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CRISIS, RESTRUCTURING AND GROWTH

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

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ABSTRACT:

This paper explores how a transition from a progressive to a flat tax scheme would affect economic growth in the OECD countries on the period from 1997 to 2007. A meta-regression analysis on eighteen calibration studies on flat tax reforms provides robust results of the mean tax elasticity as well as estimates for long run growth. Based on the 2006/2007 level of tax progressivity and tax elasticity, the average growth potential is found to be around 6.75 percent, translating into a growth potential of 9.16 percent in real output for the OECD area.

Key Words: Flat tax, Economic Growth, OECD.

JEL Classification: E62, F47, H21.

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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.

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

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

1. INTRODUCTION

In the OECD countries complicated tax schemes are the rule rather than the exception. The governments have over time amended the tax system for redistributive and other political purposes. Unfortunately, these tax schemes create significant efficiency gaps in the economies (see e.g. Arnold, 2008)[3]. Even for professionals, most of today's tax schemes in the OECD area are not easy to understand. Tax evasion, tax avoidance and tax planning are widespread for individuals, private firms and even among state-owned companies. The negative impact of complicated tax schemes is enlarged by large shadow economies (Schneider, 2005) and reduced incentives. On the other hand, some economists argue that flat tax schemes may provide the tax payers with benefits such as lower tax burden, reduced compliance costs, increased incentives, and, not least, fair treatment, whereas the benefits for the governments may be reduced compliance control costs and possibly increased tax income (see Hall and Rabushka, 1995 and Rabushka, 2009). Not surprisingly, in the last years an increasing number of countries have been implementing flat tax schemes[4].

[3] A discussion of the impact of taxes in economic efficiency can be found in Adams (2001), where he also explains the world history from a taxation perspective.

[4] The Flat Tax Club consists of countries and jurisdictions such as 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). See Edwards and Mitchell (2008) and Rabushka (2009).

The exercise that we propose to perform in this paper is particularly relevant in the current context of international financial and real economy crisis. To overcome the global recession and retain international competitiveness, countries need to evaluate the effectiveness of alternative fiscal policies[5].

The focus of this paper is then the relation between taxation, in terms of alternative tax schemes, and economic growth. We study the long run economic effects of an introduction of flat tax schemes in the OECD countries. Previous studies have indicated that flat tax schemes might boost growth. However, given the different methodologies used and the diverse estimates obtained for economic growth potential, it is hard to evaluate what the real impacts of flat tax reforms may be. In this study, we intend to give a unifying figure for the effects of flat tax schemes[6].

In order to accomplish our objectives, we perform a meta-regression analysis on the effects of a flat-tax scheme on economic growth. The meta-regression analysis considers eighteen calibration studies on flat tax reforms. We use the mean tax elasticity from these studies, to obtain estimates for the long run growth in the OECD area.

Some of the studies used in the meta-regression analysis present more than one measure of tax elasticity. We therefore had to select which measure to employ in the meta-regression analysis. Stanley and Jarrell (1998) provide a useful discussion on this matter. Multiple measures from one study are used only when representing different model frameworks. Occasionally it is clearly stated by the author(s) of the study the preferred measure and therefore, in these cases, we also adopt it. When this does not occur, we have calculated the average elasticity. Table 1 show the empirical studies included in the meta-regression analysis.

[5] In addition to the crisis we also have to think about globalization as 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, reasoning that competition between countries increases government efficiency. Tax competition is not solely a "tax haven" issue; it is also present between OECD countries (see Devereux et al., 2002, and Gotaas, 2007).

[6] See for example Jensen (2008) for a review of current scenarios and trends within taxation, the role of government, and the case for flat tax reforms as an opportunity for increased growth and prosperity.

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 (2006)	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

Elasticity estimates authors' own calculations.

The tax elasticity is compared in a meta-regression analysis to infer whether the model specification biases the results. We find that the calibration model specification and parameterization may have significant effects on the growth outcome. In particular, growth effects range from 0 to 17.88 percent. The average growth potential in the studies is 6.75 percent. Based on the relation between taxation and economic growth determined in the regression model, we then estimate the effects of implementing a flat tax scheme in the OECD countries. 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. These results remain robust after controlling for estimation bias in the parameter coefficients.

The paper proceeds as follows. Section 2 discusses the theoretical framework for the empirical exercise. Section 3 reviews the literature on taxation and growth. In section 4 the meta-regression analysis is performed. In section 5, we simulate the effects of flat tax reform in the OECD area to a flat tax scenario as opposed to the current progressive tax schemes. Section 6 concludes and suggests further research.

2. THEORETICAL and EMPIRICAL FRAMEWORK

The background of this paper is on flat tax schemes in the context of economic growth models. In terms of the empirical framework, the starting point is the econometric technique known as meta-analysis and the definition of tax elasticity. First, we describe the properties of flat tax schemes in terms of the notions of tax wedge and deadweight loss. Then, we

make a very short summary of the growth models that are at the base of the calibration studies that we use in our empirical investigation to estimate the effects of tax reforms. After that, we present the meta-regression analysis. We close this section by defining tax elasticity in the context of our empirical analysis.

