How Do Laffer Curves Differ Across Countries?[☆]

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Abstract

We seek to understand how Laffer curves differ across countries in the US and the EU-14, thereby providing insights into fiscal limits for government spending and the service of sovereign debt. As an application, we analyze the consequences for the permanent sustainability of current debt levels, when interest rates are permanently increased e.g. due to default fears. We build on the analysis in Trabandt and Uhlig (2011) and extend it in several ways. To obtain a better fit to the data, we allow for monopolistic competition as well as partial taxation of pure profit income. We update the sample to 2010, thereby including recent increases in government spending and their fiscal consequences. We provide an analysis for the pessimistic case that the recent fiscal shifts are permanent. We include a cross-country analysis on consumption taxes as well as a more detailed investigation of the inclusion of human capital considerations for labor taxation.

Keywords: Laffer curve, taxation, cross country comparison, debt sustainability, fiscal limits, quantitative endogenous growth, human capital and labor taxation

JEL Classification: E0, E13, E2, E3, E62, H0, H2, H3, H6

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1. Introduction

We seek to understand how Laffer curves differ across countries in the US and the EU-14. This provides insight into the limits of taxation. As an application, we analyze the consequences of recent increases in government spending and their fiscal consequences as well as the consequences for the permanent sustainability of current debt levels, when interest rates are permanently high e.g. due to default fears.

We build on the analysis in Trabandt and Uhlig (2011). There, we have characterized Laffer curves for labor and capital taxation for the U.S., the EU-14, and individual European countries. In the analysis, a neoclassical growth model featuring "constant Frisch elasticity" (CFE) preferences are introduced and analyzed: we use the same preferences here. The results there suggest that the U.S. could increase tax revenues considerably more than the EU-14, and that conversely the degree of self-financing of tax cuts is much larger in the EU-14 than in the U.S.. While we have calculated results for individual European countries, the focus there was directed towards a comparison of the U.S. and the aggregate EU-14 economy.

This paper provides a more in-depth analysis of the cross-country comparison. Furthermore, we modify the analysis in two important dimensions. The model in Trabandt and Uhlig (2011) overstates total tax revenues to GDP compared to the data: in particular, labor tax revenues to GDP are too high. We introduce monopolistic competition to solve this: capital income now consists out of rental rates to capital as well as pure profits, decreasing the share of labor income in the economy. With this change alone, the model now overpredicts the capital income tax revenue. We therefore furthermore assume that only a fraction of pure profit income is actually reported to the tax authorities and therefore taxed. With these two changes, the fit to the data improves considerably compared to the original version, see figure 2. In terms of the Laffer curves, this moves countries closer to the peak of the labor tax Laffer curve and somewhat farther away from the peak of the capital tax Laffer curve. For the cross-country comparison, we assume that all structural parameters for technologies and preferences are the same across countries. The differences between the Laffer curves therefore arise solely due to differences in fiscal policy i.e. the mix of distortionary taxes, government spending and government debt. We find that labor income and consumption taxes are important for accounting for most of the cross-country differences.

We update our analysis in Trabandt and Uhlig (2011) by including the additional years 2008-2010. This is particularly interesting, as it allows us to examine the implications of the recent substantial tax and revenue shocks. While recent fiscal policy changes were intended to be temporary, we examine the pessimistic scenario that they are permanent. To do so, we calibrate the model to the Laffer curves implied by the strained fiscal situation of 2010, and compare them to the Laffer curves of the average extended sample 1995-2010. We find that the 2010 calibration moves all countries considerably closer to the peak of the labor tax Laffer curve, with the scope for additional labor tax increases cut in half.

We then use these results to examine the scope for long-term sustainability of current debt levels, when interest rates are permanently higher due to, say, default fears. This helps to understand the more complex situation of an extended period with substantially increased interest rates due to, say, default fears. More precisely, we answer the following question: what is the maximum steady state interest rate on outstanding government debt that the government could afford without cutting government spending, based on a calibration to the fiscal situation in 2010? To do so, we calculate the implied peak of the Laffer curve and compute the maximum interest rate on outstanding government debt in 2010 that would still balance the government budget constraint in steady state. The results are in table 6: the most interesting column there may be the second one. We find that the USA can afford the highest interest rate if labor taxes are moved to the peak of the Laffer curve: depending on the debt measure used, a real interest rate of of 8.7% to 10.8% is sustainable. Interestingly, Ireland can also afford the high rate of 8%, when moving labor taxes only. By contrast, Belgium, Italy, France, Finland, Sweden and the Netherlands cannot afford permanent real rates above 4.5%, when financing the additional interest payments with higher labor tax rates alone, while, say, Germany, Portugal and Spain can all afford an interest rate somewhere above 6%. The picture improves somewhat, but not much, when labor taxes and capital taxes can both be adjusted: notably, Belgium, Denmark, Sweden and Italy cannot permanently afford real interest rates above 5%. It is worth emphasizing that we have not included the possibility of cutting government spending and/or transfers and that our analysis has focussed on the most pessimistic scenario of a permanent shift.

In the baseline model, physical capital is the production factor that gets accumulated. It may be important, however, to allow for and consider human capital accumulation, when examining the consequences of changing Labor taxation. We build on the quantitative endogenous growth models introduced in Trabandt and Uhlig (2011), and provide a more detailed cross-country comparison. We find that the capital tax Laffer curve is affected only rather little across countries when human capital is introduced into the model. By contrast, the introduction of human capital has important effects for the labor income tax Laffer curve. Many countries are pushed on the slippery slope sides of their labor tax Laffer curves once human capital is accounted for. Intuitively, higher labor taxes lead to a faster reduction of the labor tax base since households work less and aquire less human capital which in turn leads to lower labor income.

We add a cross-country analysis on consumption taxes. In Trabandt and Uhlig (2011), we have shown that the consumption tax Laffer curve has no peak. Essentially, the difference between the labor tax Laffer curve and the consumption tax Laffer curve arises due to "accounting" reasons: the additional revenues are provided as transfers, and are used for consumption purchases, to be taxed at the consumption tax rate. In Trabandt and Uhlig (2011), we only provided the analysis for the U.S. and the aggregate EU-14 economy. Here, we extend the consumption tax analysis to individual countries. The range of maximum additional tax revenues (in percent of GDP) in the baseline model is roughly 40-100 percent while it shrinks to roughly 10-30 percent in the model with added human capital. Higher consumption taxes affect equilibrium labor by increasing the labor wedge. As above, human capital amplifies the reduction of the labor tax base triggered by a higher labor wedge. Overall, maximum possible tax revenues due to consumption taxes are reduced massively, although at fairly high consumption tax rates.

The paper is organized as follows. Section 2 provides the model. The calibration and parameterization of the model can be found in section 3. Section 4 provides and discusses the results. Section 5 discusses the extension of the model with human capital as well as the results for consumption taxation. Finally, section 6 concludes.

2. Model

We employ the baseline model in Trabandt and Uhlig (2011) and extend it by allowing for intermediate inputs, supplied by monopolistically competitive firms. Time is discrete, $t = 0, 1, \ldots, \infty$. Households maximize

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

subject to

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

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 firms and asset payments m_t. The payments m_t are income from an exogenous asset or "tree", see Trabandt and Uhlig (2011) for the details. The household obtains interest earnings R_t^b and lump-sum transfers s_t from the government. It has to pay consumption taxes τ_t^c, labor income taxes τ_t^n and capital income taxes τ_t^k on dividends and on a share ϕ of profits.[1]

As introduced and extensively discussed in Trabandt and Uhlig (2011), but also used in Hall (2009), Shimer (2009) and King and Rebelo (1999), we work with constant Frisch elasticity preferences (CFE) of the following form:

$$u(c,n) = \log(c) - \kappa n^{1+\frac{1}{\varphi}} \qquad (2)$$

if $\eta = 1$ and by

$$u(c,n) = \frac{1}{1-\eta}\left(c^{1-\eta}\left(1-\kappa(1-\eta)n^{1+\frac{1}{\varphi}}\right)^{\eta} - 1\right) \qquad (3)$$

[1] We allow for partial profit taxation due to the various deductions and exemptions that are available for firms and households in this regard. Further, note that capital income taxes are levied on dividends net-of-depreciation as in Prescott (2002, 2004) and in line with Mendoza et al. (1994).

if $\eta > 0, \eta \neq 1$, where $\kappa > 0$. These preferences are consistent with balanced growth and feature a constant Frisch elasticity of labor supply, given by φ, without constraining the intertemporal elasticity of substitution.

Competitive final good firms maximize profits

$$max_{k_{t-1},z_t} \quad y_t - d_t k_{t-1} - p_t z_t \tag{4}$$

subject to the Cobb-Douglas production technology, $y_t = \xi^t k_{t-1}^{\theta} z_t^{1-\theta}$, where ξ^t denotes the trend of total factor productivity. p_t denotes the price of an homogenous input, z_t, which in turn is produced by competitive firms who maximize profits

$$\max_{z_{t,i}} \quad p_t z_t - \int p_{t,i} z_{t,i} di \tag{5}$$

subject to $z_t = \left(\int z_{t,i}^{\frac{1}{\omega}} \, di\right)^{\omega}$ with $\omega > 1$. Intermediate inputs, $z_{t,i}$, are produced by monopolistically competitive firms which maximize profits

$$\max_{p_{t,i}} \quad p_{t,i} z_{t,i} - w_t n_{t,i}$$

subject to their demand functions and production technologies:

$$\begin{aligned} z_{t,i} &= \left(\frac{p_t}{p_{t,i}}\right)^{\frac{\omega}{\omega-1}} z_t \\ z_{t,i} &= n_{t,i} \end{aligned}$$

In equilibrium, all firms set the same price which is a markup over marginal costs. Formally, $p_{t,i} = p_t = \omega w_t$. Aggregate equilibrium profits are given by $\Pi_t = (\omega - 1) \, w_t n_t$.

The government faces the budget constraint,

$$g_t + s_t + R_t^b b_{t-1} = b_t + T_t \tag{6}$$

where government tax revenues are given by

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k [(d_t - \delta) k_{t-1} + \phi \Pi_t] \tag{7}$$

It is the goal to analyze how the equilibrium shifts, as tax rates are shifted. More generally, the tax rates may be interpreted as wedges as in Chari et al. (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.

The paper focuses on the comparison of balanced growth paths. It is assumed that $m_t = \psi^t \bar{m}$ where ψ is the growth factor of aggregate output. A key assumption is that government debt as well as government spending do not deviate from their balanced growth pathes, i.e. $b_{t-1} = \psi^t \bar{b}$ and $g_t = \psi^t \bar{g}$. When tax rates are shifted, government transfers adjust according to the government budget constraint (6), rewritten as $s_t = \psi^t \bar{b}(\psi - R_t^b) + T_t - \psi^t \bar{g}$.

In equilibrium households choose plans to maximize utility, firms solve their maximization problems and the government sets policies that satisfy its budget constraint.

3 Data, calibration and parameterization

The model is calibrated to annual post-war data of the USA, the aggregate EU-14 economy and individual European countries. An overview of the calibration is in tables 1 and 2. There are two new key parameters, compared to Trabandt and Uhlig (2011). The first parameter is ω, the gross markup, due to monopolistic competition. We set $\omega = 1.3$, which appears to be a reasonable number, given the literature. The second parameter is ϕ, the share of monopolistic-competition profits which are subject to capital taxes. We set this parameter rather arbitrarily to the capital share, i.e. to 0.36, and chosen with an eye towards the fit of the model to the data.

The sample covered in Trabandt and Uhlig (2011) is 1995-2007. Here we extend the sample to 2010 using the same data sources. We update all data up to 2010, except for taxes and tax revenues which we can update only to 2009 due to data availability reasons. For most of the analysis in this paper, we assume that the 2010 observation for taxes and revenues are the same as in 2009. Appendix A contains the time series for the tax rates, based on the methodology by Mendoza et al. (1994).[2] We also pursue an alternative approach for tax rates for the year 2010, see subsection 3.2 below for the details.

We refine the calculation of transfers in the data compared to Trabandt and Uhlig (2011). In the data, there is a non-neglible difference between government tax revenues and government revenues. This difference is mostly due to "other government revenue" and "government sales". We substract these two items from the measure of transfers defined in Trabandt and Uhlig (2011).

US and aggregate EU-14 tax rates, government expenditures and government debt are set according to the upper part of table 1. We also calibrate the model to individual EU-14 country data for tax rates, government spending and government debt as provided in table 2. Although we allow fiscal policy to be different across countries, we restrict the analysis to identical parameters across countries for preferences and technology, see the lower part of table 1 for the details.

Finally, the empirical measure of government debt for the US as well as the EU-14 area provided by the AMECO database is nominal general government consolidated gross debt (excessive deficit procedure, based on ESA 1995) which is divided by nominal GDP. For the US the gross debt to GDP ratio is 66.2% in the sample. For checking purposes, we also examine the implications if we use an alternative measure of US government debt: debt held by the public. See tables 1 and 2 for the differences. However, given that to our knowledge data on "debt held by the public" is not available for European countries, we shall proceed by using gross debt as a benchmark if not otherwise noted. Where appropriate, we shall perform a sensitivity analysis with respect to the measure of US government debt.

3.1 Model Fit and Sensitivity

The structural parameters are set such that model implied steady states are close to the data. In particular, figure 1 provides a comparison of the data vs. model fit for key great ratios, hours

[2] The additional appendix examines the sensitivity of the methodology with respect to the treatment of social security contributions for the labor tax calculations.

as well as transfers and tax revenues.[3] Overall, the fit is remarkable given the relatively simple model in which country differences are entirely due to fiscal policy.[4]

Most of the structural parameter values in the lower part of table 1 are standard and perhaps uncontroversial, see e.g. Cooley and Prescott (1995), Prescott (2002, 2004, 2006) and Kimball and Shapiro (2008).

The new parameters here compared to Trabandt and Uhlig (2011) are the gross markup, $\omega = 1.3$ and the share of monopolistic-competition profits subject to capital taxation, $\phi = \theta = 0.36$. Figure 2 contains a sensitivity analysis for ω and ϕ. When $\omega \to 1$, the model overstates labor tax revenues and understates capital tax revenues, see the black crosses in figure 2. In the adapted model with intermediate inputs, a gross markup $\omega > 1$ reduces the labor tax base. At the same time, profits increase the capital tax base, but too much if profits are fully subject to capital taxation, i.e. $\phi = 1$, see the red triangles in figure 2. Overall, the fit improves considerably if we set the share of profits subject to capital taxes, $\phi = \theta = 0.36$. The fit is not sensitive to ϕ: all values in $\phi \in [0.3, 0.4]$ work practically just as well in terms of the fit, for example.

For comparision purposes, the additional appendix contains core results of this paper when we assume $\omega \to 1$ instead. Note that in this case, the value of ϕ becomes immaterial since equilibrium profits are zero.

3.2. The year 2010

At the end of our sample, government spending and government debt have risen substantially as a fallout of the financial crisis, see table 2. We are particularly interested in characterizing Laffer curves for the year 2010. While there is no tax rate data for the year 2010 at the time of writing this paper, we do have data for government spending and debt in 2010. We wish to consider the pessimistic scenario of a steady state, in which these changes are permanent. We

[3] We assume a mapping of data and model in the literal sense, i.e. the one based on the definitions of the national income and product accounts and the revenues statistics. For work that takes an alternative perspective and emphasizes the general relativity of fiscal language, see Green and Kotlikoff (2009).

[4] The present paper, and in particular the comparison of data vs. model hours is closely related to Prescott (2002, 2004) and subsequent contributions by e.g. Blanchard (2004), Alesina et al. (2006), Ljungqvist and Sargent (2007), Rogerson (2007) and Pissarides and Ngai (2009).

therefore use the government budget constraint of the model to infer the labor tax rate, i.e. we calculate the implied labor tax given government debt and government consumption in 2010 as well as average (1995-2010) model implied government transfers.

