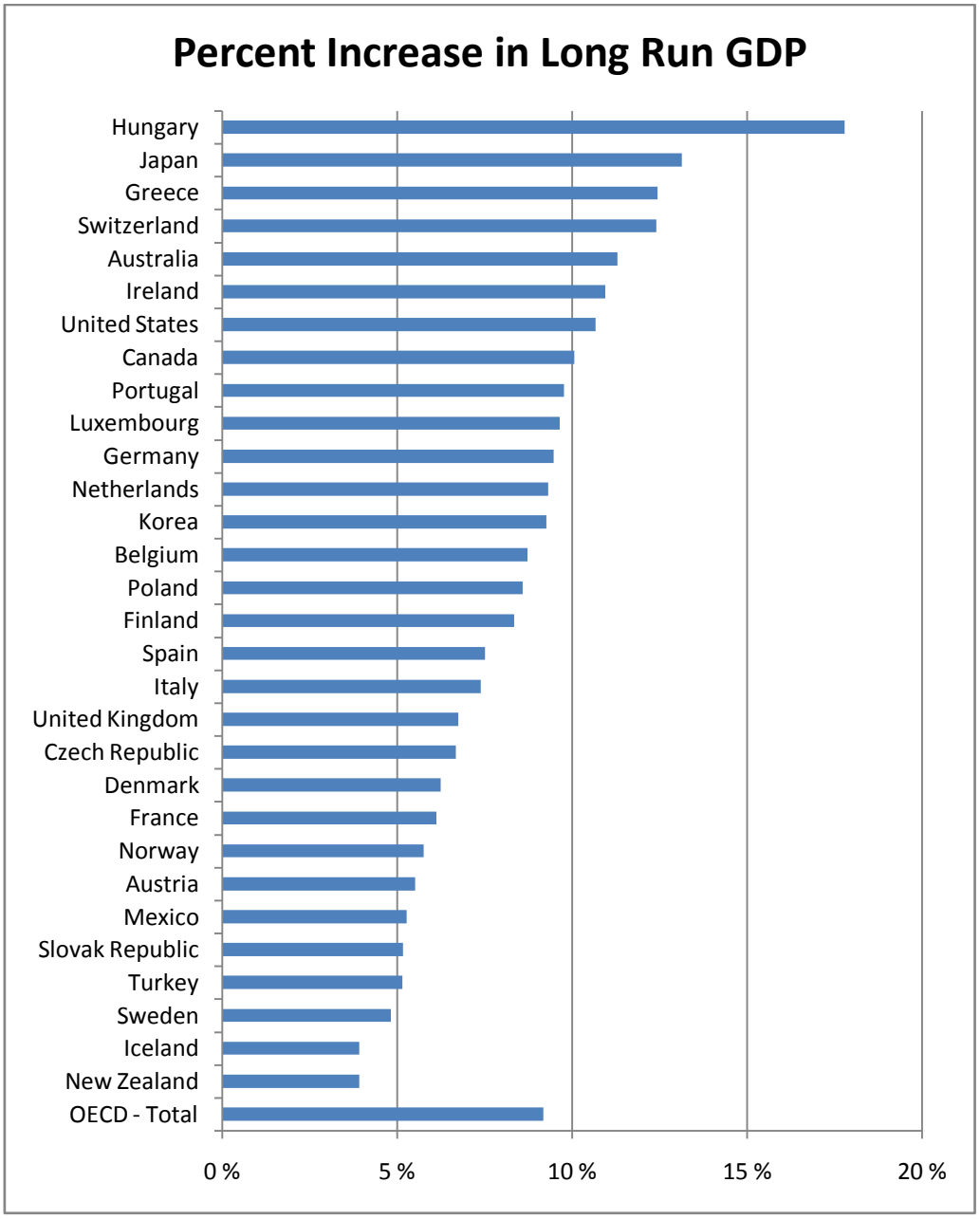
Source: Tax versus GDP ratio is from OECD Centre for Tax Policy and Administration, Revenue Statistics 1965-2007, 2008 Edition, table 1. [http://www.oecd.org/ctp/revenuestats]. Elasticities are based on author's own calculations.

The changes in tax progressivity are assumed to yield 1, i.e. a pure flat tax with no deductions. This extreme scenario is chosen to show the inherent potential of proportional taxes, although the Hall-Rabushka flat tax and most other suggested and implemented flat tax schemes also include fixed deductions which imply progressivity in the tax scheme. Using the purely flat tax also avoid entering an extensive analysis of tax rates and deduction levels, which are likely to be different for each country in that the current tax levels differ substantially (see table 4).

Comparing the estimated average elasticity and tax progressivity reduction shows that for the articles studied, change in tax progressivity has a larger share of the efficiency gain than do change in tax rate. This is a supporting evidence for the flat tax scheme in that progressive tax structures have more adverse effects on output than do high tax rates. As most studies concern the US, which has relatively low tax progressivity among the OECD countries, the overall increase is expected to be somewhat larger.

Tax progressivity for each OECD country is from table 4. The reductions in tax progressivity range from 0.29 to 2.45. By utilizing equation (22) the efficiency gains for the OECD countries are estimated based on the approximated tax elasticities and tax progressivity calculations. The potential effect on economic growth from shifting to a strictly proportional tax scheme ranges from 3.9 percent (New Zealand and Iceland) to a magnitude of 17.8 percent (Hungary). The unweighted average for the OECD countries is 9.16 percent. Figure 9 shows the individual estimations. These are then compared with other studies to control the validity of the estimates.

Figure 9: Growth Potential by Flat Tax Reform for the OECD Countries in 2007



Source: Author's own calculations. Data derived from OECD.Stat and SourceOECD.