Flat Tax Schemes

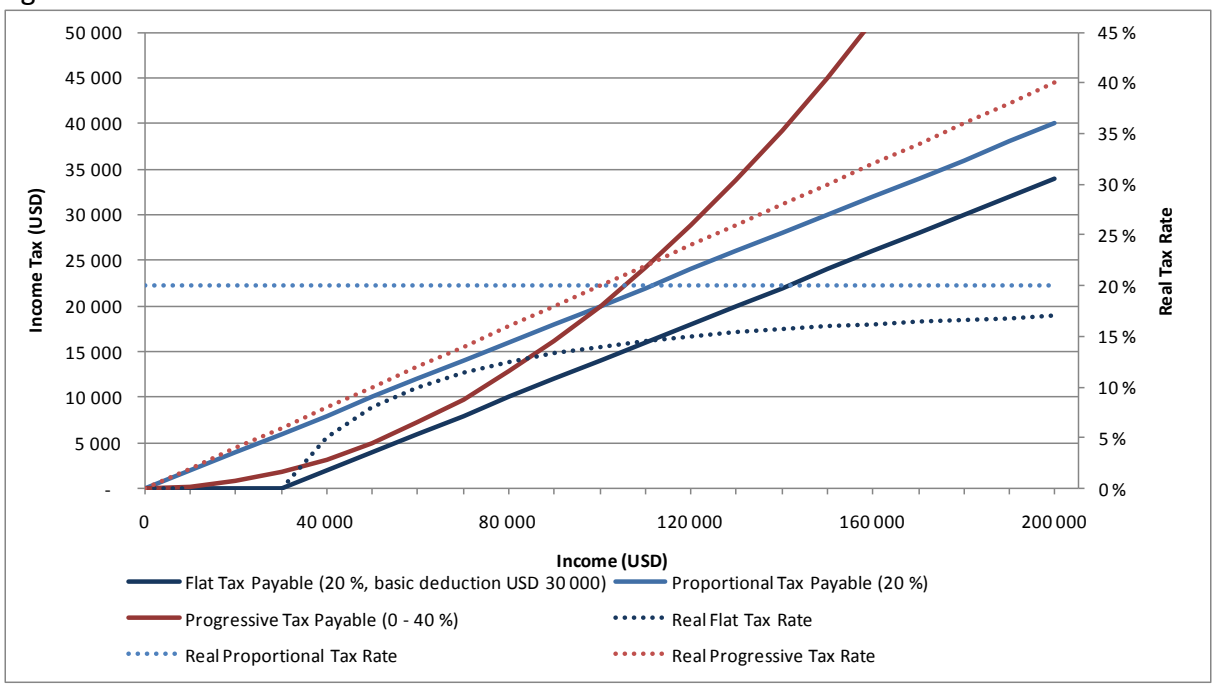
Flat tax schemes levy one single tax rate on all income for all tax payers regardless of income level. No deductions are granted, and all loopholes are eliminated. Most value added tax and social security schemes are proportional. In turn, progressive tax schemes levy low tax rates on small incomes and high tax rates on large incomes. Hence the share of tax burden is increasing. In addition numerous deductions are often implemented for distributive or policy reasons. Most OECD countries still use this type of tax scheme. However, some OECD countries and several non-OECD countries have switched from highly progressive tax schemes to flat tax schemes, often accompanied by a reduction in tax levels.

The flat tax scheme does not necessarily need to be strictly proportional, since some progressivity exists when basic deductions are granted to limit the tax burden of the lower income groups. All other deductions and loopholes are however eliminated. Flat tax schemes may hence have less negative impact on the economy than more progressive tax schemes due to: (1) increased incentives – productivity growth increases profits proportionally rather than under-proportionally, 2) resources being spent on more productive activities than tax planning, and 3) direct and indirect efficiency effects, e.g. perceived beneficial framework conditions, reduced cost of compliance (for tax payers) and control (for government), increased entrepreneurship, attract foreign direct investment, and so forth (see for instances Cullena and Gordon, 2007)[7]. For these reasons Hall and Rabushka (1995) propose a full-scale reform of the US federal income tax.

Figure 1 illustrates our points above on the differences between progressive, proportional and flat tax schemes (see also Davies and Hoy, 2002 and Moyes and Shorrocks, 1998).

[7] From an equality and fairness perspective only flat tax schemes provide both horizontal and vertical equity, i.e. tax payers at similar income levels face similar tax rates (horizontal equity) and simultaneously tax payers at lower income levels face lower tax rates than those at higher levels (vertical equity).

Figure 1: Tax Schemes



Tax Wedge and Deadweight Loss

The efficiency loss of taxes is best illustrated through the notions of tax wedge and deadweight loss. Tax wedge is the difference between labor costs and net wage (i.e. government revenue), either the tax is paid by the employer (payroll tax) or the employee (wage tax)[8]. The OECD defines tax wedge as the "sum of personal income tax and employee plus employer social security contributions together with any payroll tax less cash transfers". The tax wedge implies a pure loss to society; the lost value to employer and employee not captured by government revenue. This is the basic version of the deadweight loss, e.g. Feldstein (1999) further includes tax avoidance and taxable income elasticity. Mankiw (1998) provides an entire chapter devoted to the costs of taxation.

The notion of a deadweight loss implies that government revenue is spent as efficiently as it would be by employers and employees. Additional efficiency costs arise when this is not the case; however this is not captured by the deadweight loss formula. Ding (2008) however finds 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.

[8] Who pays the tax is actually irrelevant, as the tax burden depends on the elasticity of supply and demand (Mankiw, 1998, and Pindyck and Rubinfeld, 2005).

The deadweight loss implied by the tax wedge implicitly implies that there are efficiency gains from reducing tax level and progressivity. This is confirmed in Feldstein (1999), and Hansen and Verdelin (2007), both of which also find effects of increased deadweight loss from increasing tax progressivity. Extending the deadweight loss formula to also include disincentives may yield increasing effects on deadweight loss, but Hansen and Verdelin (2007) find the effects to vary with the level of income. Tax planning, evasion and avoidance are, however, significant issues in this respect.

Growth Models

The relationship between taxation and economic growth has been studied through the employment of different growth models, such as Solow, Ramsey, overlapping generations, and endogenous growth models. For a review of these growth models, see Farmer (1999), Romer (2001), Gärtner (2006) and McCandless (2008). Note that some of the calibration studies that we use in the meta-regression analysis deploy the previously mentioned growth models directly; others apply modified (adjusted or augmented) versions.

The neoclassical Solow model is the starting point of all growth analysis. In spite of suffering from important limitations (for example, it assumes constant returns to scale and a closed economy with no government) extensions of the Solow growth model may however increase its explanatory value. The Ramsey model extends the Solow model by considering an infinite horizon and endogenizing the saving rate. In particular, households make optimal intertemporal decisions on saving and consumption. Augmentation of the Ramsey model may further include Cobb-Douglas production function, leisure, variable labor, and tax. In turn, the basic overlapping generations (OLG) model is a dynamic lifecycle model which captures heterogeneity among agents. It is similar to the Ramsey model but with finitely-lived individuals in different generations who trade in markets. The AK model, in turn, is the simplest form of an endogenous growth model. It is an extension of the Solow model which allows output to grow in proportion to capital.