Table 2 contains the resulting labor tax rates across countries. According to the model, in the US and EU-14 labor taxes need to be 7-8 percentage points higher to balance the government budget in 2010 compared to the sample average. There is substantial country specific variation. While e.g. labor taxes in Germany and Italy remain literally unchanged, those in the United Kingdom, Ireland, Spain and the Netherlands increase by 10 or more percentage points.

4. Results

4.1. Sources of differences of Laffer curves

What accounts for the differences between the USA Laffer curves and (individual) EU-14 Laffer curves? To answer this question, we proceed as follows. As before, we calibrate the model to country specific averages of 1995-2010, see table 2, keeping structural parameters as in table 1. Next, we compute Laffer curves.

Results are reported in tables 3 and 4 labelled "Baseline". All other columns report results if in the USA calibration, fiscal instruments are set to European country specific values (each at a time).

It appears that labor income and consumption taxes are important for accounting for cross-country differences. In other words, it is the so-called labor wedge that appears to be of central importance for the shape of the labor and capital tax Laffer curves across countries.

Interestingly, observe that maximal additional tax revenues for labor and capital income taxes are relatively similar. This result is somewhat different than in Trabandt and Uhlig (2011) which is due to intermediate inputs and profit taxation in the present paper.

Note that imposing country specific debt to GDP ratios has no effect in this *particular* experiment. A different debt to GDP ratio, *given taxes and government consumption*, will result in different transfers in the status quo equilibrium. Since the model features Ricardian equivalence, the results are the same as in the USA baseline case.

4.2. Laffer curves: average 1995-2010 vs. 2010

We compute Laffer curves and the Laffer hill for a 1995-2010 vs. 2010 calibration. That is, the model is either calibrated in terms of fiscal policy to the average of 1995-2010 or to the year 2010, see table 2. Structural parameters are set as in table 1.

Figure 3 shows the resulting Laffer curves for all countries for the average 1995-2010 calibration. Figure 4 provides a comparison of Laffer curves for the 1995-2010 vs. 2010 calibration for the USA and aggregate EU-14 economy. Further cross-country results in this respect are available in table 5 and in figure 5. In the latter figure, the dashed-dotted line shows the distance to the peak for the US when the initial steady state tax is varied and the model is re-calibrated for each assumed tax rate. Interestingly, the slope of that line is -1.

According to the results, the vast the majority of countries have moved closer to the peaks of their labor and capital income tax Laffer curves and Laffer hills respectively. The movements to the peaks are sizeable for some countries such as e.g. the United Kingdom, the Netherlands and Ireland for labor taxes.

Again, whether "gross US debt or "US debt held by the public" is used does not matter for the results for the average 1995-2010 sample. For the year 2010, however, small differences arise since transfers are kept at the model average for 1995-2010.

4.3. Laffer curve and interest rates

What is the maximum interest rate on outstanding government debt that the government could afford without cutting government spending? Put differently, how high can interest rates on government debt be so that fiscal sustainability is still preserved if countries move to the peak of their Laffer curves?

To answer this question we pursue the following experiment. We calibrate the model in terms of fiscal policy to the year 2010, see table 2. Structural parameters are set as in table 1. We calculate

Laffer curves for labor and capital taxation as well as the Laffer hill for joint variations of capital and labor taxes. Keeping model implied government transfers and government consumption to GDP ratios at their 2010 levels, we calcuate the interest rate that balances the government budget at maximal tax revenues.

For the calcuations, we focus on balanced growth relationships ignoring transition issues for simplicity. Consider the scaled government budget constraint along the balanced growth path:

$$\left(\overline{s/y}\right)_{2010} + \left(\overline{g/y}\right)_{2010} = \left(\overline{b/y}\right)_{2010} (\psi - \bar{R}_{Max}) + \left(\overline{T/y}\right)_{Max} \tag{8}$$

where $\left(\overline{T/y}\right)_{Max}$ denotes the maximum additional tax revenues (expressed in % of baseline GDP) that results from moving from the 2010 status quo to the peak of the Laffer curve. We solve for $\bar{R}_{Max} = 1 + \bar{r}_{Max}$ that balances the above government budget constraint.

Table 6 contains the model results. For each of the three tax experiments (adjusting only labor taxes, adjusting only capital taxes, adjusting both), the table lists the maximal additional obtainable revenue as a share of GDP as well as the maximal sustainable interest rate that can be sustained with these revenues. For comparison, the last two columns of the table also contain real long-term interest rates for 2010 downloaded from the European Commission AMECO database. These are nominal 10 years government bond interest rates minus inflation - either using the GDP deflator (ILRV, first column) or the consumption deflator (ILRC, second column). The value for the aggregate EU-14 is the real GDP weighted average of individual European countries.

The most interesting column in table 6 may be the second one. We find that the USA can afford the highest interest rate if labor taxes are moved to the peak of the Laffer curve: depending on the debt measure used, a real interest rate of of 8.7% to 10.8% is sustainable. Interestingly, Ireland can also afford the high rate of 8%, when moving labor taxes only. By contrast, Belgium, Italy, France, Finland, Sweden and the Netherlands cannot afford permanent real rates above 4.5%, when financing the additional interest payments with higher labor tax rates alone, while, say, Germany, Portugal and Spain can all afford an interest rate somewhere above 6%. The picture improves somewhat, but not much, when labor taxes and capital taxes can both be adjusted: notably, Belgium, Denmark, Sweden and Italy cannot permanently afford real interest rates above 5%.

Note that now, the comparison of "US gross government debt" vs. "US debt held by the public" matters for the results since government spending is kept constant. Indeed, the US could affort higher interest rates if "US debt held by the public" is considered.

For the above analysis, some caveats should be kept in mind. First, the interest rate on outstanding government debt deviates from the one on private capital but does not crowd out private investment. In other words, it is implicitly assumed that the interest rate payments due to the higher interest rate are paid lump-sum to the households and thereby do not affect household consumption, hours or investment, and that it does not affect the rate at which firms can borrow privately.

Note that the steady state safe real interest rate is calibrated to equal 4 percent and represents therefore the lower bound for $\bar{r}_{Max}$: our analysis on sustainable rates may therefore be too optimistic, keeping in mind that the interest rates are real interest rates, not nominal interest rates. It is worth emphasizing that we have not included the possibility of cutting government spending and/or transfers[5] and that our analysis has focussed on the most pessimistic scenario of a permanent shift.

5. Extensions: human capital, consumption taxes

5.1. Baseline model vs. human capital accumulation

We compare the distance to the peak of Laffer curves for the above baseline model and the above baseline model with added human capital accumulation. More specifically, we assume that human capital is accumulated following the second generation case considered in Trabandt and Uhlig (2011).[6]

[5] For related work on these issues, see e.g. Bi (2010) and Bi et al. (2010).

[6] See e.g. Jones (2001), Barro and i Martin (2003) or Acemoglu (2008) for textbook treatments of models with endogenous growth and human capital accumulation. Below we consider a specification incorporating learning-by-doing as well as schooling, following Lucas (1988) and Uzawa (1965). While first-generation endogenous growth models have stressed the endogeneity of the overall long-run growth rate, second-generation growth models have

In particular, we assume that human capital can be accumulated by both learning-by-doing as well as schooling. The agent splits total non-leisure time n_t into work-place labor $q_t n_t$ and schooling time $(1 - q_t)n_t$, where $0 \leq q_t \leq 1$. Agents accumulate human capital according to

$$h_t = (Aq_t n_t + B(1 - q_t)n_t)^{\omega} h_{t-1}^{1-\omega} + (1 - \delta_h)h_{t-1} \quad (9)$$

where $A \geq 0$ and $B > A$ parameterize the effectiveness of learning-by-doing and schooling respectively and where $0 < \delta_h \leq 1$ is the depreciation rate of human capital. Wages are paid per unit of labor and human capital so that the after-tax labor income is given by $(1 - \tau_t^n)w_t h_{t-1} q_t n_t$. Given this, the adaptions of the model on the parts of firms is straightforward so that we shall leave them out here.

The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1. Parameters for human capital accumulation are set as in Trabandt and Uhlig (2011). More precisely, the same calibration strategy for the initial steady state is applied as before, except assuming now $\bar{q}\bar{n}_{US} = 0.25$. Further, $\omega = 0.5$ and $\delta_h = \delta$ are set for simplicity. A is set such that initial $\bar{q}_{US} = 0.8$. Moreover, B is set to have $h_{US} = 1$ initially.

Figure 6 shows the comparison for the US and EU-14. Further cross-country results are contained in figure 7. Interestingly, the capital tax Laffer curve is affected only very little across countries when human capital is introduced. By contrast, the introduction of human capital has important effects for the labor income tax Laffer curve. Many countries are pushed on the slippery slope sides of their labor tax Laffer curves. This result is due to two effects. First, human capital turns labor into a stock variable rather than a flow variable as in the baseline model. Higher labor taxes induce households to work less and to aquire less human capital which in turn leads to lower labor income. Consequently, the labor tax base shrinks much more quickly when labor taxes are raised. Second, the introduction of intermediate inputs moves countries closer to the

stressed potentially large level effects, without affecting the long-run growth rate. We shall focus on the second generation case here since little evidence has been found that taxation impacts on the long-run growth rate, see e.g. Levine and Renelt (1992).

peaks of their labor tax Laffer curves already in the baseline model compared to Trabandt and Uhlig (2011). This effect is reinforced when human capital is introduced.

5.2. Consumption taxes

We compute maximum additional tax revenues that are possible from increasing consumption taxes. We do this in the above baseline model and in the model with added human capital accumulation as in the previous subsection. The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1. Parameters for human capital accumulation are set as in the previous subsection.

The upper panel of figure 8 shows the comparison for the US and EU-14. Further cross-country results are shown in the lower panel of the same figure. As documented and examined in Trabandt and Uhlig (2011), the consumption tax Laffer curve has no peak. However, the introduction of human capital has important quantitative effects across countries. The range of maximum additional tax revenues (in percent of GDP) in the above baseline model is roughly 40-100 percent while it shrinks to roughly 10-30 percent in the model with added human capital. Higher consumption taxes affect equilibrium labor by increasing the labor wedge similar to labor taxes. Human capital amplifies the reduction of the labor tax base triggered by a higher labor wedge by the same argument as in the previous subsection. Overall, maximum possible tax revenues due to consumption taxes are reduced massively, although at fairly high consumption tax rates.

6. Conclusion

We have studied how Laffer curves differ across countries in the US and the EU-14. This provides insight into the limits of taxation. To that end, we extended the analysis in Trabandt and Uhlig (2011) to include monopolistic competition as well as partial taxation of the monopolistic-competition profits: we have shown that this improves the fit to the data considerably. For the cross-country comparison, we assume that all structural parameters for technologies and preferences are the same across countries. The differences between the Laffer curves therefore arise solely due to differences in fiscal policy i.e. the mix of distortionary taxes, government spending and government debt. We find that labor income and consumption taxes are important for accounting for most of the cross-country differences.

To examine recent developments, we calibrate the steady state of the model to the Laffer curves implied by the strained fiscal situation of 2010, and compare them to the Laffer curves of the average extended sample 1995-2010. We find that the 2010 calibration moves all countries considerably closer to the peak of the labor tax Laffer curve, with the scope for additional labor tax increases cut in half. We calculate the implications for the long-term sustainability of current debt levels, by calculating the maximal permanently sustainable interest rate. We calculated that the USA can afford the highest interest rate if only labor taxes are adjusted to service the additional debt burden: depending on the debt measure used, a real interest rate of of 8.7% to 10.8% is sustainable. Interestingly, Ireland can also afford the high rate of 8%, when moving labor taxes only. By contrast, Belgium, Italy, France, Finland, Sweden and the Netherlands cannot afford permanent real rates above 4.5%, when financing the additional interest payments with higher labor tax rates alone, while, say, Germany, Portugal and Spain can all afford an interest rate somewhere above 6%. The picture improves somewhat, but not much, when labor taxes and capital taxes can both be adjusted: notably, Belgium, Denmark, Sweden and Italy cannot permanently afford real interest rates above 5% .

We have shown that the introduction of human capital has important effects for the labor income tax Laffer curve across countries. Many countries are pushed on the slippery slope sides of their labor tax Laffer curves once human capital is accounted for.

We have performed a cross-country analysis on consumption taxes. We document that the range of maximum additional tax revenues (in percent of GDP) in the baseline model is roughly 40-100 percent while it shrinks to roughly 10-30 percent in the model with added human capital, although the underlying consumption taxes are fairly high in both cases.

References

Acemoglu, D., 2008. Introduction to Modern Economic Growth, 1st Edition. Princeton University Press, Princeton.

Alesina, A., Glaeser, E., Sacerdote, B., 2006. Work and leisure in the US and Europe: Why so different? NBER Macroeconomic Annual 2005, Vol. 20, MIT Press, Cambridge, pp. 1–100.

Barro, R. J., i Martin, X. S., 2003. Economic Growth, 2nd Edition. MIT Press, Cambridge.

Bi, H., 2010. Sovereign default risk premia, fiscal limits, and fiscal policy. Unpublished Manuscript.

Bi, H., Leeper, E. M., Leith, C., 2010. Stabilization versus sustainability: Macroeconomic policy tradeoffs. Unpublished Manuscript.

Blanchard, O., 2004. The economic future of europe. Journal Of Economic Perspectives 18(4), 3–26.

Chari, V. V., Kehoe, P. J., Mcgrattan, E. R., 2007. Business cycle accounting. Econometrica 75 (3), 781–836.

Cooley, T. F., Prescott, E., 1995. Economic growth and business cycles. In: T. F. Cooley (Ed.), Frontiers Of Business Cycle Research, Princeton University Press, Princeton, pp. 1–38.

Green, J., Kotlikoff, L. J., 2009. On the general relativity of fiscal language. Key Issues in Public Finance - A Conference in Memory of David Bradford, Eds. Alan J. Auerbach And Daniel Shaviro, Harvard University Press.

Hall, R. E., 2009. Reconciling cyclical movements in the marginal value of time and the marginal product of labor. Journal of Political Economy 117 (2), 281–323.

Jones, C. I., 2001. Introduction to Economic Growth, 2nd Edition. Norton, New York.

Kimball, M. S., Shapiro, M. D., 2008. Labor supply: Are the income and substitution effects both large or both small? NBER Working Paper 14208, NBER.

King, R. S., Rebelo, S. T., 1999. Resuscitating real business cycles. In: J. B. Taylor And M. Woodford (Eds.), Handbook Of Macroeconomics, Amsterdam: Elsevier 1B, pp. 927–1007.

Levine, R., Renelt, D., 1992. A sensitivity analysis of cross-country growth regressions. American Economic Review 82(4), 942–63.

Ljungqvist, L., Sargent, T. J., 2007. Do taxes explain european employment? Indivisible labor, human capital, lotteries, and savings. NBER Macroeconomics Annual 2006, Vol. 21, MIT Press, Cambridge, pp. 181–246.

Lucas, R. E., 1988. On the mechanics of economic development. Journal of Monetary Economics 22, 3–42.

Mendoza, E. G., Razin, A., Tesar, L. L., 1994. Effective tax rates in macroeconomics: Cross-country estimates of tax rates on factor incomes and consumption. Journal Of Monetary Economics 34, 297–323.

Pissarides, C., Ngai, L. R., 2009. Welfare policy and the sectoral distribution of employment. Center for Structual Econometrics Discussion Paper No. 09/04, London School of Economics.

Prescott, E. C., 2002. Prosperity and depression. American Economic Review 92, 1–15.

Prescott, E. C., 2004. Why do americans work so much more than europeans? Quarterly Review, Federal Reserve Bank Of Minneapolis 28, 2–13.

