NBER WORKING PAPER SERIES

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Working Paper 15343
http://www.nber.org/papers/w15343

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2009

A number of people and seminar participants provided us with excellent comments, for which we are grateful, and a complete list would be rather long. Explicitly, we would like to thank Wouter DenHaan, Robert Hall, John Cochrane, Rick van der Ploeg and Richard Rogerson. This research was supported by the Deutsche Forschungsgemeinschaft through the SFB 649 ”Economic Risk”, by the RTN network MAPMU (contract HPRN-CT-2002-00237) and by the NSF grant SES-0922550. An early draft of this paper has been awarded with the CESifo Prize in Public Economics 2005. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the ECB or Sveriges Riksbank. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 15343
September 2009
JEL No. E0,E60,H0

ABSTRACT

We characterize the Laffer curves for labor taxation and capital income taxation quantitatively for the US, the EU-14 and individual European countries by comparing the balanced growth paths of a neoclassical growth model featuring ”constant Frisch elasticity” (CFE) preferences. We derive properties of CFE preferences. We provide new tax rate data. For benchmark parameters, we find that the US can increase tax revenues by 30% by raising labor taxes and 6% by raising capital income taxes. For the EU-14 we obtain 8% and 1%. Denmark and Sweden are on the wrong side of the Laffer curve for capital income taxation.

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Abstract

We characterize the Laffer curves for labor taxation and capital income taxation quantitatively for the US, the EU-14 and individual European countries by comparing the balanced growth paths of a neoclassical growth model featuring "constant Frisch elasticity" (CFE) preferences. We derive properties of CFE preferences. We provide new tax rate data. For benchmark parameters, we find that the US can increase tax revenues by 30% by raising labor taxes and 6% by raising capital income taxes. For the EU-14 we obtain 8% and 1%. Denmark and Sweden are on the wrong side of the Laffer curve for capital income taxation.

Key words: Laffer curve, incentives, dynamic scoring, US and EU-14 economy

JEL Classification: E0, E60, H0

1 Introduction

How do tax revenues and production adjust, if labor taxes or capital income taxes are changed? To answer this question, we characterize the Laffer curves for labor taxation and capital income taxation quantitatively for the US, the[1] EU-14 and individual European countries by comparing the balanced growth paths of a neoclassical growth model, as tax rates are varied. The government collects distortionary taxes on labor, capital and consumption and issues debt to finance government consumption, lump-sum transfers and debt repayments.

We employ a preference specification which is consistent with long-run growth and features a constant Frisch elasticity of labor supply, originally proposed by King and Rebelo (1999). We call these CFE ("constant Frisch elasticity") preferences. We calculate and discuss their properties as well as discuss the implications for the cross-elasticity

[1] For data availability reasons, we could not include Luxembourg in our analysis. Therefore, we refer to the EU-14 rather than the EU-15.

of consumption and labor as emphasized by Hall (2008), which should prove useful beyond the question at hand. To our knowledge, this has not been done previously in the literature and therefore provides an additional key contribution of this paper.

For the benchmark calibration with a Frisch elasticity of 1 and an intertemporal elasticity of substitution of 0.5, the US can increase tax revenues by 30% by raising labor taxes and 6% by raising capital income taxes, while the same numbers for the EU-14 are 8% and 1%. We furthermore calculate the the degree of self-financing of tax cuts and provide a sensitivity analysis for the parameters. To provide this analysis requires values for the tax rates on labor, capital and consumption. Following Mendoza, Razin, and Tesar (1994), we calculate new data for these tax rates in the US and individual EU-14 countries for 1995 to 2007 and provide their values in appendix A: these too should be useful beyond the question investigated in this paper.

In 1974 Arthur B. Laffer noted during a business dinner that "there are always two tax rates that yield the same revenues".[2] Subsequently, the incentive effects of tax cuts was given more prominence in political discussions and political practice. We find that there is a Laffer curve in standard neoclassical growth models with respect to both capital taxation and labor income taxation. According to our quantitative results, Denmark and Sweden indeed are on the "wrong" side of the Laffer curve for capital income taxation.

Following Mankiw and Weinzierl (2005), we pursue a dynamic scoring exercise. That is, we analyze by how much a tax cut is self-financing if we take incentive feedback effects into account. We find that for the US model 32% of a labor tax cut and 51% of a capital tax cut are self-financing in the steady state. In the EU-14 economy 54% of a labor tax cut and 79% of a capital tax cut are self-financing.

We show that the fiscal effect is indirect: by cutting capital income taxes, the biggest contribution to total tax receipts comes from an increase in labor income taxation. We show that lowering the capital income tax as well as raising the labor income tax results in higher tax revenue in both the US and the EU-14, i.e. in terms of a "Laffer hill", both the US and the EU-14 are on the wrong side of the peak with respect to their capital tax rates.

[2]see Wanniski (1978).

There is a considerable literature on this topic, but our contribution differs from the existing results in several dimensions. Baxter and King (1993) employ a neoclassical growth model with productive government capital to analyze the effects of fiscal policy. Garcia-Mila, Marcet, and Ventura (2001) use a neoclassical growth model with heterogeneous agents to study the welfare impacts of alternative tax schemes on labor and capital.

Lindsey (1987) has measured the response of taxpayers to the US tax cuts from 1982 to 1984 empirically, and has calculated the degree of self-financing. Schmitt-Grohe and Uribe (1997) show that there exists a Laffer curve in a neoclassical growth model, but focus on endogenous labor taxes to balance the budget, in contrast to the analysis here. Ireland (1994) shows that there exists a dynamic Laffer curve in an AK endogenous growth model framework, with their results debated in Bruce and Turnovsky (1999), Novales and Ruiz (2002) and Agell and Persson (2001). In an overlapping generations framework, Yanagawa and Uhlig (1996) show that higher capital income taxes may lead to faster growth, in contrast to the conventional economic wisdom. Floden and Linde (2001) contains a Laffer curve analysis. Jonsson and Klein (2003) calculate the total welfare costs of distortionary taxes including inflation. They find them to be five times higher in Sweden than the US, and that Sweden is on the slippery slope side of the Laffer curve for several tax instruments. Our results are in line with these findings, with a sharper focus on the location and quantitative importance of the Laffer curve with respect to labor and capital income taxes.

Our paper is closely related to Prescott (2002, 2004), who raised the issue of the incentive effects of taxes by comparing the effects of labor taxes on labor supply for the US and European countries. We broaden that analysis here by including incentive effects of labor and capital income taxes in a general equilibrium framework with endogenous transfers. Their work has been discussed by e.g. Ljungqvist and Sargent (2006), Blanchard (2004) as well as Alesina, Glaeser, and Sacerdote (2005). The dynamic scoring approach of Mankiw and Weinzierl (2005) has been discussed by Leeper and Yang (2005).

Like Christiano and Eichenbaum (1992), Baxter and King (1993), McGrattan (1994), Lansing (1998), Cassou and Lansing (2006), Klein, Krusell, and Rios-Rull (2004) as well as Trabandt (2006), we assume that government spending may be valuable only insofar as it provides utility separably from consumption and leisure.

The paper is organized as follows. We specify the model in section 2 and its parameterization in section 3. Section 4 discusses our results. Further details are contained in the appendix as well as in a technical appendix.

2 The Model

Time is discrete, $t = 0, 1, \ldots, \infty$. The representative household maximizes the discounted sum of life-time utility subject to an intertemporal budget constraint and a capital flow equation. Formally,

$$max_{c_t,n_t,k_t,x_t,b_t} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t, n_t) + v(g_t) \right]$$

s.t.

$$\begin{aligned} (1+\tau_t^c)c_t + x_t + b_t &= (1-\tau_t^n)w_t n_t + (1-\tau_t^k)(d_t - \delta)k_{t-1} \\ &\quad + \delta k_{t-1} + R_t^b b_{t-1} + s_t + \Pi_t + \mathrm{m}_t \\ k_t &= (1-\delta)k_{t-1} + x_t \end{aligned}$$

where c_t, n_t, k_t, x_t, b_t, m_t denote consumption, hours worked, capital, investment, government bonds and an exogenous stream of payments. The household takes government consumption g_t, which provides utility, as given. Further, the household receives wages w_t, dividends d_t, profits Π_t from the firm and asset payments m_t. Moreover, the household obtains interest earnings R_t^b and lump-sum transfers s_t from the government. The household has to pay consumption taxes τ_t^c, labor income taxes τ_t^n and capital income taxes τ_t^k. Note that capital income taxes are levied on dividends net-of-depreciation as in Prescott (2002, 2004) and in line with Mendoza, Razin, and Tesar (1994).

Note further that we assume there to be an asset ("tree"), paying a constant stream of payments m_t, growing at the balanced growth rate of the economy. We allow the payments to be negative and thereby allow the asset to be a liability. This feature captures a permanently negative or positive trade balance, equating m_t to net imports, and introduces international trade in a minimalist way. As we shall concentrate on balanced growth path equilibria, this model is therefore consistent with an open-economy interpretation with source-based capital income taxation, where the rest of the world grows at the same rate and features households with the same time preferences. Indeed, the trade balance plays a role in the reaction of steady state labor to tax changes and therefore for the shape of the Laffer curve. For transitional issues, additional details become relevant. Our model is a closed economy. Labor immobility between the US and the EU-14 is probably a good approximation. For capital, this may be justified with the Feldstein and Horioka (1980) observation that domestic saving and investment are highly correlated or by interpreting the model in the light of ownership-based taxation instead of source-based taxation. In both cases changes in fiscal policy will have only minor cross border effects. For explicit tax policy in open economies, see e.g Mendoza and Tesar (1998) or Kim and Kim (2004) and the references therein.

The representative firm maximizes its profits subject to a Cobb-Douglas production technology,

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

s.t.

$$y_t = \xi^t k_{t-1}^{\theta} n_t^{1-\theta} \tag{2}$$

where ξ^t denotes the trend of total factor productivity.

The government faces the budget constraint,

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{3}$$

where government tax revenues T_t are

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k (d_t - \delta) k_{t-1}. \tag{4}$$

Our goal is to analyze how the equilibrium shifts, as tax rates are shifted. We focus on the comparison of balanced growth paths. Assume that

$$m_t = \psi^t \bar{m} \tag{5}$$

where ψ is the growth factor of aggregate output. Our key assumption is that government debt as well as government spending do not deviate from their balanced growth pathes, i.e.

$$b_{t-1} = \psi^t \bar{b} \tag{6}$$

and

$$g_t = \psi^t \bar{g} \tag{7}$$

When tax rates are shifted, government transfers adjust according to the government budget constraint (3), rewritten as

$$s_t = \psi^t \bar{b}(\psi - R_t^b) + T_t - \psi^t \bar{g}. \tag{8}$$

As an alternative, we shall also consider keeping transfers on the balanced growth path and adjusting government spending instead.

More generally, the tax rates may be interpreted as wedges as in Chari, Kehoe, and Mcgrattan (2007), and some of the results in this paper carry over to that more general interpretation. What is special to the tax rate interpretation and crucial to the analysis in this paper, however, is the link between tax receipts and transfers (or government spending) via the government budget constraint.

2.1 The Constant Frisch Elasticity (CFE) preferences

The intertemporal elasticity of substitution as well as the Frisch elasticity of labor supply are key properties of the preferences for the analysis at hand. As a benchmark, it is reasonable to assume that preferences are separable, consistent with long-run growth (i.e. consistent with a constant labor supply as wages and consumption grow at the same rate) and feature a constant Frisch elasticity,

$$\varphi = \frac{dn}{dw}\frac{w}{n}|_{\bar{U}_c} \tag{9}$$

We shall call preferences with these features "constant Frisch elasticity" preferences or CFE preferences. As this paper makes considerable use of these preferences, we shall investigate their properties in some detail. The following result has essentially been stated in King and Rebelo (1999), equation (6.7) as well Shimer (2008), but without a proof.

Proposition 1 *Suppose preferences are separable across time with a twice continuously differentiable felicity function $u(c,n)$, which is strictly increasing and concave in c and $-n$, discounted a constant rate β, consistent with long-run growth and feature a constant Frisch elasticity of labor supply φ, and suppose that there is an interior solution to the first-order condition. Then, the preferences feature a constant intertemporal elasticity of substitution $1/\eta > 0$ and are given by*

$$u(c,n) = \log(c) - \kappa n^{1+\frac{1}{\varphi}} \tag{10}$$

if $\eta = 1$ and by

$$u(c,n) = \frac{1}{1-\eta}\left(c^{1-\eta}\left(1 - \kappa(1-\eta)n^{1+\frac{1}{\varphi}}\right)^{\eta} - 1\right) \tag{11}$$

if $\eta > 0, \eta \neq 1$, where $\kappa > 0$, up to affine transformations. Conversely, this felicity function has the properties stated above.

