What is the Fiscal Position in Finland? Laffer Curves Calculated

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Abstract

In this paper, a general equilibrium model is formalized in order to analyze the long-run fiscal position of the Finnish economy. First, the model is calibrated to match the data to the Finnish economy. Laffer curves for consumption, labor and capital taxation are calculated. It is found that, thus far, Finnish economy is located on the left side of the Laffer peak in labor and in capital taxation. Consumption Laffer curve is strictly increasing between 0 and 100 percent tax rate with the baseline calibration. Additionally, it is found that the parameter governing the substitutability or complementarity of private and public consumption plays an important role in determining the shape of the consumption Laffer curve. Finally, the self-financing rate of a labor tax cuts is found to be 72 % in the benchmark steady state.

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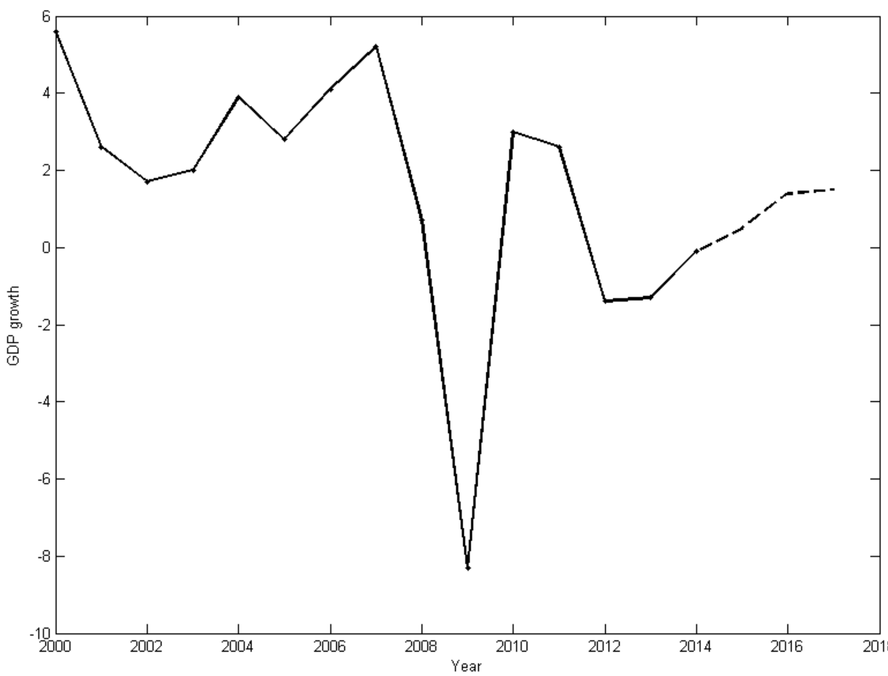
1 Introduction and the Present State

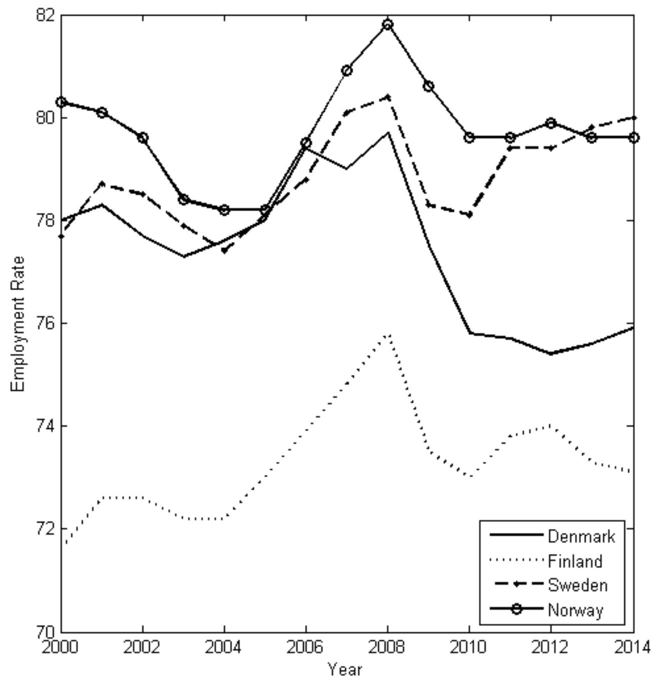
Finland is facing difficult economic challenges. The Finnish economy has been stagnant for the past five years and in general, the latest economic forecasts do not seem to promise a quick turn for the better. During the past three years, 2012-2014, there has been negative economic growth and the latest forecast of Ministry of Finance, for example, promises only modest growth to the near future (figure 1).

Figure 1: Realized and projected GDP growth in Finland 2000-2017



On the other hand, the Finnish labor market looks grim as well. Working aged population is declining due to graying population and insufficient immigration, but also, the employment rate is clearly lagging behind the Nordic peer countries. As is evident from figure 2, Finland's employment rate was below its Nordic peers before 2008 and still is, implying that there might be structural factors contributing to the relatively low level of employment. The problem becomes highlighted as the Nordic welfare model offers a substantial promise for services and, consequently, public expenditures are high. The welfare state is sustainable only if the relevant tax base ie. employment rate is sufficiently high, which is not the case at this moment in time in Finland.

Figure 2: Employment rates in the Nordic countries 2000-2014.



The dispirited economic environment has forced to make very difficult decisions Tax ratio, describing the ratio of taxes and compulsory social security contributions to gross domestic product, for example, has risen from 41 % in 2008 to 44.1 % in 2014. Despite the increases in taxes and cuts in spending, the government finances still aren't sustainable in the long run. The health-care and long-term care expenditures alone are projected to increase, respectively, by 0.7 and 2.1 pp. as % of GDP between 2013-2060 without any active policy measures ([European Commission (2015)]). There is a strong political consensus that active policy measures and structural reforms are needed in order to preserve the welfare state.

The ongoing stagnation raises a number of questions. What is the optimal way of collecting public funding? If taxes must be raised, which type of tax should it be? Is there fiscal space left to increase taxes or is the economy already on the "wrong side" of the Laffer curve? And if so, by how much? What happens with respect to public finances if income tax rate is *decreased*? These are all questions that this paper strives to answer to.