The estimated results for 9 of the OECD countries are compared with findings in other studies. The comparison generally provides support for the estimations, as most studies find similar results, or including ranges of results. The countries compared, and the results, are as follows:

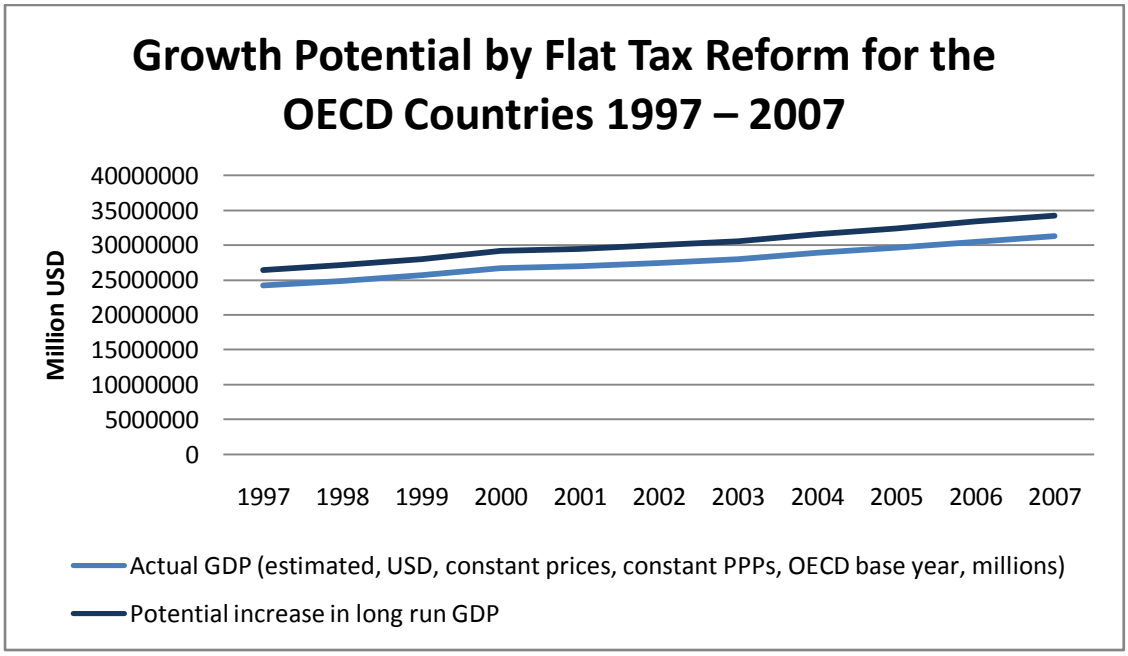
- Canada (10.06 percent): Similar to the efficiency costs of the current tax scheme, which Diewert (1988) find to range from 10 to 20 percent. The estimation is higher than the efficiency gains referred to by Clemens et al. (2001) and Emes et al. (2001) – 2 – 4 percent by capital formation, 3 percent by work incentives. In Fraser Forum (February 2008) Alvin Rabushka and Niels Veldhuis also assume a 6 percent increase in output.
- Denmark (6.23 percent): Slightly higher than the estimate of 5.4 percent in Jensen, Nielsen, Pedersen and Sorensen (1994).
- Italy (7.38 percent): Comparable with Colombino and del Boca (1990) who estimate 43.75 percent less inefficiency in the purely flat tax scheme.
- Norway (5.75 percent): Exceeds the estimations in Stølen et al. (1999), where an analysis by Brita Bye, Erling Holmøy and Birger Strøm (Statistics Norway) show output effects ranging from -0.65 percent to 0.63 percent by revenue neutral tax reform (tax progressivity is reduced by half of the present reduction).The predicted efficiency gain is however in the small compared to the efficiency cost of 34.2 percent on welfare estimated in Aaberge et al. (2000).
- Slovak Republic (5.16 percent): Relatively high, considering that the country already has a flat tax at 19 percent with a basic deduction. The growth potential hence indicates that even with a flat tax scheme the overall tax burden is still high, and hence illustrates the effect of reducing tax rates even further and removing the basic deduction. Krajčír and Ódor (2005) simulate between 0.2 and 0.5 percent annual growth in GDP from the present flat tax reform.
- Spain (7.50 percent): Far less than the 12.6 percent efficiency gain found by González-Torrabadella and Pijoan-Mas (2006), this is partially due to the difference in initial tax progressivity (they use 1999 as base year, whereas this paper uses 2007 as base year).
- Sweden (4.80 percent): Lower than the 7.6 percent efficiency gain Elger and Lindqvist (2007) find when analyzing a pure flat tax scheme.
- United Kingdom (6.74 percent): Similar to the loose estimations in Heath (2006).
- United States (10.66 percent): Close to what Altig et al. (2001) find to be the effects of shifting to a proportional consumption tax. CBO, US Congress (1997) also refers to general equilibrium and structural macroeconomic models which yields increases in long run growth by 1 to 10 percent. Romer and Romer (2007) find even larger effects in their narrative analysis of tax changes, in that increasing taxes by 1 percent of GDP reduces

GDP by 3 percent. The estimation is however larger than the simulation result of 5.2 percent by Allen Sinai referred to in Thorning (2002). This simulation is based on a flat tax introduced in 1991, and the GDP increase is simulated in 2004. There is however an upward trend, which might imply an even level of GDP in the long run. Thorning (2002) also presents results from 9 other studies on flat tax reforms, these ranges from -4.2 to 16.9 percent output growth.

The overall long run growth potential for the OECD countries fits well within the range of the calibration studies used in the meta-regression analysis. The increased growth effect (from 6.75 based on the meta-regression to 9.16 percent) is partially due to the reduction in tax progressivity (0.89) being almost twice of the average reduction in (0.48). Compared with the econometric studies the estimate is similar to the growth effects of effective marginal tax rates which Padovano and Galli (2001) estimate to 1.1 – 1.2 percentage points on growth rate. The estimation shows a larger effect than what Koester and Kormendi (1987), and Lee and Gordon (2005) find, however they do not consider any change in tax progressivity. To illustrate the potential growth path of economic output in a scenario where all OECD countries introduce flat tax reforms, the estimated long run output growth of 9.16 percent for all OECD countries is added to actual GDP for the period 1997 - 2007. The most probable effect of flat tax reforms on economic output for the OECD countries is shown in figure 10.

