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K. Peren Arin, Michael Berlemann, Faik Koray, Torben Kuhlenkasper

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Corresponding author:
Torben Kuhlenkasper
Hamburg Institute of International Economics (HWWI)
Office in Bremen
Fahrenheitstr. 1 | 28359 Bremen | Germany
Phone +49 (0)421 2208 - 240 | Fax +49 (0)421 2208 - 150
kuhlenkasper@hwwi.org | www.hwwi.org

HWWI Research Paper
Hamburg Institute of International Economics (HWWI)
Heimhuder Str. 71 | 20148 Hamburg | Germany
Tel +49 (0)40 34 05 76 - 0 | Fax +49 (0)40 34 05 76 - 776
info@hwwi.org | www.hwwi.org
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The Taxation-Growth-Nexus Revisited*

K. Peren Arin
Massey University
Department of Commerce
Auckland, New Zealand
&
Centre for Applied Macroeconomic Research
Canberra, Australia

Michael Berlemann
Helmut Schmidt University Hamburg
Faculty of Economics & Social Sciences
Hamburg, Germany
&
CESifo Munich, Germany

Faik Koray
Louisiana State University
Baton Rouge, United States

Torben Kuhlenkasper
Hamburg Institute
of International Economics (HWWI)
Hamburg, Germany

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Abstract

One of the major challenges of empirical tax research is the identification and calculation of appropriate tax data. While there is consensus that average marginal tax rates are most suitable for studying the effects of tax policy on economic growth, due to data limitations the calculation of marginal tax rates has been limited to the U.S. and the U.K. This paper provides calculations of average marginal tax rates for the four Scandinavian countries using the methodologies of Seater [1982, 1985] and Barro and Sahasakul [1983, 1986]. Then, by pooling the newly calculated tax rates for the Scandinavian countries with the data for the U.S. and the U.K., we investigate the effects of tax policy shocks on the per capita GDP growth rate. Our results suggest that an increase in average marginal tax rates has a negative impact on economic growth. Employing Additive Mixed Panel Models with penalized splines as estimation approach, we show that changes in tax rates have nonlinear effects. Increasing average marginal tax rates turn out to be the most distorting at relatively moderate tax rates.

Keywords: Average marginal tax rates, tax policy, economic growth, panel data analysis, additive mixed models

JEL classification: E62, H30

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1 Introduction

The question of whether tax policy has an effect on economic growth has always been on the top of the agenda of economic research. Consequently, there exists a large and reasonably clear theoretical picture of the various different channels through which taxes might or might not have an impact on long-run economic growth. According to the neoclassical growth model (Solow [1956], Swan [1956]), tax policy has no long-run effect on economic growth. This view has been eroded by endogenous growth models (see e.g. Barro [1990], King and Rebelo [1990] and Lucas [1990]) in which taxes have an influence on steady state growth rates whenever they affect investment in human or physical capital. Based on several variants of endogenous growth models, various theoretical arguments have been developed on how different types of taxes influence economic growth. However, the empirical evidence on the effects of fiscal policy on economic growth is comparatively scant and mixed (see e.g. Easterly and Rebelo [1993a], Kocherlakota and Yi [1997], Mendoza et al. [1997], Kneller, Bleaney and Gemell [1999], Widmalm [2001], Lee and Gordon [2005] or Adam and Bevan [2005]).

As far as tax policy is concerned, the inconclusive results are likely due to the different and often not fully adequate tax measures which have been in use in empirical studies. According to Mendoza et al.[1997], the main obstacle in empirical research on growth effects of tax policy is the difficulty to construct adequate tax variables. Most theoretical reasonings are based on marginal tax rates. However, time series for average marginal tax rates, the most accurate tax measure (Easterly and Rebelo [1993b]), are available only for the United States (Seater [1982, 1985] and Barro and Sahasakul [1983, 1986]) and the United Kingdom (Rym and Koray [2004]). Therefore, most empirical studies rely on either average or statutory tax rates. However, both are only rough approximations to the average marginal tax rate. For example, when variation in tax codes stem from differences in progressivity, shares of tax revenue in GDP or income typically constitute poor proxies for average marginal tax rates (Li and SARTE [2004]).