Proof: *It is well known that consistency with long run growth implies that the preferences feature a constant intertemporal elasticity of substitution $1/\eta > 0$ and are of the form*

$$u(c,n) = \log(c) - v(n) \tag{12}$$

if $\eta = 1$ and

$$u(c,n) = \frac{1}{1-\eta}\left(c^{1-\eta}v(n) - 1\right) \tag{13}$$

where $v(n)$ is increasing (decreasing) in n iff $\eta > 1$ ($\eta < 1$). We concentrate on the second equation. Interpret w to be the net-of-the-tax-wedge wage, i.e. $w = ((1-\tau^n)/(1+\tau^c))\tilde{w}$, where $\tilde{w}$ is the gross wage and where τ^n and τ^c are the (constant) tax rates on labor income and consumption. Taking the first order conditions with respect to a budget constraint

$$c + \ldots = wn + \ldots$$

we obtain the two first order conditions

$$\begin{aligned} \lambda &= c^{-\eta}v(n) & (14)\\ -(1-\eta)\lambda w &= c^{1-\eta}v'(n) & (15) \end{aligned}$$

Use (14) to eliminate $c^{1-\eta}$ in (15), resulting in

$$-\frac{1-\eta}{\eta}\lambda^{\frac{1}{\eta}}w = \frac{1}{\eta}v'(n)\left(v(n)\right)^{\frac{1}{\eta}-1} = \frac{d}{dn}\left(v(n)\right)^{\frac{1}{\eta}} \quad (16)$$

The constant elasticity φ of labor with respect to wages implies that n is positively proportional to w^{φ}, for λ constant[3]*. Write this relationship and the constant of proportionality conveniently as*

$$w = \xi_1\eta\lambda^{\frac{-1}{\eta}}\left(1+\frac{1}{\varphi}\right)n^{\frac{1}{\varphi}} \quad (17)$$

for some $\xi_1 > 0$, which may depend on λ. Substitute this equation into (16). With λ constant, integrate the resulting equation to obtain

$$\xi_0 - \xi_1(1-\eta)n^{\frac{1}{\varphi}+1} = v(n)^{\frac{1}{\eta}} \quad (18)$$

for some integrating constant ξ_0. Note that $\xi_0 > 0$ in order to assure that the left-hand side is positive for $n = 0$, as demanded by the right-hand side. Furthermore, as $v(n)$ cannot be a function of λ, the same must be true of ξ_0 and ξ_1. Up to a positive affine transformation of the preferences, one can therefore choose $\xi_0 = 1$ and $\xi_1 = \kappa$ for some $\kappa > 0$ wlog. Extending the proof to the case $\eta = 1$ is straightforward. •

Hall (2008) has recently emphasized the importance of the Frisch demand for consumption[4] $c = c(\lambda, w)$ and the Frisch labor supply $n = n(\lambda, w)$, resulting from solving the first-order conditions (14) and (15). His work has focussed attention in particular on the cross-elasticity between consumption and wages. That elasticity is generally not constant for CFE preferences, but depends on κ and the steady state level of labor

[3]The authors are grateful to Robert Shimer, who pointed out this simplification of the proof.

[4]Hall (2008) writes the Frisch consumption demand and Frisch labor supply as $c = C(\lambda, \lambda w)$ and $n = N(\lambda, \lambda w)$.

supply. The next proposition provides the elasticities of $c(\lambda, w)$ and $n(\lambda, w)$, which will be needed in (23). In particular, it follows that

$$\text{cross-Frisch-elasticity of consumption wrt wages} = \frac{\varphi}{\eta}\nu_{cn} \tag{19}$$

for some value ν_{cn}, given as an expression involving balanced growth labor supply and the CFE parameters. In equation (38) below, we shall show that ν_{cn} can be calculated from additional balanced growth observations as well as φ and η alone, without reference to κ. Put differently, balanced growth observations as well as the Frisch elasticity of labor supply and η imply a value for the cross elasticity of Frisch consumption demand. Conversely, a value for the latter has implication for some of the other variables: it is not a "free parameter". When we calibrate our model, we will provide the implications for the cross-elasticity in table 8, which one may wish to compare to the value of 0.3 given by Hall (2008). As a start, the proposition below or, more explicitly, equation (38) further below implies, that the ν_{cn} and therefore the cross elasticity is positive iff $\eta > 1$ (and is zero, if $\eta = 1$).

The proposition more generally provides the equations necessary for calculating the log-linearized dynamics of a model involving CFE preferences, or, alternatively, for solving for the elasticity of the Frisch demand and Frisch supply. Given φ, η and ν_{cn}, all other coefficients are easily calculated.

Note in particular, that the total elasticity of the Frisch consumption demand with respect to deviations in the marginal value of wealth is not equal to the (negative of) $1/\eta$, but additionally involves a term due to the change in labor supply in reaction to a change in the marginal value of wealth. This is still true, when writing the Frisch consumption demand as $c = C(\lambda, \lambda w)$ as in Hall (2008), and calculating the own elasticity per the derivative with respect to the first argument (i.e., holding λw constant). The proposition implies that

$$\text{own-Frisch-elasticity of consumption wrt } \lambda = -\frac{\varphi}{\eta}\nu_{nn} = \frac{-1}{\eta} + \frac{\varphi(1-\eta)}{\eta^2}\nu_{cn} \tag{20}$$

or (for consumption)

$$\text{own-Frisch-elasticity} = \frac{-1}{\eta} + \left(\frac{1}{\eta} - 1\right) \text{cross-Frisch-elasticity} \tag{21}$$

Therefore, this expression should be matched to the benchmark value of -0.5 in Hall (2008), rather than $-1/\eta$. We shall follow the literature, though, and use $\eta = 2$ as our benchmark calibration, and will provide values for the elasticity above as a consequence, once the model is fully calibrated. For example, the cross-Frisch-elasticity of 0.3 and a value of $\eta = 2$ implies an own-Frisch-elasticity of -0.65. Conversely, an own-Frisch-elasticity of -0.5 and a cross-Frisch-elasticity of 0.3 implies $\eta = 3.5$. The proof of the following proposition is available in a technical appendix.

Proposition 2 *Suppose an agent has CFE preferences, where the preference parameter κ_t is possibly stochastic. The log-linearization of the first-order conditions (14) and (15) around a balanced growth path at some date t is given by*

$$\begin{array}{lcl} \hat{\lambda}_t & = & \nu_{cc}\hat{c}_t + \nu_{cn}\hat{n}_t + \nu_{c\kappa}\hat{\kappa}_t \\ \hat{\lambda}_t + \hat{w}_t & = & \nu_{nc}\hat{c}_t + \nu_{nn}\hat{n}_t + \nu_{n\kappa}\hat{\kappa}_t \end{array} \tag{22}$$

or, alternatively, can be solved as log-linear Frisch consumption demand and Frisch labor supply per

$$\begin{array}{lcl} \hat{c}_t & = & \left(\frac{-1}{\eta} + \frac{\varphi}{\eta^2}\nu_{cn}\right)\hat{\lambda}_t + \frac{\varphi}{\eta}\nu_{cn}\hat{w}_t - \frac{\varphi}{\eta}\nu_{c\kappa}\hat{\kappa}_t \\ \hat{n}_t & = & \frac{\varphi}{\eta}\hat{\lambda}_t + \varphi\hat{w}_t - \varphi\hat{\kappa}_t \end{array} \tag{23}$$

where hat-variables denote log-deviations and where

$$\begin{array}{lcl} \nu_{cc} & = & -\eta \\ \nu_{cn} & = & -\left(1+\frac{1}{\varphi}\right)(1-\eta)\left(\left(\eta\kappa\bar{n}^{1+\frac{1}{\varphi}}\right)^{-1} + 1 - \frac{1}{\eta}\right)^{-1} \\ \nu_{c\kappa} & = & \frac{\varphi}{1+\varphi}\nu_{cn} \\ \nu_{nn} & = & \frac{1}{\varphi} - \frac{1-\eta}{\eta}\nu_{cn} \\ \nu_{nc} & = & 1-\eta \\ \nu_{n\kappa} & = & 1 - \frac{1-\eta}{\eta}\nu_{c\kappa} \end{array}$$

As an alternative, we also use the Cobb-Douglas preference specification

$$U(c_t, n_t) = \alpha\log(c_t) + (1-\alpha)\log(1-n_t) \tag{24}$$

as it is an important and widely used benchmark, see e.g. Cooley and Prescott (1995), Chari, Christiano, and Kehoe (1995) or Uhlig (2004).

2.2 Equilibrium

In equilibrium the household chooses plans to maximize its utility, the firm solves its maximization problem and the government sets policies that satisfy its budget constraint. Inspection of the balanced growth relationships provides some useful insights for the issue at hand. Some of these results are more generally useful for examining the impact of wedges on balanced growth allocations as in Chari, Kehoe, and Mcgrattan (2007).

Except for hours worked, interest rates and taxes all other variables grow at a constant rate

$$\psi = \xi^{\frac{1}{1-\theta}}$$

For CFE preferences, the balanced growth after-tax return on any asset is

$$\bar{R} = \beta\psi^{-\eta}, \tag{25}$$

thereby tying β to observations on $\bar{R}$ and ψ as well as assumptions on η. We assume throughout that parameters are such that

$$\bar{R} > 1 \tag{26}$$

Let $\overline{k/y}$ denote the balanced growth path value of the capital-output ratio k_{t-1}/y_t. It is given by

$$\overline{k/y} = \left(\frac{\bar{R} - 1}{\theta(1-\tau^k)} + \frac{\delta}{\theta} \right)^{-1} \tag{27}$$

which in turn imply the labor productivity and the before-tax wage level

$$\begin{aligned} \frac{y_t}{\bar{n}} &= \psi^t \, \overline{k/y}^{\frac{\theta}{1-\theta}} && (28) \\ w_t &= (1-\theta)\frac{y_t}{\bar{n}} && (29) \end{aligned}$$

This provides the familiar result that the balanced growth capital-output ratio and before-tax wages only depend on policy through the capital income tax τ^k, decreasing monotonically, and depend on preference parameters only via $\bar{R}$. It also implies that the tax receipts from capital taxation and labor taxation relative to output are given by these tax rates times a relative-to-output tax base which only depends on the capital income tax rate. The level of these receipts therefore moves with the level of output or, equivalently for constant capital income taxes, with the level of equilibrium labor.

It remains to solve for the level of equilibrium labor. Let $\overline{c/y}$ denote the balanced growth path ratio c_t/y_t. With the CFE preference specification and along the balanced growth path, the first-order conditions of the household and the firm imply

$$\left(\eta\kappa\bar{n}^{1+\frac{1}{\varphi}}\right)^{-1} + 1 - \frac{1}{\eta} = \alpha\,\overline{c/y} \tag{30}$$

where

$$\alpha = \frac{1+\tau^c}{1-\tau^n}\,\frac{1+\frac{1}{\varphi}}{1-\theta} \tag{31}$$

depends on tax rates, the labor share and the Frisch elasticity of labor supply.

The feasibility constraint implies

$$\overline{c/y} = \chi + \gamma\frac{1}{\bar{n}} \tag{32}$$

where

$$\begin{aligned}\chi &= 1-(\psi-1+\delta)\,\overline{k/y}\\ \gamma &= (\bar{m}-\bar{g})\,\overline{k/y}^{\frac{-\theta}{1-\theta}}\end{aligned}$$

Substituting equation (32) into (30) therefore yields a one-dimensional nonlinear equation in $\bar{n}$, which can be solved numerically, given values for preference parameters, production parameters, tax rates and the levels of $\bar{b}$, $\bar{g}$ and $\bar{m}$.

The following proposition follows in a straightforward manner from examining these equations, so we omit the proof.

Proposition 3 *Assume that $\bar{g} \geq \bar{m}$. Then, the solution for $\bar{n}$ is unique. It is decreasing in τ^c or τ^n, with $\tau^k, \bar{b}, \bar{g}$ fixed.*

In particular, for constant τ^k and τ^c, there is a tradeoff as τ^n increases: while equilibrium labor and thus the labor tax base decrease, the fraction taxed from that tax base increases. This tradeoff gives rise to the Laffer curve.

Similarly, and in the special case $\bar{g} = \bar{m}$, n falls with τ^k, creating the same Laffer curve tradeoff for capital income taxation. With $\bar{g} > \bar{m}$, but the unusual assumption that $\psi \leq 1 - \delta$, $\bar{n}$ can be shown to increase with τ^k. Generally, the tradeoff for τ^k appears to be hard to sign and we shall rely on numerical calculations instead.

For a consumption tax increase, labor and the consumption-output ratio falls, if $\bar{m} < \bar{g}$, because the reimbursement of the additional tax receipts as lump sum transfers lessen the incentives to work. Consider a simpler one-period model without capital and the budget constraint

$$(1 + \tau^c)c = (1 - \tau^n)wn + s \tag{33}$$

If n and s remain constant, as τ^c is changed, then the consumption tax revenue will be the share $\tau^c/(1+\tau^c)$ of the constant right-hand-side income, and therefore increases with τ^c. If the additional revenues are used to increase the transfers s and labor is chosen optimally, the right hand side increases due to the increased transfers, but decreases due to the lessened incentives to work. A Laffer curve may result, if labor supply is sufficiently elastic. We shall investigate this issue numerically.

Alternatively, consider fixing $\bar{s}$ rather than $\bar{g}$. Rewrite the budget constraint of the household as

$$\overline{c/y} = \tilde{\chi} + \tilde{\gamma}\frac{1}{\bar{n}} \tag{34}$$

where

$$\begin{aligned}
\tilde{\chi} &= \frac{1}{1+\tau^c}\left(1 - (\psi - 1 + \delta)\,\overline{k/y} - \tau^n(1-\theta) - \tau^k\left(\theta - \delta\,\overline{k/y}\right)\right) \\
\tilde{\gamma} &= \frac{\bar{b}(\bar{R} - \psi) + \bar{s} + \bar{m}}{1+\tau^c}\,\overline{k/y}^{\frac{-\theta}{1-\theta}}
\end{aligned}$$

can be calculated, given values for preference parameters, production parameters, tax rates and the levels of $\bar{b}$, $\bar{s}$ and $\bar{m}$.

To see the difference to the case of fixing $\bar{g}$, consider again the one-period model and budget constraint (33). Maximizing growth-consistent preferences as in (13) subject to this budget constraint, one obtains

$$(\eta - 1)\frac{v(n)}{nv'(n)} = 1 + \frac{s}{(1-\tau^n)wn} \tag{35}$$

If transfers s do not change with τ^c, then consumption taxes do not change labor supply. Moreover, if transfers are zero, $s = 0$, labor taxes do not have an impact either. In both cases, the substitution effect and the income effect exactly cancel just as they do for an increase in total factor productivity. This insight generalizes to the model at hand, albeit with some modification.