A limitation of the basic versions of all four models mentioned above is exogenous growth in capital and labor. Their advantage is 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 not the case if we consider technological development, economies of scale

and scope, and population growth. Hence, to capture the fundamentals behind growth, endogenous growth models must be employed.

As mentioned, augmenting the basic versions, or extending into general equilibrium (GE) or real business cycle (RBC) models, may yield empirical frameworks with endogenous growth. These models differ from the ones described above in that long run growth is not converging. More important for our case is that fiscal policies will affect growth, and therefore changes in the savings rate can have direct and indirect effects on growth[9]. In this sense, dynamic models are usually more adequate to determine the effects of tax reforms.

Meta-Regression Analysis

Multiple regression analysis predicts the value of a dependent variable based on other independent variables. Meta regression analysis can provide information on both whether there is a relationship between the variables and the form of these relationships. Using control variables for properties like methodology, variable definition and sample characteristics, it is possible to infer around the obtained results for different studies.

Most studies that use the meta-regression analysis have as input econometric studies. However, there are too few econometric studies on the effects of tax reforms on economic growth to make a robust meta-regression analysis. There are however several calibration studies on the topic of tax reform. Since calibration exercises are more vulnerable than econometric studies for specification bias, the meta-regression analysis seems to be a good way to try to evaluate the robustness of the results obtained via calibration.

The ordinary least square regression model is used to compare control variables (indicator variables) for model structure and parameter variables for model parameterizations. The methodology for meta-analysis is based on Stanley (2001). See also Card and Krueger (1995), Phillips and Goss (1995), Stanley (1998), Stanley and Jarrell (1998), Görg and Strobl (2001), and Jarrell and Stanley (2004). The meta-regression model is of the form:

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j Z_{ij} + \varepsilon_i \qquad i = 1,2,\dots,n \tag{3}$$

[9] For an opposing view see Mendoza et al. (1997).

where Y_i is the average tax elasticity in study i, and Z_{ij} represents the meta-independent variables characterizing the calibration studies in the sample in order to explain the variation in the Y_is across the studies. β_j is the coefficient of the jth control variable (see list in table 2), and ε_i is the error term. In the next section, we discuss the studies used in the meta-regression analysis (see list in table 1).

Tax Elasticity

Given that the different calibration studies used in the meta-regression exercise employ different measures of output, we calculate the tax elasticity associated with each study. We follow, in particular, the methodology by Philips and Goss (1995). Tax elasticity is the percentage change in real output caused by a one percent change in tax progressivity. Average tax elasticity is then:

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

where $\Delta\gamma$ is efficiency gain, m is the number of elasticity estimates. In turn, tax progressivity is defined as the ratio:

$$\Theta = \frac{1-\tau_s}{1-\tau_c} \tag{2}$$

where τ_s is the lowest effective marginal tax rate and τ_c is the highest[10]. Using the tax progressivity ratio allows for inferring whether changes in output are due to changes in tax level or tax progressivity.

3. LITERATURE REVIEW

In this section we review the calibration studies used in the meta-regression analysis. As discussed by Jensen (2008), Heath (2006) and Clemens et al. (2001), the literature on the effects of tax reform on economic growth is quite extensive. However, a number of studies on flat tax were left out of the meta-regression analysis due to their methodology. In

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

addition, as we have mentioned previously, we limit our meta-regression analysis to calibration studies given the few econometric studies available[11].

Altig and Carlstrom (1991) study the interaction between inflation, taxation and macroeconomic performance in an overlapping-generations model. 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.

Pecorino (1994), based on Lucas' (1990) framework with an extended human capital production function, studies the growth effects of a tax reform in the US. He finds that removing tax on physical capital earnings (from a 36 percent rate) would increase the wage tax rate from 40 to 45 percent and reduce the 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 would 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. On the other hand, when unions take into account the disutility of work of union members, long run output can increase 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. They find that eliminating all taxes (which equals reducing tax progressivity to 1) would yield 0 - 0.33 percentage point increases in growth rate.

[11] On econometric studies see Vedder (1985), Koester and Kormendi (1987), Colombino and del Boca (1990), Padovano and Galli (2001) and Lee and Gordon (2005).

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. Two tax reforms are considered: a flat rate consumption tax similar to Hall-Rabushka's flat tax, and a flat rate income-based value-added tax. They find that a revenue neutral flat consumption tax of 21.7 percent yields a 3.3 percent increase in long run output, whereas the income-based tax with a rate of 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. In particular, more neutral tax systems can increase long run output by 1.72 – 6.03 percent, depending on the responsiveness in the 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 of 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. The effects of introducing flat rate taxes are significant, and aggregate welfare is unambiguously higher. Growth effects of eliminating tax

progressivity amount to 0.13 – 0.53 percentage points on growth rate, while welfare effects amount 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 (yet some groups lose). The estimated long run increase in output ranges from 1.9 percent in the case of a flat tax with transition relief, to 9.4 percent in the case of a proportional consumption tax.

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) for the US. They show that the decrease in tax progressivity from the Tax Reform Act of 1986 (TRA-86) increased the growth rate of output per capita by 0.12 – 0.34 percentage points.

Conesa and Krueger (2006) 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 to a flat marginal tax rate of 17.2 percent and a fixed deduction of USD 9 400, yielding a shift in GDP per capita of 0.64 percent. They also show 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. 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 were even higher, ranging from 1.9 to 6 percent. This is consistent with other research proposing that taxing

consumption rather than income has 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 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 of 23.11 percent combined with a fixed deduction of 30 percent of per capita income will reduce the tax payable for the 60 percent with lowest incomes, and still yield a 5.1 percent increase in output.