Prescott, E. C., 2006. Nobel lecture: The transformation of macroeconomic policy and research. Journal Of Political Economy 114(2), 203–235.

Rogerson, R., 2007. Taxation and market work: is Scandinavia an outlier? Economic Theory 32 (1), 59–85.

Shimer, R., 2009. Convergence in macroeconomics: The labor wedge. American Economic Journal: Macroeconomics 1(1), 280–297.

Trabandt, M., Uhlig, H., May 2011. The Laffer curve revisited. Journal of Monetary Economics 58 (4), 305–327.

Uzawa, H., 1965. Optimum technical change in an aggregative model of economic growth. International Economic Review 6, 18–31.

7. Tables and Figures

Variable	US	EU-14	Description	Restriction
			Fiscal Policy	
τ^n	27.3	40.9	Labor tax rate	Data
τ^k	34.5	31.9	Capital tax rate	Data
τ^c	4.6	16.7	Consumption tax rate	Data
$\overline{g/y}$	18.0	23.1	Gov. consumption+invest. to GDP	Data
			Gross Government Debt	
$\overline{b/y}$	66.2	67.3	Government gross debt to GDP	Data
$\overline{s/y}$	4.3	11.0	Government transfers to GDP	Implied
			Sensitivity: Government Debt Held By The Public	
$\overline{b/y}$	42.4	-	Government debt held by public to GDP	Data
$\overline{s/y}$	4.9	-	Government transfers to GDP	Implied
			Trade	
$\overline{m/y}$	3.6	-1.2	Net imports to GDP	Data
			Technology	
ψ	1.5	1.5	Annual balanced growth rate	Data
θ	0.36	0.36	Capital share in production	Data
δ	0.07	0.07	Annual depreciation rate of capital	Data
$\bar{R}-1$	4	4	Annual real interest rate	Data
ω	1.3	1.3	Gross markup	Data
ϕ	0.36	0.36	Share of profits subject to capital taxes	Data
			CFE Preferences	
η	2	2	Inverse of IES	Data
φ	1	1	Frisch labor supply elasticity	Data
κ	2.55	2.55	Weight of labor	$\bar{n}_{us} = 0.25$

Table 1: Baseline calibration and parameterization for the US and EU-14 benchmark model. Numbers expressed in percent where applicable. Sample: 1995-2010. IES denotes intertemporal elasticity of substitution. CFE refers to constant Frisch elasticity preferences. $\bar{n}_{us}$ denotes balanced growth labor in the US which is set to 25 percent of total time.

	$\bar{\tau}^n$			$\bar{\tau}^c$		$\bar{\tau}^k$		$\overline{b/y}$		$\overline{m/y}$		$\overline{g/y}$		$\overline{s/y}$	
	∅	2010[a]	2010[b]	∅	2010	∅	2010	∅	2010	∅	2010	∅	2010	∅	2010
USA	27	25	35	5	4	35	31	66	92	4	4	18	20	4	4
USA*	27	25	35	5	4	35	31	42	64	4	4	18	20	5	5
EU-14	41	41	48	17	15	32	31	67	83	-1	-1	23	25	11	11
GER	41	42	42	16	17	23	24	64	83	-3	-5	21	21	11	11
FRA	45	45	51	18	16	35	34	63	82	-0	2	27	28	11	11
ITA	47	49	50	14	13	34	38	111	119	-1	2	22	23	14	14
GBR	28	29	41	15	13	44	43	48	80	2	3	22	26	10	10
AUT	50	51	53	20	20	24	23	66	72	-3	-5	21	21	18	18
BEL	48	47	53	17	17	43	43	104	97	-4	-3	24	26	16	16
DNK	48	50	56	34	31	50	56	49	44	-5	-6	28	32	23	23
FIN	48	45	56	26	23	32	30	45	48	-6	-3	25	27	16	16
GRE	40	38	47	15	13	17	16	105	143	10	8	21	21	9	9
IRL	27	26	45	24	19	17	16	48	96	-13	-19	19	23	6	6
NET	44	46	60	19	19	28	23	58	63	-7	-8	27	32	7	7
PRT	28	29	36	19	16	27	28	61	93	9	7	23	24	7	7
ESP	35	35	48	14	10	27	22	54	60	3	2	22	24	8	8
SWE	56	52	51	26	26	39	48	54	40	-7	-6	30	31	16	16

Table 2: Individual country calibration of the benchmark model for the average (∅) sample 1995-2010 and for the year 2010. Country codes: Germany (GER), France (FRA), Italy (ITA), United Kingdom (GBR), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). See table 1 for abbreviations of variables. All numbers are expressed in percent. a - due to data availability reasons, the year 2009 value for tax rates has been assumed to remain in 2010 for most of the analysis in this paper. b - we deviate from a in subsection 3.2 by letting labor taxes in 2010 adjust to balance the 2010 government budget. More precisely, we calculate the 2010 labor tax given government debt and consumption in 2010 as well as average (1995-2010) model implied transfers. * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database.

Max. add. tax revenues (in % of baseline GDP)							
		Start with US and impose country calibration for...					
	Baseline	$\bar{\tau}^n$	$\bar{\tau}^k$	$\bar{\tau}^c$	$\overline{b/y}$	$\overline{g/y}$	$\overline{m/y}$
USA	5.9	5.9	5.9	5.9	5.9	5.9	5.9
USA*	5.9	5.9	5.9	5.9	5.9	5.9	5.9
EU-14	1.8	2.4	6.1	3.8	5.9	6.4	6.4
GER	2.3	2.4	6.7	3.9	5.9	6.1	6.6
FRA	1.0	1.5	5.8	3.6	5.9	6.8	6.3
ITA	0.8	1.3	5.9	4.2	5.9	6.2	6.4
GBR	3.7	5.7	5.2	4.0	5.9	6.3	6.0
AUT	0.3	0.7	6.6	3.3	5.9	6.1	6.5
BEL	0.5	1.1	5.2	3.7	5.9	6.5	6.7
DNK	-0.0	1.0	4.7	1.6	5.9	7.0	6.8
FIN	0.5	1.1	6.1	2.5	5.9	6.6	7.0
GRE	1.8	2.6	7.1	4.1	5.9	6.1	5.3
IRL	6.3	6.0	7.1	2.8	5.9	6.0	8.1
NET	2.0	1.7	6.3	3.4	5.9	6.9	7.0
PRT	3.8	5.8	6.4	3.4	5.9	6.4	5.4
ESP	3.2	3.8	6.4	4.3	5.9	6.2	6.0
SWE	0.0	0.2	5.5	2.6	5.9	7.3	7.1

Table 3: Labor tax Laffer curve: sources of differences across countries. The table provides maximal additional tax revenues (in percent of baseline GDP) if labor taxes are varied. "Baseline" refers to the results when the model is calibrated to country specific averages of 1995-2010, see table 2. Parameters for technology and preferences are set as in table 1. All other columns report results if in the US calibration, fiscal instruments are set to country specific values (each at a time). * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database.

Max. add. tax revenues (in % of baseline GDP)							
		Start with US and impose country calibration for...					
	Baseline	$\bar{\tau}^n$	$\bar{\tau}^k$	$\bar{\tau}^c$	$\overline{b/y}$	$\overline{g/y}$	$\overline{m/y}$
USA	3.8	3.8	3.8	3.8	3.8	3.8	3.8
USA*	3.8	3.8	3.8	3.8	3.8	3.8	3.8
EU-14	2.2	2.4	4.2	2.5	3.8	4.1	4.1
GER	3.3	2.4	5.5	2.6	3.8	4.0	4.3
FRA	1.6	2.0	3.8	2.4	3.8	4.4	4.1
ITA	1.5	1.9	3.8	2.8	3.8	4.0	4.1
GBR	1.7	3.8	2.5	2.6	3.8	4.1	3.9
AUT	1.9	1.6	5.3	2.2	3.8	4.0	4.2
BEL	0.7	1.8	2.6	2.5	3.8	4.2	4.3
DNK	0.0	1.7	1.7	1.2	3.8	4.5	4.3
FIN	1.5	1.8	4.2	1.7	3.8	4.3	4.5
GRE	3.3	2.4	6.3	2.7	3.8	4.0	3.5
IRL	5.5	3.9	6.2	1.9	3.8	3.9	5.1
NET	2.8	2.1	4.7	2.3	3.8	4.4	4.5
PRT	3.2	3.8	4.9	2.3	3.8	4.1	3.6
ESP	3.2	2.9	4.9	2.8	3.8	4.0	3.9
SWE	0.7	1.2	3.1	1.8	3.8	4.6	4.5

Table 4: Capital tax Laffer curve: sources of differences across countries. The table provides maximal additional tax revenues (in percent of baseline GDP) if capital taxes are varied. "Baseline refers" to the results when the model is calibrated to country specific averages of 1995-2010, see table 2. Parameters for technology and preferences are set as in table 1. All other columns report results if in the US calibration, fiscal instruments are set to country specific values (each at a time). * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database.

	Vary Labor Taxes, $\bar{\tau}^n$ $\Delta\overline{T}_{Max}$		Vary Capital Taxes, $\bar{\tau}^k$ $\Delta\overline{T}_{Max}$		Vary $\bar{\tau}^n$ and $\bar{\tau}^k$ jointly $\Delta\overline{T}_{Max}$	
	∅	2010	∅	2010	∅	2010
USA	24.5	16.4	16.0	13.5	28.2	20.8
USA*	24.5	16.7	16.0	13.7	28.2	21.0
EU-14	5.1	2.3	6.1	5.0	8.0	5.5
GER	6.9	6.4	9.9	9.2	12.2	11.4
FRA	2.5	1.0	4.0	3.4	4.9	3.5
ITA	2.2	1.0	4.0	2.7	4.6	2.9
GBR	11.4	4.1	5.3	3.1	12.3	5.2
AUT	0.8	0.6	4.7	5.0	4.7	4.9
BEL	1.2	0.3	1.7	1.4	2.2	1.5
DNK	-0.0	0.5	0.0	0.1	0.0	0.5
FIN	1.1	0.0	3.5	2.7	3.8	2.9
GRE	5.7	3.0	10.1	8.9	11.3	9.2
IRL	23.5	12.3	20.8	17.2	32.0	23.0
NET	5.5	0.7	7.8	6.6	10.0	6.6
PRT	12.2	7.2	10.3	7.8	15.6	10.6
ESP	10.4	4.0	10.5	8.9	14.7	9.7
SWE	0.0	0.3	1.6	0.7	1.6	0.8

Table 5: Laffer curves and Laffer hill for 1995-2010 vs. 2010 calibration. The model is either calibrated to the average of 1995-2010 or to the 2010, see table 2. Parameters are set as in table 1. $\Delta\overline{T}_{Max}$ denotes the maximum additional tax revenues (in %) that results from moving from to the peak of the Laffer curve. * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database.

	Vary Labor Taxes, $\bar{\tau}^n$		Vary Capital Taxes, $\bar{\tau}^k$		Vary $\bar{\tau}^n$ and $\bar{\tau}^k$ jointly		Data: long-term interest rates[†]	
	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$		
USA	4.3	8.7	3.6	7.9	5.5	9.9	2.0	1.4
USA*	4.4	10.8	3.6	9.6	5.5	12.6	2.0	1.4
EU-14	0.9	5.1	1.9	6.3	2.1	6.5	2.4	1.5
GER	2.2	6.6	3.1	7.7	3.8	8.6	2.1	0.8
FRA	0.4	4.5	1.4	5.7	1.4	5.7	2.3	1.9
ITA	0.4	4.3	1.1	4.9	1.2	5.0	3.7	2.5
GBR	1.5	5.9	1.1	5.4	2.0	6.4	0.5	-0.4
AUT	0.2	4.3	2.0	6.8	2.0	6.8	1.4	1.1
BEL	0.2	4.2	0.6	4.6	0.6	4.7	1.6	1.6
DNK	0.3	4.7	0.0	4.1	0.3	4.7	-0.5	0.4
FIN	0.0	4.0	1.2	6.5	1.3	6.7	2.6	1.1
GRE	1.0	4.7	3.0	6.1	3.1	6.2	7.3	4.4
IRL	3.9	8.0	5.4	9.6	7.2	11.5	8.4	8.0
NET	0.3	4.5	2.7	8.3	2.7	8.3	1.7	1.5
PRT	2.4	6.6	2.6	6.8	3.5	7.8	4.3	3.7
ESP	1.4	6.2	3.0	9.0	3.3	9.4	3.8	1.8
SWE	0.1	4.4	0.3	4.8	0.4	4.9	1.6	1.6

Table 6: Maximum additional tax revenue and interest rates for the labor and capital tax Laffer curve respectively Laffer hill. The model is calibrated to the year 2010, see table 2. Parameters are set as in table 1. $\Delta\overline{T/y}_{Max}$ denotes the maximum additional tax revenues (expressed in % of baseline GDP) that results from moving from the 2010 status quo to the peak of the Laffer curve. $\bar{r}_{Max}$ is the maximum net real interest rate that the government could afford on outstanding debt in the year 2010 if all additonal tax revenue is spent on interest rate payments. [†] - real long-term interest rates for 2010 downloaded from the European Commission AMECO database. These are nominal 10 years government bond interest rates minus inflation - either using the GDP deflator (ILRV, first column) or the consumption deflator (ILRC, second column). EU-14 value is the real GDP weighted average of European countries. * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database. All numbers in the table in percent.

	Distance to Peak in Terms of Tax Rates (in %)			
	Vary Labor Taxes, $\bar{\tau}^n$		Vary Capital Taxes, $\bar{\tau}^k$	
	Baseline	Human Capital	Baseline	Human Capital
USA	33.7	14.7	35.5	34.5
USA*	33.7	14.7	35.5	34.5
EU-14	18.1	-2.9	30.1	30.1
GER	19.9	0.9	40.4	40.4
FRA	13.6	-9.4	25.1	25.1
ITA	12.2	-10.8	25.5	23.5
GBR	28.1	5.1	22.3	21.3
AUT	7.6	-16.4	31.8	29.8
BEL	9.2	-14.8	15.7	15.7
DNK	-0.3	-30.3	2.8	1.8
FIN	9.1	-13.9	26.5	27.5
GRE	17.7	-5.3	41.4	36.4
IRL	39.0	27.0	52.6	57.6
NET	19.8	1.8	36.7	40.7
PRT	27.4	4.4	36.5	33.5
ESP	24.8	3.8	37.1	36.1
SWE	1.2	-22.8	17.7	20.7

Table 7: Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation (second generation, see the main text and Trabandt and Uhlig (2011) for details). Distance is measured in terms of tax rates. All numbers are expressed in percent. The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011). * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database. All numbers in the table in percent.

	Vary Consumption Taxes: Distance to Peak in Terms of Tax Revenues (in % of GDP)	
	Baseline	Human Capital
USA	90.7	28.6
USA*	90.7	28.6
EU-14	64.4	21.2
GER	62.8	21.6
FRA	58.3	19.2
ITA	67.3	20.7
GBR	78.8	25.0
AUT	63.9	20.0
BEL	57.5	18.2
DNK	50.3	15.6
FIN	48.7	16.9
GRE	98.3	28.0
IRL	45.9	19.7
NET	42.9	16.7
PRT	91.5	28.3
ESP	76.8	24.8
SWE	39.1	13.7

Table 8: Maximum additional tax revenues due to consumption taxes. Baseline model versus baseline model with added human capital accumulation (second generation human capital accumulation growth model, see the main text and Trabandt and Uhlig (2011) for details). Additional tax revenues are measured in percent of baseline GDP. The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011). * - results when "debt held by the public" is used for the USA rather than the harmonized cross-country measure of gross government debt provided by the AMECO database. All numbers in the table in percent.