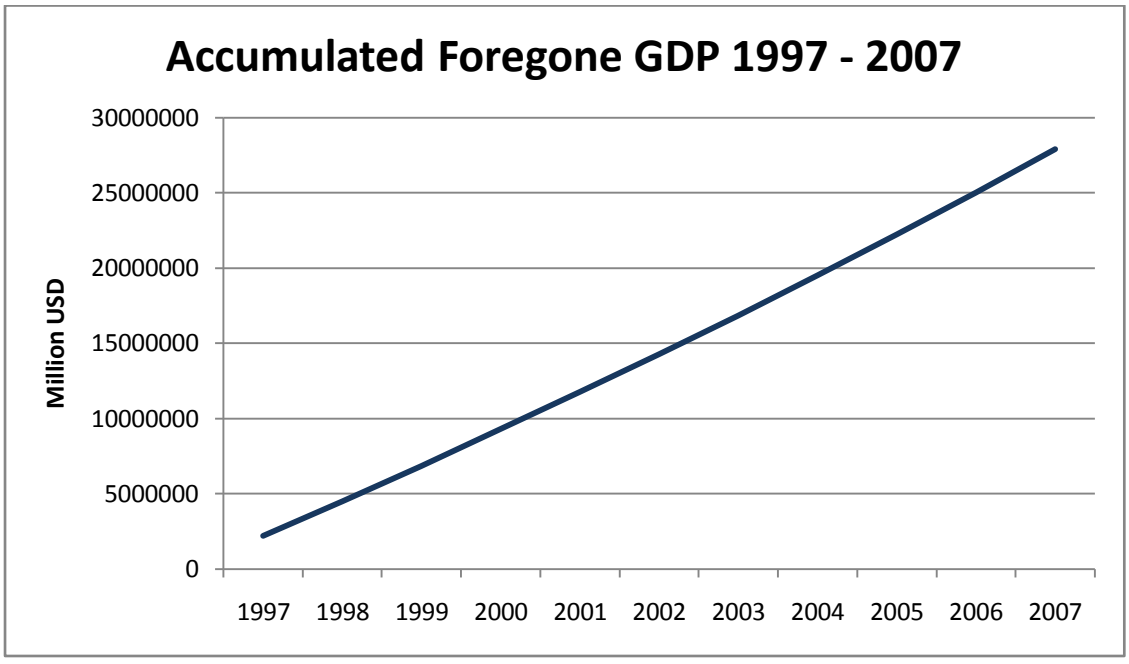
Engen and Skinner (1996) denote that even modest growth effects have large long run effects. To illustrate this figure 11 shows the accumulated foregone output for the period 1997 to 2007.

Figure 10: Growth Potential by Flat Tax Reform for the OECD Countries 1997 – 2007



Source: Author's own calculations. Data derived from OECD.Stat and SourceOECD.

Figure 11: Accumulated Foregone Growth Potential for the OECD countries 1997 – 2007



Source: Author's own calculations. Data derived from OECD.Stat and SourceOECD.

The flat tax rates necessary for revenue neutral tax reforms estimated in the calibration studies range from 17 to 35 percent, hence the estimated growth effects imply that the flat tax rates be within these boundaries. This simplification restricts the possibility for inferring on the tax rates necessary for revenue neutral reforms. Intuitively, the effects on economic output will be larger than predicted if the flat tax rate is set lower than 17 percent, and smaller if the flat tax rate is set higher than 35 percent. See González-Torrabadella and Pijoan-Mas (2006), and Elger and Lindqvist (2007) for quantitative studies of the diminishing effects on output as the progressivity of flat tax schemes increases.

Reducing tax progressivity to 1 shows the largest possible effect on output. This is not a feasible flat tax scheme for most OECD countries. The Hall-Rabushka flat tax with basic deductions will on the other hand provide a sound and middle-ground tax scheme where the considerations of the poor are taken care of. The tax rates and deduction levels are likely to differ as they are associated with the tax level in each country. Determining the necessary tax rates and the corresponding deduction levels for the flat tax schemes to be revenue neutral is not analyzed in this paper. However, as González-Torrabadella and Pijoan-Mas (2006) point out, setting the tax rate and corresponding deduction level too high will have adverse effects on economic growth. For some high-tax countries the conclusion may hence be that the fundamental flat tax reform is not feasible unless accompanied by a fundamental reform of government expenditure.

7.2 Sensitivity Analysis

The estimated growth for the OECD countries is based on estimations on tax elasticity and tax progressivity. The tax elasticities are based on estimated growth effects relative to changes in tax progressivity. Hence there might be an estimation bias present. To control for this the dependent variable is tested for the meta-regression variation and the estimation variation, based on the 95 percent confidence interval for the estimates from the meta-regression analysis and for the OECD countries, respectively. The moderator and parameter variables are tested for meta-regression variation, based on ± 1 standard error of coefficients from regression (4). The results are shown in table 6 and table 7.

For the dependent variable the estimations used in the meta-regression analysis varies more than the estimations for the OECD countries. The wider range is reasonable as the estimates are based on the meta-regression elasticities ranging from -0.503 to -0.003, compared with the approximated elasticities for the OECD countries ranging from -0.180 to -0.037. The boundaries range from 14.02 to 2.09 percent in the meta-regression case. All control variables yield a similar range, indicating that the result from the regression model is robust. The moderator variables range from 9.29 to 4.21 percent, the narrower range confirms that tax elasticity has a smaller share of efficiency gain than do change in tax progressivity. As previously discussed the parameter variables are less robust; here the widest range is in the case of *TIME_DISC*, which ranges from 16.39 to -2.89. This confirms that parameter variables should be estimated carefully and with high precision, as even minor deviations may alter the result substantially. The control of coefficients in table 14 (appendix III) serves as a complimentary robustness check for the parameter variables. For the dependent variable in the estimates for the OECD countries the upper and lower boundaries are 11.08 and 6.85 percent, respectively.

The sensitivity analysis show that the estimated effects on economic growth from introducing flat tax in the OECD countries are robust, as *TIME_DISC* (low case) is the only incidence where the estimated growth is negative. The high case is however at the other extreme. The remaining 13 control variables yield consistent positive growth effects.