Díaz-Giménez and Pijoan-Mas (2006) study the consequences of two revenue-neutral flat tax reforms in the US. In the lower progressivity case (flat marginal tax rate of 22 percent and fixed deductions of USD 16 000), output increases by 2.4 percent and productivity by 3.2 percent. There is, however, a welfare loss of -0.17 percent. On the other hand, in the higher progressivity case (flat marginal tax rate of 29 percent and fixed deduction of USD 32 000), output decreases by -2.6 percent and productivity by -1.4 percent. In this case there is a welfare gain of 0.45 percent. The contractionary results, however, make this reform less feasible. Finally they conclude that flat taxes are better for the poorer than progressive tax regimes.

The Office of Tax Analysis, US Department of the Treasury (2006) studies the economic effects of extending marginal tax reductions enacted in 2001 and 2003, which are 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 compared to 1.1 percent, and is strongly discouraged.

Elger and Lindqvist (2007) study the effects of a flat tax reform in Sweden. They find that a strictly proportional tax scheme with a marginal tax rate of 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 of 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.

As we can see, the effects of tax reforms on economic growth are quite diverse. It is therefore important to be able to provide a unifying figure that can serve as a guide to governments. We propose to do this in the next sections.

4. META-REGRESSION ANALYSIS

Sample Description and Modification

As noted by Görg and Strobl (2001) the selection of variables in a meta-regression analysis is usually arbitrary, since there is no theory to guide us on the choice. We opt by following Phillips and Goss' (1995) suggestion of choosing a set of moderator variables that are commonly used in calibration studies (see table 2). These moderator variables are dummies describing the characteristics of each study regarding measure, data source, and model structure. We further include the study parameters which Stokey and Rebelo (1995) find to be significantly correlated with output estimations. Labor supply elasticity is not included, however, as all but one study (González-Torrabadella and Pijoan-Mas, 2006) treat this parameter endogenously. Tax treatment of human capital is assumed to be well covered by the dependent variable.

A preliminary regression (1) (see table 3) shows that the moderator variables constitute a poor model fit, in that adjusted R-squared is 0, and the variance inflation factors range from 3.3 to 23.5. The multicollinearity problem is confirmed. A Pearson correlation test shows that the number of variables that are significantly correlated is relatively high. 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. Only one parameter variable is not significantly correlated with the other variables. 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. The correlation between *AVG_ELASTICITY* and these three

moderator variables, which are directly attached to the measure (i.e. whether the change in output is measured at level or growth rate, in percent or percentage points, overall or per capita) 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) (see table 3) shows, on the other hand, that none of the three variables have significant explanatory effect on *AVG_ELASTICITY*. Furthermore, the variance inflation factors range from 1.3 to 2.7, which indicates a moderate correlation. These contradictory results verify the multicollinearity problem.

To reduce the distortionary effects of multicollinearity, we address the issue of having mapped a larger number of variables than the obtained sample size. Campos et al. (2005) emphasize general-to-specific modeling as a viable method for selecting useful empirical models. The general model is reduced by eliminating statistically insignificant variables while maintaining congruence. As some growth models (described in section 2, and employed in the studies reviewed in section 3) have similar or overlapping specifications, we may assume that the properties of the most correlated moderator variables are interlinked with other moderator variables. In order to establish congruence initially we modify the regression model by substituting the four most correlated moderator variables with the four study parameters. A total of 16 control variables (k) are hence analyzed initially. The parameter variables are biased towards the mean by replacing missing values by mean values. Each parameter variable contains from two to eight missing values for different studies, which would result in 12 eliminated studies if not using the mean value or omitting the variables. The estimation bias is controlled for in 18 regressions with different setups, where the preliminary model parameter variable coefficients are compared with parameter variable coefficients estimated under alternative conditions.

The tax reform scenarios differ in terms of tax progressivity. For simplicity, we assume that the obtained tax progressivity reflects the full potential of tax progressivity change. In some cases the flat tax is 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. Hence the tax elasticity might be understated, rather than the opposite.

The effect on output relative to change in tax progressivity – tax elasticity – is shown in the dependent variable AVG_ELASTICITY. For all studies included in the meta-regression there is a negative correlation between tax progressivity and output, hence a stronger effect is indicated by increasing the negative tax elasticity. The studies in the regression are sorted by calibration benchmark year to be able to take into account differences in model calibrations as the modeled economies change.

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 measures 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

Meta-Regression Analysis

The general regression model (3) is then (table 3):

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

where $AVG\_ELASITICTY_i$ is the average tax elasticity of study i, $\beta_j x$ is the coefficient of the jth moderator or parameter variable, and ε_i is the error term.

The general regression model fits the data very well. There are however two indications that multicollinearity is still present. First, from the aforementioned Pearson correlation test, now nine moderator and parameter variables are significantly correlated with the dependent variable at 1, 5 or 10 percent level. Additionally three instances have correlation close to but above the 10 percent level. Second, the variance inflation factors are still rather high, ranging from 3.6 to 22.2.

We then reduce the general regression model by omitting the insignificant variables *PRODUCTIVITY* and *HETERO*. This solves to a large extent both the previously mentioned problem and the multicollinearity issues.

The final and our preferred meta-regression model (4) is hence of the form (table 3):

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

As shown in table 3, the variance inflation factors are now in the range from 2.6 to 10.7, still indicating a degree of multicollinearity, however, 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 discussed, 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 are used first to avoid bias, then maximum and minimum values are used to control for extremes. The sensitivity analysis shows that the estimated coefficients for *CAP_SHARE*, *TIME_DISC* and *INT_SUBST* hold relatively well. For *CAP_DEP* the test shows high volatility in the coefficient estimates. As the variable only has eleven observations, this is reasonable. The bias towards the mean for all parameter variables must however be accounted for when drawing any conclusions.