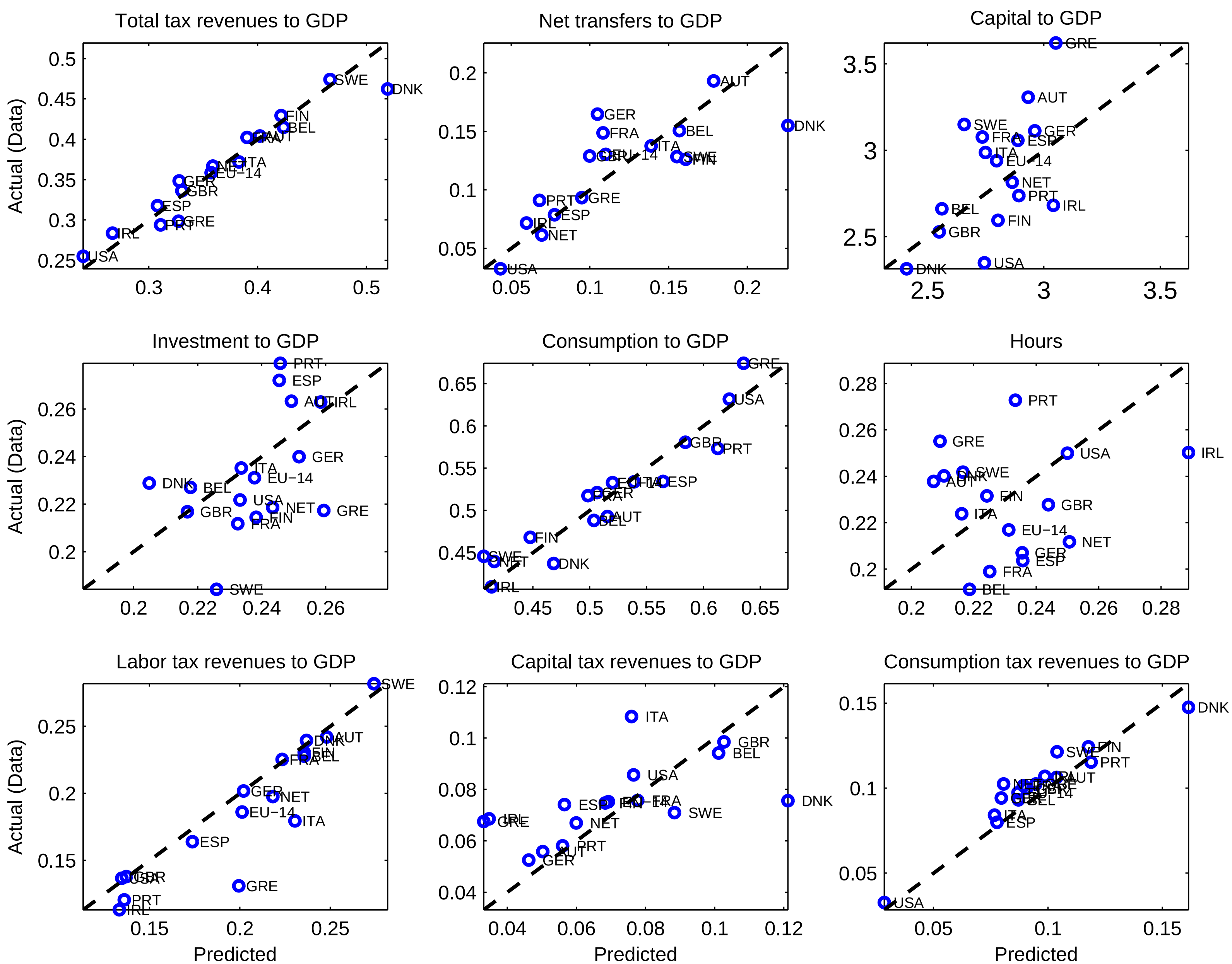


Figure 1: Comparison of "actual" vs. "predicted" variables. "Actual" refers to data sample averages for 1995-2010. "Predicted" refers to model implied steady state (balanced growth path) variables when the model is calibrated as in see table 2 (gross US debt). Parameters for technology and preferences are set as in table 1 (gross debt).

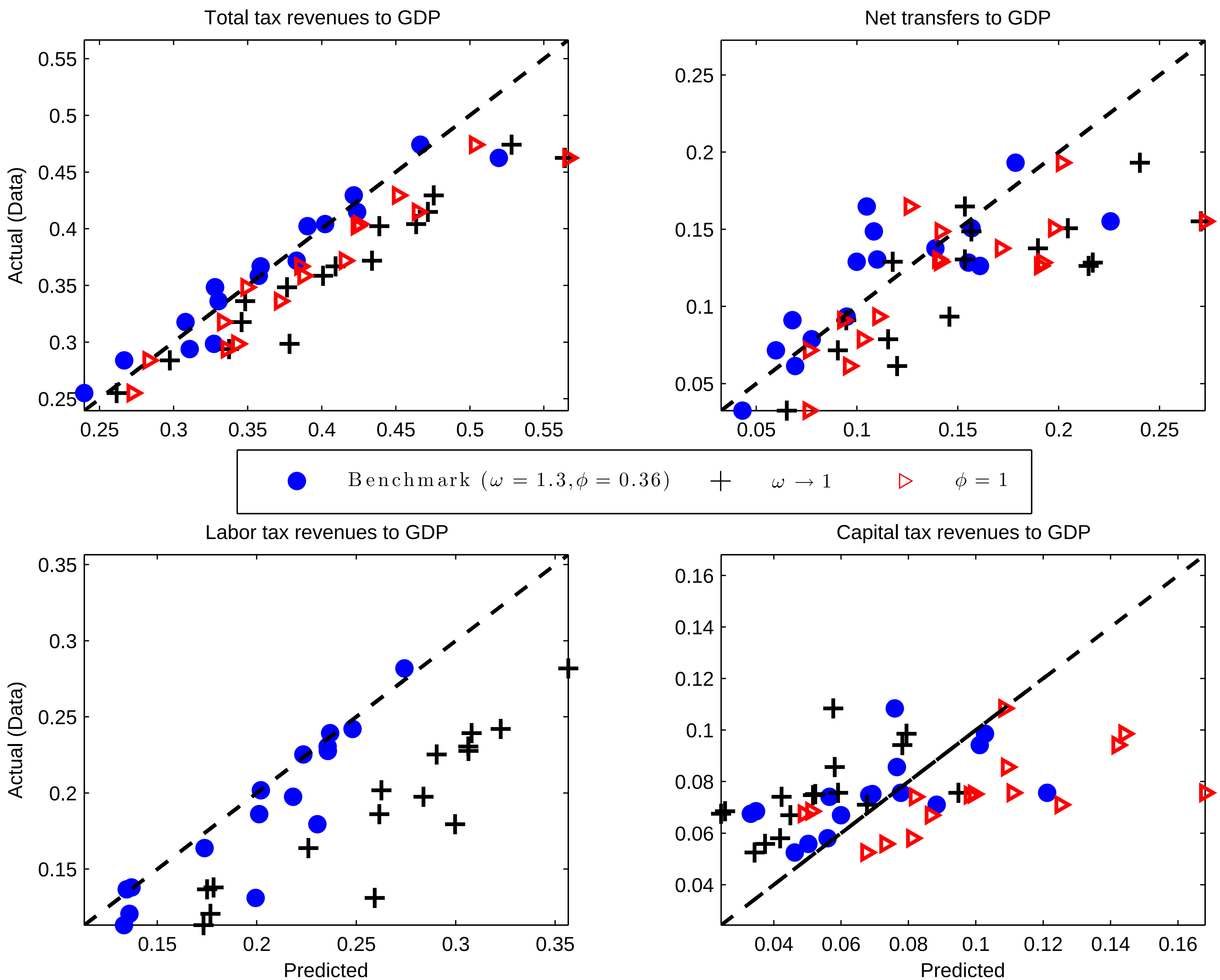


Figure 2: Sensitivity of "actual" vs. "predicted" tax revenues and government transfers. "Actual" refers to data sample averages for 1995-2010. "Predicted" refers to model implied steady state (balanced growth path). Three cases are examined. The benchmark case is the model used in the paper, and as in figure 1. The case $\omega \to 1$ obtains, when there is no market power by intermediate goods producers: this is our previously used model in Trabandt and Uhlig (2011). Finally, there is the intermediate case with monopolistic competition, but where profits are fully subject to capital taxation, $\phi = 1$. Note that all other variables plotted in figure 1 are unaffected by the sensitivity analysis, except for hours. However, the impact on hours is small and therefore omitted here. All other parameters and steady states are as in tables 1 and 2 (gross US debt).

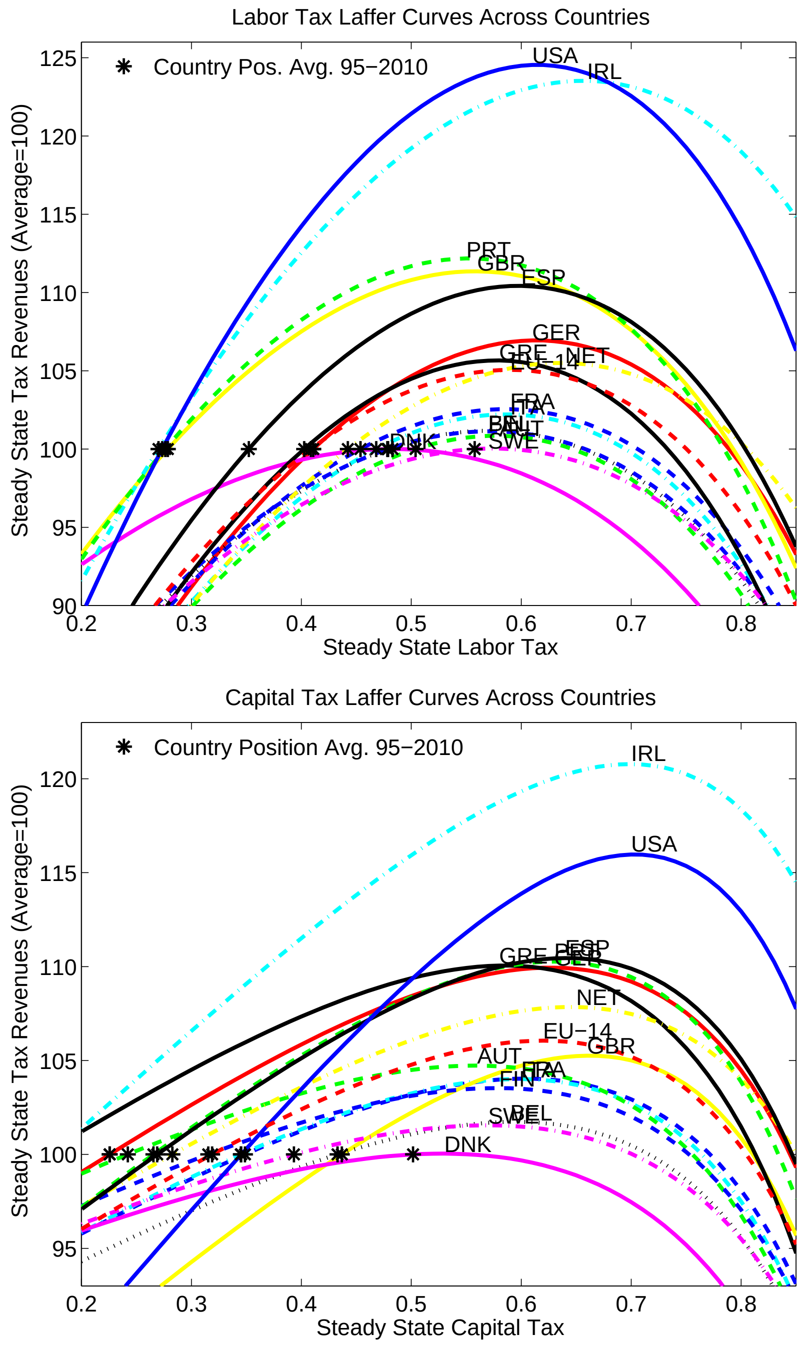


Figure 3: Labor and capital tax Laffer curves across all countries. The model is calibrated to the average of 1995-2010, see table 2 (gross US debt). Parameters for technology and preferences are set as in table 1 (gross US debt). Shown are steady state (balanced growth path) total tax revenues when labor taxes (upper panel) or capital taxes (lower panel) are varied between 0 and 100 percent. All other taxes and parameters are held constant. Total tax revenues at the average 1995-2010 tax rates are normalized to 100. Stars indicate positions of respective countries on their Laffer curves. Note that the first letter of each country name indicates the peak of the respective Laffer curve.

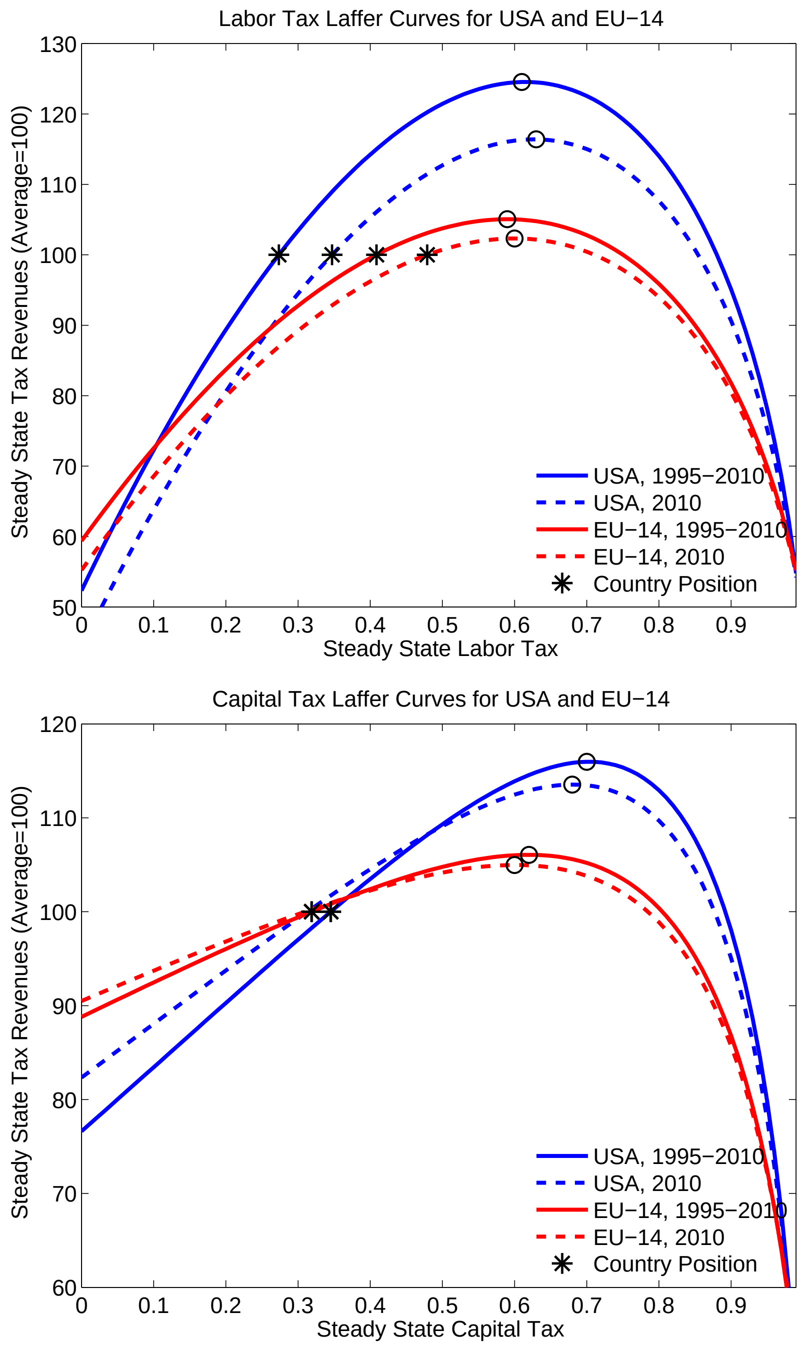


Figure 4: Comparing the US and the EU-14 labor and capital tax Laffer curve. The model is either calibrated to the average of 1995-2010 or to the 2010, see table 2 (gross US debt). Parameters for technology and preferences are set as in table 1 (gross US debt). Shown are steady state (balanced growth path) total tax revenues when labor taxes (upper panel) or capital taxes (lower panel) are varied between 0 and 100 percent. All other taxes and parameters are held constant. Total tax revenues at the average 1995-2010 or at the year 2010 tax rates are normalized to 100. Stars indicate positions of respective countries on their Laffer curves.