There is considerable literature on Laffer curves, especially recently in the context of general equilibrium models.[1] The paper that is closest to this paper is that of [Trabandt and Uhlig (2011)], who calculate Laffer curves for the US, the EU-14 and individual European countries using a neoclassical growth model. The results show that, in general, the peak of the (labor income) Laffer curve is located between tax rates of 55% and 68%, depending on country. The labor income tax rate maximizing the accrual in Finland was found to be 62% and, so in Finland, it would be possible to obtain additional tax revenue by increasing the labor income tax rate by 3 points at maximum.

[Feve et al (2013)] analyze the US economy in a neoclassical growth framework with incomplete markets and heterogeneous agents. The authors pay particular attention to the adjustment mechanism of the government budget constraint as taxes are varied. According to the results, the Laffer curve has a traditional inverse-U shape when public transfers are allowed to vary, but the form changes into a horizontal S when the endogenous variable in the government budget constraint is public debt. In other words, the adjustment mechanism that determines the change in the budget constraint seems to be an important factor for the shape of the Laffer curve.

In a recent paper, [Holter et al (2014)] study the connection between progressivity of the tax schedule and the ability of the government to generate tax revenues in the US. The authors find that a more progressive labor income tax code significantly reduces tax revenues. Converting the US tax code into a flat tax increases the peak of the Laffer curve by 6 %, whereas converting the US tax progressivity to the Danish tax code decreases the Laffer curve's peak by 7 %. [Guner et al (2014)] and [Badel and Huggett (2014)] also find that there is only limited potential for raising tax revenue through tightening the progressivity of the tax code in the US.

[Zanetti (2012)] studies how long-run government revenues comply with labor market

[1] The concept of Laffer curve is considerably more complex if the point of view is microeconomic instead macroeconomic, which is used view point of this paper.

search frictions. It is shown that the organization of labor market plays an important role when analyzing Laffer curves. [Zanetti (2012)] shows that, for instance, the level of unemployment benefit correlates negatively with government revenues, shifting the Laffer curve downwards when the benefit level is increased. Furthermore, [Zanetti (2012)] shows that, in a search theoretic model, also parameters driving wage bargaining power, disutility of work and the cost of forming a work relationship have an effect on government revenues. Finally, it is found that the (exogenous) job separation rate seems to be an exception in the used framework; it doesn't seem to have a lot of effect on the level or shape of the Laffer curve.

In this paper, a neoclassical representative agent framework is analyzed. Based on the work by [Holter et al (2014)], [Guner et al (2014)] and [Badel and Huggett (2014)], the estimates presented in section 3 are most likely the upper bound of the true values as the progressivity of the tax code is not explicitly taken into account. Allowing for heterogeneity in the model framework is also left for future research.

It is crucially important to keep in mind that maximizing tax revenue is not the same as maximizing welfare - often it is the other way round. This paper is motivated by the fact that the tax ratio is quite high in Finland and, therefore, it is even more important to know the fiscal position of the economy, that is, whether the economy is located on the left or right side of the Laffer peak. According to [Trabandt and Uhlig (2011)], for example, Sweden and Denmark are already on the "wrong" side of the Laffer curve for capital income taxation in which case, according to the cited framework, *more* tax revenue could be collected if capital income tax was *decreased*.

It is not only important to know in which side of the Laffer peak the economy is. It is also important to know the fiscal position of the economy - how far the economy is from the slippery slope. If an economy is close to the Laffer peak, the fiscal space is narrow, and policies should be adjusted accordingly.

The main contribution of this paper is to discuss the fiscal position of the Finnish economy, and to update the Laffer curve estimates to the post great recession period. The perspective is first and foremost one of applied economics. Also the self-financing rate of labor income tax cut is calculated. The second contribution of this paper is to provide the reader with comprehensive sensitivity analysis of the results. This is an element that is missing from the current literature on the Laffer curve estimates in general equilibrium frameworks.

The paper is organized as follows. In the second section, the model framework is described in detail. In the third section, the model is calibrated, and the steady state dynamics of the model are examined. Also the results of the paper, that is, the Laffer curves are calculated and self-financing rate of labor income taxation is presented. The fourth section conducts a sensitivity analysis on the essential parameters and exogenous variables. The fifth section concludes.

2 The Model

The model utilized in this paper is a rather standard neoclassical growth model which closely resembles models used by, for example, [Papageorgiou (2012)] or [Trabandt and Uhlig (2011)]. The model economy consists of a large number of identical agents and firms and a government. In this paper, only steady-states, that is, the long-run equilibrium is analyzed. A representative agent consumes goods, works and saves in the form of capital and government bonds. Firms that produce final goods utilize public capital as a factor of production. Intermediate good firms compete in a monopolistic manner and, consequently, yield a profit. The government collects capital, consumption and labor income taxes, and issues bonds to finance its consumption, investments, transfer payments and debt services.

2.1 Individuals

A representative individual chooses consumption (c_t), hours worked (n_t), capital stock (k_t^p), private investment (i_t^p), and government bond holdings (b_t) to maximize his or her discounted expected utility. Utility is derived from consumption, leisure ($1-n_t$), and exogenous government expenditures (g_t):

$$U_t = \max E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, 1-n_t, g_t)$$

subject to

$$\begin{aligned}(1+\tau_t^c)c_t + i_t^p + (1+\gamma^A)b_t &= (1-\tau_t^n)w_t n_t + (1-\tau_t^k)(r_t^k - \delta^p)k_{t-1}^p \\ &\quad + \delta^p k_{t-1}^p + (1+r_t^b)b_{t-1} + s_t + \Pi_t^F + \Pi_t^I, \quad (1)\\ (1+\gamma^A)k_t^p &= (1-\delta^p)k_{t-1}^p + i_t^p, \quad (2)\end{aligned}$$

where $\beta \in (0,1)$ is the utility discount rate and τ_t^c, τ_t^n and τ_t^k denote consumption, labor and capital taxes, respectively. On the income side, w_t denotes wage rate, s_t government transfers, Π_t^F profits of the final good firms, Π_t^I profits of the intermediate good firms and r_t^k and r_t^b the interest rate applied to capital and government bonds, respectively. The private and public capital depreciation rates are respectively given by δ^p and δ^g.