In this paper, we contribute to the cited literature in two ways. First, we calculate average marginal tax rates for the Scandinavian countries: Denmark, Finland, Norway and Sweden. Then, by combining this new data set with what is already available for the U.S. and U.K., we investigate the effects of taxation on economic growth in a panel setting by employing additive mixed models adhering the main covariate effect in a functional but otherwise a-priori unspecified form. Our results suggest that taxation is indeed distortionary for economic growth. However, the relationship is nonlinear in nature and the effect is stronger for low AMTR-levels. If taxation exceeds a certain threshold, it looses its importance and the relationship to the per-capita GDP growth rates weakens.

The remainder of the paper is organized as follows. Section 2 discusses the methodological issues in calculating average marginal tax rate measures. In section 3, we construct time series of these measures for Norway, Sweden, Finland and Denmark. We also review briefly the already existing calculations of these measures for the United States and the United Kingdom. In section 4, we give details about the employed statistical methodology and present the results of the empirical analysis of the growth effects of tax policy. Section 5 concludes.

2 Methodological issues in calculating average marginal tax rates

While calculating AMTRs based on microeconomic data is comparatively simple, this is hardly the case when dealing with macroeconomic data (RYM and KORAY, [2004]). In order to calculate AMTRs from macro data, three slightly different methodologies were employed. Before making use of them, we shall briefly outline these methods in the following.

The first methodology goes back to SEATER [1982, 1985] who calculated AMTRs by dividing the change in tax revenue ($T_i - T_{i-1}$) by the change in total income before tax ($Y_i^b - Y_{i-1}^b$) for every income class i, weighting with the share of the income class W_i and summing up for all classes:

$$AMTR^S = \sum_{i=1}^{n} \frac{T_i - T_{i-1}}{Y_i^b - Y_{i-1}^b} \cdot W_i^Y. \tag{1}$$

Instead of total income before taxes, Barro and Sahasakul [1983, 1986] use after tax income ($Y_i^a - Y_{i-1}^a$) to calculate AMTRs. In a first variant, again shares of total income before tax are used as weights for the income classes, i.e.

$$AMTR^{BI} = \sum_{i=1}^{n} \frac{T_i - T_{i-1}}{Y_i^a - Y_{i-1}^a} \cdot W_i^Y. \tag{2}$$

In a second variant, Barro and Sahasakul [1986] use the share of tax payers per income class as weights. Thus, we end up with the calculation formula

$$AMTR^{BII} = \sum_{i=1}^{n} \frac{T_i - T_{i-1}}{Y_i^a - Y_{i-1}^a} \cdot W_i^{TP}. \tag{3}$$

Whenever income is distributed unequally, the $AMTR^{BI}$ measure should exceed the $AMTR^{BII}$ measure due to the progressive tax systems in most countries. The $AMTR^{BI}$ should also exceed the $AMTR^S$ measure since total income before tax is larger than after tax. Note that the Seater measure of average marginal tax rates $AMTR^S$ can never exceed values of 100%. Since both Barro measures recur on the after tax income this holds not true for $AMTR^{BI}$ and $AMTR^{BII}$.

3 Data and calculation of average marginal tax rates

3.1 Existing data

As pointed out earlier, average marginal tax rates have already been calculated for the United States and the United Kingdom. We therefore rely on the data reported in the referring studies and describe this data only briefly in the following. A more detailed description and discussion of the data can be found in the cited literature.

The United States is the first country for which average marginal tax rates have been calculated. While the first calculations go back to Seater [1982,1985] and Barro and Sahasakul [1983,1986] it was Stephenson [1998] who extended the calculations up to 1994. Since our empirical study employs a number of additional variables which were not available before 1960 we only consider the sub-period from 1960 to 1994. Figure 1 reports the average marginal tax rates measures as calculated by Stephenson [1998].