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

Model Testing and Interpretation

Comparing the standard errors of the residuals from the analysis of variance with the mean of AVG_ELASTICITY, it appears that the standard errors are 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 can demonstrate whether the null hypothesis may be rejected. 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 problem can however still be present. The residual plots show that the required conditions are met to a reasonable extent, since the residuals are approximately normally distributed and have a constant variance. However they can be somewhat autocorrelated, given that 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) for positive and negative autocorrelation, the test is inconclusive. A Pearson test shows no evidence of correlation between average benchmark year and AVG_ELASTICITY. Summing up, from the above it then appears that the model's fit is good[12].

For the coefficients, the corresponding P-values denote whether the null hypothesis is true (high P-value) or not. The latter case is denoted in the regression table with the significance level of the t-statistics. 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. Hence the size and negativity of the intercept is not to be strictly interpreted, however it fits well with the direction given by the studies in the meta-regression. The measure moderator variable coefficients have the expected sign, except for

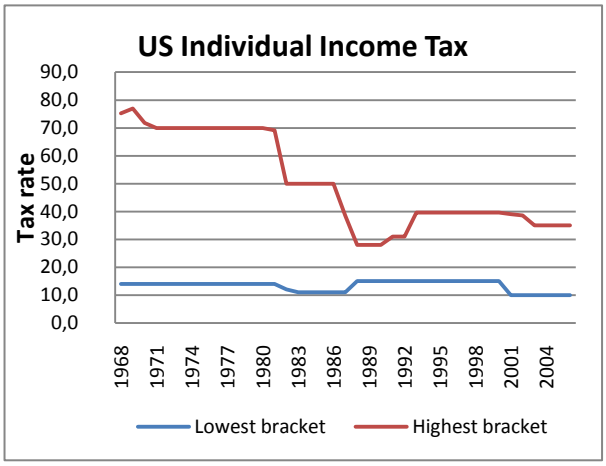
[12] It is worth mentioning that the final regression model shows a slightly less good fit than the initial model, even though the variance inflation factor is reduced by more than half. This indicates that the final model is more robust against interdependence between variables without losing explanatory value.

CH_PERCENT and *COUNTRY*. The decreasing effect of using percent as opposed to percentage points is surprising, as the data clearly show that the tax elasticity in studies using percentage points is overall much lower than in the studies using percent. The coefficient may be biased however due to multicollinearity as its variance inflation factor is 8.7. Using US data only reduces the predicted elasticity by 0.266, however due to the low number of non-US studies in the regression, the result is not robust. If the overlapping generations model was used instead, 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. In turn, differences in skills and an open economy reduce the elasticity by 0.240 and 0.138. 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 elasticity[13].

The consistently good fit of the meta-regression analyses illustrates that the calibration model specification and parameterization have a significant effect on outcomes. This implies 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 is of less importance in terms of time. As tax policies in fact evolve over time in what respects tax progressivity, this indicates a model specification problem. See figure 2 for an illustration of tax progressivity in the US for the period covered by the studies. Intuitively, the effects of introducing a flat tax should be declining until 1988, increasing between 1988 – 1993, and then be stable until 2006, except for the lag between 2000 and 2002. For the studies no such conclusions can be drawn. Comparing with the run chart in figure 3 there is a trend to broaden the model specification. This suggests that the earlier studies were more strict and static than the more recent ones, ignoring important effects of reducing tax progressivity.

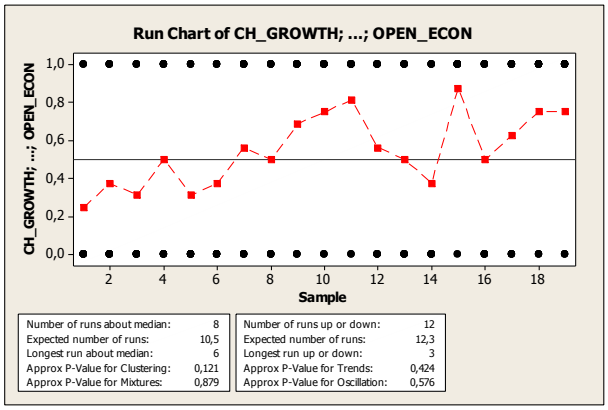
[13] The model also indicates that including heterogeneous agents will yield higher elasticity, whereas a productivity variable will have modest effects.

Figure 2: 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).

Figure 3: 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 useful for aggregate predictions is interesting. Also the use of econometrically derived sufficient statistics for calibration models will improve the prediction quality.

We conclude the meta-regression analysis by introducing 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 predicted using the regression model (4) in table 3. Means are used for missing values. There is reasonable fit between predicted and average tax elasticity, where the predicted mean tax

elasticity is -0.141 with boundaries -0.220 and -0.063 (95 percent confidence interval). This equals the mean of the average tax elasticity, but the boundaries are slightly wider (upper bound of average tax elasticity is -0.211, lower bound is -0.072). In order to derive efficiency gains from tax elasticity and changes in tax progressivity, equation (1) is then reduced to:

$$\Delta\gamma = -\Delta\Theta Y_i \tag{4}$$

The mean reduction in tax progressivity in the studies used in the meta-regression is 0.48. This implies that the average increase in the long run growth is 6.75 percent for the studies analyzed, with upper and lower boundaries at 10.06 and 3.44 percent, respectively. The prediction is equivalent to the range found in econometric studies, with boundaries at 10.51 and 2.99 percent.