The periodic utility function is increasing and concave and is assumed to be of the following form:

$$u(c_t + vg_t, 1-n_t) = \frac{\left((c_t + vg_t)^{\gamma}(1-n_t)^{1-\gamma}\right)^{1-\sigma}}{1-\sigma}$$

With the above given utility function, the Frisch elasticity of labor, that is, the labor supply elasticity with the marginal utility of wealth held constant is given by the following:

$$\eta^{\lambda} = \frac{1-n_t}{n_t}\frac{(1-\gamma(1-\sigma))}{\sigma}, \quad (3)$$

where $\eta^{\lambda} = \frac{\partial n_t}{\partial \hat{w}_t}\frac{\hat{w}_t}{n_t}||\lambda$ denotes the Frisch elasticity, λ is the marginal utility of wealth and $\hat{w}_t = (1-\tau^n)w_t$ denotes the wage rate net of taxes. The Frisch elastiticy is increasing as a function of *a* tax rate, because an increase in a given tax rate leads to a decrease in the labor supply, which in turn, due to the term $\frac{1-n_t}{n_t}$, leads to an increase in Frisch elasticity. The first order conditions of the household's optimization are as follows:

$$\frac{\partial u(.)}{\partial n_t} = -\frac{\partial u(.)}{\partial c_t}\frac{(1-\tau_t^n)}{(1+\tau_t^c)}w_t, \tag{4}$$

$$\frac{1}{(1+\tau_t^c)}\frac{\partial u(.)}{\partial c_t} = \beta E_t\left[\frac{1}{(1+\tau_{t+1}^c)}\frac{\partial u(.)}{\partial c_{t+1}}(1+(1-\tau_{t+1}^k)(r_{t+1}^k-\delta))\right], \tag{5}$$

$$\frac{1}{(1+\tau_t^c)}\frac{\partial u(.)}{\partial c_t} = \beta E_t\left[\frac{1}{(1+\tau_{t+1}^c)}\frac{\partial u(.)}{\partial c_{t+1}}(1+r_{t+1}^b)\right]. \tag{6}$$

Equation (4) characterizes the labour supply decision of an individual, equations (5) and (6) determine the equilibrium rate of return for capital, and guarantee that there are no arbitrage opportunities between the rate of return for capital and government bonds, ie. $(1-\tau_t^k)(r_t^p-\delta^p) = r_t^b$.

2.2 Firms

There is a large number of identical final good firms that produce a homogeneous product by choosing k_t^p and z_t and utilizing public capital (k_t^g). The price of the homogeneous input, z_t, is denoted by p_t. Final good firms maximize profits, which are given by the following:

$$\Pi_t^F = y_t - r_t^k k_t^p - p_t z_t$$

Output, y_t, of a representative final good firm is given by

$$y_t = A_t\left(\theta_1 k_{t-1}^{-\rho} + \theta_2 z_t^{-\rho}\right)^{-1/\rho}(k_t^g)^{\theta_3}, \tag{7}$$

where $A_t = (1 + g^A)A_{t-1}$ is the total factor productivity, g^A denotes the trend growth of the total factor productivity and θ_1, θ_2 and θ_3 are the output elasticity of private capital, of labour and of public capital, respectively. The interest rate of private capital and wage rate are respectively given by:

$$r_t^k = \frac{\partial y_t}{\partial k_t^k}, \tag{8}$$

$$p_t = \frac{\partial y_t}{\partial z_t}. \tag{9}$$

Following [Trabandt and Uhlig (2012)], the homogeneous input z_t is produced by competitive firms who are maximizing their profits $p_t z_t - \int p_{t,i} z_{t,i} di$ subject to $z_t = \left(\int z_{t,i}^{1/\omega}\right)^{\omega}$. Intermediate inputs, $z_{t,i}$ are produced by monopolistically competitive firms whose optimization problem is given by:

$$\max_{p_{t,i}} \Pi_t^I = p_{t,i} z_{t,i} - w_t n_{t,i} \tag{10}$$

subject to

$$z_{t,i} = \left(\frac{p_t}{p_{t,i}}\right)^{\frac{\omega}{\omega-1}} z_t, \tag{11}$$

$$z_{t,i} = n_{t,i}. \tag{12}$$

In the long-run equilibrium, all firms set identical price, $p_{t,i} = p_t = \omega w_t$ and consequently the profit of the intermediate firm can be derived from the equation (10): $\Pi_t^I = (\omega - 1) w_t n_t$.

2.3 Government

The government collects taxes, T_t, and issues bonds, b_t, in order to finance expenditures for government consumption (g_t), investments (i_t^g), transfers (s_t) and debt services:

$$T_t = \tau_t^c c_t + \tau_t^n w_t n_t + \tau_t^k (r_t^k - \delta^p) k_{t-1}^p, \tag{13}$$

$$g_t + i_t^g + s_t + (1 + r_t^b) b_{t-1} = (1 + \gamma^A) b_t + T_t. \tag{14}$$

The evolution of public capital is given by:

$$(1 + \gamma^A) k_t^g = (1 - \delta^g) k_{t-1}^g + i_t^g, \tag{15}$$

where i_t^g denotes public investment. In addition, the no-ponzi constraint must apply:

$$\lim_{T \to \infty} \left(\frac{b_{T+1}}{\prod_{j=1}^{T} (1 + r_j^b)} \right) = 0. \tag{16}$$

The no-ponzi condition states that the discounted stream of taxes must equal the current value of outstanding government debt plus stream of government expenditures. Exogenous variables, that is public consumption (g_t), public debt (b_t) and public investment (i_t^g), are given by:

$$g_t = \bar{g}\ \bar{y}, \tag{17}$$

$$b_{t-1} = \bar{b}\ \bar{y}, \tag{18}$$

$$i_t^g = \bar{i^g}\ \bar{y}, \tag{19}$$

where $\bar{g}$, $\bar{b}$ and $\bar{i^g}$ are output-ratios that are calibrated to match the data. When taxes, government consumption, investment or debt is altered, government adjusts transfers (s_t)

according to the government budget constraint:

$$s_t = (1+\gamma^A)b_t + T_t - g_t - i_t^g - (1+r_t^b)b_{t-1}. \tag{20}$$

Alternatively, one could make government transfers, s_t, exogenous, and adjust government consumption, government investment, or government debt instead. As stated in section 1, this can make a difference to the results.