Proposition 4 *Fix $\bar{s}$, and instead adapt $\bar{g}$, as the tax revenues change across balanced growth equilibria.*

- *There is no impact of consumption tax rates τ^c on equilibrium labor. As a consequence, tax revenues always increase with increased consumption taxes.*
- *Suppose that*

  $$0 = \bar{b}(\bar{R} - \psi) + \bar{s} + \bar{m} \tag{36}$$

  Furthermore, suppose that labor taxes and capital taxes are jointly changed, so that

  $$\tau^n = \tau^k \left(1 - \frac{\delta}{\theta}\overline{k/y}\right) \tag{37}$$

  where the capital-income ratio depends on τ_k per (27). Equivalently, suppose that all income from labor and capital is taxed at the rate τ_n without a deduction for depreciation. Then there is no change of equilibrium labor.

Proof: *For the claim regarding consumption taxes, note that the terms $(1 + \tau_c)$ for $\tilde{\chi}$ and $\tilde{\gamma}$ cancel with the corresponding term in α in equation (30). For the claim regarding τ_k and τ_n, note that (37) together with (27) implies*

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

Then either by rewriting the budget constraint with an income tax τ_n and calculating the consumption-output ratio or with

$$\tilde{\chi} = \frac{1-\tau^n}{1+\tau^c}\left(1-\theta\frac{\Psi-1+\delta}{\bar{R}-1+\delta}\right)$$

as well as $\tilde{\gamma} = 0$, one obtains that the right-hand side in equation (30) and therefore also $\bar{n}$ remain constant, as tax rates are changed. •

This discussion highlights in particular the tax-unaffected income $\bar{b}(\bar{R}-\psi)+\bar{s}+\bar{m}$ on equilibrium labor. It also highlights an important reason for including the trade balance in this analysis.

Given $\bar{n}$, it is then straightforward to calculate total tax revenue as well as government spending. Conversely, provided with an equilibrium value for $\bar{n}$, one can use this equation to find the value of the preference parameter κ, supporting this equilibrium. A similar calculation obtains for the Cobb-Douglas preference specification.

While one could now use $\bar{n}$ and κ to calculate ν_{cn} for the coefficients in proposition 2, there is a more direct and illuminating approach. Equation (30) can be rewritten as

$$\nu_{cn} = -\left(1+\frac{1}{\varphi}\right)(1-\eta)\left(\alpha\,\overline{c/y}\right)^{-1} \tag{38}$$

allowing the calculation of ν_{cn} from observing the consumption-output ratio, the parameter α as well as φ and η, without reference to κ. Put differently, these values imply a value for ν_{cn} and therefore for the cross-elasticity of the Frisch consumption demand with respect to wages. The values implied by our calibration below are given in table 8.

3 Calibration and Parameterization

We calibrate the model to annual post-war data of the US and EU-14 economy. Mendoza, Razin, and Tesar (1994), calculate average effective tax rates from national product and income accounts for the US. For this paper, we have followed their methodology to calculate tax rates from 1995 to 2007 for the US and 14 of the EU-15 countries, excluding Luxembourg for data availability reasons[5]. Appendix A provides some the details on the required calculations and the data used, with further discussion of our approach and further detail available in a technical appendix. Tables 13, 14 and 15 contain our calculated panel of tax rates for labor, capital and consumption respectively.

All other data we use for the calibration comes from the AMECO database of the European Commission. An overview of the calibration is provided in tables 1 and 2.

Variable	US	EU-14	Description	Restriction
τ^n	28	41	Labor tax	Data
τ^k	36	33	Capital tax	Data
τ^c	5	17	Consumption tax	Data
$\overline{b/y}$	63	65	Gov. debt to GDP	Data
$\overline{g/y}$	18	23	Gov.cons+inv. to GDP	Data
($\overline{s/y}$	8	15	Gov. transfer to GDP	Implied)
ψ	2	2	growth rate	Data
$\bar{R}$	4	4	real interest	Data
$\overline{m/y}$	4	-1	net imports	Data
($\overline{b/y}(\bar{R}-\psi)+\overline{s/y}+\overline{m/y}$	12	16	untaxed income	implied)

Table 1: Baseline calibration, part 1

Var.	US	EU-14	Description	Restriction
θ	0.38	0.38	Capital share on prod.	Data
δ	0.07	0.07	Depr. rate of capital	Data
η	2	2	inverse of IES	benchmark
φ	1	1	Frisch elasticity	benchmark
κ	3.46	3.46	weight of labor	$\bar{n}_{us} = 0.25$
η	1	1	inverse of IES	alternative
φ	3	3	Frisch elasticity	alternative
κ	3.38	3.38	weight of labor	$\bar{n}_{us} = 0.25$
α	0.319	0.321	Cons. weight in C-D	$\bar{n}_{us} = 0.25$

Table 2: Baseline calibration, part 2

Most of the preference parameters are standard. We set parameters such that the household chooses $\bar{n} = 0.25$ in the US baseline calibration. This is consistent with

[5] Carey and Rabesona (2002) also have calculated effective average tax rates on labor, capital and consumption from 1975 to 2000 for the OECD countries. However, as their data set stops in 2000 and deviates for some items from Mendoza, Razin, and Tesar (1994), we needed to provide our own calculations. The differences to Carey-Rabesona in the overlapping part of the data set turn out to be small.

evidence on hours worked per person aged 15-64 for the US. Our data appendix A contains the details.

For the intertemporal elasticity of substitution, we follow a general consensus for it to be close to 0.5 and therefore $\eta = 2$, as our benchmark choice. The specific value of the Frisch labor supply elasticity is of central importance for the shape of the Laffer curve. In the case of the alternative Cobb-Douglas preferences the Frisch elasticity is given by $\frac{1-\bar{n}}{\bar{n}}$ and equals 3 when $\bar{n} = 0.25$. This value is in line with e.g. Kydland and Prescott (1982), Cooley and Prescott (1995) and Prescott (2002, 2004), while a value close to 1 as in Kimball and Shapiro (2003) may be closer to the current consensus view.

We therefore use $\eta = 2$ and $\varphi = 1$ as the benchmark calibration for the CFE preferences, and use $\eta = 1$ and $\varphi = 3$ as alternative calibration and for comparison to a Cobb-Douglas specification. A more detailed discussion is provided in subsection B.2 of the technical appendix.

3.1 EU-14 Model and individual EU countries

As a benchmark, we keep all other parameters as in the US model, i.e. the parameters characterizing the growth rate as well as production and preferences. As a result, we calculate the differences between the US and the EU-14 as arising solely from differences in fiscal policy. This corresponds to Prescott (2002, 2004) who argues that differences in hours worked between the US and Europe are due to different level of labor income taxes.

In the subsection B.3 of the technical appendix, we provide a comparison of predicted versus actual data for three key values: equilibrium labor, the capital-output ratio and the consumption-output ratio. Discrepancies remain. While these are surely due to a variety of reasons, in particular e.g. institutional differences in the implementation of the welfare state, see e.g. Rogerson (2007) or Pissarides and Ngai (2008), variation in parameters across countries may be one of the causes. For example, Blanchard (2004) as well as Alesina, Glaeser, and Sacerdote (2005) argue that differences in preferences as well as labor market regulations and union policies rather than different fiscal policies are key to understanding why hours worked have fallen in Europe compared to the US.

	$\bar{\tau}^n$	$\bar{\tau}^k$	$\bar{\tau}^c$	$\psi\bar{b}/\bar{y}$	$\bar{m}/\bar{y}$	$\bar{g}/\bar{y}$	$\bar{s}/\bar{y}$
USA	28	36	5	63	4	18	8
EU-14	41	33	17	65	-1	23	15
GER	41	23	15	62	-3	21	15
FRA	46	35	18	60	-1	27	15
ITA	47	34	15	110	-2	21	19
GBR	28	46	16	44	2	21	13
AUT	50	24	20	65	-3	20	23
BEL	49	42	17	107	-4	24	21
DNK	47	51	35	50	-4	28	27
FIN	49	31	27	46	-8	24	22
GRE	41	16	15	100	10	20	15
IRL	27	21	26	43	-13	19	11
NET	44	29	19	58	-6	27	12
PRT	31	23	21	57	8	23	11
ESP	36	30	14	54	3	21	13
SWE	56	41	26	58	-7	30	21

Table 3: Country calibration

To obtain further insight and to provide a benchmark, we therefore vary parameters across countries in order to obtain a perfect fit to observations for these three key values. We then examine these parameters whether they are in a "plausible range", compared to the US calibration. Finally, we investigate how far our results for the impacts of fiscal policy are affected. It will turn out that the effect is modest, so that our conclusions may be viewed as fairly robust.

More precisely, we use averages of the observations on x_t/y_t, k_{t-1}/y_t, n_t, c_t/y_t, g_t/y_t, m_t/y_t and tax rates as well as a common choices for ψ, φ, η to solve the equilibrium relationships

$$\frac{x_t}{k_{t-1}} = \psi - 1 + \delta \tag{39}$$

for δ, (27) for θ, (30) for κ and aggregate feasiblity for a measurement error, which we interpret as mismeasured government consumption (as this will not affect the allocation otherwise).

Table 4 provides the list of resulting parameters. Note that we shall need a larger value for κ and thereby a greater preference for leisure in the EU-14 (in addition to the observed higher labor tax rates) in order to account for the lower equilibrium labor in Europe. Some of the implications are perhaps unconvential, however, and if so, this may indicate that alternative reasons are the source for the cross-country variations. For example, while Ireland is calculated to have one of the highest preferences for leisure, Greece appears to have one of the lowest.

	θ	δ	κ	$\bar{g}_{other}/\bar{y}$
USA	0.35	0.083	3.619	0.004
EU-14	0.38	0.070	4.595	-0.017
GER	0.37	0.067	5.179	-0.002
FRA	0.41	0.069	5.176	0.004
ITA	0.39	0.070	5.028	0.004
GBR	0.36	0.064	4.385	0.005
AUT	0.39	0.071	3.985	0.006
BEL	0.39	0.084	5.136	0.005
DNK	0.40	0.092	3.266	0.007
FIN	0.34	0.070	3.935	0.014
GRE	0.40	0.061	3.364	-0.005
IRL	0.36	0.086	5.662	0.006
NET	0.38	0.077	5.797	0.001
PRT	0.39	0.098	3.391	0.005
ESP	0.42	0.085	5.169	0.003
SWE	0.36	0.048	2.992	0.004

Table 4: Parameter Variations, given CFE preferences with $\varphi = 1$, $\eta = 2$

4 Results

As a first check on the model, table 5 compares the measured and the model-implied sources of tax revenue, relative to GDP. Due to the allocational distortions caused by the taxes, there is no a priori reason that these numbers should coincide. While the models overstate the taxes collected from labor income in the EU-14, they provide the correct numbers for revenue from capital income taxation, indicating that the methodology of Mendoza-Razin-Tesar is reasonable capable of delivering the appropriate tax burden on capital income, despite the difficulties of taxing capital income in practice. Table 6 sheds further light on this comparison: hours worked are overstated while total capital is understated for the EU-14 by the model. With the parameter variation in table 4, the model will match the data perfectly by construction, as indicated by the last line. This applies similarly to individual countries as section B.3 in the technical appendix shows. Generally, the numbers are roughly correct in terms of the order of magnitude, though, so we shall proceed with our analysis.

	Labor Tax Rev. US	Labor Tax Rev. EU-14	Cap. Tax Rev. US	Cap. Tax Rev. EU-14	Cons. Tax Rev. US	Cons. Tax Rev. EU-14
Data	14	19	9	8	3	10
Model						
$\varphi = 1, \eta = 2$	17	25	7	6	3	8
$\varphi = 3, \eta = 1$	17	25	7	6	3	8
C-D	17	25	7	6	3	8
Varied params., $\varphi = 1, \eta = 2$	17	25	7	6	3	8

Table 5: Comparing measured and implied sources of tax revenue

	Priv. Cons. US	Priv. Cons. EU-14	Capital US	Capital EU-14	Hours Worked US	Hours Worked EU-14
Data	61	51	238	294	25	20
Model						
$\varphi = 1, \eta = 2$	60	50	286	294	25	**23**
$\varphi = 3, \eta = 1$	60	50	286	294	25	23
C-D	60	50	286	294	25	23
Varied params., $\varphi = 1, \eta = 2$	61	51	238	294	25	20

Table 6: Comparing measured and calculated key macroeconomic aggregates: consumption, capital (in % of GDP) and hours worked (in % total time)

4.1 Labor Tax Laffer Curves

The Laffer curve for labor income taxation in the US is shown in figure 1. Note that the CFE and Cobb-Douglas preferences coincide closely, if the intertemporal elasticity of substitution $1/\eta$ and the Frisch elasticity of labor supply φ are the same at the benchmark steady state. Therefore, CFE preferences are close enough to the Cobb-Douglas specification, if $\eta = 1$, and provide a growth-consistent generalization, if $\eta \neq 1$.

For marginal rather than dramatic tax changes, the slope of the Laffer curve near the current data calibration is of interest. The slope is related to the degree of self-financing of a tax cut, defined as the ratio of additional tax revenues due to general equilibrium incentive effects and the lost tax revenues at constant economic choices. More formally and precisely, we calculate the degree of self-financing of a labor tax cut per

$$\text{self-financing rate} = 1 - \frac{1}{w_t \bar{n}} \frac{\partial T_t(\tau_n, \tau_k)}{\partial \tau_n} \approx 1 - \frac{1}{w_t \bar{n}} \frac{T_t(\tau_n + \epsilon, \tau_k) - T_t(\tau_n - \epsilon, \tau_k)}{2\epsilon}$$

where $T(\tau_n, \tau_k, \tau_c; g, b)$ is the function of tax revenues across balanced growth equilbria for different tax rates, and constant paths for government spending g and debt b. This self-financing rate is a constant along the balanced growth path, i.e. does not depend on t. Likewise, we calculate the degree of self-financing of a capital tax cut.