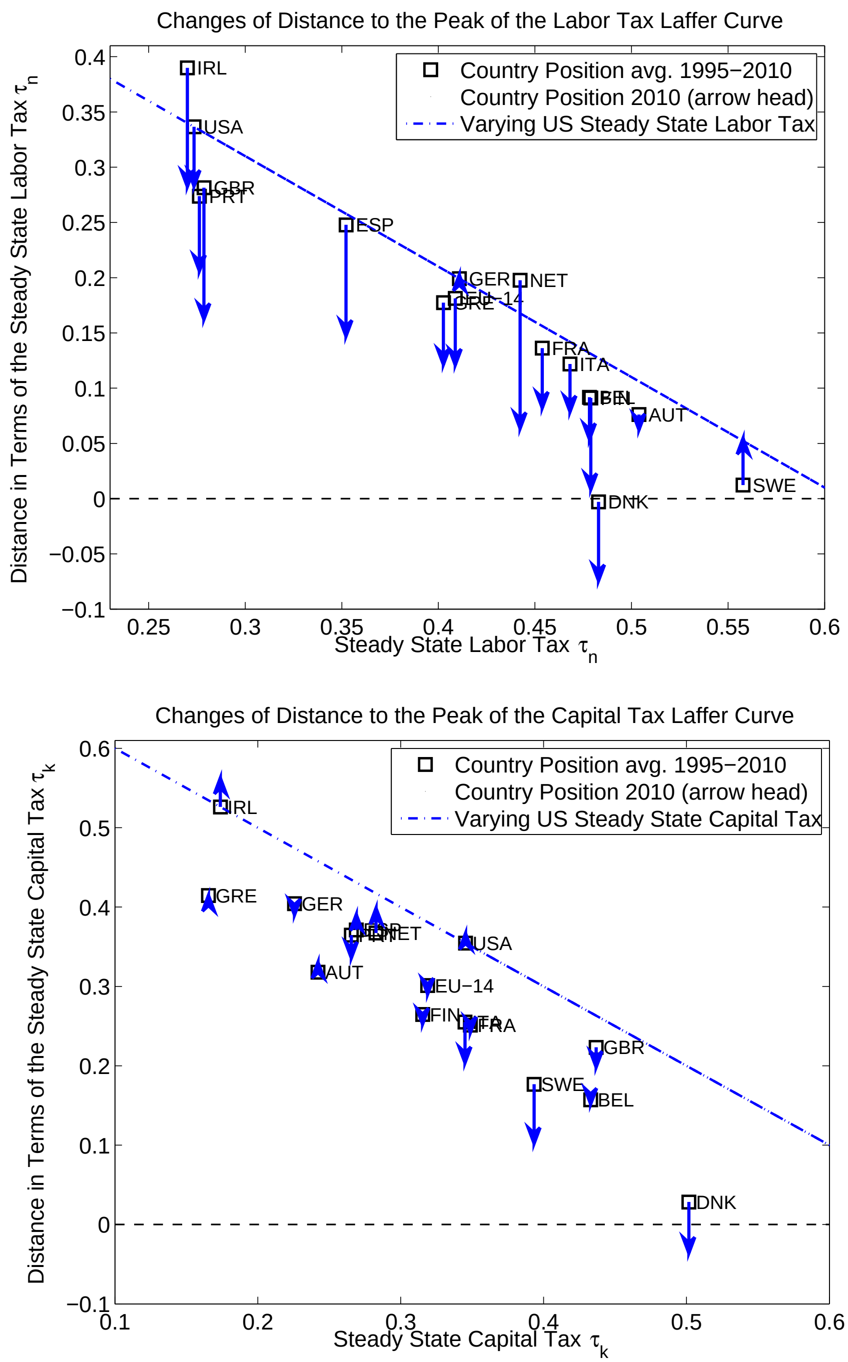


Figure 5: Distance to the peak of Laffer curves for average 1995-2010 vs. 2010 calibration. The model is either calibrated to the average of 1995-2010 or to the 2010, see table 2 (gross US debt). Parameters for technology and preferences are set as in table 1 (gross US debt). Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax rates. The dashed-dotted line shows the distance to the peak for the US when the initial steady state tax is varied and the model is re-calibrated for each assumed tax rate.

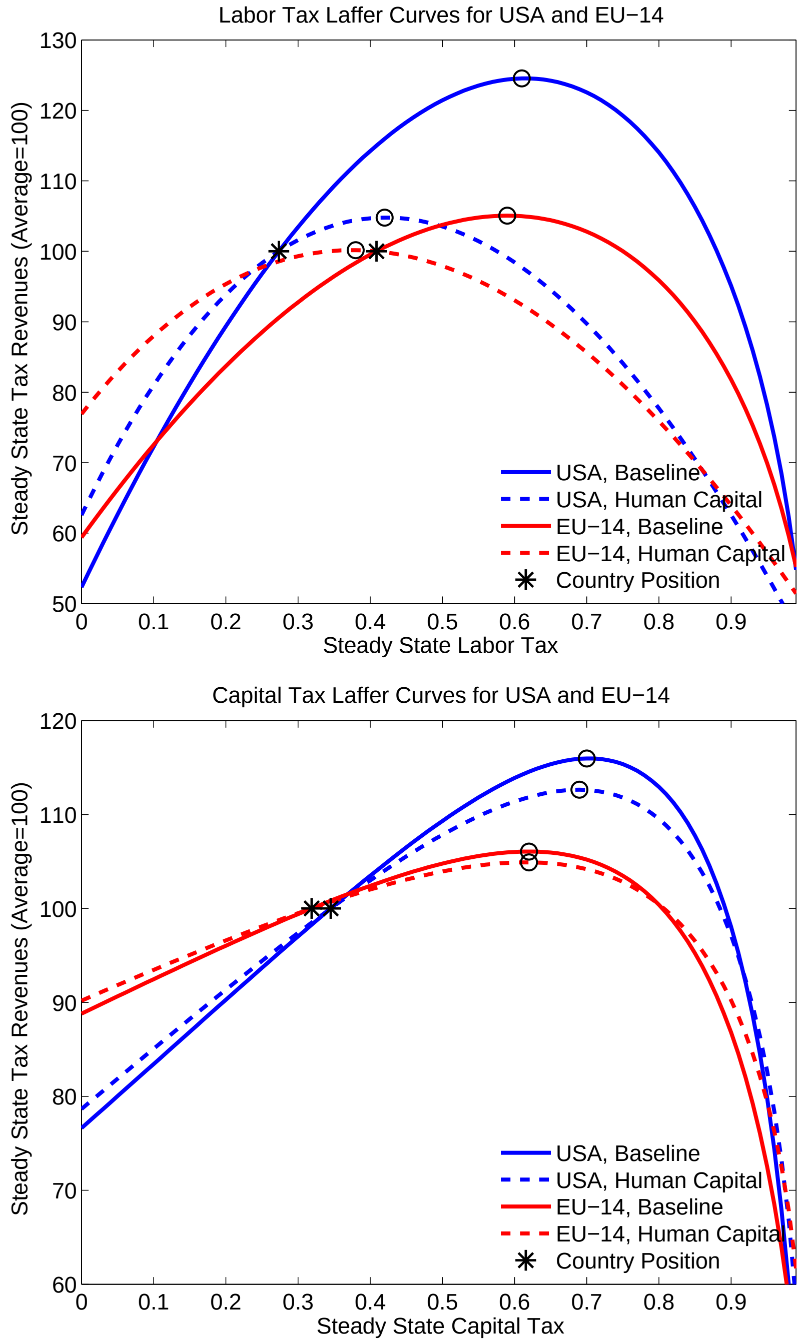
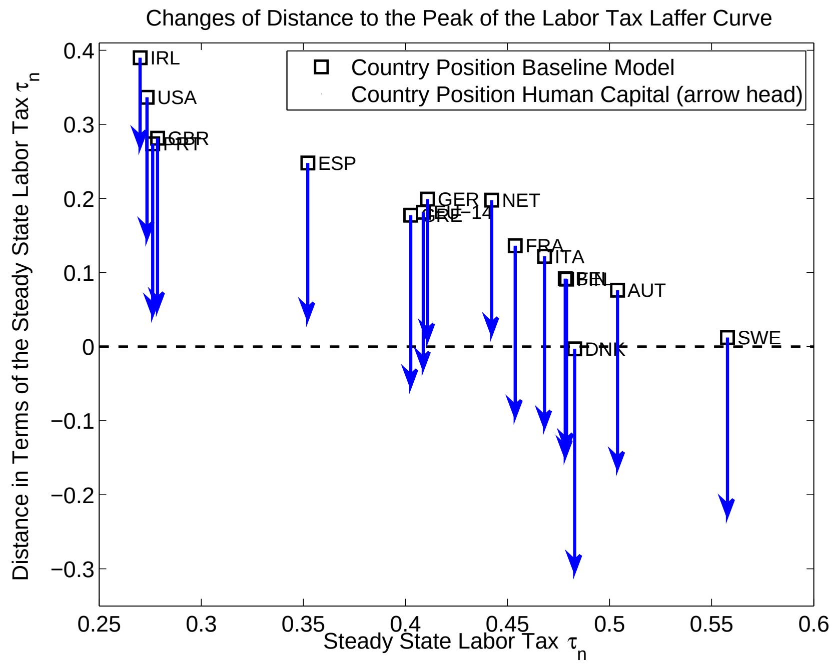


Figure 6: Labor and capital tax Laffer curves: the impact of endogenous human capital accumulation. Shown are steady state (balanced growth path) total tax revenues when labor taxes are varied between 0 and 100 percent in the USA and EU-14. All other taxes and parameters are held constant. Total tax revenues at the average tax rates are normalized to 100. Two cases are examined. First, the benchmark model with exogenous growth. Second, the benchmark model with a second generation version of endogenous human capital accumulation (see the main text and Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1 (gross US debt). Parameters for human capital accumulation are set as in the main text Trabandt and Uhlig (2011).



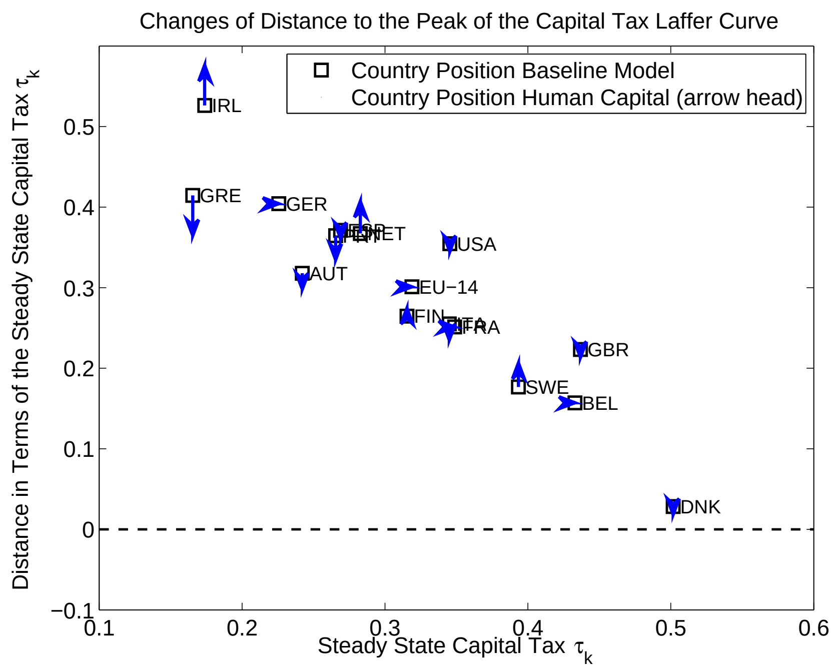


Figure 7: Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation (second generation, see the main text Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1 (gross US debt). Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011). Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax rates.

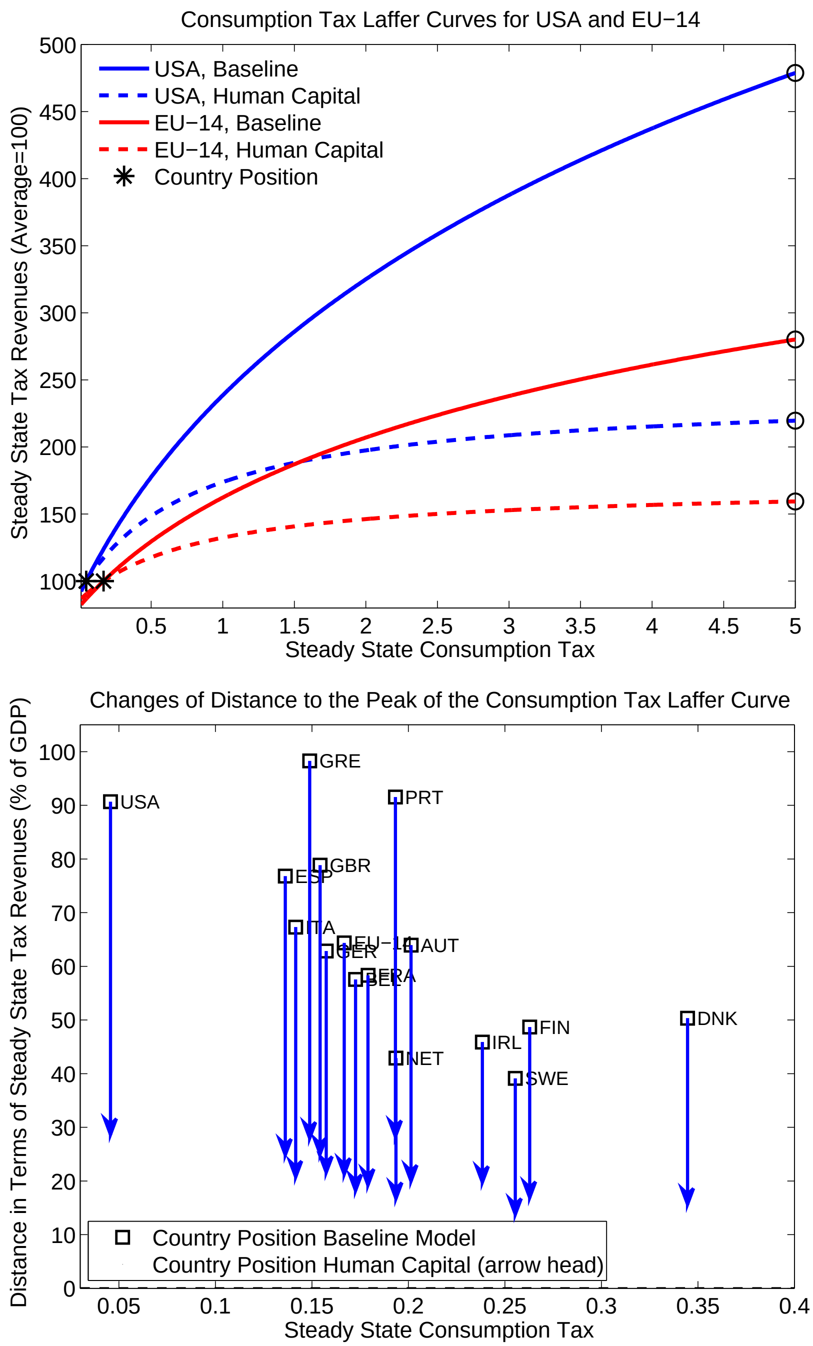


Figure 8: Upper panel: Consumption tax Laffer curve in the USA and EU-14: the impact of endogenous human capital accumulation. Shown are steady state (balanced growth path) total tax revenues when consumption taxes are varied between 0 and 500 percent. All other taxes and parameters are held constant. Total tax revenues at the average consumption tax rate are normalized to 100. Two cases are examined. First, the benchmark model with exogenous growth. Second, the benchmark model with a second generation version of endogenous human capital accumulation (see the main text and Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table 1 (gross US debt). Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011).
Lower panel: Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation. Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax revenues (in percent of GDP).