5. INTRODUCTION OF FLAT TAX REFORM IN THE OECD COUNTRIES

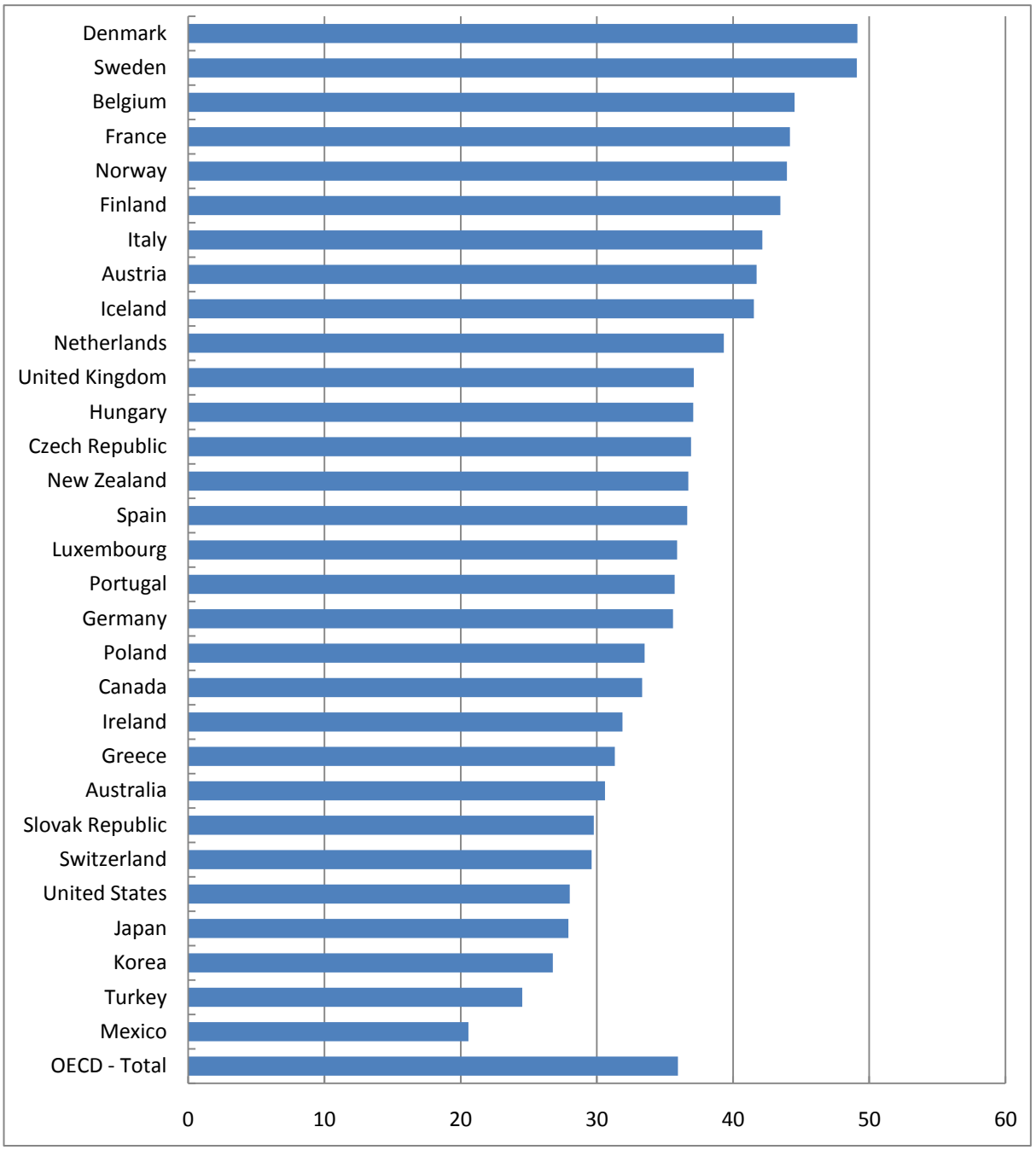
The marginal income tax rates and the corresponding tax progressivity for the OECD countries in 2007 are listed in table 4. As before, the personal allowance implies a lower marginal tax rate of zero. The total tax burden for persons and businesses is shown in figure 4, further comprising business taxes, value added taxes, and duties; including these would drive up the effective marginal tax rates extensively. For example, according to the OECD Economic Survey of Sweden for 2007, combining "social contributions, income and consumption taxes drives the effective marginal tax rate above 70 percent for over a third of the full-time employed, helping to explain why working hours for those employed are below the OECD average" (OECD, 2007). 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.

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) Tax progressivity authors' own calculations.
*) 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

Figure 4: Total Tax Revenue as Percentage of GDP, 2006



Source: OECD Centre for Tax Policy and Administration, Revenue Statistics 1965-2007, 2008 Edition, Chart A.
OECD – Total is authors' own estimate (unweighted average) based on data from OECD.Stat.

Bottom marginal tax rates are zero for all countries[14] 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.

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

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

All studies used in the meta-regression analysis in section 4 are related to a single OECD country. In turn, the econometric studies mentioned previously, concern one or several OECD countries. Comparing the results from the final regression model with estimations for the OECD countries will hence yield relevant estimates, even if not directly transposable. These estimations are then based on the relation between tax elasticity, tax progressivity, and economic growth, which the meta-regression analysis finds to be robust. As most of these studies consider long run growth effects this is also the emphasis in the following. The studies yielding efficiency gains as an increase in the growth rate are however consistent with the remaining ones and the effects on economic growth would 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 burdens in the OECD countries, as shown in figure 4, 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 a downward pressure on governments' fiscal policies and a lower tax burden; whereas lower tax elasticity 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 the tax burden. Modeling and measuring this relationship are outside the scope of this paper, hence the more simple linear relationship between tax burden and tax elasticity is assumed[15]. Still, increased tax revenue may be expected, as a simplified and less intrusive tax scheme provides less incentive for evasion

[15] Trabandt and Uhlig (2007) find that EU-15 is moving closer to the peak of the 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.

and avoidance (Hall and Rabushka, 1995). Schneider (2005) estimates the average shadow economy for 21 OECD countries to 16.3 percent.