We calculate these self-financing rates numerically as indicated by the second expression, with ϵ set to 0.01 (and tax rates expressed as fractions). If there were no endogenous change of the allocation due to a tax change, the loss in tax revenue due to a one percentage point reduction in the tax rate would be $w_t \bar{n}$, and the self-financing rate would calculate to 0. At the peak of the Laffer curve, the tax revenue would not change at all, and the self-financing rate would be 100%. Indeed, the self-financing rate would become larger than 100% beyond the peak of the Laffer curve.

For labor taxes, table 7 provides results for the self-financing rate as well as for the location of the peak of the Laffer curve for our benchmark calibration of the CFE preference parameters, as well as a sensitivity analysis. Figure 3 likewise shows the sensitivity of the Laffer curve to variations in φ and η. The peak of the Laffer curve shifts up and to the right, as η and φ are decreased. The dependence on η arises due to the nonseparability of preferences in consumption and leisure. Capital adjusts as labor adjusts across the balanced growth paths.

The table provides results for the US as well as the EU-14: there is considerably less scope for additional financing of government revenue in Europe from raising labor taxes. For our preferred benchmark calibration with a Frisch elasticity of 1 and an intertemporal elasticity of substitution of 0.5, we find that the US and the EU-14 are located on the left side of their Laffer curves, but while the US can increase tax revenues by 30% by raising labor taxes, the EU-14 can raise only an additional 8%.

To gain further insight, figure 2 compares the US and the EU Laffer curve for our benchmark calibration of $\varphi = 1$ and $\eta = 2$, benchmarking both Laffer curves to

100% at the US labor tax rate. As the CFE parameters are changed, so are the cross-Frisch elasticities and own-Frisch elasticities of consumption: the values are provided in table 8.

Parameter Region:	% self-fin. US	 EU-14	max. τ^n US	 EU-14	max. add. tax rev. US	 EU-14
$\varphi = 1, \eta = 2$:	32	54	63	62	30	8
$\varphi = 3, \eta = 1$:	38	65	57	56	21	4
$\varphi = 3, \eta = 2$:	49	78	52	51	14	2
$\varphi = 1, \eta = 2$:	32	54	63	62	30	8
$\varphi = 0.5, \eta = 2$:	21	37	72	71	47	17
$\varphi = 1, \eta = 2$:	32	54	63	62	30	8
$\varphi = 1, \eta = 1$:	27	47	65	65	35	10
$\varphi = 1, \eta = 0.5$:	20	37	69	68	43	15

Table 7: Labor Tax Laffer curves: degree of self-financing, maximal tax rate, maximal additional tax revenues. Shown are results for the US and the EU-14, and the sensitivity of the results to changes in the CFE preference parameters.

Parameter Region:	cross-Frisch-elast. US	 EU-14	own-Frisch-elast. US	 EU-14
$\varphi = 1, \eta = 2$:	0.4	0.3	-0.7	-0.7
$\varphi = 3, \eta = 1$:	-0.0	-0.0	-1.0	-1.0
$\varphi = 3, \eta = 2$:	1.1	0.9	-1.0	-1.0
$\varphi = 1, \eta = 2$:	0.4	0.3	-0.7	-0.7
$\varphi = 0.5, \eta = 2$:	0.2	0.2	-0.6	-0.6
$\varphi = 1, \eta = 2$:	0.4	0.3	-0.7	-0.7
$\varphi = 1, \eta = 1$:	-0.0	-0.0	-1.0	-1.0
$\varphi = 1, \eta = 0.5$:	-0.7	-0.6	-2.7	-2.6

Table 8: Cross-Frisch elasticities of consumption wrt wages and own-Frisch elasticities of consumption wrt to the Lagrange multiplier on wealth.

Table 9 as well as figure 4 provide insight into the degree of self-financing as well as the location of the Laffer curve peak for individual countries, for both the case of keeping the parameters the same across all countries as well as varying them according to table 4.

It matters for the thought experiment here, that the additional tax revenues are spent on transfers, and not on other government spending. For the latter, the substitution effect is mitigated by an income effect on labor: as a result the Laffer curve

	% self-fin.		max. τ_n		max. add. tax rev.	
Parameters:	same	varied	same	varied	same	varied
USA	32	30	63	64	30	33
EU-14	54	55	62	61	8	7
GER	50	51	64	64	10	10
FRA	62	62	63	63	5	5
ITA	63	62	62	62	4	4
GBR	42	42	59	59	17	17
AUT	71	70	61	62	2	2
BEL	69	68	61	62	3	3
DNK	83	79	55	57	1	1
FIN	70	68	62	63	3	3
GRE	54	55	60	59	7	7
IRL	35	34	68	69	30	32
NET	53	53	67	67	9	9
PRT	45	44	59	60	14	15
ESP	46	46	62	62	13	13
SWE	83	86	63	61	1	0

Table 9: Labor Tax Laffer curves across countries, for $\varphi = 1, \eta = 2$: degree of self-financing, maximal tax rate, maximal additional tax revenues. Shown are results for keeping the same parameters for all countries and for varying the parameters so as to obtain observed labor, capital-output ratio, investment-output ratio and aggregate feasibility.

becomes steeper with a peak to the right and above the peak coming from a "labor tax for transfer" Laffer curve, see figure 5.

This matters even more for consumption taxes. As we have shown above, the consumption tax revenue increase with increased consumption taxes, in the case the additional revenues are used for additional government spending, while there can be a Laffer curve, in case the additional revenues are used for transfers. Figure 7 shows the consumption Laffer curve once for our benchmark parameterization and once for an extreme version of an infinite Frisch elasticity, both for the US and for the EU-14 and benchmarking both Laffer curves to 100% at the US consumption tax rate. The figure shows the Laffer curve in consumption taxes to be increasing throughout, and the potential for additional revenues to be dramatic. Whether it is possible in practice to raise consumption taxes amounting to, say, 80% of the sales price (as would be the case for $\tau_c = 4$) is a different matter, though.

4.2 Capital Tax Laffer Curves

Figure 6 shows the Laffer curve for capital income taxation in the US. Benchmark results, a comparison to the EU as well as the sensitivity analysis with respect to the CFE parameters are given in table 10 as well as the right column of figure 3 and in figure 8, benchmarking both Laffer curves to 100% at the US capital tax rate. For our preferred benchmark calibration with a Frisch elasticity of 1 and an intertemporal elasticity of substitution of 0.5, we find that the US and the EU-14 are located on the left side of their Laffer curves, but the scope for raising tax revenues by raising capital income taxes are small: they are bound by 6% in the US and by 1% in the EU-14.

The cross-country comparison is in the right column of figure 4 and in table 11. Several countries, e.g. Denmark and Sweden, show a negative self-financing fraction: these countries are on the "slippery side" of the Laffer curve and can actually improve their budgetary situation by cutting capital taxes, according to our calculations.

Parameter	% self-fin.		max. τ^k		max. add. tax rev.	
Region:	US	EU-14	US	EU-14	US	EU-14
$\varphi = 1, \eta = 2$:	51	79	63	48	6	1
$\varphi = 3, \eta = 1$:	55	82	62	46	5	1
$\varphi = 3, \eta = 2$:	60	87	60	44	4	0
$\varphi = 1, \eta = 2$:	51	79	63	48	6	1
$\varphi = 0.5, \eta = 2$:	45	73	64	50	7	1
$\varphi = 1, \eta = 2$:	51	79	63	48	6	1
$\varphi = 1, \eta = 1$:	48	77	64	49	6	1
$\varphi = 1, \eta = 0.5$:	45	73	64	50	7	1

Table 10: Capital Tax Laffer curves: degree of self-financing, maximal tax rate, maximal additional tax revenues. Shown are results for the US and the EU-14, and the sensitivity of the results to changes in the CFE preference parameters.

As one can see, the additional revenues that can be obtained from an increased capital income taxation are small, once the economy has converged to the new balanced growth path. The transition matters substantially for capital income taxation, obviously, but the dynamics here is similar to the much-studied dynamics of capital in closed-economy or open-economy real business cycles models due to a deviation of the capital stock from its steady state value. Generally, the speed of convergence will e.g. depend on the openness of the country and costs of adjustments. We do not have much

Parameters:	% self-fin. same	varied	max. τ_k same	varied	max. add. tax rev. same	varied
USA	51	46	63	68	6	7
EU-14	79	80	48	47	1	1
GER	70	71	49	49	2	2
FRA	88	89	44	43	0	0
ITA	88	88	42	42	0	0
GBR	73	73	57	58	1	1
AUT	88	88	35	35	0	0
BEL	103	98	40	43	0	0
DNK	137	126	30	35	1	1
FIN	92	90	38	40	0	0
GRE	73	74	42	39	2	2
IRL	50	48	62	67	8	8
NET	75	74	50	52	1	1
PRT	65	61	50	55	3	3
ESP	68	67	52	53	2	2
SWE	109	116	33	29	0	0

Table 11: Capital Tax Laffer curves across countries, for $\varphi = 1, \eta = 2$: degree of self-financing, maximal tax rate, maximal additional tax revenues. Shown are results for keeping the same parameters for all countries and for varying the parameters so as to obtain observed labor, capital-output ratio, investment-output ratio and aggregate feasibility.

to contribute to that debate here, but it is useful to keep the potentially long transitional dynamics in mind before drawing policy conclusions from the numbers presented here.

It is instructive to investigate, why the capital Laffer curve is so flat e.g. in Europe. Figure 9 shows a decomposition of the overall Laffer curve into its pieces: the reaction of the three tax bases and the resulting tax receipts. The labor tax base is falling throughout: as the incentives to accumulate capital are deteriorating, less capital is provided along the balanced growth equilibrium, and therefore wages fall. The capital tax revenue keeps rising quite far, though: indeed, even the capital tax base keeps rising. An important lesson to take away is therefore this: if one is interested in examining the revenue consequences of increased capital taxation, it is actually the consequence for labor tax revenues which is the "first-order" item to watch. This decomposition and insight shows the importance of keeping the general equilibrium repercussions in mind when changing taxes.

Table 12 summarizes the range of results of our sensitivity analysis both for labor taxes as well as capital taxes for the US and the EU-14.

	US	EU
Potential additional tax revenues (in %):		
labor taxes	14% .. 47%	2% .. 17%
capital taxes	4% .. 7%	0% .. 1%
Maximizing tax rate (in %) :		
labor taxes	52% .. 72%	51% .. 71%
capital taxes	60% .. 64%	44% .. 50%
Percent self-financing of a tax cut (in %):		
labor taxes	20% .. 49%	37% .. 78%
capital taxes	45% .. 60%	73% .. 87%

Table 12: *The range of results for the parameter variations considered.*

Furthermore, one may be interested in the combined budgetary effect of changing labor and capital income taxation. This gets closer to the literature of Ramsey optimal taxation, to which this paper does not seek to make a contribution. But figure 10, providing the contour lines of a "Laffer hill", nonetheless may provide some useful insights. As one compares balanced growth paths, it turns out that revenue is maximized when raising labor taxes but lowering capital taxes: the peak of the hill is in the lower right hand side corner of that figure.

5 Conclusion

This paper examines the following question: how does the behavior of households and firms in the US compared to the EU-14 adjust if fiscal policy changes taxes? The Laffer curve provides us with a framework to think about the incentive effects of tax cuts. Therefore, the goal of this paper is to examine the shape of the Laffer curve quantitatively in a simple neoclassical growth model calibrated to the US as well as to the EU-14 economy. We show that there exist robust steady state Laffer curves for labor taxes as well as capital taxes. According to the model the US and the EU-14 area are located on the left side of their Laffer curves. However the EU-14 countries are much closer to the slippery slopes than the US. More precisely, we find that the US can increase tax revenues by 30% by raising labor taxes but only 6% by raising capital income taxes, while the same numbers for EU-14 are 8% and 1% respectively. An overview of the sensitivity of these results to alternative values for the Frisch elasticity of labor supply and the intertemporal elasticity of substitition has been provided in table 12.

In addition, our results indicate that tax cuts in the EU-14 area are self-financing to a much higher degree compared to the US. We find that for the US model 32% of a labor tax cut and 51% of a capital tax cut are self-financing in the steady state. In the EU-14 economy 54% of a labor tax cut and 79% of a capital tax cut are self-financing.

We therefore conclude that there rarely is a free lunch due to tax cuts. However, a substantial fraction of the lunch will be paid for by the efficiency gains in the economy due to tax cuts.