Table 6: Sensitivity Analysis Dependent Variable

Dependent: $\overline{\Delta\gamma}$ (percent)		ΔΘ		
		High	Low	
Y_i	MRA (0.67)	OECD (1.02)	MRA (0.29)	OECD (0.76)
High				
MRA (-0.211)	14.02		6.10	
OECD (-0.116)		11.80		8.80
Low				
MRA (-0.072)	4.80		2.09	
OECD (-0.090)		9.19		6.85

MRA – Estimate from meta-regression analysis
OECD – Estimate for OECD countries

Table 7: Sensitivity Analysis Moderator and Parameter Variables

Dependent: $\overline{\Delta\gamma}$ (percent)	$\overline{\Delta\theta}Y_i$	
	High	Low
Moderator Variables		
CH_GROWTH	8.43	5.08
CH_PERCENT	8.22	5.29
CH_PER_CAPITA	7.07	6.43
COUNTRY	9.29	4.21
PROP_TAX	7.46	6.04
OVERLAP_GEN	7.51	5.99
SKILL	7.39	6.11
POP_GROWTH	7.19	6.31
GOV_EXP	8.66	4.84
OPEN_ECON	7.23	6.28
Parameter Variables		
CAP_SHARE	11.44	2.06
CAP_DEP	11.79	1.72
TIME_DISC	16.39	-2.89
INT_SUBST	9.24	4.27

7.3 Some Inequality and Welfare Considerations

In many studies where output is compared with equality, the efficiency gains in output from a flat tax come at the expense of vertical inequality. On this basis some of these studies, e.g. Decoster, De Swerdt, and Orsini (2008), Fuest, Peichl, and Schaefer (2008), draw the conclusion that flat tax reforms are not feasible, particularly not for the OECD type of countries. This is confirmed in Nielsen (2006) where he finds that the main obstacles to the introduction of a flat tax in Norway have been a lack of the proposals' ability to meet survival criteria of value acceptability, technical and political feasibility, and budgetary implications. The infeasibility does however stand in sharp contrast with public opinion, which in several OECD countries opposes the current tax schemes to a large degree[23]. Opposition might be even stronger, as Roberts, Hite, and Bradley (1994) find that a large share of respondents

[23] Teather (2005) refers to a UK survey where 81 percent of young people are more worried about high tax levels than war, environment and tuition fees.
The TaxPayers' Alliance September Poll 2007 for UK shows that 77 percent think government should tax 25 percent or less from households. [http://tpa.typepad.com/about/2007/10/annual-conferen.html]
In the 2007 Annual Survey of U.S. Attitudes on Taxes and Wealth, 83 percent of the respondents said the federal income tax is very complex or somewhat complex. [http://www.taxfoundation.org/files/sr154.pdf]

prefers the progressive tax scheme when questionnaires use abstract frames but flat or regressive taxes in concrete situations, indicating that conclusions from public opinion polls using abstract questions should be carefully interpreted. Hence, as Nielsen (2006) and Evans and Aligica (2008) suggest, given a situation of a large policy window, or a policy champion, where the ideas, interests and consequences are aligned, the flat tax will be politically feasible also for the OECD countries[24].

Paulus and Peichl (2008) suggest that the long run efficiency and growth effects of flat tax reforms might make the increasing vertical inequality acceptable. They also find that that for some Mediterranean countries, and other countries with similar tax structure, a flat tax can increase both equality and economic efficiency.

Other studies also suggest that win-win scenarios might exist, where fairness is obtained without loss of welfare, and/or increased inequality. In general this is possible if and only if the improved incentives from tax reform result in increased efficiency and thereby increased income which more than offset the increased tax burden for those benefiting relatively more from current tax systems. Jensen et al. (1994) find that both efficiency and welfare increase. Aaberge et al. (1995) find that the reduction in tax progressivity in Norway from 1979 to 1992 increased mean welfare, however the increase would have been even larger if a flat tax (20.1 percent rate, revenue neutral) was implemented. In the latter case inequality would also be reduced. Creedy (1996), and Cugno and Zanola (2000) find that flat tax schemes under certain conditions are preferable to more progressive tax schemes in terms of welfare. Seldon and Boyd (1996) find that the Armey-Shelby flat tax with a 17 percent overall tax rate will benefit all income groups; the lowest income group most by 7.6 percent, whereas the middle income groups benefit from 1.0 to 2.5 percent, and the highest income group benefit 2.4 percent. Teather (2005) find similar results for UK. Kakwani and Lambert (1999) find a welfare loss of 1 percent due to the 1984 progressive tax scheme in Australia. Aaberge et al. (2000) find that a flat tax in Norway will both have large efficiency and welfare gains, and reduce inequality. They do however find that for Italy and Sweden only efficiency improves. Davies and Hoy (2002) find that the flat tax may reduce inequality compared to the

[24] According to Alvin Rabushka and Mart Laar, policy makers must be prepared, and they must stand the fight. Source: SPECTATOR.co.uk: Flat tax and faint hearts [http://www.spectator.co.uk/print/the-magazine/cartoons/14303/flat-tax-and-faint-hearts.thtml]

progressive tax scheme, even without prohibitively high tax rates. Jorgenson and Yun (2002) find welfare gains of USD 814.9 billion for the Hall-Rabushka flat tax and USD 756 billion for the Armey-Shelby flat tax (1997 dollars).

The argument that flat taxes increase vertical inequality might hence be based on valid concerns for some, hardly all OECD countries. On the contrary, the main reason for government reluctance might be that flat tax schemes are less susceptible to political pressure (Slemrod (1990)). If assuming that flat taxes do increase inequality, this should not be seen as only negative, as the implicit increased incentives will increase factor input. The latter is however critical dependent on whether the factor markets are provided with less rigidity (Vietor (2007)) (i.e. labor reforms will for some countries be necessary), and also that the masks in the social security net is widened so only those really needing may receive social benefits. Furthermore, by referring to the initial quote by Mill (1900) what the change in vertical inequality really shows is to what extent some groups or individuals benefit at the expense of the others under the current fiscal systems. A necessary implication of correcting this inequality and unfairness is hence that some lose and some gains.