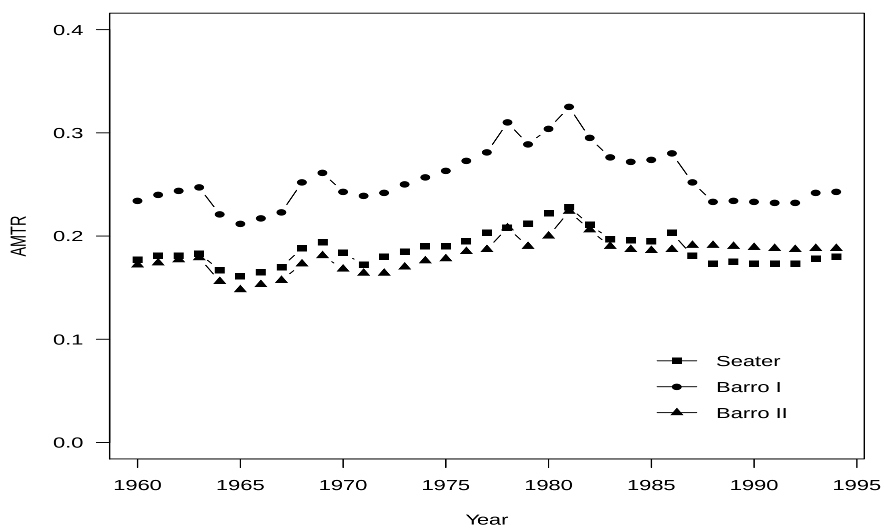

Figure 1: Average marginal tax rate measures for United States, 1960-1994

The data for the United Kingdom were taken from Rym and Koray [2004] who calculated the three average marginal tax rate measures for the period of 1948 to 1998. Again, because of data availability reasons, we only consider the data from 1960 to 1998. Figure 2 gives an overview of the average marginal tax rates measures as calculated by Rym and Koray [2004].

Figure 2: Average marginal tax rate measures for United Kingdom, 1960-1998

3.2 Newly constructed data

The data for calculating AMTRs for Norway were collected from the statistical yearbooks 1960-2004, published by NORWAY STATISTICS. With the exception of the years 1977 and 1993, the necessary data to calculate the described AMTR measures were available for the period 1957-2002. In order to calculate the three alternative AMTR measures, we used the number of tax payers per income class, ordinary income per income class and total taxes per income class. As the total income in the non-income class was zero, the two lowest income classes were pooled. The resulting AMTR measures for Norway are shown in figure 3.

The data for calculating AMTRs for Sweden were provided by STATISTICS SWEDEN on request. For Sweden, the necessary data are available for the period 1983-2003. In order to calculate the three alternative AMTR measures, we employed data on the number of people per income class, the share of tax payers per income class, total taxes per income class and tax as share of income per income class. As in Norway, the total income in the non-income class was zero.

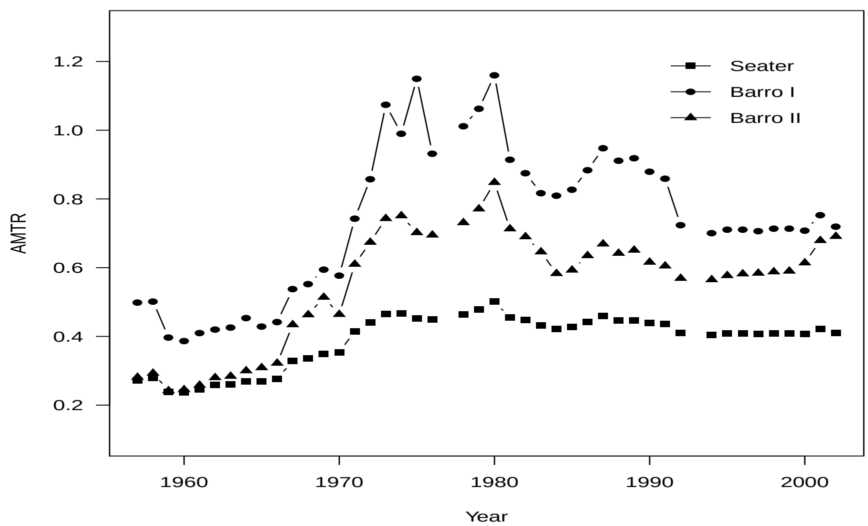

Figure 3: Average marginal tax rate measures for Norway, 1960-2004

Thus, we again pooled the two lowest income classes. The resulting AMTR measures for Sweden are shown in figure 4.

The Finnish data were extracted from statistical yearbooks, published by STATISTICS FINLAND. For Finland the necessary data are available for the period 1969-2001, except for the years 1971, 1972, 1986 and 1990. The AMTR measures were calculated using the number of taxpayers per income class and income subject to state taxation per income class[1] and total taxes per income class. As in Norway and Sweden, the lowest two income classes were pooled due to total income in the non-income class was zero. The resulting AMTR measures for Finland are shown in figure 5.