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Figure 1: The US Laffer Curve for Labor Taxes

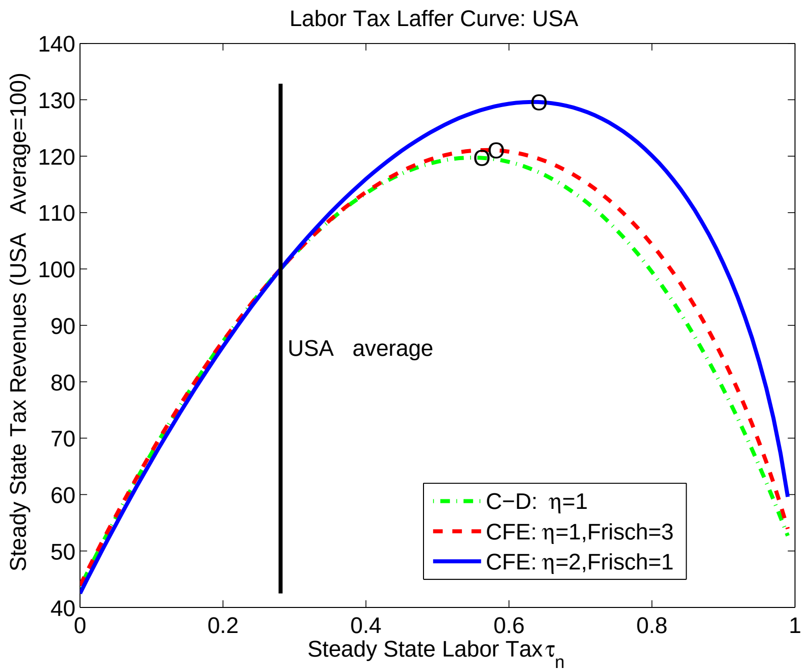


Figure 2: Comparing the US and the EU Labor Laffer Curve

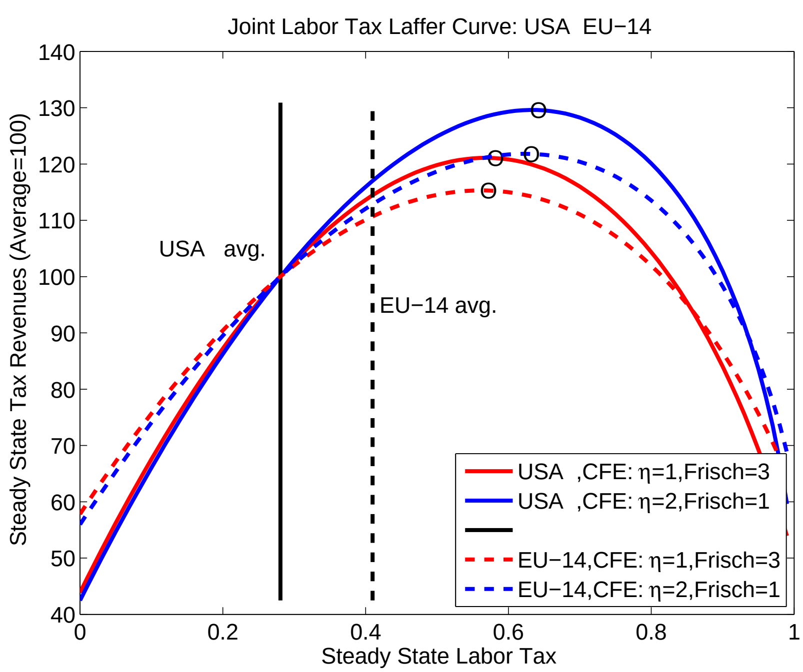
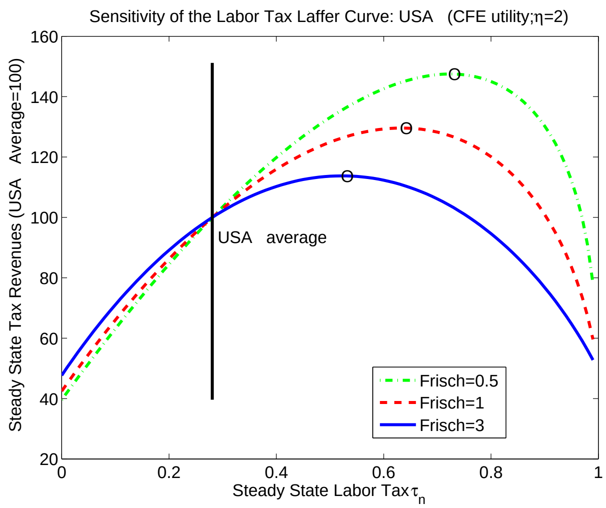
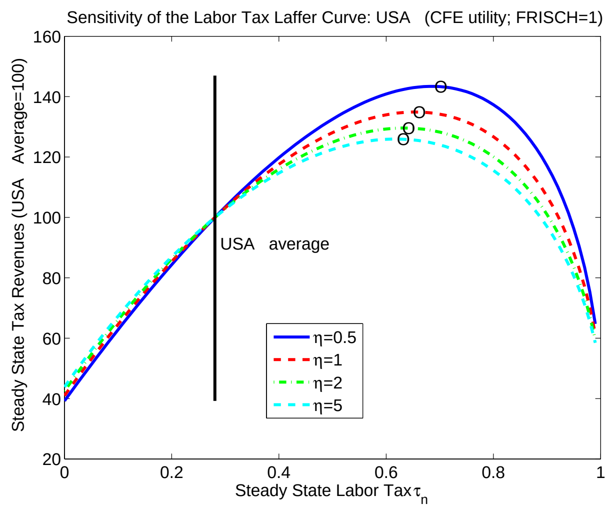


Figure 3: Sensitivity to φ and η

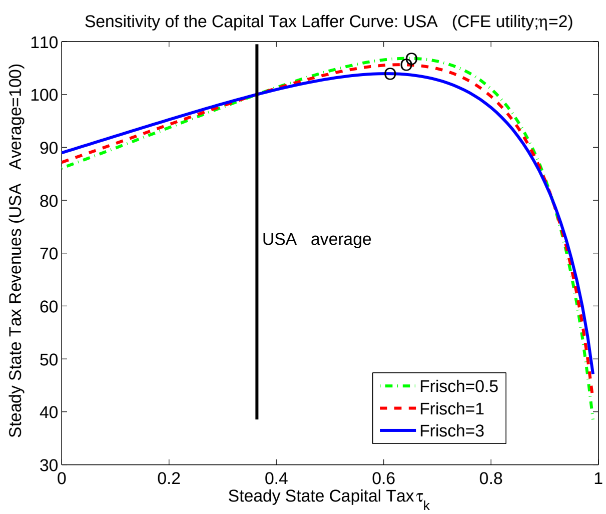
Sensitivity to φ Sensitivity to η

Labor Tax Laffer Curves:





Capital Tax Laffer Curves:



