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Gonzalo Fernández de Córdoba
José L. Torres

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Fiscal Harmonization in the Presence of Public Inputs*

Gonzalo Fernández-de-Córdoba
Universidad de Salamanca

José L. Torres
Universidad de Málaga

Abstract. Fiscal harmonization for the European Union member states is a goal that encounters major difficulties for its implementation. Each country faces a particular trade-off between fiscal revenues generated by taxation and the productive efficiency loss induced by their respective tax code. Countries for which a particular harmonized tax code requires more taxation, will have to face an increased efficiency loss, for those required to decrease their taxes, will have to face a loss in fiscal revenue. This papers provides a quantitative measure of these trade-offs, for a number of taxes and for the European Union member states, using a DGE model with public inputs. Calibration of the model for the EU-15 member states gives us the following results: i) The maximum tax revenue level is not far away from the current tax levels for most countries, ii) The cases of Sweden, Denmark and Finland are anomalous, as productive efficiency can be gained by lowering tax rates without affecting fiscal revenues, iii) In general, countries would obtain efficiency gains without changing fiscal revenues by reducing the capital tax and increasing the labor tax and iv) Capital tax harmonization to the average capital tax rate can be done with quite small changes in both fiscal revenues and output for the majority of countries.

JEL Classification Numbers: E43, E62

Key words: Fiscal harmonization, applied general equilibrium.

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Contact Author: Gonzalo Fernández de Córdoba. Address: Departamento de Economía e Historia Económica. Universidad de Salamanca. Edificio FES Campus Miguel de Unamuno. Spain. Tlf: +00-34-923-294500 (Ext. 3172). Fax: +00-34-923-294686. e-mail: gfdc@usal.es

1 Introduction

Fiscal harmonization for the European Union member states is a goal that encounters major difficulties for its implementation. Each country faces a particular trade-off between fiscal revenues generated by taxation and the productive efficiency loss induced by the tax code. Countries for which a particular harmonized tax code requires more taxation, will have to face an increased productive efficiency loss, for those required to decrease their taxes, will have to face a loss in fiscal revenues. However, if we consider a menu of taxes, we can find some space for fiscal harmonization changing the composition of the tax code. By, say, increasing labor income tax in some proportion, and reducing capital tax in some other proportion, we could keep constant fiscal revenues while increasing productive efficiency. This paper provides a quantitative measure of these trade-offs for a number of taxes and for the European Union member states (EU-15).[1]

Fiscal harmonization is a very important question in the context of the European Union, particularly with respect to capital income taxes for which there exist important differences across EU countries. Differences in capital taxes will lead to competition to attract capital from abroad (the so-called *race to the bottom*), given the high capital mobility around the world. This is particularly important in the context of the European Union where there is free capital mobility and it was the European Commission who stressed the need to remove the corporate tax obstacles in order to promote the creation of an integrated single market for doing business in Europe. Tanzi and Bovenberg (1990) pointed out the need to harmonize capital taxes within the EU, given the existence of an unified market with free capital movements. However, it is not clear the way how harmonization should be done. First, the particular tax system implemented by each country reflects different objectives with different government expenditure patterns. On the other hand, there are no clear reasons to think that a particular tax system is preferable to another, and rises the question about the system around which to harmonize the different tax systems.

As pointed out by Tanzi and Bovenberg (1990), without harmonization of capital income taxes, the allocation of capital across countries would be inefficient due to the fact that the capital returns would tend to be equalized after and not before taxes as well as the existence of externalities on other countries. Sørensen (2004) use a static general equilibrium model to analyze corporate tax

[1] We consider all the countries of the EU-15 except Luxemburg.

harmonization in the European Union, where harmonization is assumed to take place at the unweighted average corporate tax rate. He obtain that the aggregate static efficiency gain from corporate tax harmonization would be quite small.

In this paper we study the scope for fiscal harmonization in the EU countries. For it, we consider a highly aggregated dynamic general equilibrium model similar to that of Conesa and Kehoe (2003) and Fernández de Córdoba and Torregrosa (2005), to study the effects of different tax codes for each of the countries in the EU-15. The main difference between our model and those of the literature is that we introduce in the production function a public input, where the stock of public capital is financed with fiscal revenues. Following Feehan and Matsumoto (2002) we consider factor-augmenting public inputs, that is, such inputs are considered as intermediate goods that affect the production function and give rise to increasing returns. In the absence of a public input in the production function, the tax code trivially associated to full efficiency is zero for all taxes. Since we want to study the trade off between productive efficiency and fiscal revenues for a collection of countries with different public capital stocks, the introduction of a public input induces the need of some country-specific tax exaction in order to have production. In this line, the paper develops a DGE model calibrated to data from the EU economies to obtain effective average tax rates, preference and technology parameters to solve a set of question regarding the fiscal policy in the EU countries.