2.4 General Equilibrium

In competitive (decentralized) equilibrium individuals maximize their utility, firms maximize profits, all constraints are satisfied and all markets clear. Specifically general equilibrium is the path of endogenous variables $\{y_t, c_t, n_t, k_t^p, k_t^g, i_t^p, r_t^k, r_t^b, w_t, T_t, s_t, \Pi_t^p, \Pi_t^I\}$ which satisfies the individual budget constraint (1), law of motion for capital (2), individual first order conditions (4) - (6), production technology (7), factor price equations (8) and (9), profit maximization problem of intermediate firm problem (10)-(12) and the characterization of government (14)-(16) and (20), given the exogenous variables that are government consumption (17), government debt (18), government investments (19) and the tax rates τ_t^c, τ_t^n and τ_t^k.

3 Calibration and Steady State

3.1 Benchmark Calibration

The model is calibrated to match the essential features of the Finnish economy. The data used is of annual frequency, and the period is post-2008 to capture the recent challenges in the economic environment, particularly the deteriorated fiscal position of the economy since 2009.

There are a number of parameters to be calibrated. Following the usual practice, as many parameters as possible are calibrated using existing research, and the rest are set to match certain ratios in the data. All the calibrated values of parameters and exogenous variables are reported in tables 1 and 2.

Table 1: Calibration of Parameters

Parameter	Value
γ^A	0.015
θ_1	0.350
θ_2	0.611
θ_3	0.040
ρ	0.666
δ^p	0.060
δ^g	0.060
σ	2
γ	0.361
ν	0.1
β	0.991
ω	1.1

The exogenous real trend growth rate of GDP, γ^A, is assumed to be 1.5 %. Following [Baxter and King (1993)], the share of public capital in the production function, θ_3, is set to 0.040, which matches the 2009-2014 average public investment to output ratio in the national accounts data in Finland. The labor share parameter in the production function, θ_2, is calibrated to match the wage sum share of national income which is 0.611 in Finland in 2009-2014. Finally, the capital share in output is the residual $1 - \theta_2 - \theta_3$. Following [Ripatti and Vilmunen (2001)], the elasticity of substitution between private capital and labor, ρ, is set to 0.6.

Deep preference parameters of the representative agent are σ, γ, ν and β that represent, respectively, the measure of risk aversion, the consumption weight in utility function, the parameter for public consumption in utility function and, finally, the time discount factor of the utility function. The utility discount factor, β, defines, in steady state, the real interest rate of the economy which, in turn, is a function of capital-output ratio. Accordingly, β is calibrated to match the 2009-2013 capital-output ratio of the Finnish economy which is equal to 2.619. The consumption weight in the utility function, γ, following, for example

[Cooley and Soares (1999)] and [Papageorgiou (2012)], is set so that the average working hours matches the 2009-2013 national accounts data, according to which 25.5 % of time per employee is spent working.

The preference parameter, ν, that measures the degree of complementarity between private and public consumption is set to 0.1 following, for example, [Baier and Glomm (2001)] and [Papageorgiou (2012)]. If $\nu > 0$, private and public consumption are complements, whereas $\nu < 0$ implies that they are substitutes. Finally, the measure of risk aversion, or, "the curvature parameter", σ, is set to equal 2, which is in line with previous related literature. With the parametrization given above, the Frisch elasticity of labor supply (see equation (3)) equals 1.99 in the benchmark steady state, which is in line with the previous macroeconomic literature.

Exogenous variables are, as well as the parameters above, calibrated to match the 2009-2014 data, if available. This implies that the government consumption to output ratio and the debt-to-gdp ratio, are set to, respectively, 0.243 and 0.493. Finally, the benchmark tax rates τ_t^n, τ_t^k and τ_t^c are specified using the method developed by [Mendoza et al. (1994)] wherein the idea is to compare relevant tax revenue to the relevant tax base. The tax rates are interpreted to be average effective tax rates (AETR). Naturally, the method is not able to capture the complex nature of the tax system. However, on average, it is presumably a reasonable approximation of the reality.

Table 2: Calibration of Exogenous Variables

Variable	Value
g/y	0.243
τ^c	0.233
τ^n	0.445
τ^k	0.307
b/y	0.493

3.2 Steady State

The essential steady state values produced by the model, are provided in table 3. It seems that the baseline steady state calibration fits the data reasonably well.

Table 3: Steady State and Data Averages 2009-2013

Variable	Model produced value	Data value
c/y	0.521	0.539
i/y	0.196	0.182
k^g/y	0.533	0.564
r^b	0.009	0.015*

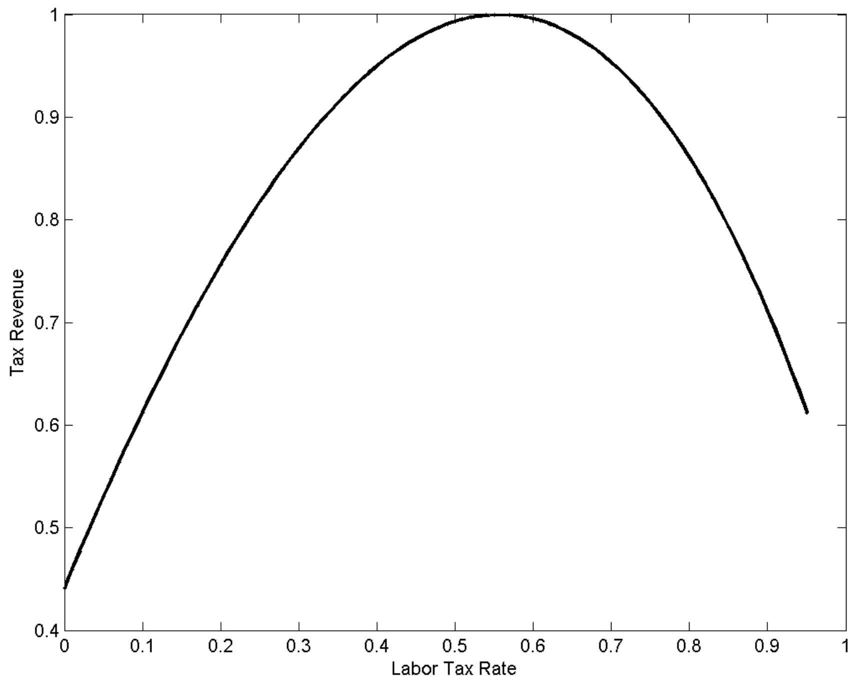
* average yield on 5 year government bond 2009-2014.