The data for Denmark were extracted from the internet pages of STATISTICS DENMARK. Appropriate data are available for the period of 1993 to 2001. The

[1]For the years 1969-1974, we used total income instead of income subject to state taxation due to lacking data. When both categories were provided in the yearbooks during the years 1975-1977, both categories were almost identical. Thus, this procedure should have no significant influence on the results.

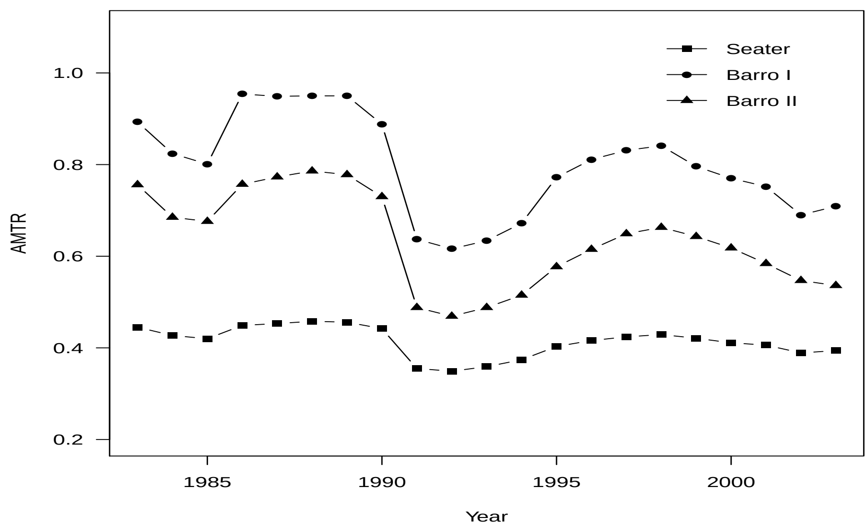

Figure 4: Average marginal tax rate measures for Sweden, 1983-2003

data for Denmark is based on surveys which are conducted annually. However, Statistics Denmark always reports average data for the last three years. This is due to the fact that every single year only one third of the survey sample is replaced with new observations. Since only the new observations contain new information on marginal tax rates, we attribute the three-year averages to the third year of every survey sample. In order to calculate the three alternative AMTR measures we employ data on the number of adult persons per household per income class, the number of households per income class, total income per income class and total taxes per income class. The resulting AMTR measures for Denmark are shown in figure 6.

4 Estimation strategy

In order to analyze the effects of tax policy on economic growth, we employ the methodology introduced by Barro [1991] and used frequently thereafter (see

Figure 5: Average marginal tax rate measures for Finland, 1969-2001

e.g. Mankiw, Romer and Weil [1992] or Jones [1994]). The so-called Barro-regressions base on the idea to regress the per-capita growth rate for a cross-section of countries on two groups of possible determinants. The first group consists of variables resulting from formal growth models such as population growth, physical and human capital or the initial level of per-capita-income. These variables serve as control variables in Barro-regressions. The second group consists of variables which are not explicitly modeled in growth models, but may have an effect on economic growth.[2] We are especially interested in the effects of a variation in the average marginal tax rate. However, as indicated by Adam and Bevan [2005] and Bania, Gray and Stone [2007] the effects of tax policy on economic growth might be non-linear. Instead of assuming a linear-quadratic relationship, we let the data specify the concrete relationship between average marginal tax rates and per-capita GDP growth. Thus, we combine a number of

[2]In his seminal contribution, Barro [1991] finds political instability and market distortions to have detrimental effects on economic growth.