8 CONCLUSION

This master thesis explores the effects of flat tax reforms on economic growth in the OECD countries, focusing on the period from 1997 to 2007. A meta-regression analysis on 18 calibration studies on the subjects of tax reforms (of which 15 concerns US) summarizes the average growth potential to 6.75 percent. Extending the findings in the meta-regression analysis to current tax progressivity and economic growth the most probable growth effects for the OECD countries are estimated. The 2006/2007 level of tax progressivity and elasticity is estimated to yield a growth potential of 9.16 percent in real output for the OECD area. Controlling for estimation bias in parameter coefficients and prediction model, the conclusions remain robust. A recent OECD study (Arnold (2008)) confirms to a large extent my findings on the relation between taxation and economic growth.

The large Keynesian countercyclical fiscal policies currently implemented by most OECD countries are mostly short or medium term solutions. These measures could be accompanied, some even substituted by the long run solutions provided by flat tax schemes; the costs, if any, would not be close to the rescue deals already passed. As Alvin Rabushka notes in his Flat Tax blog on December 15, 2008; "Every group that benefits from a new provision becomes another political constituency for keeping and expanding it."[25] Countercyclical fiscal policies tent to yield more groups with increasing demands.

The flat tax era is still infant, but the opportunities for change have improved. Flat tax reforms are likely to reduce the length and depth of the current worldwide economic downturn, to speed up recovery and future growth and prosperity.

8.1 Limitations and areas for further research

Two extensions of interest appear which are related to the measuring of the necessary flat tax rates and corresponding deduction levels for the OECD countries in a Hall-Rabushka flat tax scenario. First, a measure including only income and business tax is of interest. This may be the most feasible reform today due to constraints in partisan politics. The second extension of interest is a measure which also includes the removal of value-added taxes, hence completely extinguishing double taxation as intended by Hall and Rabushka (1995). Using estimations for growth rates as opposed to long run growth is also intriguing, especially when considering short-sighted policy makers.

The meta-regression analysis might be further developed to include the endogenous labor supply elasticities as pointed out by Stokey and Rebelo (1995). For the purpose of this paper the exogenous parameterization is a reasonable measurement of the parameters' effects on output estimates. The meta-regression analysis is limited to flat tax articles using calibration methodology. A similar analysis with articles using panel data or cross-section methodologies (e.g. Vedder (1985), Koester and Kormendi (1987), Colombino and del Boca

[25] Flat tax – Essays on the Adoption and Results of Flat Tax Around the Globe [http://flattaxes.blogspot.com/]

(1990), Padovano and Galli (2001), Lee and Gordon (2005)) would provide additional insights on results of existing research, and set direction for future framework and modeling efforts.

The tax elasticities in the predictions are average for each country; an extension of the model might be to estimate tax elasticities for different income groups for each country. A comparable measure is the elasticity of taxable income, which Gruber and Saez (2000) find to differ as much as the tax elasticities differ between the countries. This will also affect the growth effect of a flat tax reform.

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APPENDICES

Appendix I: Meta-Regression Analysis: Descriptive Statistics

Figure 12: Summary for *AVG_ELASTICITY*

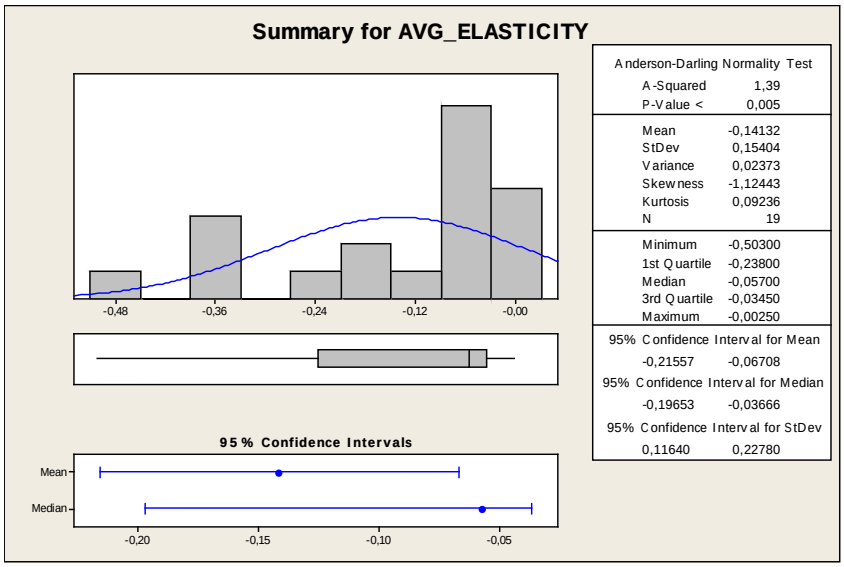


Table 8: Descriptive Statistics

Dependent Variable	Mean	Standard Error of Mean	Trimmed Mean	Standard Deviation	Variance	Sum of Squares	Minimum	Median	Maximum	Skewness	n
AVG_ELASTICITY	-0.141	0.035	-0.128	0.154	0.024	0.807	-0.503	-0.057	-0.003	-1.12	19