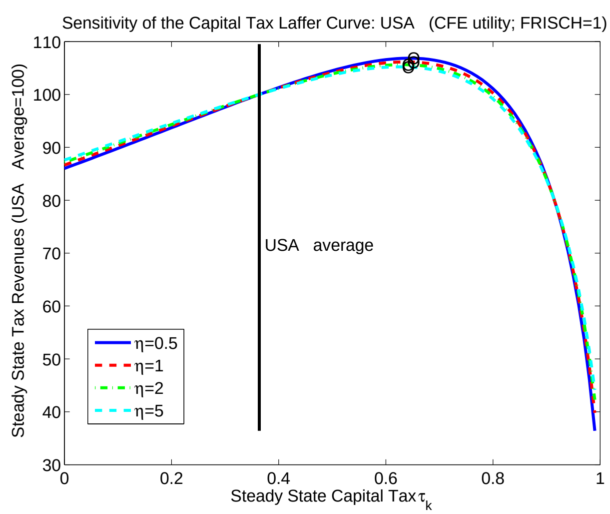


Figure 4: Distances to the Laffer Peak across countries

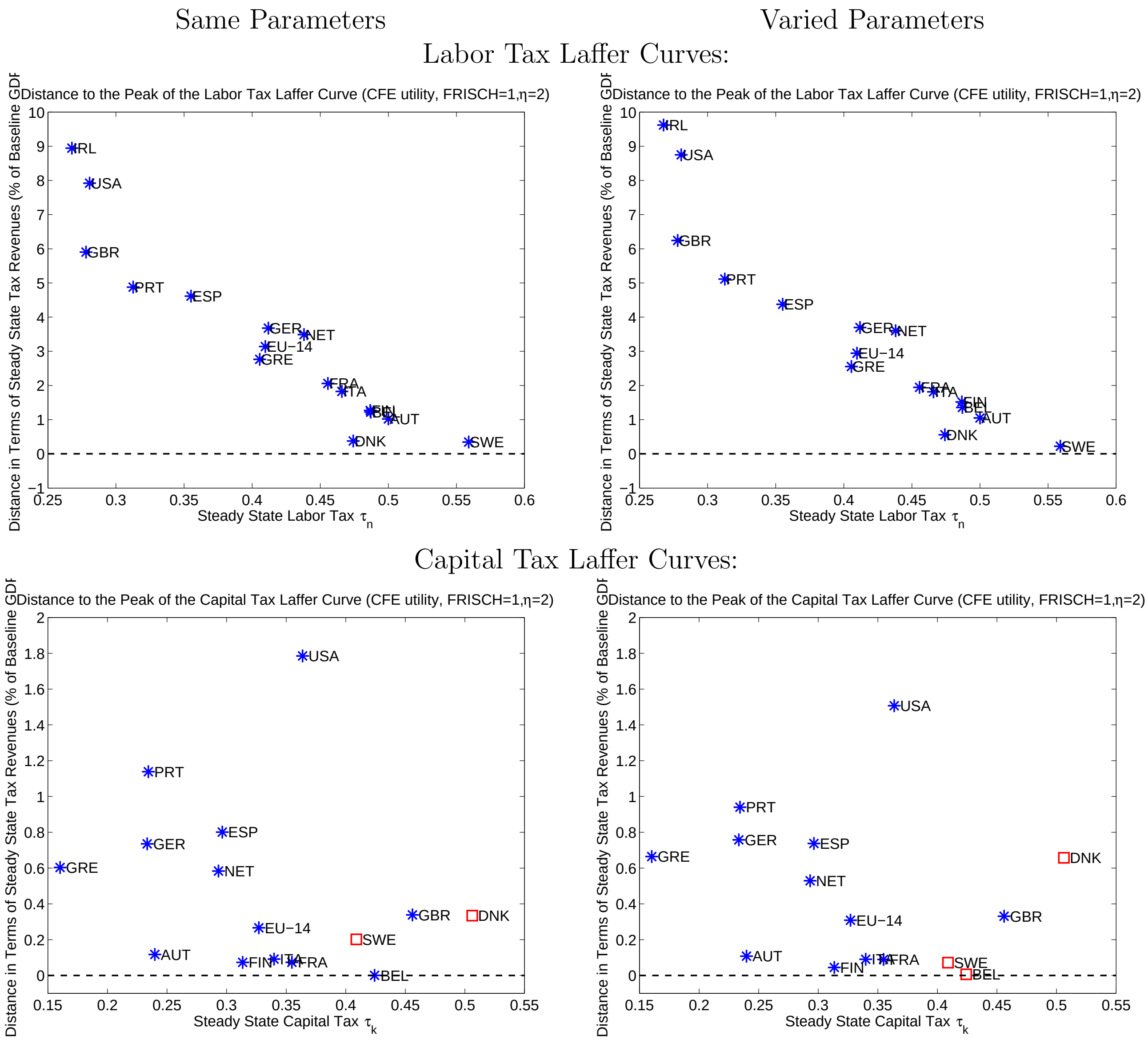


Figure 5: Labor Taxes Laffer Curve: Spending versus Transfers

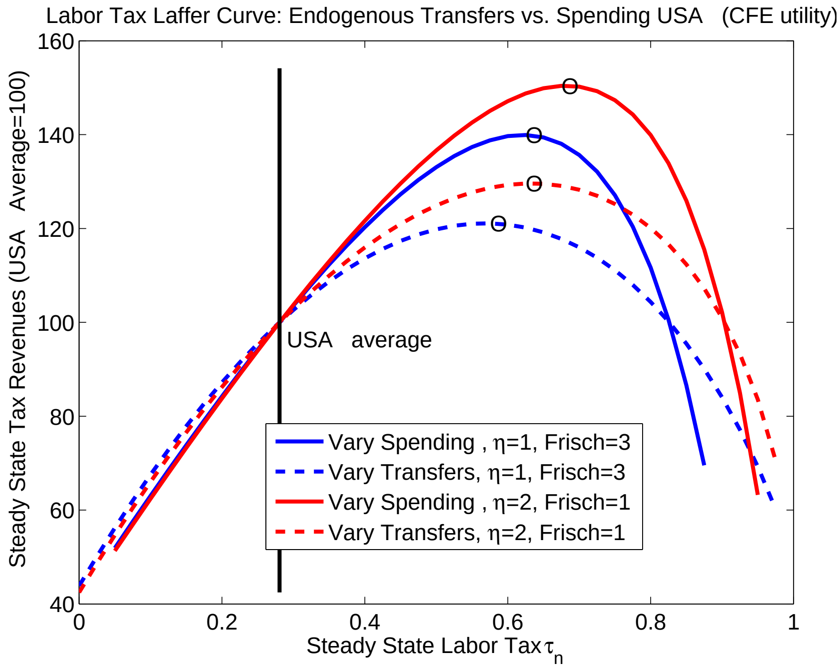


Figure 6: The US Laffer Curve for Capital Taxes

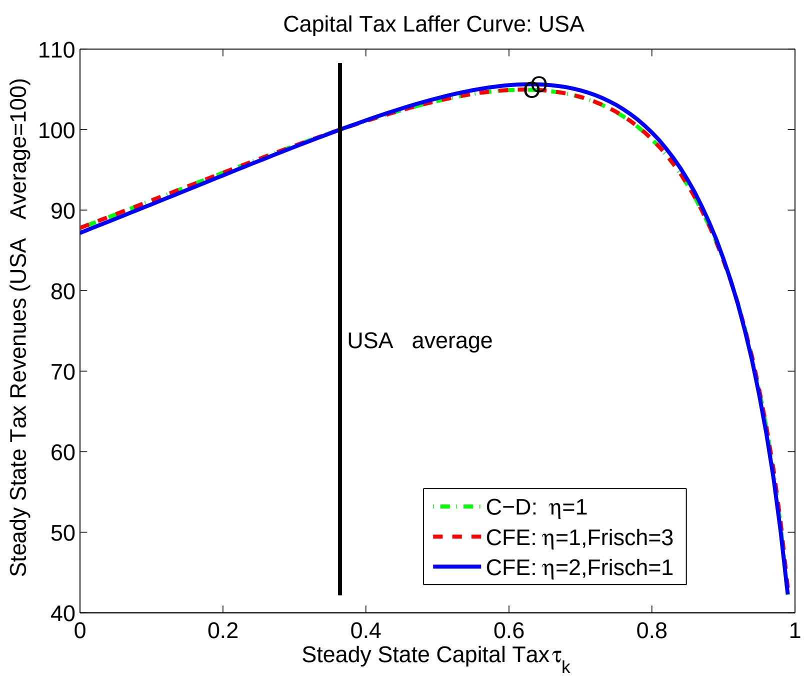


Figure 7: Comparing the US and the EU Consumption Laffer Curve

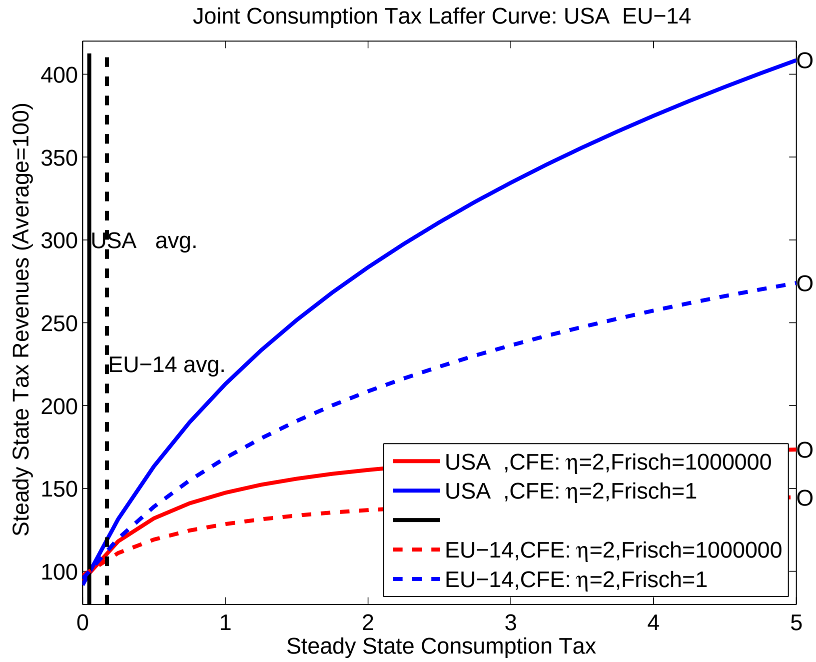


Figure 8: Comparing the US and the EU Capital Laffer Curve

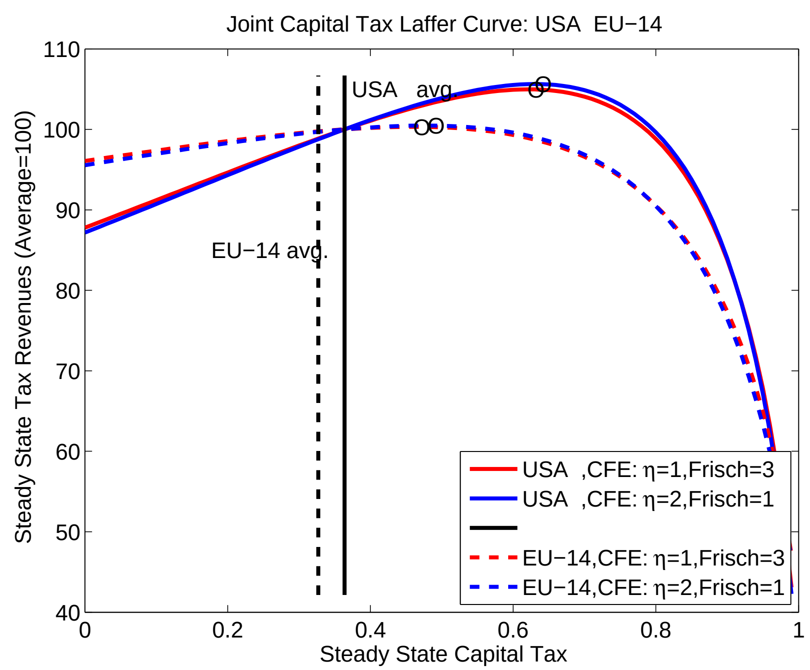


Figure 9: Decomposing Capital Taxes: EU 14

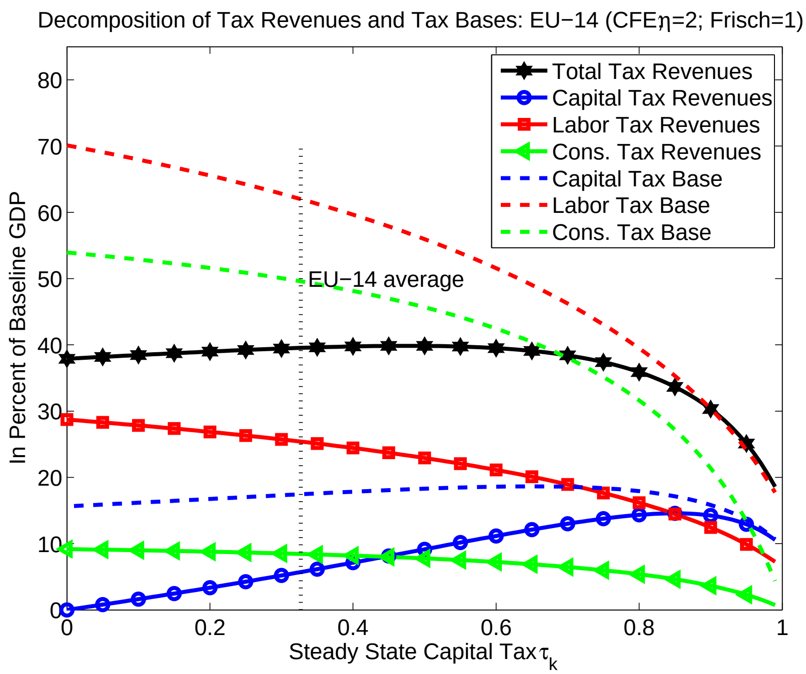
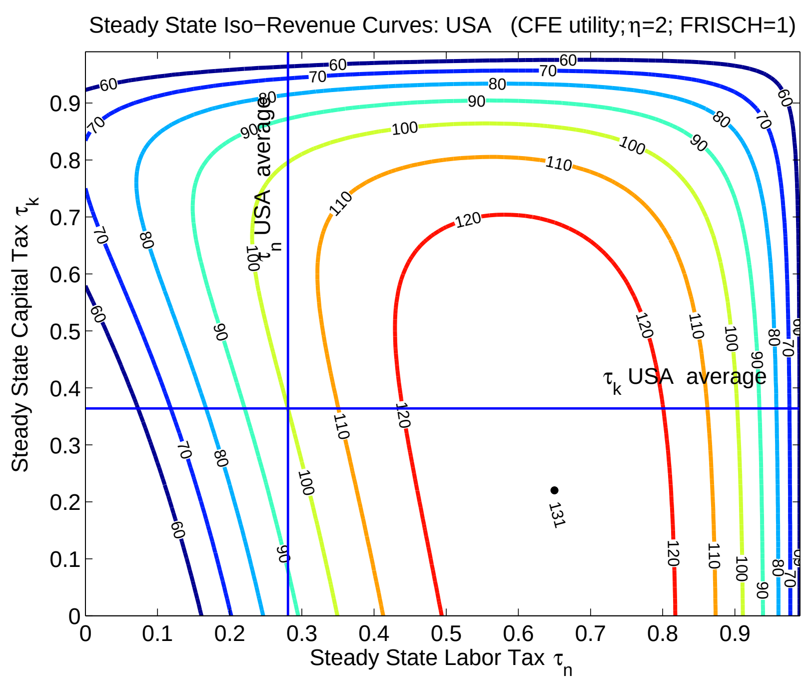


Figure 10: The "Laffer hill" for the US ($\eta = 2, \varphi = 1$).



Appendix

A EU-14 Tax Rates and GDP Ratios

In order to obtain EU-14 tax rates and GDP ratios we proceed as follows. E.g., EU-14 consumption tax revenues can be expressed as:

$$\tau^c_{EU-14,t} c_{EU-14,t} = \sum_j \tau^c_{j,t} c_{j,t} \tag{40}$$

where j denotes each individual EU-14 country. Rewriting equation (40) yields the consumption weighted EU-14 consumption tax rate:

$$\tau^c_{EU-14,t} = \frac{\sum_j \tau^c_{j,t} c_{j,t}}{c_{EU-14,t}} = \frac{\sum_j \tau^c_{j,t} c_{j,t}}{\sum_j c_{j,t}}. \tag{41}$$

The numerator of equation (41) consists of consumption tax revenues of each individual country j whereas the denominator consists of consumption tax revenues divided by the consumption tax rate of each individual country j. Formally,

$$\tau^c_{EU-14,t} = \frac{\sum_j T^{Cons}_{j,t}}{\sum_j \frac{T^{Cons}_{j,t}}{\tau^c_{j,t}}}. \tag{42}$$

The methodology of Mendoza, Razin, and Tesar (1994) allows to calculate implicit individual country consumption tax revenues so that we can easily calculate the EU-14 consumption tax rate $\tau^c_{EU-14,t}$. Likewise, applying the same procedure we calculate EU-14 labor and capital tax rates. Taking averages over time yields the tax rates we report in table 1.

In order to calculate EU-14 GDP ratios we proceed as follows. E.g., the GDP weighted EU-14 debt to GDP ratio can be written as:

$$\frac{b_{EU-14,t}}{y_{EU-14,t}} = \frac{\sum_j \frac{b_{j,t}}{y_{j,t}} y_{j,t}}{\sum_j y_{j,t}} \tag{43}$$

where b_j and y_j are individual country government debt and GDP. Likewise, we apply the same procedure for the EU-14 transfer to GDP ratio. Taking averages over time yields the numbers used for the calibration of the model.

Tables 13, 14 and 15 contain our calculated panel of tax rates for labor, capital and consumption respectively.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
USA	27.6	28.2	28.6	28.9	29.2	29.6	29.4	27.2	26.3	26.1	27.4	27.9	28.4
EU-14	42.3	42.2	42.0	41.3	41.5	40.5	40.2	39.7	40.1	40.1	40.5	41.0	41.3
GER	42.0	40.9	41.4	41.9	41.7	41.4	41.7	40.8	40.6	40.0	40.2	41.2	41.5
FRA	46.2	46.8	46.6	45.4	45.8	45.3	44.7	44.4	45.0	44.7	46.0	45.9	45.7
ITA	46.4	48.5	49.7	45.9	46.3	45.7	45.5	45.6	45.9	46.2	46.1	46.2	47.8
GBR	26.8	26.1	25.7	26.9	27.4	27.8	27.7	27.2	27.7	28.8	29.3	29.8	30.4
AUT	47.5	48.7	50.0	50.1	50.3	49.4	50.8	50.7	50.7	50.8	50.3	50.3	50.3
BEL	48.1	48.0	48.6	49.0	48.4	48.3	48.3	49.0	49.3	49.6	49.5	48.5	48.8
DNK	46.4	46.8	47.4	46.6	48.6	48.8	48.7	47.5	47.7	46.6	47.0	46.7	47.9
FIN	51.9	52.6	50.4	49.9	48.9	49.4	48.6	48.0	46.6	45.8	46.6	47.1	47.2
GRE	NaN	NaN	NaN	NaN	NaN	40.2	39.8	41.0	42.3	40.5	40.3	40.0	40.3
IRL	NaN	NaN	NaN	NaN	NaN	NaN	NaN	25.4	25.6	26.9	27.0	27.4	28.5
NET	49.4	46.4	46.8	42.3	43.6	43.6	40.4	40.7	41.0	41.8	42.8	45.8	45.0
PRT	29.4	29.8	30.1	29.9	30.1	30.8	31.2	31.4	32.0	31.9	32.5	32.7	34.4
ESP	NaN	NaN	NaN	NaN	NaN	34.1	34.8	35.1	35.1	35.1	35.9	36.6	37.4
SWE	52.9	54.6	56.3	58.1	60.7	57.2	55.2	53.6	55.2	55.9	56.0	56.5	54.6

Table 13: *Labor income taxes in percent across countries and time*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
USA	37.8	37.3	37.1	37.5	37.3	38.3	36.1	32.9	33.6	34.0	36.4	36.4	38.2
EU-14	29.6	30.9	32.6	33.3	35.2	34.7	33.7	31.7	30.6	31.0	32.7	34.8	34.4
GER	23.1	22.8	22.8	23.9	25.9	27.0	21.6	21.4	22.0	21.6	22.3	24.4	24.8
FRA	27.9	30.3	32.2	34.9	37.5	36.9	38.0	36.0	34.6	36.6	37.1	40.1	39.2
ITA	32.7	34.0	36.2	32.3	35.1	32.2	33.7	32.9	31.7	31.8	32.8	37.4	39.1
GBR	40.3	39.9	42.8	45.9	47.4	52.1	52.5	45.8	42.4	42.5	46.9	49.2	45.1
AUT	20.4	23.5	25.6	25.6	24.0	23.6	28.7	24.4	24.0	23.6	22.9	22.3	23.2
BEL	38.1	40.4	41.9	44.9	44.9	44.3	46.6	45.3	42.8	41.4	40.8	40.5	39.6
DNK	43.3	44.6	44.9	52.5	47.8	46.2	49.5	50.7	51.5	52.3	57.3	58.3	59.3
FIN	28.2	32.0	32.4	33.3	33.3	39.2	31.4	31.1	29.3	29.5	30.1	28.4	29.3
GRE	NaN	NaN	NaN	NaN	NaN	20.1	17.1	16.7	15.0	14.8	15.5	14.5	14.5
IRL	NaN	NaN	NaN	NaN	NaN	NaN	NaN	17.5	19.0	20.3	21.0	24.2	22.5
NET	27.6	30.4	30.3	30.9	31.4	30.3	31.3	29.5	26.9	27.4	30.8	28.2	26.1
PRT	18.9	20.6	21.2	21.0	23.4	26.1	24.4	25.2	23.4	23.2	24.0	25.6	27.6
ESP	NaN	NaN	NaN	NaN	NaN	25.9	24.8	26.6	27.1	29.1	32.6	35.0	36.2
SWE	30.1	36.2	39.0	39.8	41.5	49.8	47.2	40.4	40.3	40.7	44.0	40.8	41.8