Appendix A. Tables

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
USA	27.4	28.0	28.5	28.7	29.0	29.4	29.1	26.8	25.9	25.8	26.9	27.3	27.7	26.8	25.1	25.1
EU-14	42.0	42.0	41.8	41.0	41.3	40.3	40.1	39.5	39.9	39.9	40.3	40.7	40.9	41.4	41.4	41.4
GER	41.5	40.5	41.0	41.5	41.4	41.4	41.7	40.7	40.5	39.9	39.9	40.7	41.1	41.4	42.1	42.1
FRA	46.1	46.7	46.5	45.2	45.6	45.2	44.6	44.3	44.9	44.6	45.8	45.7	45.3	45.3	45.1	45.1
ITA	46.1	48.4	49.6	45.6	46.4	45.6	45.4	45.5	45.8	46.0	45.8	45.9	47.4	48.3	48.6	48.6
GBR	26.5	25.8	25.3	26.5	27.1	27.5	27.4	26.8	27.3	28.3	29.1	29.8	30.1	30.2	29.1	29.1
AUT	47.7	49.1	50.4	50.5	50.5	49.8	51.4	51.2	51.2	51.1	50.5	50.3	50.3	50.9	50.7	50.7
BEL	47.9	47.8	48.5	48.8	48.1	47.9	47.8	48.5	48.7	49.1	47.9	46.8	46.8	47.1	46.7	46.7
DNK	46.8	47.3	47.9	47.0	49.3	49.5	49.3	48.3	48.4	47.4	47.6	47.5	48.8	48.4	49.6	49.6
FIN	51.7	52.4	50.2	49.7	48.8	49.2	48.5	48.0	46.6	45.7	46.5	46.9	46.5	45.9	44.8	44.8
GRE	NaN	NaN	NaN	NaN	NaN	39.6	40.6	41.0	42.0	40.5	41.0	40.1	41.1	40.8	38.1	38.1
IRL	NaN	NaN	NaN	NaN	NaN	NaN	NaN	25.9	26.5	27.9	27.7	28.7	28.4	26.0	26.0	26.0
NET	49.4	46.4	46.8	42.3	43.6	43.6	40.4	40.7	41.0	41.8	42.5	45.3	45.0	46.9	46.0	46.0
PRT	26.8	26.6	26.7	26.3	26.2	26.8	27.4	27.4	28.0	27.2	27.6	28.3	28.9	29.2	29.3	29.3
ESP	NaN	NaN	NaN	NaN	NaN	33.8	34.5	34.8	34.8	34.9	35.4	36.1	36.6	35.9	35.3	35.3
SWE	53.5	55.1	57.0	58.8	61.3	57.7	55.7	54.0	56.0	56.6	56.6	56.7	54.9	54.1	52.2	52.2

Table A.9: Labor income taxes in percent across countries and time. Country codes: Germany (GER), France (FRA), Italy (ITA), United Kingdom (GBR), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). * - due to data availability reasons, 2010 tax rates are assumed to be the same as in 2009. For an alternative, see subsection 3.2 in the main text.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
USA	36.4	35.9	35.5	36.0	35.8	36.7	34.2	31.6	32.3	32.4	34.7	35.7	37.8	34.8	31.3	31.3
EU-14	29.1	30.4	32.0	32.8	34.4	33.9	32.8	30.9	29.9	30.4	31.9	33.8	33.5	32.5	31.0	31.0
GER	21.8	21.6	21.6	22.8	24.7	25.8	20.4	20.4	21.3	20.7	21.6	23.1	23.5	23.9	24.0	24.0
FRA	27.3	29.9	31.9	34.5	36.7	36.2	37.2	35.6	34.2	35.9	36.1	38.9	37.4	38.5	33.8	33.8
ITA	33.2	34.2	36.5	32.6	35.1	31.7	33.1	32.5	31.2	31.4	32.3	36.4	38.1	38.3	37.6	37.6
GBR	39.2	38.4	41.0	44.6	45.5	49.6	50.0	43.8	40.8	41.2	44.4	47.0	43.9	43.2	43.2	43.2
AUT	20.9	24.1	25.8	25.7	24.6	24.3	29.3	24.3	24.3	24.1	23.2	22.5	23.4	24.9	23.0	23.0
BEL	38.7	41.0	42.6	45.4	45.4	44.6	46.3	44.6	42.2	40.9	43.5	44.0	42.7	45.0	42.9	42.9
DNK	42.3	43.5	43.7	51.1	45.4	44.3	47.8	48.4	49.3	50.0	55.0	58.0	56.9	55.9	55.6	55.6
FIN	27.4	31.6	32.3	33.7	33.8	39.6	32.2	31.9	30.3	30.4	30.9	30.2	30.4	30.6	29.8	29.8
GRE	NaN	NaN	NaN	NaN	NaN	21.1	17.3	17.3	15.7	15.5	16.6	15.5	16.2	15.8	15.5	15.5
IRL	NaN	NaN	NaN	NaN	NaN	NaN	NaN	15.5	16.6	17.9	18.2	20.4	18.9	17.5	15.7	15.7
NET	27.6	30.4	30.3	30.9	31.4	30.3	31.3	29.5	26.9	27.4	30.0	27.1	27.0	25.9	23.1	23.1
PRT	20.9	22.7	23.3	23.2	25.8	28.1	25.7	27.0	26.0	25.3	27.4	28.7	30.9	32.8	28.4	28.4
ESP	NaN	NaN	NaN	NaN	NaN	24.7	23.7	25.3	25.7	27.7	31.3	33.6	34.9	25.0	21.9	21.9
SWE	29.0	35.1	37.0	37.3	38.8	47.0	43.2	37.3	35.4	36.4	40.1	38.3	39.6	39.1	47.8	47.8

Table A.10: Capital income taxes in percent across countries and time. Country codes: Germany (GER), France (FRA), Italy (ITA), United Kingdom (GBR), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). * - due to data availability reasons, 2010 tax rates are assumed to be the same as in 2009.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
USA	5.1	5.1	5.0	5.0	4.9	4.7	4.6	4.5	4.4	4.4	4.5	4.5	4.3	4.1	4.0	4.0
EU-14	17.0	17.1	17.1	17.3	17.6	17.4	16.9	16.8	16.7	16.6	16.5	16.6	16.7	16.1	15.2	15.2
GER	15.4	15.3	15.0	15.2	16.0	16.0	15.6	15.5	15.7	15.2	15.1	15.3	16.7	16.6	16.7	16.7
FRA	18.6	19.4	19.6	19.6	19.8	18.8	18.1	18.0	17.5	17.6	17.5	17.4	17.1	16.5	15.6	15.6
ITA	15.3	14.4	14.2	15.1	14.7	15.6	14.9	14.6	14.1	13.7	13.7	14.2	14.0	13.1	12.5	12.5
GBR	16.7	16.9	16.7	16.7	16.7	16.3	15.7	15.5	15.6	15.6	15.0	14.8	14.7	14.1	13.0	13.0
AUT	19.3	20.0	21.0	21.0	21.6	20.5	20.2	20.7	20.2	20.2	20.0	19.2	19.6	19.6	19.5	19.5
BEL	16.5	16.8	17.1	17.0	18.0	17.9	16.8	17.2	17.0	17.8	18.2	18.3	17.8	16.8	16.5	16.5
DNK	32.4	33.9	34.2	35.4	36.4	35.7	35.8	35.7	35.0	34.8	35.6	36.0	35.2	33.1	31.0	31.0
FIN	26.5	26.4	28.9	28.5	28.9	28.1	26.8	26.7	27.2	26.2	26.1	25.8	24.8	23.9	22.9	22.9
GRE	15.7	15.8	16.3	15.6	15.8	15.1	15.7	15.6	14.9	14.5	14.2	14.4	14.8	14.1	12.8	12.8
IRL	24.1	24.4	24.8	26.0	26.5	25.4	22.2	23.5	23.3	25.0	26.0	25.9	24.5	21.1	19.3	19.3
NET	17.9	18.4	18.5	18.7	19.5	19.3	19.9	19.1	19.2	19.8	20.7	20.5	20.5	20.2	18.7	18.7
PRT	19.2	19.8	19.5	20.6	20.6	19.4	19.5	20.2	20.0	19.7	20.5	20.7	19.6	18.4	15.8	15.8
ESP	12.8	13.1	13.5	14.3	15.0	14.7	14.2	14.3	14.7	14.7	14.9	14.9	14.3	12.4	10.2	10.2
SWE	26.8	25.4	25.2	25.5	25.0	24.7	25.1	25.1	25.1	25.3	25.7	25.8	26.1	26.2	25.8	25.8

Table A.11: Consumption taxes in percent across countries and time. Country codes: Germany (GER), France (FRA), Italy (ITA), United Kingdom (GBR), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). * - due to data availability reasons, 2010 tax rates are assumed to be the same as in 2009.

Appendix: Additional Results

Appendix B. Results for perfect competition

This section contains core results when $\omega \to 1$, i.e. no market power by intermediate goods producers. Note that in this case, the value of ϕ becomes immaterial since equilibrium profits are zero.

Parameters and Results when $\omega \to 1$ is assumed.

Variable	US	EU-14	Description	Restriction
			Fiscal Policy	
τ^n	27.3	40.9	Labor tax rate	Data
τ^k	34.5	31.9	Capital tax rate	Data
τ^c	4.6	16.7	Consumption tax rate	Data
$\overline{b/y}$	66.2	67.3	Annual government gross debt to GDP	Data
$\overline{g/y}$	18.0	23.1	Gov.consumption+invest. to GDP	Data
$\overline{s/y}$	6.5	15.3	Government transfers to GDP	Implied
			Trade	
$\overline{m/y}$	3.6	-1.2	Net imports to GDP	Data
			Technology	
ψ	1.5	1.5	Annual balanced growth rate	Data
θ	0.36	0.36	Capital share in production	Data
δ	0.07	0.07	Depreciation rate of capital	Data
$\bar{R}-1$	4	4	Annual real interest rate	Data
ω	$\to 1$	$\to 1$	Gross markup	Data
ϕ	-	-	Share of profits subject to capital taxes	Data
			CFE preferences	
η	2	2	Inverse of IES	Data
φ	1	1	Frisch labor supply elasticity	Data
κ	3.48	3.48	Weight of labor	$\bar{n}_{us} = 0.25$

Table B.12: The case of $\omega \to 1$. Baseline calibration and parameterization for the US and EU-14 benchmark model. Numbers expressed in percent where applicable. Sample: 1995-2010. IES denotes intertemporal elasticity of substitution. CFE refers to constant Frisch elasticity preferences. $\bar{n}_{us}$ denotes balanced growth labor in the US which is set to 25 percent of total time.

Parameters and Results when $\omega \to 1$ is assumed.

	$\bar{\tau}^n$			$\bar{\tau}^c$		$\bar{\tau}^k$		$\overline{b/y}$		$\overline{m/y}$		$\overline{g/y}$		$\overline{s/y}$	
	∅	2010[a]	2010[b]	∅	2010	∅	2010	∅	2010	∅	2010	∅	2010	∅	2010
USA	27	25	33	5	4	35	31	66	92	4	4	18	20	7	7
EU-14	41	41	46	17	15	32	31	67	83	-1	-1	23	25	15	15
GER	41	42	42	16	17	23	24	64	83	-3	-5	21	21	15	15
FRA	45	45	49	18	16	35	34	63	82	-0	2	27	28	16	16
ITA	47	49	50	14	13	34	38	111	119	-1	2	22	23	19	19
GBR	28	29	38	15	13	44	43	48	80	2	3	22	26	12	12
AUT	50	51	52	20	20	24	23	66	72	-3	-5	21	21	24	24
BEL	48	47	51	17	17	43	43	104	97	-4	-3	24	26	20	20
DNK	48	50	55	34	31	50	56	49	44	-5	-6	28	32	27	27
FIN	48	45	54	26	23	32	30	45	48	-6	-3	25	27	22	22
GRE	40	38	45	15	13	17	16	105	143	10	8	21	21	14	14
IRL	27	26	41	24	19	17	16	48	96	-13	-19	19	23	9	9
NET	44	46	56	19	19	28	23	58	63	-7	-8	27	32	12	12
PRT	28	29	35	19	16	27	28	61	93	9	7	23	24	9	9
ESP	35	35	45	14	10	27	22	54	60	3	2	22	24	11	11
SWE	56	52	52	26	26	39	48	54	40	-7	-6	30	31	22	22

Table B.13: The case of $\omega \to 1$. Individual country calibration of the benchmark model for the average (∅) sample 1995-2010 and for the year 2010. Country codes: Germany (GER), France (FRA), Italy (ITA), United Kingdom (GBR), Austria (AUT), Belgium (BEL), Denmark (DNK), Finland (FIN), Greece (GRE), Ireland (IRL), Netherlands (NET), Portugal (PRT), Spain (ESP) and Sweden (SWE). See table B.12 for abbreviations of variables. All numbers are expressed in percent. a - due to data availability reasons, the year 2009 value for tax rates has been assumed to remain in 2010 for most of the analysis in this paper. b - we deviate from a in subsection 3.2 by letting labor taxes in 2010 adjust to balance the 2010 government budget. More precisely, we calculate the 2010 labor tax given government debt and consumption in 2010 as well as average (1995-2010) model implied transfers.

Results when $\omega \to 1$ is assumed.

Max. add. tax revenues (in % of baseline GDP)							
		Start with US and impose country calibration for...					
	Baseline	$\bar{\tau}^n$	$\bar{\tau}^k$	$\bar{\tau}^c$	$\overline{b/y}$	$\overline{g/y}$	$\overline{m/y}$
USA	8.7	8.7	8.7	8.7	8.7	8.7	8.7
EU-14	3.3	3.9	8.9	6.4	8.7	9.4	9.3
GER	3.8	3.9	9.4	6.6	8.7	9.1	9.7
FRA	2.2	2.6	8.7	6.2	8.7	10.0	9.2
ITA	1.8	2.3	8.7	6.8	8.7	9.2	9.3
GBR	6.5	8.5	8.1	6.6	8.7	9.2	8.9
AUT	0.9	1.4	9.3	5.8	8.7	9.1	9.6
BEL	1.4	2.0	8.1	6.3	8.7	9.5	9.7
DNK	0.4	1.9	7.6	3.7	8.7	10.2	9.9
FIN	1.4	2.0	8.9	4.8	8.7	9.7	10.2
GRE	3.1	4.1	9.8	6.7	8.7	9.0	8.0
IRL	9.6	8.8	9.7	5.2	8.7	8.9	11.7
NET	3.6	2.9	9.1	5.9	8.7	10.1	10.2
PRT	6.3	8.6	9.2	5.9	8.7	9.3	8.1
ESP	5.2	5.8	9.2	6.9	8.7	9.2	8.8
SWE	0.3	0.5	8.4	4.9	8.7	10.5	10.3

Table B.14: The case of $\omega \to 1$. Labor tax Laffer curve: sources of differences across countries. The table provides maximal additional tax revenues (in percent of baseline GDP) if labor taxes are varied. "Baseline" refers to the results when the model is calibrated to country specific averages of 1995-2010, see table B.13. Parameters for technology and preferences are set as in table B.12. All other columns report results if in the US calibration, fiscal instruments are set to country specific values (each at a time).