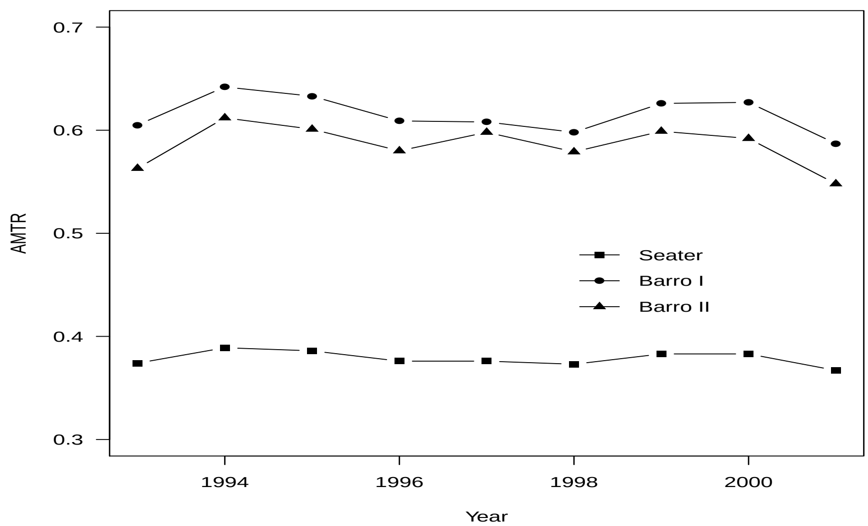

Figure 6: Average marginal tax rate measures for Denmark, 1993-2001

control variables - entering the the models in a linear way[3] - with the functional form of the average marginal tax rates measures.

Since the necessary tax data is available for only six countries, a pure cross-section analysis is infeasible. Moreover, the time series for most countries are too short to make single-country studies possible. Therefore, we rely on a panel estimation strategy to study the effects of tax policy on economic growth. In addition to the functional estimation approach, we have to take into account the (unbalanced) panel structure[4] of the data into account which exhibits unobserved heterogeneity. We do this by including unobserved country-specific (random) effects in the model.

We thus estimate a semi-parametric Additive Mixed Model, described in the sta-

[3]Even by employing a full non-parametric approach with functional forms for every covariate, the control variables reveal a linear relationship to the dependent variable for our data.

[4]The panel structure is unbalanced due to differing time periods of observations and missing values for some countries for some years.

tistical literature for instance by Wood [2006], Jiang [2007] and Zuur et.al. [2008]. In the following we outline our estimation approach in some more detail. Classical regression models assume that a response or endogeneous variable y depends on some covariates $x_1, \ldots, x_p$ in a linear fashion

$$y = \beta_0 + x_1\beta_1 + \cdots + x_p\beta_p + \epsilon,$$

where ϵ is a random noise error, usually assumed to be normally distributed. While the linear approach is simple, it is certainly too simplistic for our covariates at hand. Instead, letting $x_1, \ldots, x_q$ with $q < p$ denote metrically scaled covariates (like the AMTR measures), we replace the linear structure by a functional form

$$y = \beta_0 + f_1(x_1) + \ldots + f_q(x_q) + x_{q+1}\beta_{q+1} + \ldots + x_p\beta_p + \epsilon. \tag{4}$$

Here $f_j(x_j)$ are smooth but otherwise undetermined functions to be estimated from the data. Models of class (4) have been coined (Generalized) Additive Models by Hastie and Tibshirani [1990] and are extensively discussed in Wood [2006] (see also Ruppert et.al. [2003,2009]). Model (4) itself is not identifiable since the offset can go in any function. Therefore we need the further constraint that $f_j(x_j)$ integrates to zero with respect to the (empirical) distribution function of x_j. Fitting model (4) is carried out with penalized spline smoothing. The idea is to replace the function $f_j(x_j)$ by some high dimensional basis representation

$$f_j(x_j) = B_j(x_j)b_j,$$

where $B(.)$ can be taken as cubic smoothing spline (see Wahba [1978]). Note that since basis $B_j(.)$ is high dimensional, the resulting fit will be poor unless we impose a penalty in coefficient vector b_j. The common choice is to work with quadratic penalties of the form $\lambda_j b_j^T D_j b_j$ with D_j as the penalty matrix (see Wood [2006] for more details) and λ_j as the penalty parameter. Using cubic smoothing splines it can be shown that the quadratic form penalizes the integrated squared second order derivative of function $f_j(.)$.

Following WAHBA [1978], WONG and KOHN [1996] or WOOD [2003], we can interpret the quadratic penalty as a prior on the spline coefficients in the form $b_j \sim N(0, \lambda_j^{-1} D_j^{-1})$, which replaces the additive model (4) by

$$y|b_1, \ldots, b_j \sim N\left(\beta_0 + \sum_{j=1}^{q} B_j(x_j)b_j + \sum_{j=q+1}^{p} x_j\beta_j, \sigma_\epsilon^2\right)$$
$$b_j \sim N(0, \lambda_j^{-1} D_j^{-1}),\ j = 1, \ldots, q. \tag{5}$$

The Bayesian formulation resulting from (5) is known as Linear Mixed Model in statistics (see e.g. SEARLE ET.AL. [1992] or MCCULLOCH and SEARLE [2001]) and its estimation can be easily carried out with maximum likelihood theory. Integrating b_j in (5) gives the likelihood and we can derive σ_ϵ^2, λ_j, $j = 1, \ldots, 1$ as well as β_j, $j = q+1, \ldots, p$ as parameters. This is implemented in available software, where we make use of R, see PINHEIRO and BATES [2000] and R DEVELOPMENT CORE TEAM [2010]. The estimation is carried out with the R-package `gamm4`, see WOOD [2010].