Although the three non-US studies show an elasticity well below the mean of the US studies (-0.158), they are within the similar range (-0.503 to -0.003). A regression using the mean elasticity for the US, and the elasticity for Sweden, Spain and Denmark, and the respective tax burdens in figure 4 indicates however that using the tax burden as proxy for tax elasticity is a reasonable approximation. 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 predictions using the regression equation for the US, Spain, Sweden and Denmark with the average tax elasticity 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

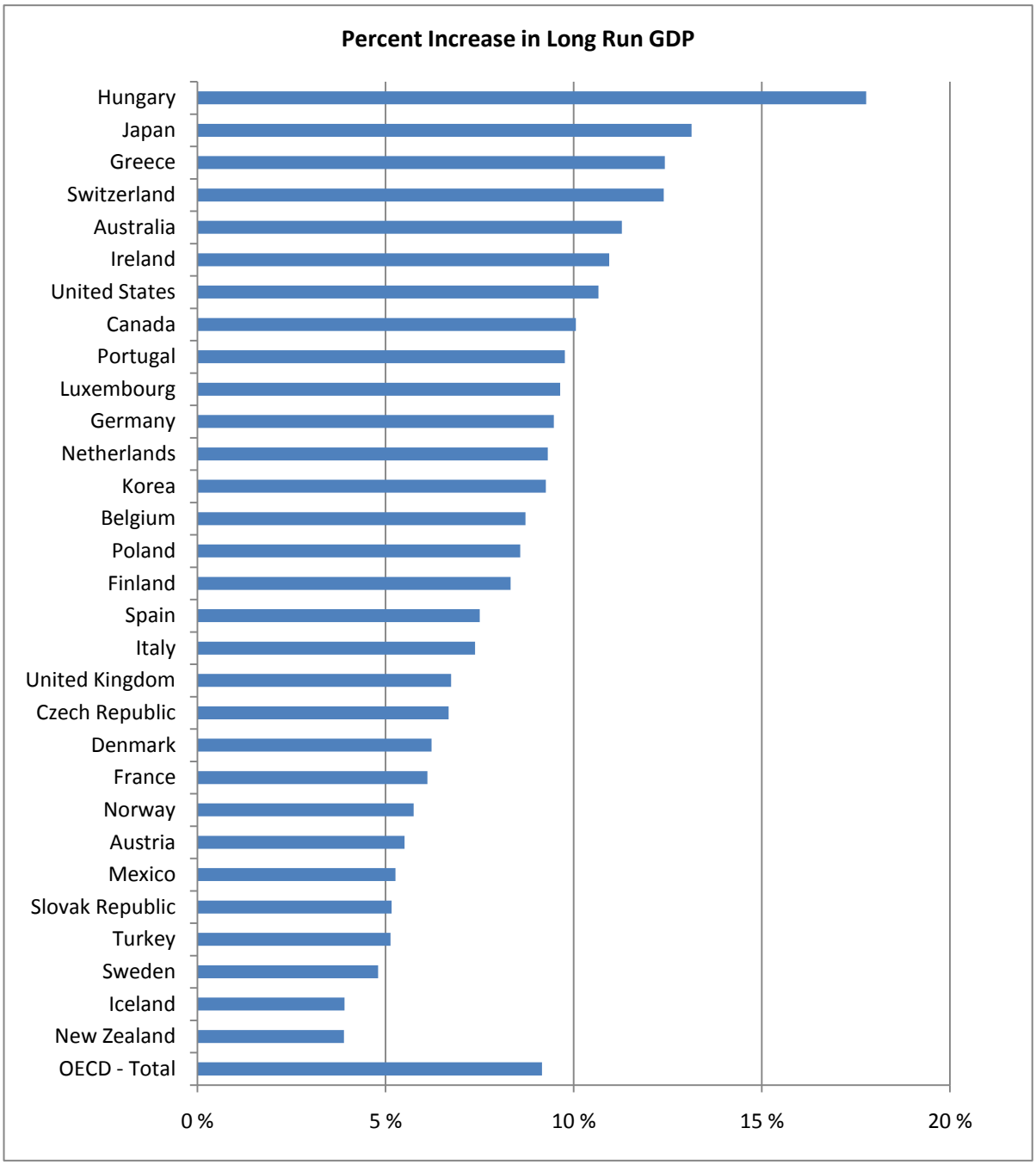
Source: Tax versus GDP ratio is from OECD Centre for Tax Policy and Administration, Revenue Statistics 1965-2007, 2008 Edition, table 1. Elasticities are based on author's own calculations.

The changes in the 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 avoids entering into an extensive analysis of tax rates and deduction levels, which are likely to be different for each country since the current tax levels differ substantially (see table 4).

Comparing the average tax elasticity and the tax progressivity reduction shows that the change in tax progressivity has a larger share of the efficiency gain than do changes 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. Like most studies concerning the US, which has relatively low tax progressivity compared to other OECD countries, the overall increase is expected to be somewhat larger.

Tax progressivity for each OECD country is seen from table 4. The reductions in tax progressivity range from 0.29 to 2.45. By utilizing equation (4) the efficiency gains for the OECD countries are estimated based on the approximated tax elasticity 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 5 shows the individual estimations. These are then compared with other studies in order to control for the validity of the estimates.

Figure 5: Growth Potential from Flat Tax Reforms for the OECD Countries in 2007



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

The estimated results for nine 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.

- Canada (10.06 percent): Similar to the efficiency costs of the current tax scheme, which Diewert (1988) finds 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.