Results when $\omega \to 1$ is assumed.							
Max. add. tax revenues (in % of baseline GDP)							
		Start with US and impose country calibration for...					
	Baseline	$\bar{\tau}^n$	$\bar{\tau}^k$	$\bar{\tau}^c$	$\overline{b/y}$	$\overline{g/y}$	$\overline{m/y}$
USA	1.9	1.9	1.9	1.9	1.9	1.9	1.9
EU-14	0.4	0.6	2.1	0.9	1.9	2.1	2.1
GER	0.9	0.6	2.9	1.0	1.9	2.0	2.3
FRA	0.1	0.3	1.9	0.9	1.9	2.4	2.1
ITA	0.1	0.2	1.9	1.1	1.9	2.1	2.1
GBR	0.6	1.8	1.1	1.0	1.9	2.1	2.0
AUT	0.1	0.1	2.8	0.7	1.9	2.0	2.2
BEL	0.0	0.2	1.2	0.9	1.9	2.2	2.3
DNK	0.5	0.2	0.6	0.2	1.9	2.5	2.3
FIN	0.1	0.2	2.2	0.4	1.9	2.3	2.4
GRE	0.8	0.6	3.4	1.0	1.9	2.0	1.7
IRL	2.8	1.9	3.3	0.5	1.9	2.0	3.0
NET	0.7	0.4	2.4	0.8	1.9	2.4	2.5
PRT	1.2	1.9	2.6	0.8	1.9	2.1	1.7
ESP	1.1	1.0	2.5	1.1	1.9	2.1	1.9
SWE	0.0	0.0	1.5	0.5	1.9	2.6	2.5

Table B.15: The case of $\omega \to 1$. Capital tax Laffer curve: sources of differences across countries. The table provides maximal additional tax revenues (in percent of baseline GDP) if capital taxes are varied. "Baseline refers" to the results when the model is calibrated to country specific averages of 1995-2010, see table B.13. Parameters for technology and preferences are set as in table B.12. All other columns report results if in the US calibration, fiscal instruments are set to country specific values (each at a time).

Results when $\omega \to 1$ is assumed.

	Vary Labor Taxes, $\bar{\tau}^n$ $\Delta\overline{T}_{Max}$		Vary Capital Taxes, $\bar{\tau}^k$ $\Delta\overline{T}_{Max}$		Vary $\bar{\tau}^n$ and $\bar{\tau}^k$ jointly $\Delta\overline{T}_{Max}$	
	∅	2010	∅	2010	∅	2010
USA	33.3	25.1	7.3	5.7	33.4	25.1
EU-14	8.4	5.4	1.0	0.6	8.4	5.4
GER	10.1	9.6	2.3	2.1	10.1	9.6
FRA	4.9	3.0	0.3	0.1	5.1	3.1
ITA	4.2	2.6	0.3	0.0	4.4	2.9
GBR	18.7	10.1	1.6	0.5	19.5	10.7
AUT	2.0	1.8	0.3	0.3	2.0	1.8
BEL	3.0	1.8	0.0	0.0	3.6	2.3
DNK	0.6	0.0	0.9	1.9	2.3	2.3
FIN	2.9	0.9	0.2	0.0	3.0	1.0
GRE	8.2	5.6	2.1	1.6	8.2	5.6
IRL	32.3	22.6	9.4	7.5	32.6	23.8
NET	8.7	3.6	1.6	1.1	8.7	3.8
PRT	18.6	13.2	3.6	2.3	18.7	13.3
ESP	15.0	8.6	3.1	2.2	15.0	8.7
SWE	0.7	1.0	0.0	0.3	0.9	1.9

Table B.16: The case of $\omega \to 1$. Laffer curves and Laffer hill for 1995-2010 vs. 2010 calibration. The model is either calibrated to the average of 1995-2010 or to the 2010, see table 2. Parameters are set as in table B.12. $\Delta\overline{T}_{Max}$ denotes the maximum additional tax revenues (in %) that results from moving from to the peak of the Laffer curve.

Results when $\omega \to 1$ is assumed.

	Vary Labor Taxes, $\bar{\tau}^n$		Vary Capital Taxes, $\bar{\tau}^k$		Vary $\bar{\tau}^n$ and $\bar{\tau}^k$ jointly	
	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$	$\Delta\overline{T/y}_{Max}$	$\bar{r}_{Max}$
USA	7.2	11.8	1.6	5.8	7.2	11.8
EU-14	2.3	6.7	0.3	4.3	2.3	6.7
GER	3.7	8.5	0.8	5.0	3.7	8.5
FRA	1.3	5.6	0.1	4.1	1.4	5.7
ITA	1.2	5.0	0.0	4.0	1.3	5.1
GBR	4.0	9.0	0.2	4.3	4.2	9.3
AUT	0.8	5.2	0.1	4.2	0.8	5.2
BEL	0.9	4.9	0.0	4.0	1.1	5.2
DNK	0.0	4.1	1.2	6.7	1.4	7.2
FIN	0.5	5.0	0.0	4.0	0.5	5.0
GRE	2.2	5.5	0.6	4.4	2.2	5.5
IRL	7.8	12.1	2.6	6.7	8.2	12.5
NET	1.6	6.6	0.5	4.8	1.7	6.8
PRT	4.8	9.1	0.8	4.9	4.8	9.1
ESP	3.2	9.4	0.8	5.3	3.2	9.4
SWE	0.6	5.4	0.2	4.4	1.0	6.5

Table B.17: The case of $\omega \to 1$. Maximum additional tax revenue and interest rates for the labor and capital tax Laffer curve respectively Laffer hill. The model is calibrated to the year 2010, see table B.13. Parameters are set as in table B.12. $\Delta\overline{T/y}_{Max}$ denotes the maximum additional tax revenues (expressed in % of baseline GDP) that results from moving from the 2010 status quo to the peak of the Laffer curve. $\bar{r}_{Max}$ is the maximum net real interest rate that the government could afford on outstanding debt in the year 2010 if all additonal tax revenue is spent on interest rate payments. All numbers are in percent.

Results when $\omega \to 1$ is assumed.

	Distance to Peak in Terms of Tax Rates (in %)			
	Vary Labor Taxes, $\bar{\tau}^n$		Vary Capital Taxes, $\bar{\tau}^k$	
	Baseline	Human Capital	Baseline	Human Capital
USA	33.7	14.7	35.5	34.5
EU-14	18.1	-2.9	30.1	30.1
GER	19.9	0.9	40.4	40.4
FRA	13.6	-9.4	25.1	25.1
ITA	12.2	-10.8	25.5	23.5
GBR	28.1	5.1	22.3	21.3
AUT	7.6	-16.4	31.8	29.8
BEL	9.2	-14.8	15.7	15.7
DNK	-0.3	-30.3	2.8	1.8
FIN	9.1	-13.9	26.5	27.5
GRE	17.7	-5.3	41.4	36.4
IRL	39.0	27.0	52.6	57.6
NET	19.8	1.8	36.7	40.7
PRT	27.4	4.4	36.5	33.5
ESP	24.8	3.8	37.1	36.1
SWE	1.2	-22.8	17.7	20.7

Table B.18: The case of $\omega \to 1$. Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation (second generation, see the main text and Trabandt and Uhlig (2011) for details). Distance is measured in terms of tax rates. All numbers are expressed in percent. The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table B.12. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011).

Results when $\omega \to 1$ is assumed.

	Vary Consumption Taxes: Distance to Peak in Terms of Tax Revenues (in % of GDP)	
	Baseline	Human Capital
USA	90.7	28.6
EU-14	64.4	21.2
GER	62.8	21.6
FRA	58.3	19.2
ITA	67.3	20.7
GBR	78.8	25.0
AUT	63.9	20.0
BEL	57.5	18.2
DNK	50.3	15.6
FIN	48.7	16.9
GRE	98.3	28.0
IRL	45.9	19.7
NET	42.9	16.7
PRT	91.5	28.3
ESP	76.8	24.8
SWE	39.1	13.7

Table B.19: The case of $\omega \to 1$. Maximum additional tax revenues due to consumption taxes. Baseline model versus baseline model with added human capital accumulation (second generation human capital accumulation growth model, see the main text and Trabandt and Uhlig (2011) for details). Additional tax revenues are measured in percent of baseline GDP. The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table B.12. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011).

Results when $\omega \to 1$ is assumed.

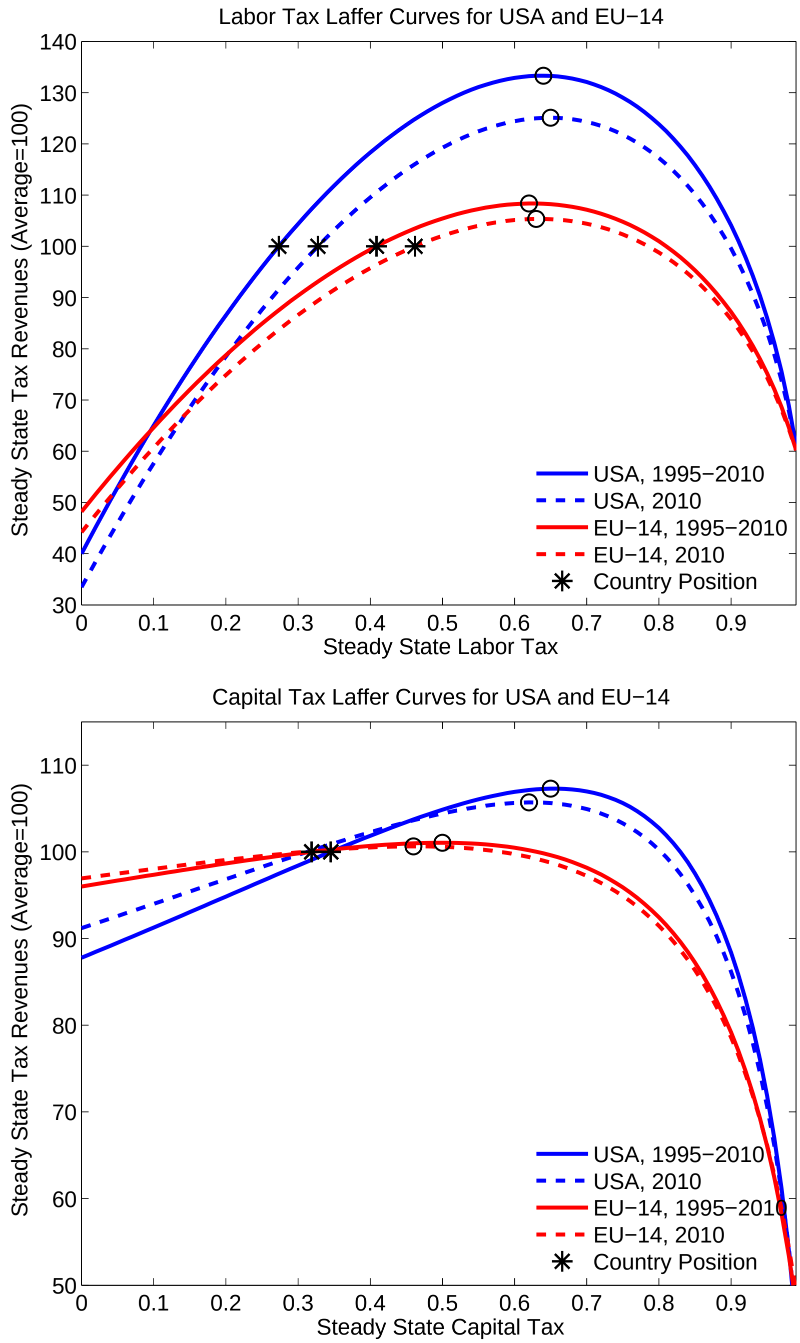


Figure B.9: The case of $\omega \to 1$. Comparing the US and the EU-14 labor and capital tax Laffer curve. The model is either calibrated to the average of 1995-2010 or to the 2010, see table B.13. Parameters for technology and preferences are set as in table B.12. Shown are steady state (balanced growth path) total tax revenues when labor taxes (upper panel) or capital taxes (lower panel) are varied between 0 and 100 percent. All other taxes and parameters are held constant. Total tax revenues at the average 1995-2010 or at the year 2010 tax rates are normalized to 100. Stars indicate positions of respective countries on their Laffer curves.

Results when $\omega \to 1$ is assumed.

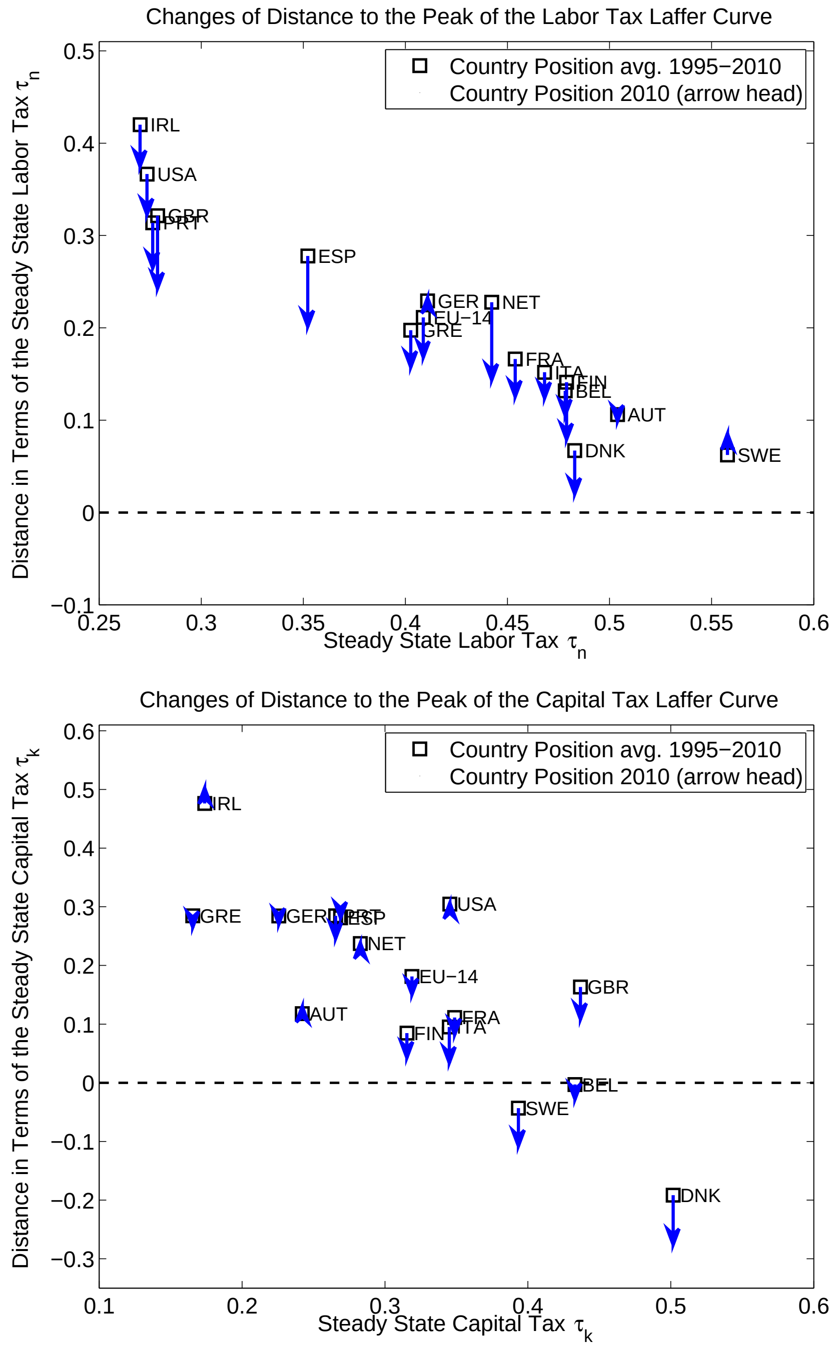


Figure B.10: <u>The case of $\omega \to 1$.</u> Distance to the peak of Laffer curves for average 1995-2010 vs. 2010 calibration. The model is either calibrated to the average of 1995-2010 or to the 2010, see table 2. Parameters for technology and preferences are set as in table 1. Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax rates.