For data analysis, where we have multiple observations per country, we supplement model (5) by introducing a country specific random effect. This takes unobserved heterogeneity in the data into account and controls for serial correlation. More specifically we replace model (5) by

$$y_{it}|b_1, \ldots, b_j \sim N\left(\beta_0 + \sum_{j=1}^{q} B_j(x_{jit})b_j + \sum_{j=q+1}^{p} x_{jit}\beta_j + \gamma_{i0}, \sigma_\epsilon^2\right)$$
$$b_j \sim N(0, \lambda_j^{-1} D_j^{-1}), j = 1, \ldots, q$$
$$\gamma_{i0} \sim N(0, \tau_0^2), \tag{6}$$

where it refers to the t-th observation drawn from the i-th country and γ_{i0} is the latest country-specific effect. Though model (6) is a conceptually serious extension of model (5), it is again a Linear Mixed Model and hence fitting is done in the same fashion and with the same software.

Our initial statistical model is thus defined as

$$gdp.growth_{it} = \alpha + f(AMTR_{it}^m) + \beta X_{it} + \gamma_{i0} + \epsilon_{it} \tag{7}$$

where $m \in \{S; BI; BII\}$, $gdp.growth_{it}$ is the per capita real growth rate of GDP for country i at time t, α is the regression constant, $AMTR_{it}$ is the average marginal tax rate measure, X_{it} is a vector of covariates, β is the vector of regression coefficients of the covariates, $\gamma_{i0} \sim N(0, \tau_0^2)$ is the country-specific effect controlling for unobserved heterogeneity and $\epsilon_{it} \sim N(0, \sigma^2)$ is the error term. The set of considered control variables is discussed in the following section

5 Control variables and data sources

5.1 Control variables

The choice of control variables in our panel regression can be based on growth theory. However, it is well known that there exist a number of competing growth theories emphasizing different sources of economic growth. Since the aim of this paper is not to discriminate between these theories, we consider a number of control variables which are most commonly used in Barro-regressions. Most economists agree that these variables may have an effect on economic growth. The influence of some of these variables might depend on whether the considered countries are in their steady states or not. For example the rate of population growth has no effect on equilibrium per-capita income growth in neoclassical growth models,[5] while this is not true on the transition path towards the steady state. Since we cannot exclude the possibility that the sample countries are not in their long-term equilibria, we decided to enter even those control variables which might have an effect on economic growth only on the path towards equilibrium. Doing so is especially necessary since we do not deal with a cross section analysis where per-capita growth rates are typically averaged over longer periods of time.

The employed control variables are described below. The data sources are summarized in Table 1.

[5]Of course, the rate of population growth is an important determinant of the equilibrium level of per-capita income.

Table 1: Control variables and data sources

Considered growth determinant	Proxy variable	Denotation	Data source
Initial level of per-capita GDP	Real per-capita gdp	*gdp.level*	Penn World Tables
Growth rate of population	Population growth rate	*pop*	Penn World Tables
Savings rate	Share of investment as a percentage of gdp	*inv*	Penn World Tables
Human capital	Tertiary education completion ratio	*com*	OECD Economic Outlook Database
Trade openness	Sum of exports and imports as a percentage of gdp	*open*	Penn World Tables
Government expenditures	Government share of real gdp per capita	*gov.share*	Penn World Tables

As it is common practice in Barro-regressions, we add the initial (log) level of the per-capita gross domestic product ($gdp - level$) to the estimation equation to control for different levels of development. It is also common to consider the rate of population growth (*pop*) as a control variable in growth regressions. Most economists agree that the savings rate is an important determinant of real per-capita growth. We calculate the savings rate via the share of investment as a percentage of gdp (*inv*). Various proxies for human capital have been in use in earlier studies. While early studies often use primary and/or secondary school enrollment rates (see e.g. Barro [1991]), more recent studies find higher education to be a more appropriate measure of human capital for OECD countries (Gemmell [1996], Griffith et al. [2004]). Therefore, we employ the tertiary education completion rate as a proxy variable for human capital. It is a well-recognized fact that there is a close relationship between growth in a country's output and growth in its volume of trade (see e.g. Jones [2002] or Weil [2009]). Thus, we also control for trade openness in our regressions. We measure trade openness by the sum of exports and imports as a percentage of GDP. Since Barro [1991], it is also customary to control for government expenditures in growth regressions. As Kocherlakota and Yi [1997] and Kneller et al. [1999] argue, doing so is especially necessary when studying the effects of tax policy. In order to control for government expenditures we add the share of the government in real per-capita gdp (*gov*) to the regressions.