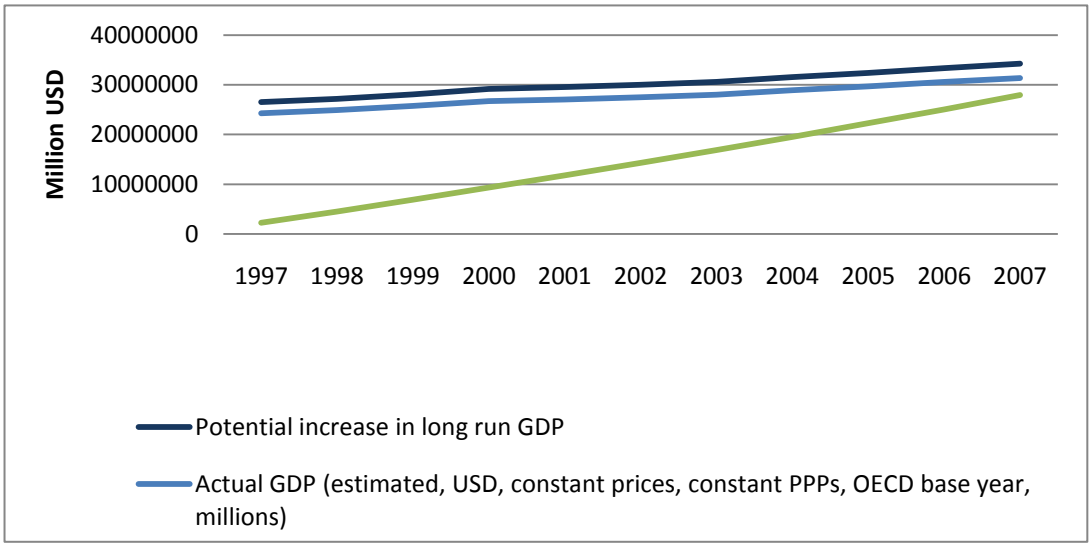
- Denmark (6.23 percent): Slightly higher than the estimate of 5.4 percent in Jensen, Nielsen, Pedersen and Sorensen (1994).
- Italy (7.38 percent): Comparable to Colombino and del Boca (1990) who estimate 43.75 percent less inefficiency in the purely flat tax scheme.
- Norway (5.75 percent): Exceeds the estimations in Stølen et al. (1999), where output effects range from -0.65 percent to 0.63 percent by a revenue neutral tax reform (tax progressivity is reduced by half of the present reduction). The predicted efficiency gain is however 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 of 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): 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 that Elger and Lindqvist (2007) find when analyzing a pure flat tax scheme.
- United Kingdom (6.74 percent): Similar to the 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. Congressional Budget Office, US Congress (1997) also refers to general equilibrium and structural macroeconomic models which yield increases in long run growth by 1 to 10 percent. Romer and Romer (2007) find even larger effects in their 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 nine other studies on flat tax reforms, these range 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 the effective marginal tax rates which Padovano and Galli (2001) estimate to be 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 probable effect of flat tax reforms on economic output for the OECD countries is shown in figure 6.

Figure 6: Growth Potential from Flat Tax Reforms for the OECD Countries 1997 – 2007



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

Engen and Skinner (1996) note that even modest growth effects have large long run effects. To illustrate this, figure 6 also shows the accumulated foregone output for the period 1997 to 2007.

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 rate needs to 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 less wealthy 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.

Sensitivity Analysis

The estimated growth for the OECD countries is based on the tax elasticity and tax progressivity. The tax elasticity is based on estimated growth effects relative to changes in tax progressivity. Hence an estimation bias might be 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 tables 6 and 7.

Table 6: Sensitivity Analysis Dependent Variable

Dependent: $\overline{\Delta\boldsymbol{\gamma}}$ (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

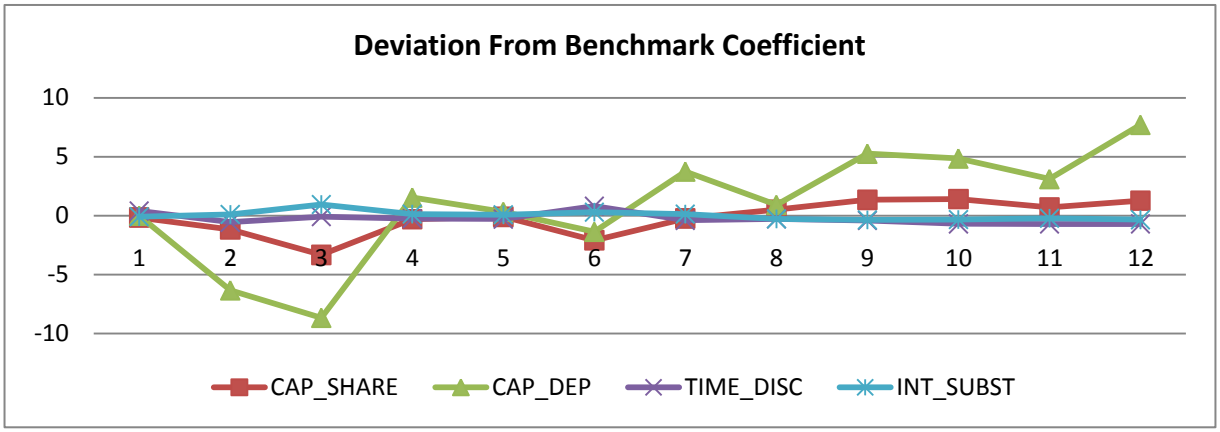
Table 7: Sensitivity Analysis Moderator and Parameter Variables

Dependent: $\overline{\Delta\boldsymbol{\gamma}}$ (percent)	$\overline{\Delta\Theta}\boldsymbol{Y_i}$	
	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

For the dependent variable the estimations used in the meta-regression analysis vary more than the estimations for the OECD countries. The wider range is reasonable as the estimates are based on the meta-regression elasticity ranging from -0.503 to -0.003, compared with the approximated elasticity 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 the tax elasticity has a smaller share of efficiency gain than do changes 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 figure 7 and table 8 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.

Figure 7: Estimated Parameter Variable Coefficients Deviation from Benchmark Coefficient



The sensitivity analysis shows that the estimated effects on economic growth from introducing a flat tax reform 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 8: Control of Estimated Parameter Variable Coefficients

	Benchmark coefficien	Altered coefficient sourc	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

2 CONCLUSION

This paper 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 tax reform calibration studies, of which 15 concern the 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 our 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 may be complemented by the long run solutions provided by flat tax schemes. The flat tax era is still at its infancy, but the opportunities for change have improved. We have shown that flat tax reforms might reduce the length and depth of the current worldwide economic downturn, to speed up recovery and improve future growth and prosperity.

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. Second, a measure which also includes the removal of value-added taxes, hence completely extinguishing double taxation as intended by Hall and Rabushka (1995).

The meta-regression analysis might be further developed to include the endogenous labor supply elasticities as pointed out by Stokey and Rebelo (1995). For 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 studies using calibration methodology. A similar analysis with studies using panel data or cross-section methodologies (e.g. Vedder, 1985; Koester and Kormendi, 1987; Colombino and del Boca,

1990; Padovano and Galli, 2001; Lee and Gordon, 2005) can provide additional insights into 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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