Moderator Variable	Mean	Standard Error of Mean	Trimmed Mean	Standard Deviation	Variance	Sum of Squares	Q1	Median	Q3	Skewness	n
CH_GROWTH	0.790	0.096	0.824	0.419	0.175	15	1	1	1	-1.54	19
CH_PERCENT	0.684	0.110	0.706	0.478	0.228	13	0	1	1	-0.86	19
CH_PER_CAPITA	0.211	0.096	0.177	0.419	0.175	4	0	0	0	1.54	19
COUNTRY	0.842	0.086	0.882	0.375	0.140	16	1	1	1	-2.04	19
HETERO	0.684	0.110	0.706	0.478	0.228	13	0	1	1	-0.86	19
PROP_TAX	0.632	0.114	0.647	0.496	0.246	12	0	1	1	-0.59	19
FLAT_TAX	0.684	0.110	0.706	0.478	0.228	13	0	1	1	-0.86	19
OVERLAP_GEN	0.526	0.118	0.529	0.513	0.263	10	0	1	1	-0.11	19
PRODUCTIVITY	0.474	0.118	0.471	0.513	0.263	9	0	0	1	0.11	19
SKILL	0.421	0.116	0.412	0.507	0.257	8	0	0	1	0.35	19
SOCIAL_SECURITY	0.474	0.118	0.471	0.513	0.263	9	0	0	1	0.11	19
POP_GROWTH	0.368	0.114	0.353	0.496	0.246	7	0	0	1	0.59	19
GOV_EXP	0.790	0.096	0.824	0.419	0.175	15	1	1	1	-1.54	19
INHERIT	0.421	0.116	0.412	0.507	0.257	8	0	0	1	0.35	19
RETIRE	0.421	0.116	0.412	0.507	0.257	8	0	0	1	0.35	19
OPEN_ECON	0.316	0.110	0.294	0.478	0.228	6	0	0	1	0.86	19

Parameter Variable	Mean	Standard Error of Mean	Trimmed Mean	Standard Deviation	Variance	Sum of Squares	Minimum	Median	Maximum	Skewness	n
CAP_SHARE	0.300	0.017	0.303	0.066	0.004	1.410	0.180	0.340	0.376	-0.44	15
CAP_DEP_PH	0.061	0.004	0.061	0.014	0.000	0.043	0.040	0.060	0.085	0.27	11
TIME_DISC	0.964	0.016	0.976	0.063	0.004	14.914	0.740	0.976	1.011	-3.31	16
INT_SUBST	0.537	0.059	0.525	0.244	0.059	5.846	0.250	0.500	1.000	0.69	17

Table 9: Pearson Correlation for Dependent and Control Variables

	AVG_ELASTICITY	CH_GROWTH	CH_PERCENT	CH_PER_CAPITA	COUNTRY	HETERO	PROP_TAX	FLAT_TAX	OVERLAP_GEN	PRODUCTIVITY	SKILL	SOCIAL_SECURITY	POP_GROWTH	GOV_EXP	INHERIT	RETIRE	OPEN_ECON	CAP_SHARE	CAP_DEP_PH	TIME_DISC
CH_GROWTH	-0.395																			
	0.094																			
CH_PERCENT	-0.555	0.760																		
	0.014	0.000																		
CH_PER_CAPITA	0.396	-0.367	-0.482																	
	0.093	0.123	0.036																	
COUNTRY	-0.257	-0.224	-0.294	0.224																
	0.289	0.357	0.222	0.357																
HETERO	-0.424	0.205	0.513	-0.205	0.016															
	0.071	0.401	0.025	0.401	0.947															
PROP_TAX	0.381	-0.127	-0.049	-0.141	-0.331	-0.049														
	0.107	0.605	0.841	0.565	0.167	0.841														
FLAT_TAX	-0.509	0.482	0.513	0.073	0.016	0.513	-0.519													
	0.026	0.036	0.025	0.766	0.947	0.025	0.023													
OVERLAP_GEN	-0.194	0.286	0.263	-0.286	-0.122	0.263	0.150	0.036												
	0.426	0.236	0.277	0.236	0.620	0.277	0.541	0.884												
PRODUCTIVITY	0.184	0.231	0.191	-0.231	-0.167	0.191	0.288	-0.036	0.267											
	0.451	0.341	0.434	0.341	0.493	0.434	0.233	0.884	0.270											
SKILL	0.581	-0.344	-0.338	0.344	-0.215	-0.338	0.430	-0.338	0.169	0.045										
	0.009	0.149	0.157	0.149	0.376	0.157	0.066	0.157	0.490	0.855										
SOCIAL_SECURITY	-0.375	0.490	0.418	0.027	0.122	0.191	-0.368	0.645	0.478	0.156	0.045									
	0.113	0.033	0.075	0.912	0.620	0.434	0.121	0.003	0.039	0.525	0.855									
POP_GROWTH	-0.334	0.127	0.049	-0.127	0.331	0.049	0.131	0.049	0.506	0.150	0.012	0.368								
	0.162	0.605	0.841	0.605	0.167	0.841	0.593	0.841	0.027	0.541	0.962	0.121								
GOV_EXP	-0.384	0.367	0.482	0.267	0.130	0.205	-0.394	0.482	0.027	-0.286	-0.083	0.490	-0.141							
	0.104	0.123	0.036	0.270	0.595	0.401	0.095	0.036	0.912	0.236	0.737	0.033	0.565							
INHERIT	-0.513	0.440	0.579	-0.440	0.077	0.35	-0.233	0.579	0.169	-0.169	-0.295	0.472	0.012	0.440						
	0.025	0.059	0.009	0.059	0.754	0.142	0.338	0.009	0.490	0.490	0.219	0.041	0.962	0.059						
RETIRE	-0.424	0.440	0.579	-0.179	-0.215	0.121	-0.233	0.350	0.596	0.045	-0.080	0.685	0.233	0.440	0.352					
	0.070	0.059	0.009	0.464	0.376	0.623	0.338	0.142	0.007	0.855	0.746	0.001	0.338	0.059	0.139					
OPEN_ECON	-0.164	0.351	0.218	-0.073	-0.016	-0.026	-0.185	-0.026	-0.263	-0.418	-0.121	-0.191	-0.284	0.351	0.109	-0.121				
	0.503	0.141	0.370	0.766	0.947	0.917	0.448	0.917	0.277	0.075	0.623	0.434	0.238	0.141	0.658	0.623				
CAP_SHARE	-0.056	0.465	0.207	-0.227	-0.251	-0.046	-0.083	0.142	0.308	0.630	0.062	0.440	0.136	-0.155	-0.048	0.411	0.131			
	0.843	0.081	0.460	0.416	0.367	0.872	0.768	0.613	0.200	0.012	0.825	0.100	0.630	0.582	0.865	0.128	0.641			
CAP_DEP_PH	0.315	0.152	0.202	0.081	-0.765	0.066	0.287	0.102	0.059	0.257	0.180	0.105	0.080	-0.131	-0.202	0.166	-0.446	-0.208		
	0.346	0.656	0.551	0.814	0.006	0.847	0.392	0.766	0.810	0.445	0.596	0.759	0.815	0.702	0.552	0.625	0.169	0.592		
TIME_DISC	0.420	-0.086	-0.226	0.241	-0.057	-0.269	-0.24	-0.161	0.233	0.151	0.217	0.305	0.157	-0.105	-0.217	0.261	-0.280	0.215	0.576	
	0.105	0.750	0.401	0.368	0.833	0.313	0.371	0.552	0.358	0.578	0.420	0.251	0.560	0.699	0.419	0.330	0.293	0.481	0.105	
INT_SUBST	0.428	-0.278	-0.294	0.255	-0.146	-0.146	-0.049	-0.235	-0.251	0.366	-0.207	-0.350	-0.304	-0.227	-0.368	-0.015	-0.452	0.224	0.503	0.229
	0.087	0.279	0.253	0.324	0.575	0.575	0.852	0.364	0.300	0.149	0.424	0.168	0.235	0.38	0.147	0.955	0.068	0.441	0.138	0.430