Results when $\omega \to 1$ is assumed.

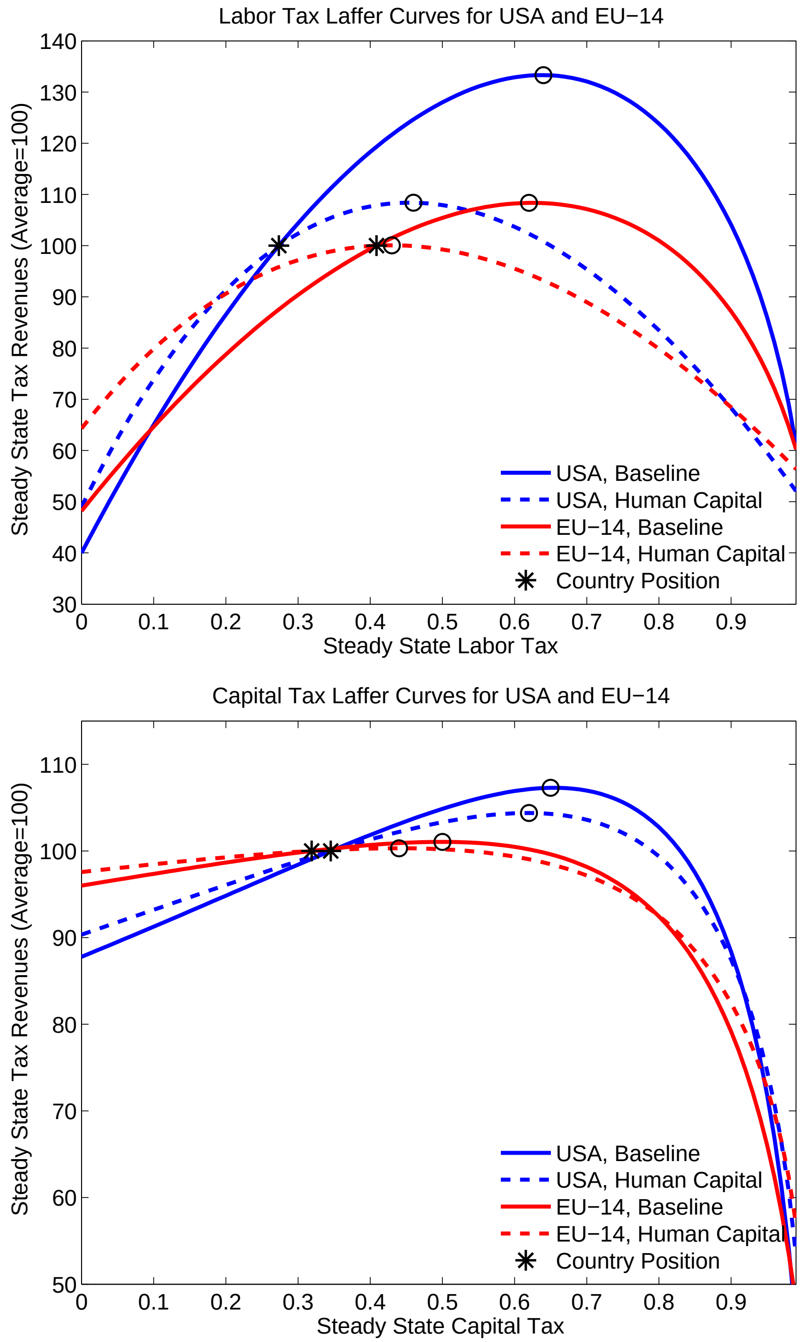


Figure B.11: The case of $\omega \to 1$. Labor and capital tax Laffer curves: the impact of endogenous human capital accumulation. Shown are steady state (balanced growth path) total tax revenues when labor taxes are varied between 0 and 100 percent in the USA and EU-14. All other taxes and parameters are held constant. Total tax revenues at the average tax rates are normalized to 100. Two cases are examined. First, the benchmark model with exogenous growth. Second, the benchmark model with a second generation version of endogenous human capital accumulation (see the main text and Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table B.12. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011).

Results when $\omega \to 1$ is assumed.

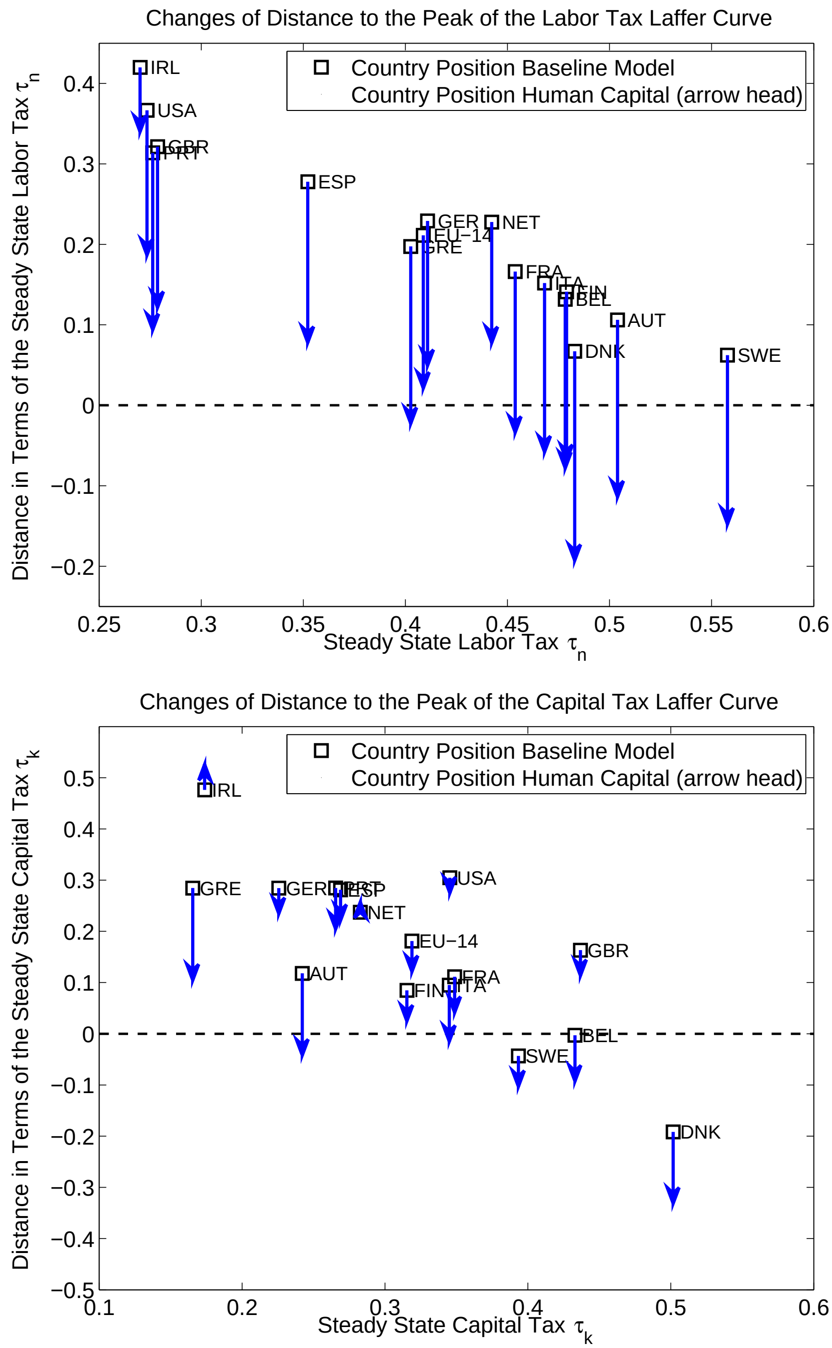


Figure B.12: The case of $\omega \to 1$. Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation (second generation, see the main text and Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table B.12. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011). Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax rates.

Results when $\omega \to 1$ is assumed.

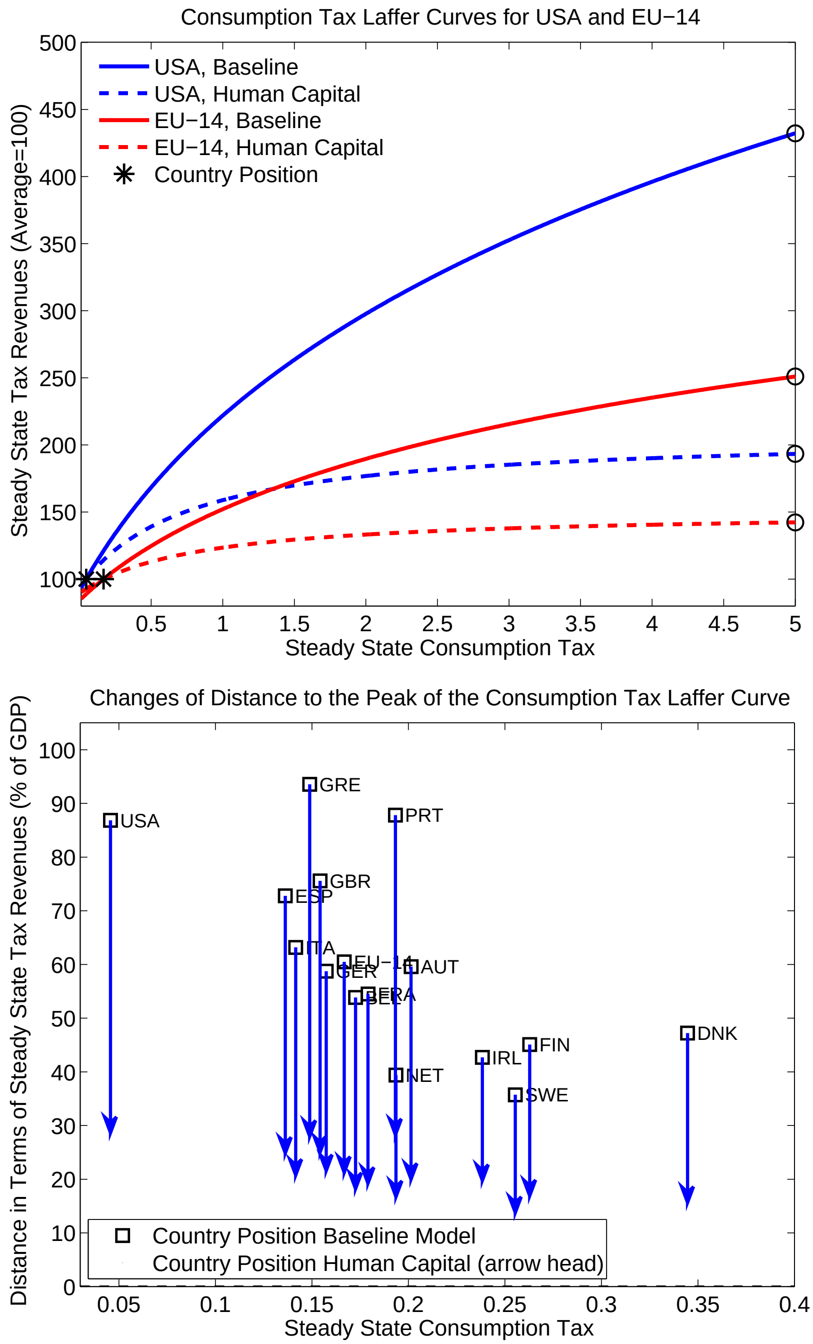


Figure B.13: The case of $\omega \to 1$. Upper panel: Consumption tax Laffer curve in the USA and EU-14: the impact of endogenous human capital accumulation. Shown are steady state (balanced growth path) total tax revenues when consumption taxes are varied between 0 and 500 percent. All other taxes and parameters are held constant. Total tax revenues at the average consumption tax rate are normalized to 100. Two cases are examined. First, the benchmark model with exogenous growth. Second, the benchmark model with a second generation version of endogenous human capital accumulation (see the main text and Trabandt and Uhlig (2011) for details). The model is calibrated to the average of 1995-2010 for fiscal variables. Standard parameters for technology and preferences are set as in table B.12. Parameters for human capital accumulation are set as in the main text and Trabandt and Uhlig (2011).
Lower panel: Distance to the peak of Laffer curves for baseline model and baseline model with added human capital accumulation. Horizontal axis shows calibrated tax rates. Vertial axis shows distance to the peak in terms of tax revenues (in percent of GDP).

Appendix C. Sensitivity of labor tax rate calculations

Following Mendoza et al. (1994), data on social security contributions enter into the calculations of labor income taxes. In this section, we examine the sensitivity of the tax rate calculations with respect to social security contributions.

The labor tax is computed as follows:

$$\text{Personal income tax:} \quad \tau^h = \frac{1100}{OSPUE+PEI+W}$$

$$\text{Labor income tax:} \quad \tau^n = \frac{\tau^h W+2000+3000}{W+2200}$$

where

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

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

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

3000: Payroll taxes, revenue statistics (OECD).

W: Gross wages and salaries: households and NPISH (AMECO).

OSPUE + PEI: Gross operating surplus minus consumption of fixed capital plus mixed income plus net property income: households and NPISH (AMECO).

Table C.20 shows labor tax rates and labor tax revenues as a ratio to GDP based on the methodology by Mendoza et al. (1994) for the average of 1995-2010. The last two columns display results when social security contributions are ignored in the calculations of tax rates. The differences between the two cases are large.

On the one hand, one could argue that social security contributions should not be part of tax rate calcuations. People get something in exchange for their payments, e.g. health care, pensions etc. From this perspective, the methodology of Mendoza et al. (1994) may overstate the actual tax burden on labor income.

On the other hand, as long as e.g. the market return on items such as pension savings is higher than the implicit return payed by the government, social security contributions represent an implicit tax on labor. At best, one wishes to isolate the implicit tax part in social security contributions. Unfortunately, this is virtually impossible due to data availability reasons. Therefore, we shall proceed by using the original methodology by Mendoza et al. (1994) as it represents an often used standard in the literature. However, we shall keep in mind the caveats.

	Sensitivity of Labor Tax Calculations			
	Mendoza et al. (1994)		Mendoza et al. (1994) ignoring SSC	
	Labor Tax Rate	Lab.Tax.Rev./GDP	Labor Tax Rate	Lab.Tax.Rev./GDP
USA	27.3	13.7	14.9	6.9
EU-14	40.9	18.6	17.0	6.5
GER	41.0	20.2	14.1	6.0
FRA	45.4	22.5	15.4	5.9
ITA	46.8	17.9	17.3	5.1
GBR	27.9	13.8	16.2	7.4
AUT	50.4	24.2	23.1	9.5
BEL	47.9	22.8	22.3	8.7
DNK	48.1	23.9	45.8	22.8
FIN	47.9	23.0	27.2	10.6
GRE	40.5	13.1	7.9	2.2
IRL	27.1	11.3	16.8	6.5
NL	44.3	19.8	12.9	5.2
PRT	27.6	12.1	9.7	3.8
ESP	35.3	16.4	11.6	4.4
SWE	55.7	28.2	37.6	15.2

Table C.20: This table shows labor tax rates and labor tax revenues as a ratio to GDP based on the methodology by Mendoza et al. (1994) for the average of 1995-2010. The last two columns display results when social security contributions are ignored in the calculations of tax rates. All numbers in percent.