The calibration given in table 3 give rise to the Laffer curves depicted in figures 3, 4 and 5. The Laffer curves are calculated so that one tax instrument at a time is varied between 0 % and 100 %, while all the other parameters and exogenous variables (including the two other tax rates) in the model are held constant. The Laffer curves are of the expected form and follow approximately the same pattern as the Laffer curves in the earlier literature (c.f. [Trabandt and Uhlig (2011)]). The baseline calibration reveals a number of interesting observations about the Finnish economy.

First, the labor tax Laffer curve peak is located at 0.56, that is, the maximal revenue generating (average effective) labor tax rate is 56 %. In the baseline calibration, the AETR was calculated to be 44.5 %, thus, there is still over 10 percentage point difference between the current situation and the Laffer peak. However, the Laffer peak lies considerably more to the left compared to the study by [Trabandt and Uhlig (2011)] who find that the Finnish Laffer peak is at 62 %. This is mostly due to the deteriorated fiscal position of the Finnish economy, which moves the Laffer peak (see section 4).

As expected, increasing the labor income tax rate, *ceteris paribus*, increases the aggregate tax revenue until the tax rate of 56 %. There is a notable caveat, though. The labor income taxation generates the relatively largest welfare loss in relative terms of all the analyzed tax instruments.

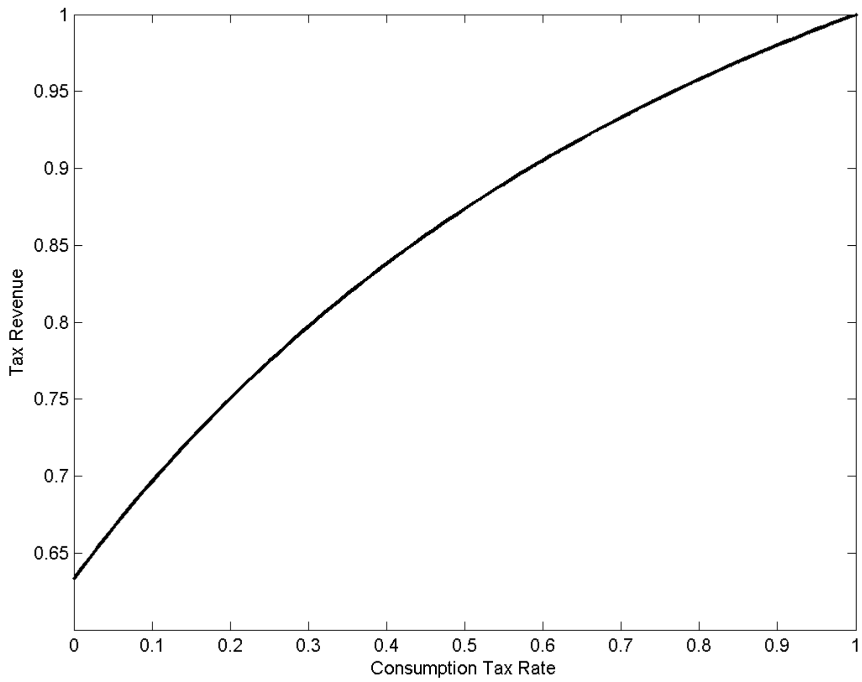
Figure 3: Labor tax Laffer curve



The consumption tax Laffer curve is depicted in figure 4. Tax revenue increases strictly as a function of the consumption tax rate in the realm of 0-100 percent consumption tax rate. The same basic result is found also in [Trabandt and Uhlig (2011)] and in [Trabandt and Uhlig (2012)].

The form of the figure 4 is not surprising, as the consumption tax doesn't have the corresponding negative effects on the labor supply or saving as the labor income tax or the capital income tax have. Production stems from labor and capital, not out of consumption. Consumption tax *does*, nevertheless, depress labor supply. Reflecting this in the context of the the model, the consumption tax can easily be, for example, 200 % which only means that the denominator in the intra-temporal Euler equation (4) is 3 instead of, for instance, 2 in the case of a 100 % consumption tax rate (inter-temporal Euler equation (5) ie. the optimal consumption path (in steady state) remains unchanged). Even with these very high tax rates, there will still be considerable labor supply and consumption, although, of course these margins do react as well. If one compares this with the labor tax rate, it would be impossible to have a 100 % labor tax rate. There would be zero labor supply, thus, zero