With the exception of the tertiary education completion rate, which comes from the OECD Economic Outlook Database, all remaining data were extracted from the Penn World Tables.[6]

5.2 Tax measures

Our primary concern is whether tax policy affects economic growth. In order to answer this question, we estimate the described model for all three average marginal tax rate measures: Seater, Barro I and Barro II.

5.3 Dependent variable

As the dependent variable we use the per capita real growth rate of GDP. While one might also think of using the absolute real growth rate instead, the per capita rate is more useful in evaluating in how far economic welfare of the citizens of a country is affected by tax policies. We calculated the per capita real growth rate using data from the Penn World Tables.

6 Estimation results

Following the above exposition, our initial statistical model is given by

$$\begin{aligned} gdp.growth_{it} &= \alpha + f(AMTR^{m}_{it}) + \beta_1 inv_{it} + \beta_2 open_{it} + \beta_3 pop_{it} \\ &\quad + \beta_4 gov.share_{it} + \beta_4 com_{it} + \beta_5 gdp.level_{it} \\ &\quad + \gamma_{i0} + \epsilon_{it}. \end{aligned} \tag{8}$$

We estimated the model for all three AMTR measures. However, the tertiary education completion ratio (com_{it}) and the initial level of the per-capita GDP ($gdp.level_{it}$) turned out to be insignificant (p-values > 0.2 for every effect) regardless of which AMTR measure was used. This result is not too surprising, since we deal with a sample of highly developed industrial countries, which differ only slightly with respect to initial levels of development and human capital.

[6]See http://pwt.econ.upenn.edu/.

Moreover, the proxy for government expenses - though showing the expected sign - turned out to be insignificant. All variables which turned out to be insignificant on conventional significance levels except the regression constant were dropped.[7]

	$\hat{\beta}_j$ (p-value)		
effect	Seater	Barro I	Barro II
(Intercept)	-0.01 (0.65)	0.02 (0.35)	-0.01 ($<$ 0.66)
inv	0.17 ($<$ 0.01)	0.12 ($<$ 0.01)	0.16 ($<$ 0.01)
open	0.03 (0.06)	—	0.04 (0.04)
pop	-3.02 ($<$ 0.01)	-1.98 ($<$ 0.01)	-2.94 ($<$ 0.01)
Var(γ_{i0})	$<$ 0.01	$<$ 0.01	$<$ 0.01

Table 2: Parametric estimation results from the empirical models

When using the Seater AMTR measure, all remaining control variables turn out to be significant (see column 2 of table 2). Moreover, they all show the expected sign. High savings rates and high levels of trade openness increase the real growth rate of GDP while high population growth turns out to have negative growth effects. When employing the Barro II measure, the results differ only slightly. However, under the Barro I measure openness turns out to be insignificant and was dropped.

Thus, we end up with the three following empirical models for the three AMTR

[7]Including these variables had no effect on the estimation results, which are available from the authors on request.

measures:

$$\begin{aligned} gdp.growth_{it} &= \beta_0 + f(AMTR^{S}_{it}) + \beta_1 inv_{it} + \beta_2 open_{it} \\ &\quad + \beta_3 pop_{it} + \beta_4 gov.share_{it} + \gamma_{i0} + \epsilon_{it} \qquad (9) \\ gdp.growth_{it} &= \beta_0 + f(AMTR^{BI}_{it}) + \beta_1 inv_{it} + \beta_2 pop_{it} \\ &\quad + \beta_3 gov.share_{it} + \gamma_{i0} + \epsilon_{it} \qquad (10) \\ gdp.growth_{it} &= \beta_0 + f(AMTR^{BII}_{it}) + \beta_1 inv_{it} + \beta_2 open_{it} \\ &\quad + \beta_3 pop_{it} + \beta_4 gov.share_{it} + \gamma_{i0} + \epsilon_{it} \qquad (11) \end{aligned}$$

In order to study the effects of taxes on economic growth, we display the smooth effects on the scale of the linear predictor with 2-standard-error confidence bands (dashed lines).