Pearson correlation

P-value

Appendix II: Meta-Regression Analysis: Regression Models

Table 10: Regression (1): All Moderator Variables

Variable	Coefficient	T-statistic
Intercept (β_0)	0.099	0.29
CH_GROWTH	0.259	0.59
CH_PERCENT	-0.073	-0.18
CH_PER_CAPITA	0.335	1.20
COUNTRY	-0.163	-0.75
HETERO	0.126	0.46
PROP_TAX	-0.132	-0.69
FLAT_TAX	-0.373	-1.16
OVERLAP_GEN	-0.097	-0.38
PRODUCTIVITY	0.046	0.33
SKILL	0.134	0.59
SOCIAL_SECURITY	-0.020	-0.07
POP_GROWTH	-0.019	-0.12
GOV_EXP	-0.170	-0.72
INHERIT	0.205	1.01
RETIRE	-0.018	-0.06
OPEN_ECON	-0.102	-0.49

Standard error of residual = 0.165865
R-Square = 87.1 %
R-Square (adjusted) = 0.0 %
F-statistic = 0.85
Durbin-Watson statistic = 2.10338
n = 19
Count of unusual observations = 0
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively

Table 11: Regression (2): Measure Moderator Variables

Variable	Coefficient	T-statistic
Intercept (β_0)	-0.057	-0.70
CH_GROWTH	0.023	0.20
CH_PERCENT	-0.169	-1.51
CH_PER_CAPITA	0.061	0.69

Standard error of residual = 0.138007
R-Square = 33.1 %
R-Square (adjusted) = 19.7 %
F-statistic = 2.48
Durbin-Watson statistic = 1.62801
n = 19
Count of unusual observations = 1
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively

Table 12: Regression (3): Meta-Regression Model – Equation (20)

Variable	Coefficient	T-statistic
Intercept (β_0)	-1.090	-5.97**
CH_GROWTH	0.286	7.23**
CH_PERCENT	0.185	3.42*
CH_PER_CAPITA	0.134	4.76**
COUNTRY	0.350	4.74**
HETERO	-0.053	-2.02
PROP_TAX	0.091	4.04*
OVERLAP_GEN	0.137	3.67*
PRODUCTIVITY	0.009	0.36
SKILL	0.245	9.12**
POP_GROWTH	-0.171	-6.63**
GOV_EXP	-0.394	-7.76**
OPEN_ECON	0.174	5.53**
CAP_SHARE	-2.430	-8.46**
CAP_DEP_PH	-4.563	-2.78
TIME_DISC	1.012	4.63**
INT_SUBST	0.787	8.18**

Standard error of residual = 0.0249480
R-square = 99.7 %
R-square (adjusted) = 97.4 %
F-statistic = 42.76**
Durbin-Watson statistic = 1.85710
n = 19
Count of unusual observations = 2
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively

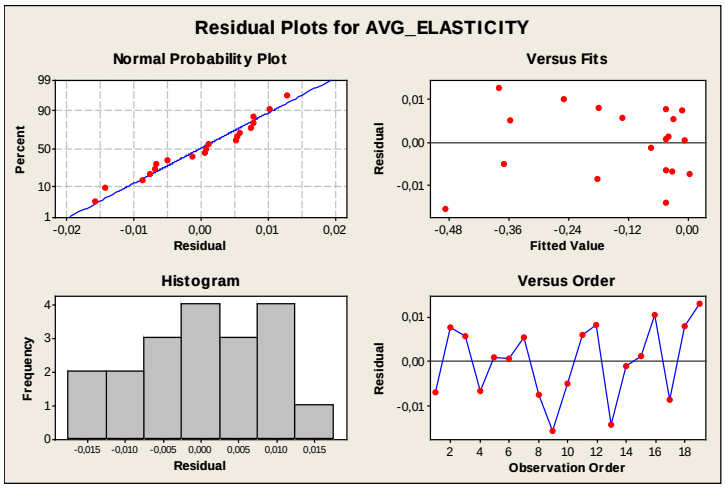
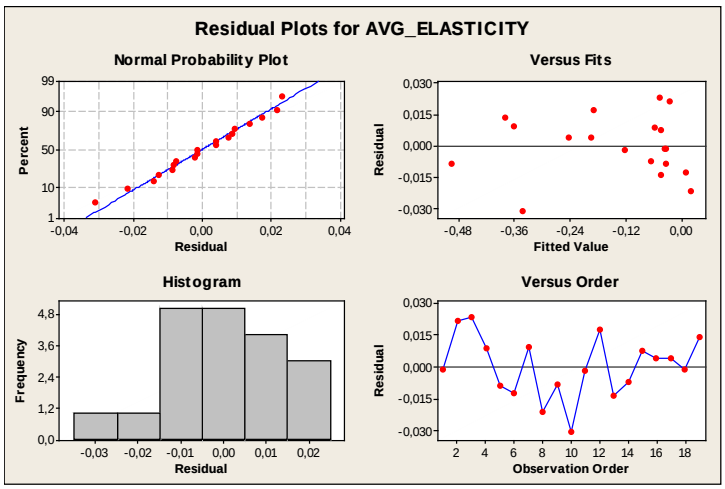