Figure 4: Consumption tax Laffer curve

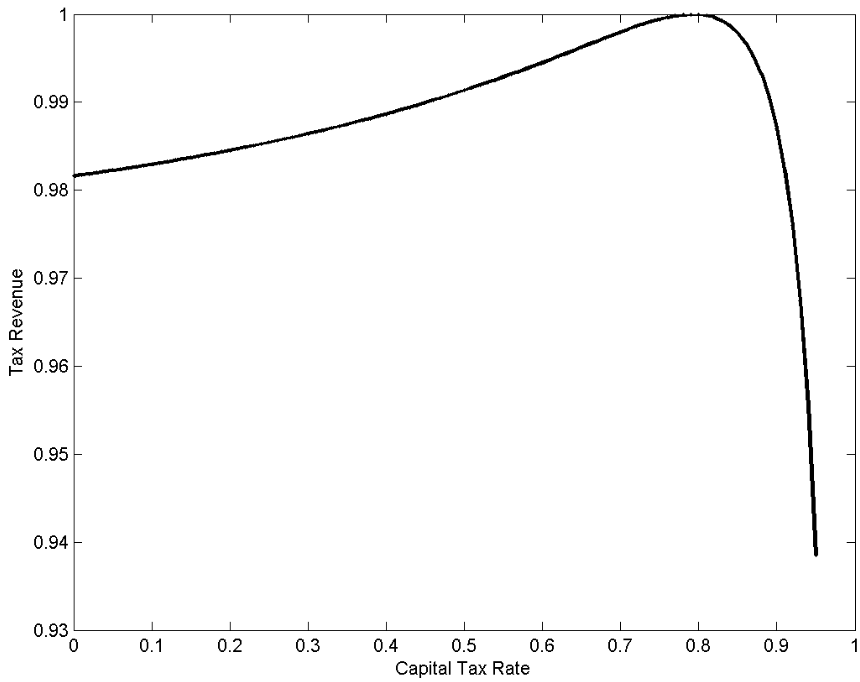


production and tax revenue and the economy would collapse in the presented framework. Of course these levels of taxation are completely theoretical, but they do illustrate the dynamics of the model framework.

Furthermore, there *is* a peak also in the consumption Laffer curve, but it is unrealistically far away from the benchmark steady state. In the benchmark scenario, the consumption Laffer peak lies at 410 %. This peak will move considerably depending on the assumptions - the utility function parameter ν is especially important for this. This is taken up in the sensitivity analysis section.

Finally, the capital tax Laffer curve is once again of the same general shape as in [Trabandt and Uhlig (2011)] or in [Trabandt and Uhlig (2012)]. The capital tax Laffer curve increases only slowly until the peak is reached, after which the decline proceeds in an accelerating pace. Interestingly, the capital tax rate is quite flat to the left of the peak. Even if the capital tax was decreased to zero, the aggregate tax revenue would decline only by approximately 2 percentage points. This reflects the well-known result by [Chamley (1986)] and

Figure 5: Capital tax Laffer curve



[Judd (1985)] who show that in a neoclassical framework, the optimal capital tax rate equals zero. The Chamley-Judd result has been later questioned. See for example [Salanie (2002)] for a good treatment of capital taxation and implications of the Chamley-Judd result. In a neoclassical representative agent framework, however, the result, in general, holds.

Once again, in the case of capital tax, the location of the Laffer peak differs from that of [Trabandt and Uhlig (2012)], but this time to the opposite direction as in the case of the labor income tax. [Trabandt and Uhlig (2012)] find the capital Laffer peak to be at 38 % whereas here the peak lies at 79 %.

3.3 Self-financing Rate of Labor Taxation

The model framework presented in this paper also makes it possible to calculate self-financing rates of taxes, that is, the "dynamic effects". Given a tax-cut, how large portion in relation to the tax-cut is returned back to the public sector due to general equilibrium effects and individual incentive effects? The self-financing rate of labor taxes, Δ_t, is defined in the following way:

$$\Delta_t = 1 - \frac{1}{w_t n_t} \frac{\partial T(\tau_t^n, \tau_t^c, \tau_t^k)}{\partial \tau_t^n}. \tag{21}$$

The equation 21 describes a minimal change in labor income tax rate (τ_t^n) in a certain equilibrium. According to the equation (21), if a change in the labor tax rate had no incentive or general equilibrium effects, we would have $\frac{\partial T(\tau_t^n, \tau_t^c, \tau_t^k)}{\partial \tau_t^n} = w_t n_t$, and the self-financing rate of a tax change would be zero. In other words, a one percentage point cut in the labor tax rate would result in one percentage less labor income tax revenue. On the other hand, if we were in the proximity of the Laffer peak, an infinitely small change in the tax rate wouldn't produce any change in the aggregate tax revenue, $\frac{\partial T(\tau_t^n, \tau_t^c, \tau_t^k)}{\partial \tau_t^n} = 0$, and the self-financing rate would be 100 %. In the right side of the Laffer curve, self-financing rate would be above 100 %.

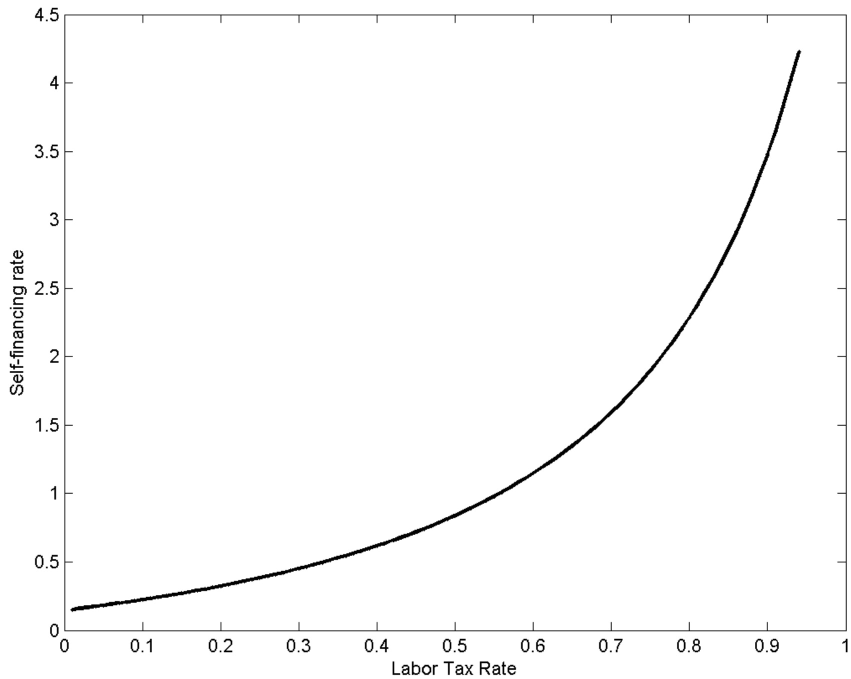
In order to calculate self-financing rates, a numerical approximation of the derivative of the tax function needs to be calculated:

$$\Delta_t = 1 - \frac{1}{w_t n_t} \frac{T(\tau_t^n + \epsilon, \tau_t^c, \tau_t^k) - T(\tau_t^n - \epsilon, \tau_t^c, \tau_t^k)}{2\epsilon}, \tag{22}$$

where $\epsilon = 0.01$. The self-financing rate of the labor income tax is depicted in figure 6.