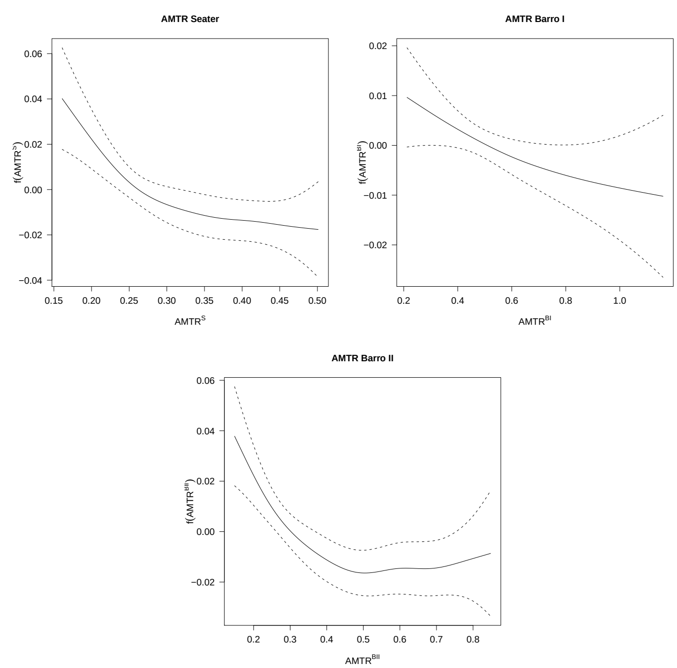

Figure 7: Smooth effect of $f(AMTR)$ with Seater, Barro I and Barro II method

In figure 7, we show the smooth effects of the three AMTR measures on economic growth. While the effects differ to some extent, they reveal a similar pattern. Lower average marginal tax rates turn out to have less detrimental effects on economic growth than higher ones. However, the negative growth effects of increases in the average marginal tax rate are most dominant for low AMTR-levels. For example, an increase in the average marginal tax rate from 0.16 to 0.23, measured by the Seater-method, depresses the economic growth rate by roughly 4 percentage points. This effect is not only statistically significant, but also economically meaningful. With increasing AMTR-levels, the distortions become smaller and finally get insignificant.[8] We thus find strong empirical evidence for non-linearities of the effects of taxation on economic activity without having to assume a concrete functional form of these effects.

6.1 Conclusions

One of the major caveats of the analysis of the effects of tax policy has been the lack of appropriate tax data. Especially data on average marginal tax rates, the most relevant tax measure for the analysis of tax policy, is quite rare. While this sort of data were available for the United States and the United Kingdom, this paper constructs the available database for the Scandinavian countries.[9] The pooled dataset allows us to study the effects of tax policy on economic growth employing a highly meaningful tax measure.

For our sample of 6 OECD countries, we find robust empirical evidence in favor of the hypothesis that taxation distorts economic growth. Interestingly, tax policy exerts non-linear effects on economic growth. At lower levels of taxation, increases in the average marginal tax rate have more detrimental effects than

[8] Of course, one should be somewhat careful with generalizing the results for AMTRs for which we have no or only limited observations. The results do not imply that increasing AMTRs to excessively high levels remains without any effect on economic growth. We simply have no observations on this situation.

[9] In order to get a broader database, it would be interesting to calculate average marginal tax rates for additional countries. However, for many OECD countries such as Germany, France or Austria the necessary tax statistics are - if at all- published only in comparatively low frequencies (typically every third year). This makes it almost impossible to construct reliable time series of average marginal tax rate measures.

on higher levels of taxation. Our results have important implications for tax policy since we find the effects of tax cuts and tax increases to depend strongly on the actual level of tax rates. At high levels of taxation, minor tax cuts may not generate any effect on economic activity and it may require a substantial tax cut to materialize an increase in economic growth.

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Hamburg Institute of International Economics (HWWI)

Heimhuder Str. 71 | 20148 Hamburg | Germany
Phone +49 (0)40 34 05 76 - 0 | Fax +49 (0)40 34 05 76 - 776
info@hwwi.org | www.hwwi.org