Table 14: *Capital income taxes in percent across countries and time*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
USA	5.1	5.1	5.0	5.0	4.9	4.8	4.6	4.5	4.5	4.4	4.5	4.4	4.2
EU-14	17.0	17.1	17.1	17.4	17.7	17.5	17.0	16.9	16.8	16.7	16.6	16.7	16.9
GER	15.4	15.3	15.0	15.2	15.9	16.0	15.5	15.5	15.6	15.1	14.9	15.2	16.6
FRA	18.5	19.4	19.5	19.5	19.7	18.7	18.0	17.9	17.5	17.5	17.6	17.4	17.2
ITA	15.4	14.4	14.2	15.1	14.7	15.6	14.9	14.6	14.1	13.7	13.7	14.3	14.0
GBR	16.9	17.2	17.2	17.1	17.1	16.7	16.1	15.9	16.0	15.9	15.4	15.1	14.9
AUT	18.6	19.1	20.2	20.4	20.9	19.7	19.4	19.9	19.4	19.5	19.4	18.8	19.2
BEL	16.4	16.7	17.1	17.0	18.0	17.7	16.6	17.0	16.8	17.5	17.8	18.0	18.2
DNK	32.4	33.9	34.2	35.4	36.4	35.7	35.8	35.7	35.0	34.8	34.9	35.2	34.3
FIN	26.5	26.5	29.0	28.7	29.0	28.1	26.8	26.9	27.3	26.3	26.2	25.8	25.0
GRE	15.8	16.0	16.5	15.7	16.2	15.2	15.8	15.7	14.9	14.5	14.2	15.1	14.9
IRL	24.2	24.6	25.1	26.3	26.6	27.3	24.2	25.1	24.9	26.1	26.6	27.1	25.6
NET	17.9	18.4	18.5	18.7	19.5	19.3	19.9	19.1	19.2	19.8	20.8	20.2	20.5
PRT	19.8	20.4	20.1	21.3	21.4	20.3	20.4	21.1	20.9	20.5	21.3	21.6	21.5
ESP	12.8	13.1	13.5	14.3	15.0	15.0	14.5	14.6	15.0	14.9	15.1	15.2	14.7
SWE	26.8	25.3	25.1	25.5	25.1	24.8	25.2	25.1	25.3	25.4	25.8	26.1	26.5

Table 15: *Consumption taxes in percent across countries and time*

TECHNICAL APPENDIX – NOT FOR PUBLICATION

B Additions to the main text

B.1 A proof

Proof: [**Proof for Proposition 2.**] *Log-linearization generally leads to (22), where*

$$\begin{aligned}
\nu_{cc} &= \frac{u_{cc}c}{u_c} \\
\nu_{cn} &= \frac{u_{cn}n}{u_c} \\
\nu_{c\kappa} &= \frac{u_{c\kappa}\kappa}{u_c} \\
\nu_{nn} &= \frac{u_{nn}n}{u_n} \\
\nu_{nc} &= \frac{u_{cn}c}{u_n} \\
\nu_{n\kappa} &= \frac{u_{c\kappa}\kappa}{u_n}
\end{aligned}$$

For the explicit expressions, calculate. For the Frisch demand and supply, use matrix inversion for (22) together with the explicit expressions for the coefficients, and calculate. •

B.2 Details on the Calibration Choices

Empirical estimates of the intertemporal elasticity vary considerably. Hall (1988) estimates it to be close to zero. Recently, Gruber (2006) provides an excellent survey on estimates in the literature. Further, he estimates the intertemporal elasticity to be two. Cooley and Prescott (1995) and King and Rebelo (1999) use an intertemporal elasticity equal to one. The general current consensus seems to be that the intertemporal elasticity of substitution is closer to 0.5, which we shall use for our baseline calibration, but also investigating a value equal to unity as an alternative, and impose it for the Cobb-Douglas preference specification.

There is a large literature that estimates the Frisch labor supply elasticity from micro data. Domeij and Floden (2006) argue that labor supply elasticity estimates are likely to be biased downwards by up to 50 percent. However, the authors survey the existing micro Frisch labor supply elasticity estimates and conclude that many estimates range between 0 and 0.5. Further, Kniesner and Ziliak (2005) estimate a Frisch labor supply elasticity of 0.5 while and Kimball and Shapiro (2003) obtain a Frisch elasticity close to 1. Hence, this literature suggests an elasticity in the range of 0 to 1 instead of a value of 3 as suggested by Prescott (2006).

In the most closely related public-finance-in-macro literature, e.g. House and Shapiro (2006), a value of 1 is often used. We shall follow that choice as our benchmark calibration, and regard a value of 3 as the alternative specification.

We therefore use $\eta = 2$ and $\varphi = 1$ as the benchmark calibration for the CFE preferences, and use $\eta = 1$ and $\varphi = 3$ as alternative calibration and for comparison to a Cobb-Douglas specification for preferences with an intertemporal elasticity of substitution equal to unity and imposing $\bar{n} = 0.25$, implying a Frisch elasticity of 3.

B.3 Comparing the model to the data

Figure 11 shows the match between model prediction and data for equilibrium labor as well as for the capital-output ratio: the discrepancies get resolved by construction in the right-hand column, with the varied parameters as in table 4. Figure 12 shows the implications for tax revenues relative to output: the predictions do not move much with the variation in the parameters. Generally, though, the model overpredicts the amount of labor tax revenues and underpredicts the amount of capital tax revenues collected, compared to the data.

Figure 11: Model-Data Comparison Without and with Varying the Parameters

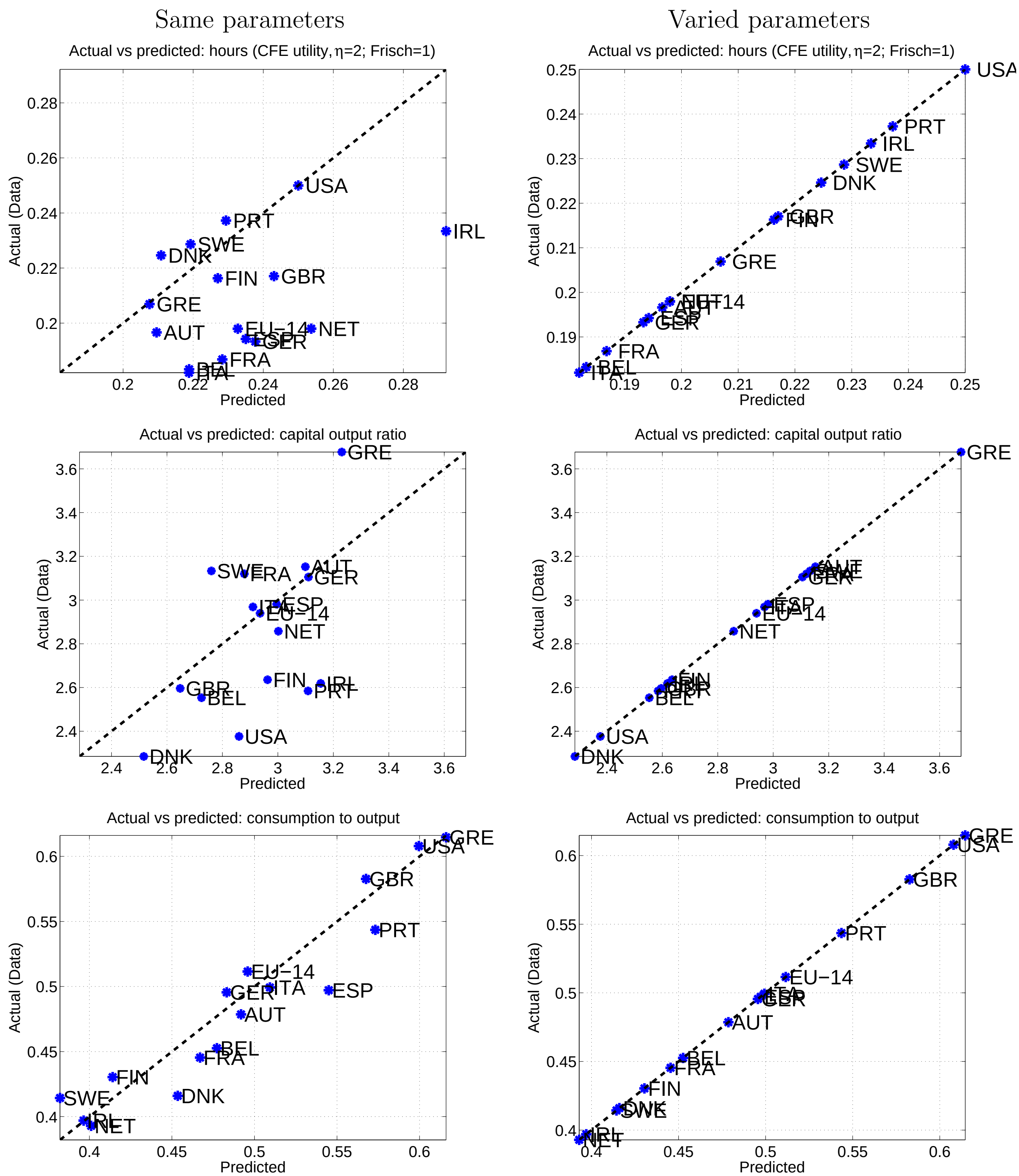
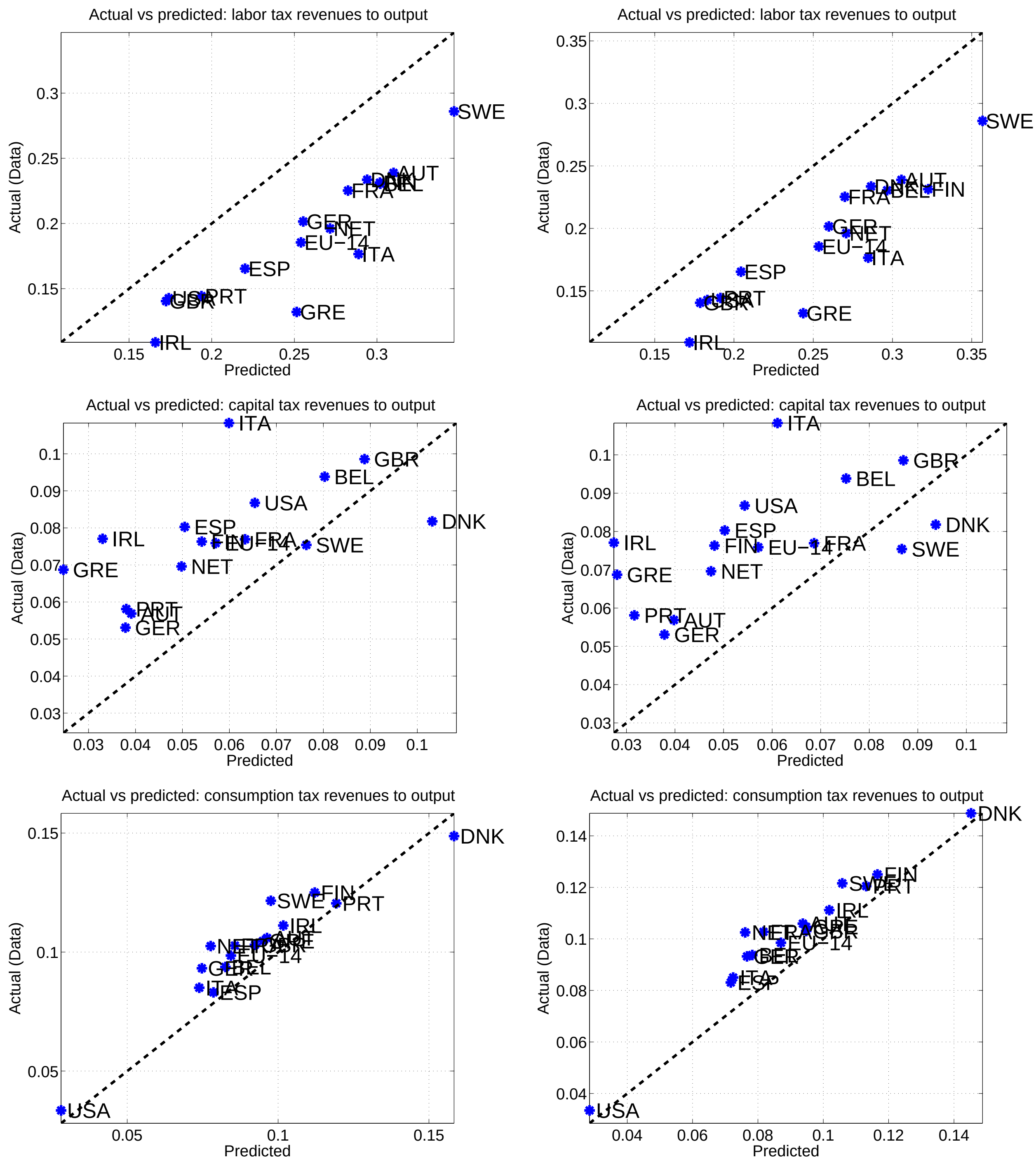