Self-financing rate of the labor tax rate is strictly increasing with tax rate. In the right side of the Laffer peak, by definition, self-financing rate is over 100 %. As a thought experiment, given that the labor income tax was 90 %, the self financing rate of a five percentage point tax cut would be approximately 350 %. The number is big, but it makes sense as with an income tax rate of 90 %, the dead-weight loss of taxation is very high. With more concrete numbers, given the current Finnish labor tax rate of approximately 45 %, the self-financing rate estimate is around 72 %. A one percent tax cut would, on impact, decrease the tax revenue by $1\% \times w_t n_t$, but $0.72\% \times w_t n_t$ would be returned back to the public sector due to

Figure 6: Self-financing rate of labor income tax



the favorable general equilibrium and incentive effects. The main point is that a higher tax rate leads to a higher self-financing rate, and also the other way round.

4 Sensitivity Analysis

In this section, underlying assumptions of the model are discussed and tested. What are the crucial assumptions that move the Laffer peak? Fiscal space decreases (compared to the baseline) whenever the Laffer peak moves to the left. However, movement of the Laffer peak is not, in itself, a good thing or a bad thing. This section is first and foremost intended to demonstrate the sensitivity of the underlying assumptions to the results presented in the previous section. In table 4, all other parameters are kept constant at the benchmark level, and only the parameter of interest is varied. Also, the sensitivity change in aggregate welfare (see equation (1)) is reported in the last column (U_t).

Altering the parameter of risk aversion, σ, doesn't induce any behavioral change in steady

Table 4: Sensitivity of the Model

Parameter	Baseline value	Modified value	Laffer Peak* τ^n	τ^c	τ^k	ΔU_t
σ	2	1.5	-	-	-	-
β	0.995	0.90	-4 %	-	-28 %	-
ρ	0.666	0.111	-7 %	-	-29 %	+
γ	0.361	0.8	+7 %	-	+6 %	+
ν	0.1	1.0	-11 %	-51 %	-28 %	+
τ^n	0.445	0.8	-	-2 %	-0.79 %	-
τ^c	0.233	0.8	-22 %	-	-0.79 %	-
τ^k	0.307	0.8	-4 %	-	-	-
g/y	0.243	0.5	+11 %	-	+10 %	-
b/y	0.493	0.8	-	-	-	0
i^g/y	0.004	0.2	+6 %	-	7 %	-

* Deviation from benchmark steady state, percentage points.
Benchmark consumption tax is 100 %.

state, thus, all variables remain the same and, consequently, position of the Laffer curve remains the same as well. There is, however, a decrease in the level of life-time utility (see equation (3)) .

The utility discount factor, β, directly determines the value of r_t^b and, consequently, the value of r_t^k. It is calibrated so that the model capital-output ratio matches the data, thus, the calibration process yields a rather high value for β which again implies that the real interest rate is quite low. This, for the most part, explains the difference in the capital tax Laffer curve compared to [Trabandt and Uhlig (2011)]. Decreasing the value of parameter β would shift the Laffer peak to the left, at the same time increasing the real interest rate, capital tax accrual and, finally the sensitivity of aggregate tax revenue to the capital tax rate.

The parameter ρ is one proxy for the "functionality" or "dynamicity" of the economy; ρ measures substitutability of capital and labor. The smaller ρ is, the greater the substitutability of labor and higher the output. The common Cobb-Douglas case can be obtained by setting $\rho = 0$. Decreasing ρ pushes the Laffer peak both in labor and in capital income tax to the left.

Increase in the consumption weight in the utility function, γ, reduces the utility weight on leisure $(1-\gamma)$. As a consequence, individuals work more, earn more and output is higher. Increasing the consumption weight in utility function moves the Laffer peak to the right by 7 pp. in labor income taxation and by 6 pp in capital taxation, thus, increasing fiscal space of the economy; as people work more and earn more, there is bigger space for higher taxation.

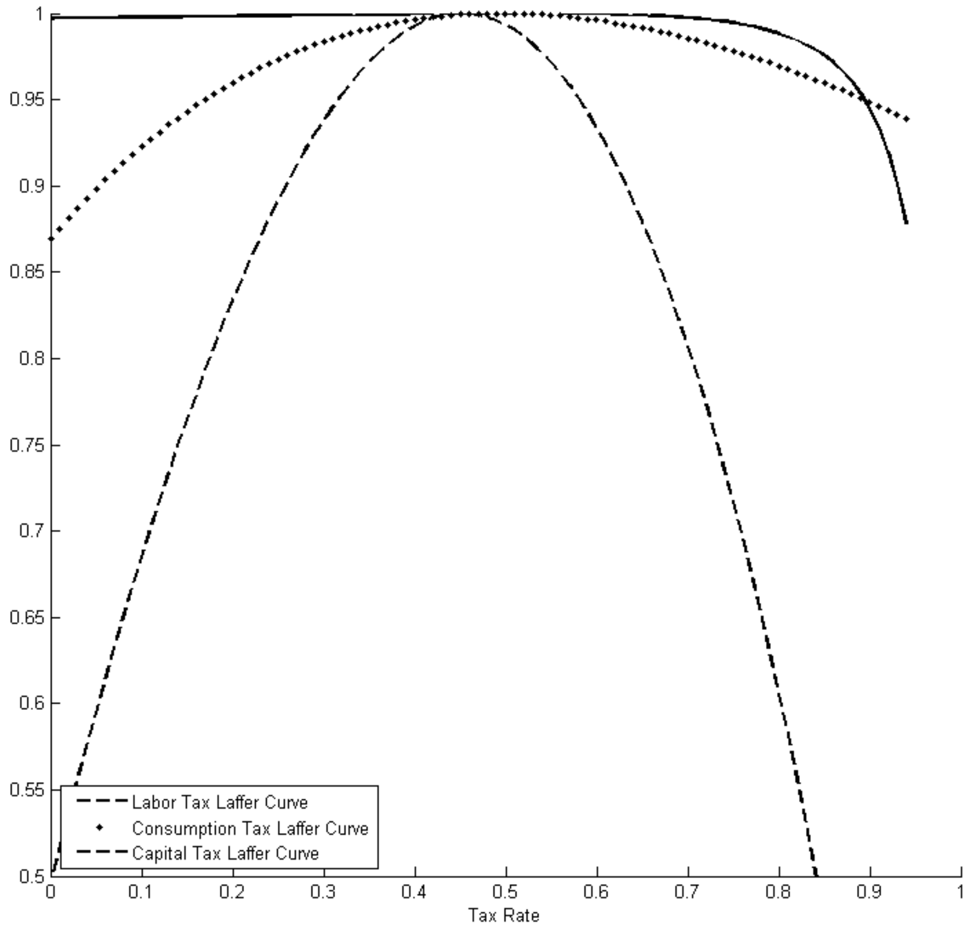
Complementarity of private and public consumption, ν, is a parameter of which there is no detailed empirical knowledge of. In the benchmark scenario it is assumed to equal 0.1. Sensitivity scenario of $\nu = 1$ implies that private consumption is as valuable to a representative agent as public consumption and suddenly, a more realistic Laffer curve for the consumption taxation emerges. All the Laffer curves with $\nu = 1$ are plotted in figure 7. As can be seen from the figure, the Laffer peak for labor income, consumption and capital income taxes lie at, respectively, 45 %, 49 % and 51 %.