Table 13: Regression (4): Meta-Regression Model – Equation (21)

Variable	Coefficient	T-statistic
Intercept (β_0)	-1.215	-6.74***
CH_GROWTH	0.310	6.97***
CH_PERCENT	0.111	2.49*
CH_PER_CAPITA	0.112	3.51**
COUNTRY	0.266	4.21**
PROP_TAX	0.105	4.42**
OVERLAP_GEN	0.082	2.71*
SKILL	0.240	7.55***
POP_GROWTH	-0.145	-5.80***
GOV_EXP	-0.341	-6.73***
OPEN_ECON	0.138	4.37**
CAP_SHARE	-2.230	-6.81***
CAP_DEP_PH	-6.224	-3.60**
TIME_DISC	1.287	6.15***
INT_SUBST	0.712	7.35***

Standard error of residual = 0.0307101
R-square = 99.1 %
R-square (adjusted) = 96.0 %
F-statistic = 32.06***
Durbin-Watson statistic = 1.58587
n = 19
Count of unusual observations = 0
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively



Appendix III: Meta-Regression Analysis: Control of Parameter Variable Coefficients

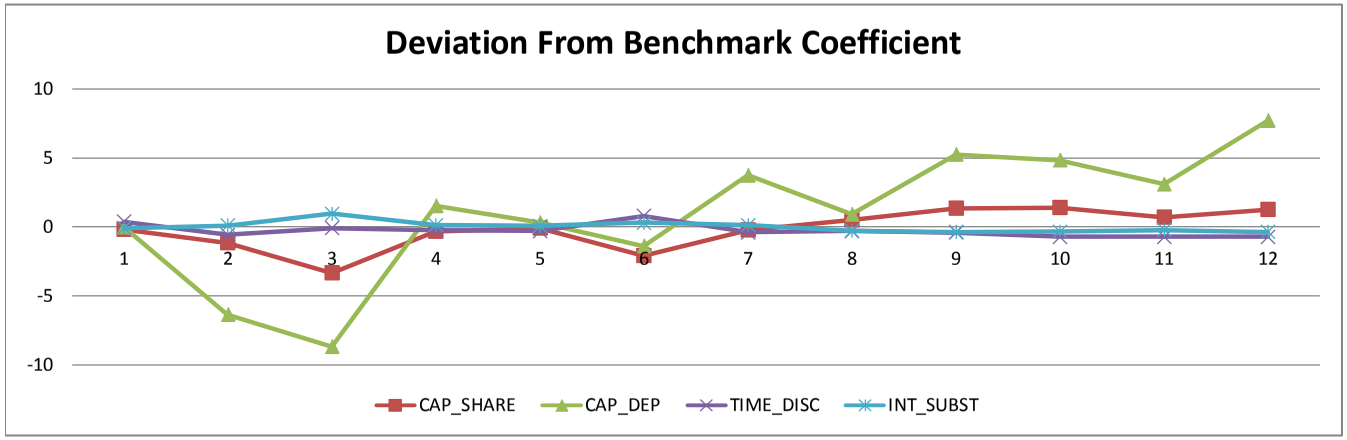
Table 14: Control of Estimated Parameter Variable Coefficients

	Benchmark coefficient	Altered coefficient source	Regression	1	2	3	4	5	6	7	8	9	10	11	12
Intercept	-1,215			-1.344	-0.009	-0.485	-1.225**	-1.030**	-1.823***	-1.293***	-0.795	-1.133	-0.842	-0.509	-1.024
CAP_SHARE	-1,789	Mean value			-2.955	-5.119	-2.087**		-3.875**	-2.027***	-1.277		-0.382	-1.082	-0.521
		Missing/maximum/minimum value		-1.947				-1.885**				-0.448			
CAP_DEP	-7,367	Mean value		-7.370		-16.030	-5.829**	-7.044		-3.621	-6.447	-2.105		-4.258	0.345
		Missing/maximum/minimum value			-13.700				-8.732*				-2.514		
TIME_DISC	1,508	Mean value		1.899	0.947		1.262**	1.221**	2.308**		1.226	1.102	0.813		0.809
		Missing/maximum/minimum value				1.424				1.113***				0.802	
INT_SUBST	0,549	Mean value		0.461	0.644	1.498		0.625**	0.847***	0.674***		0.183	0.210	0.329*	
		Missing/maximum/minimum value					0.676**				0.270				0.205
			k	13	9	14	12	14	14	14	14	14	14	14	14
			n	15	11	16	17	19	19	19	19	19	19	19	19
			R-Square	98.4 %	94.3 %	99.5%	99.8 %	96.7 %	98.4 %	98.7 %	92.0 %	90.3 %	92.9 %	92.1 %	92.0 %
			F-statistic	4.74	1.83	15.04	78.98	8.27	17.17	21.29	3.28	2.66	3.75	3.32	3.28

*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively

Regression 1-4 using missing values for one parameter variable, mean values for the remaining
Regression 5-8 using maximum value for one parameter variable, mean values for the remaining
Regression 9-12 using minimum value for one parameter variable, mean values for the remaining

Figure 13: Estimated Parameter Variable Coefficients Deviation From Benchmark Coefficient



Appendix IV: Prediction Preparation

Table 15: Elasticity versus Tax Burden

Variable	Coefficient	T-statistic
Intercept (β_0)	-0.284	-5.35**
TAX/GDP RATIO	0.005	3.95*

Standard error of residual = 0.227430
R-Square = 88.6%
R-Square (adjusted) = 83.0%
F-statistic = 15.6
n = 4
Count of unusual observations = 0
*, **, *** denote statistical significance at the 10 %, 5 %, and 1 % level, respectively