Figure 12: Model-Data Comparison Without and with Varying the Parameters

Same parameters | Varied parameters



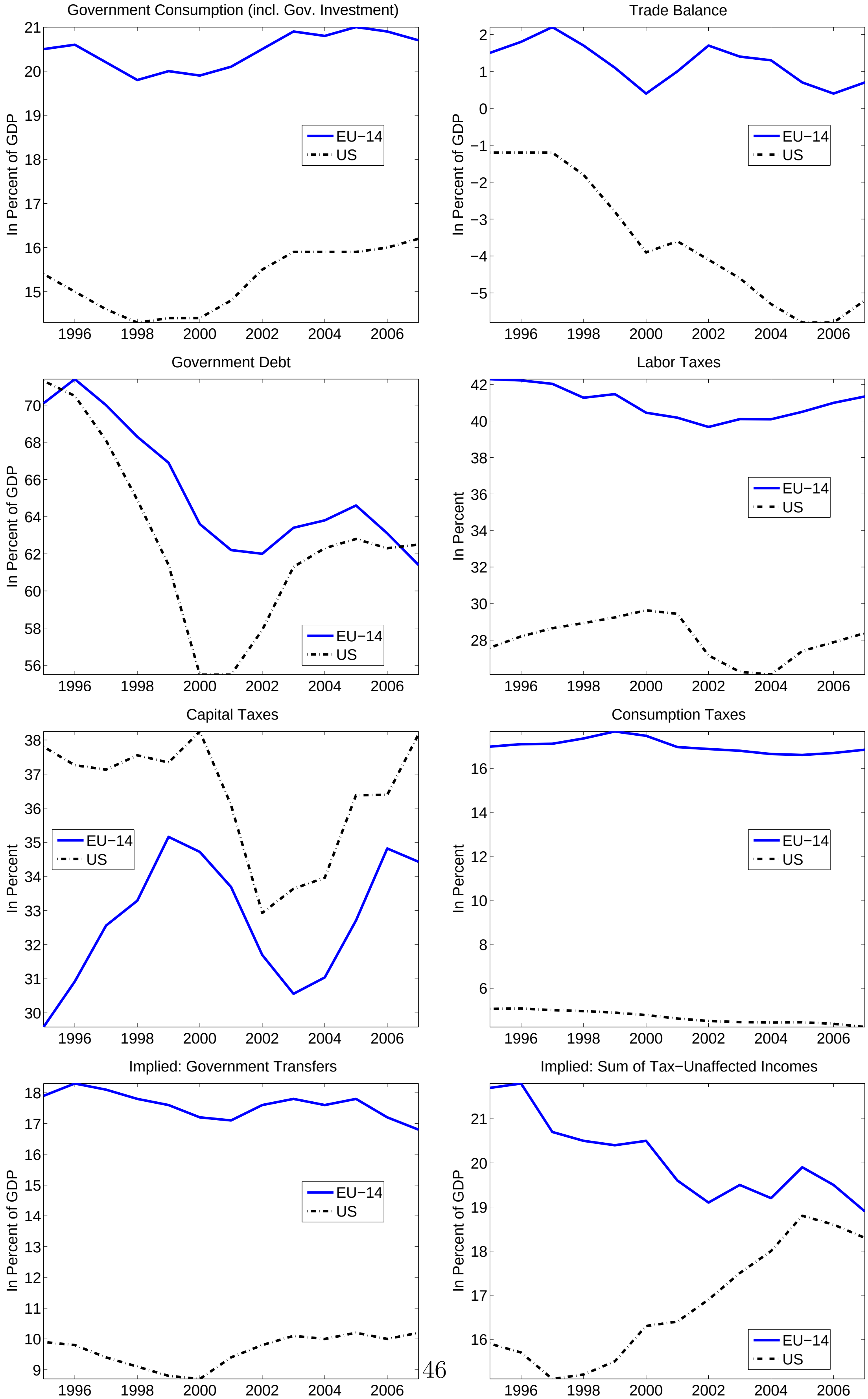
C Data Discussion and Overview

Figure 13 shows the resulting time series for taxes as well as the macroeconomic series we have used. For the calibration, we equate the values on the balanced growth path with the averages of these time series over the period from 1995 to 2007.

Using this methodology necessarily fails to capture fully the detailed nuances and features of the tax law and the inherent incentives. Nonetheless, several arguments may be made for why we use effective average tax rates instead of marginal tax rates for the calibration of the model. First, we are not aware of a comparable and coherent empirical methodology that could be used to calculate marginal labor, capital and consumption tax rates for the US and 15 European countries for a time span of, say, the last 12 years. By contrast, our calculations along with Mendoza, Razin, and Tesar (1994) and Carey and Rabesona (2002) calculate effective average tax rates for labor, capital and consumption for our countries of interest. There is some data available from the NBER for marginal tax rates on the federal and state level: however and at least for the US, the difference between marginal and average tax rates are modest.

Second, if any we probably make an error on side of caution since effective average tax rates can be seen as as representing a lower bound of statutory marginal tax rates. Third, marginal tax rates differ all across income scales. In order to properly account for this, a heterogenous agent economy is needed. This might be a useful next step but may fog up key issues analyzed in this paper initially. Fourth, statutory marginal tax rates are often different from realized marginal tax rates due to a variety of tax deductions etc. So that potentially, the effective tax rates computed and used here may reflect realized marginal tax rates more accurately than statutory marginal tax rates in legal tax codes. Fifth, using effective tax rates following the methodology of Mendoza, Razin, and Tesar (1994) facilitates comparison to previous studies that also use these tax rates as e.g. Mendoza and Tesar (1998) and many others. Nonetheless, a further analysis taking these points into account in detail is a useful next step on the research agenda.

Figure 13: Data used for Calibration of the Baseline Models



D Data Details

This appendix describes the data used in the main part of the paper. We use annual data from 1995 to 2007 for the following countries: USA, Germany (GER), France (FRA), Italy (ITA), United Kingdom (UK), Austria (AUT), Belgium (B), Denmark (DEN), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). Data from the sources listed below was downloaded in fall 2008.

D.1 Databases used

AMECO: Database of the European Commission available at:
http://ec.europa.eu/economy_finance/db_indicators/db_indicators8646_en.htm.

OECD: Databases for annual national accounts, labor force statistics and revenue statistics of the OECD. Available at:
http://stats.oecd.org/wbosdos/Default.aspx?usercontext=sourceoecd

GGDC: Groningen Growth and Development Centre and the Conference Board total economy database, January 2008 available at: *http://www.ggdc.net* or
http://www.conference-board.org/economics/downloads/TED08I.xls

NIPA: National income and product accounts provided by the BEA. Available at: *www.bea.gov.*

D.2 Macro Data

D.2.1 Raw Data

All data below except for population and hours are in \$, EUR or local currency for Denmark, Sweden and United Kingdom:

Nominal GDP: Gross domestic product at current market prices (AMECO, UVGD).

Nominal government consumption: Final consumption expenditure of general government at current prices (AMECO, UCTG).

Nominal total government expenditures: Total current expenditure: general government; ESA 1995 (AMECO, UUCG).

Nominal total government expenditures excluding interest payments: Total current expenditure excluding interest - general government - ESA 1995 (AMECO, UUCGI).

Nominal government debt: General government consolidated gross debt - Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (AMECO, UDGGL).

Nominal total private consumption: Private final consumption expenditure at current prices (AMECO, UCPH).

Nominal total private investment: Gross fixed capital formation at current prices: private sector (AMECO, UIGP).

Real capital stock: Net capital stock at constant (2000) prices; total economy (AMECO, OKND).

Real GDP: Gross domestic product at constant (2000) market prices (AMECO, OVGD).

Nominal exchange rate: ECU-EUR exchange rates - Units of national currency per EUR/ECU (AMECO, XNE).

Net exports: Net exports of goods and services at current prices (National accounts) (AMECO, UBGS).

Nominal government investment: Gross fixed capital formation at current prices: general government; ESA 1995 (AMECO, UIGG0).

Total Hours Worked: Total annual hours worked (GGDC).

Nominal durable consumption: Final consumption expenditure of households, P311: durable goods, old breakdown, national currency, current prices, national accounts database (OECD).

Population: Population 15-64, labor force statistics (OECD).

D.2.2 Data Calculations

Consumption and Investment. Total consumption in the data consists of non-durable consumption of goods and services and and durable consumption. In the model consumption is meant to be non-durable consumption only. In order to align the data with the model we therefore substract durable consumption from total consumption and add it to private investment in the data. Unfortunately, durable consumption data is available only for FRA, IRE, NET, UK and US. The sample covered is somewhat different across these countries. However, in order to proxy durable consumption data for the remaining countries we proceed as follows. We compute the ratio of durable consumption and total private consumption per year for the available country data. Interestingly, the shares for FRA, IRE and NET are twice as large as those for the UK and the US. We then calculate the total average share per year of the average UK/US and average FRA/IRE/NET shares. For the countries where there is no durable consumption data this total average share per year is applied to the annual total private consumption data in order to obtain a measure of durable consumption.

Government Interest Payments. Government interest payments are calculated as the difference between total government expenditures and total government expenditures excluding interest payments.

Implied Government Transfers and Tax-Unaffected Income. Government transfers that are consistent with the model are calculated by substracting government consumption, government interest payments and government investment from total government expenditures in the data.

Similarly, tax-unaffected income consistent with the model is calculated by adding government interest payments, government transfers and net imports in the data.

GDP Growth. Per capita GDP growth is calculated by dividing real GDP by population and then calculating annual percentage changes.

Hours Worked. In order to obtain a measure of annual hours worked per person we divide total annual hours by population. Furthermore, we assume 14.55 hours per day to be allocated between leisure and work in the US and EU-14 similar to Ragan (2005) who assumes 14 hours. We obtain a normalized average US hours per person measure of 0.25 as used in the main part of the paper.

Ratios of Variables to GDP. Based on the above data we calculate the GDP ratios for the countries. We also require the weighted EU-14 GDP ratios which are calculated according to the description in appendix A.1.

Note that variables that describe the fiscal sector such as e.g. government debt etc. are only available in nominal terms. Consistent with the model, we divide these nominal variables by nominal GDP i.e. deflate nominal variables with the GDP deflator. We also deflate all other nominal variables with the GDP deflator. Since we are interested in GDP ratios only we do not need to divide the time series by population since the division would appear in the numerator as well as in the denominator and therefore would cancel out.

D.3 Tax Rates Data

We calculate effective tax rates on labor income, capital income and consumption following the methodology of Mendoza, Razin and Tesar (1994) and used in Mendoza, Razin and Tesar (1997).

D.3.1 Raw Data

All data below are nominal in $, EUR or local currency for Denmark, Sweden and United Kingdom:

5110: General taxes, revenue statistics (OECD).

5121: Excise taxes, revenue statistics (OECD).

3000: Payroll taxes, revenue statistics (OECD).

4000: Property taxes, revenue statistics (OECD).

1000: Income, profit and capital gains taxes, revenue statistics (OECD).

2000: Social security contributions, revenue statistics (OECD).

2200: Social security contributions of employers, revenue statistics (OECD).

1100: Income, profit and capital gains taxes of individuals, revenue statistics (OECD).

1200: Income, profit and capital gains taxes of corporations, revenue statistics (OECD).

4100: Recurrent taxes on immovable property, revenue statistics (OECD).

4400: Taxes on financial and capital transactions, revenue statistics (OECD).

GW: Compensation of employees: general government - ESA 1995 (AMECO, UWCG).

OS: Net operating surplus: total economy (AMECO, UOND). This is net operating surplus plus net mixed income or equivalently the gross operating surplus minus consumption of fixed capital. For the USA OS is not available in AMECO. We obtained OS from NIPA table 11000 line 11.

W: Gross wages and salaries: households and NPISH (AMECO, UWSH). For the USA W is not available in AMECO. We obtained W from NIPA table 11000 line 4.

PEI: Net property income: households and NPISH (AMECO, UYNH). Note that in contrast to the data available to Mendoza, Razin and Tesar (1994) the present PEI data does not contain entrepreneurial income of households anymore. Instead household entrepreneurial income is contained in OSPUE defined below. For the USA PEI is not available in AMECO. We calculate this from OECD property income received (SS14 S15: Households and non-profit institutions serving households, SD4R: Property income; received, national accounts) minus property income paid (SS14 S15: Households and non-profit institutions serving households, SD4P: Property income; paid, national accounts).

OSPUE: Gross operating surplus and mixed income: households and NPISH (AMECO, UOGH). OSPUE in Mendoza, Razin and Tesar (1994) is operating surplus of private unincorporated enterprises. This data is called mixed income now. Note that all we need for the tax rate calculations below is the sum OSPUE+PEI. We miss data on household entrepreneurial income in PEI above. Therefore, we use gross operating surplus and mixed income of households in order to obtain a measure of household entrepreneurial and mixed income. For the USA OSPUE is not available in AMECO. We calculate this from the OECD (HH. Operating surplus and mixed income, gross, national accounts, detailed aggregates). We substract consumption of fixed capital obtained from the OECD (SS14 S15: Households and non-profit institutions serving households, national accounts) from gross operating surplus and mixed income in order to obtain a measure of net operating surplus and mixed income to be used for the tax rate calculations below.

For some European countries the above data starts at a later date than 1995. In addition, for a few country data time series observations for 2007 are missing. In order to obtain estimates for 2007 we apply the average growth rates of the last 5 to 20 years to the observation in 2006. Finally, we use all available individual country data for calculating weighted averages for the period 1995-2007.

D.3.2 Tax Rate Calculations

D.3.3 Effective Tax Rates

Following the methodology of Mendoza, Razin and Tesar (1994) we calculate the following effective tax rates:

Consumption tax:	$\tau^c = \frac{5110+5121}{C+G-GW-5110-5121}$
Personal income tax:	$\tau^h = \frac{1100}{OSPUE+PEI+W}$
Labor income tax:	$\tau^n = \frac{\tau^h W+2000+3000}{W+2200}$
Capital income tax:	$\tau^k = \frac{\tau^h(OSPUE+PEI)+1200+4100+4400}{OS}$

Where C, G and W denote nominal total private consumption, government consumption and wages and salaries.

For the overlapping years 2000 to 2005, our effective tax rates on consumption and labor income are close to those obtained by Carey and Rabesona's (2002) recalculation of the Mendoza, Razin and Tesar (1994). In particular, the average cross country difference in consumption taxes from 2000 to 2005 is -0.3% percent and 0.7% for labor income taxes. For capital income taxes the difference is somewhat larger i.e. -4.9%.

Sources of Tax Revenues to GDP Ratios. In the main part of the paper we require data for sources of tax revenue to GDP ratios. According to the Mendoza, Razin and Tesar (1994) methodology e.g. the capital tax is calculated as the ratio of capital tax revenues and the capital tax base. With the above data at hand it is easy to calculate capital tax revenues and divide them by nominal GDP to obtain the desired statistic. Labor and consumption tax revenues to GDP ratios are calculated in a similar way.