In other words, in the scenario where $\nu = 1$, consumption tax Laffer curve has a peak and it is located at 49 %, unlike in the baseline scenario where the consumption Laffer curve is strictly increasing. Furthermore, consumption share of output is clearly lower than in the benchmark case as public consumption crowds out private consumption and, naturally individuals work less on average because less hours is required to reach the desirable level of consumption.

An increase in either labor, consumption or capital tax rate has qualitatively similar effect on the labor market; it leads to a decrease in labor supply. Increasing labor tax rate to 80 % depresses labor supply to approximately 60 % of benchmark scenario, whereas increasing consumption tax tax rate to 80 % reduces labor supply by 18 % compared to the baseline. Finally, increasing capital tax rate to 80 % reduces labor supply "only" by 4 %, but on the other hand, capital stock decreases by 28 % leading to a higher consumption share of output and lower capital share compared to baseline.

Also the sensitivity of exogenous variables in the government budget constraint are tested. Increasing either government consumption, public debt or public investment leads to, *ceteris*

Figure 7: Sensitivity scenario with $\nu = 1$



paribus, a decline in total welfare. Increasing the government consumption share of output results in adjustment in the government budget constraint, in other words, government transfers (s_t) must decrease, leading to behavioral changes in the economy, most importantly, to an increase in labor supply. Increase in public investment share of output has qualitatively similar effects. Finally, increasing the public debt doesn't induce any behavioral responses and the Ricardian equivalence holds. The only variable that adjusts as the public debt is increased is government transfers, which changes according to $\Delta\bar{s} = (g^A - \bar{r^b})\Delta\bar{b}$.

5 Conclusions

This paper addresses the fiscal position and fiscal space of the Finnish post-recession economy. Results show that Finland is still clearly on the left side of the Laffer peak with respect to all analyzed tax types, however, the fiscal space has narrowed after the great recession.

The labor income Laffer curve is found to peak at 56 % which is over 10 pp. above the present level of 44.5 % which is estimated to be the current average effective tax rate.

The consumption Laffer curve peak is found to be very high; between consumption tax rates of 0 and 100, the revenue curve is found to be strictly increasing. With a linear tax system, there is considerable fiscal space in raising the consumption tax. There are, however, a number of complicated details that advices the policy-maker to stay cautious. First, an increase in consumption tax might have undesirable distributional effects that are not taken into account in this paper. Secondly, in reality, there are many different consumption taxes and it is not irrelevant what the composition is between, for instance, VAT, energy taxation, sin taxes and so on.

Furthermore, consumption tax rate Laffer curve is sensitive to the parametrization of the model, more precisely, the substitutability parameter between private and public consumption (ν) is highly relevant. With private and public consumption being perfect substitutes in the utility function, the Laffer peak in consumption tax rate is found to be located at 49 %.

The capital income Laffer peak is estimated to be located at 79 % which is considerably higher than the current rate of 30.7 %. There is, however, a notable caveat, that is, the Laffer curve is almost flat from zero to the Laffer peak, thus, the potential for collecting additional tax revenue with capital taxation is mild. On the other hand, in steady state, the model produces rather low real interest rate which may not be equal to the long-run steady state of the real economy even though it is in line with the post-recession economy.

Finally, also the self-financing rate of labor income taxation is estimated. According to the results, the self-financing rate of a labor income tax cut would be over 70 % at the current level of taxation, which means that a tax cut of 1 unit would actually cost "only" 0.3 units to the public sector in the long run due to the dynamic effects in labor supply and capital accumulation. Self-financing rate is increasing with tax rate and the logic behind the increasing curve is clear; higher the tax, greater the welfare loss and economic distortion, thus, higher the tax rate, the more can be gained by lowering it.

There are a number of caveats that should be kept in mind when interpreting the results. First, the model used in this paper describes the long-run equilibrium of the Finnish economy. The analysis doesn't take into account, for example, the transition path from one equilibrium point to another. It is possible, although not inevitable, that the transition could take a long time and consequently it might also take a long time to achieve the desired outcomes. There can also be additional costs during the transition.

Secondly, the model framework is a representative agent model, hence, the effects on and of changing income distributions are out of the scope of this paper. These include, for example, effects stemming from progressive taxation and innate differences between agents such as productivity. There is evidence in the existing literature, however, that taking progressive taxation into account would probably shift the Laffer peaks to the left, thus, limiting the fiscal space even further ([Holter et al (2014)]).

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