In a very related work, Trabandt and Uhlig (2006) conduct a similar analysis. They compute bi-dimmensional iso-revenue curves for the US and the EU-15.

To find the proportion in which each of the EU-15 countries should reduce or increase taxes, is the quantitative question this paper aims to answer. For it, we have modelled the productive sector producing a single output out of three productive factors, namely, private capital stock, labor, and the stock of a public input provided by the government. This specification of the aggregated production function allows us to model a public sector that operates in two dimensions: redistributing income, and providing public capital stocks, trough public investments, for the production process. The aggregated production function will provide us with a measure of the efficiency gains associated to different compositions for the income tax code.

We compute the combinations of capital and labor tax rates (taking the consumption tax rate as given) that maximize fiscal revenues, i.e., we build a bi-dimensional Laffer curve and compute its maximum in terms of these twodimensional fiscal instruments to compare the current fiscal revenue situation in each country. Two important facts arise from this comparison: First, the maximum fiscal revenue for each country is associated to relatively low values of the tax rates, and for most of the countries these values are very close to the observed ones. Second, the Laffer curve is very flat around the maximum. These two facts put together imply that the EU-15 countries studied here are not very far from the maximal fiscal revenue. Third, the rate of substitution between capital and labor taxes keeping fiscal revenues constant is very large, i.e., a large decrease in capital tax can be compensated with a small increase in the labor tax to keep a constant revenue. This is a natural result due to the relative participations in fiscal revenues. Since the rate of substitution between capital and labor taxes that keeps production constant is in general low, some space is open to modify the tax code so that revenues are kept constant while increasing productive efficiency. Fourth, given the observed consumption tax, the maximum productive efficiency level is not far from a zero income tax code level for most countries. This implies that to maintain public capital stocks, fiscal revenues obtained via the consumption tax are enough. Our approach is to find the income tax code that for each country minimizes productive efficiency losses given the observed fiscal revenue. We derive a bi-dimensional iso-output function indicating the combination of capital and labor taxes that corresponds to a certain level of aggregated output. Assuming the same level of fiscal revenues, we compute the combination of capital and labor taxes for which output is maximized. In general, the optimal taxation policy implies the reduction of the capital tax rate together with an increase in the labor tax rate. We obtain that the current income tax code for Austria is optimal. Other countries, as Belgium, Denmark, Finland and France, obtain little gains from changing the current combination of taxes to the optimal one. However, for the rest of countries there exist potential gains in efficiency by increasing labor taxes and reducing capital taxes. Also, there is a set of countries (Germany, Ireland, Portugal, Spain and the UK), for which the optimal capital tax is zero.

Being more specific with respect to the first finding, although most of the EU-15 countries are very close to the maximum revenue tax code (the maximum of the Laffer curve), as it is the case of Austria, Belgium, Denmark, Finland and Sweden, some countries are a bit further, as it is the case of Ireland, Portugal, Spain and the UK.

These four features of the Laffer curve calculated for the EU-15 countries, suggest that a reduction in capital taxation may be the proper direction to take in an agreeable fiscal harmonization. Two possibilities are considered: i) following Sørensen (2004), harmonization is assumed to take place at the unweighted average capital tax rate (0.26), and ii) harmonization is assumed to take place at the minimum capital tax rate, which corresponds to Ireland (0.14). When capital tax harmonization is assumed to take place at the average rate, fiscal revenues suffer only small changes in most of the countries. However, output shows significant changes. When harmonization is assumed to take place at the Irish capital rate, fiscal revenues are significantly reduced for most countries but with large increases in output. Alternatively, our approach of finding the optimal tax code for each country (pairs of capital and labor tax that keep revenues at the observed level with increases in productive efficiency) could result in a "convergence" of the tax codes. If this is the case we would have find the natural way to harmonize to some extent the European tax system. The measures we obtain from this simulated European tax system give us an idea of the limits to a fiscal harmonization where gains are expected for all countries.

The paper is structured as follows. In Section 2 we describe the model. Section 3 presents the data we use and the calibration procedure. Section 4 shows the figures of the bi-dimensional Laffer curves. Section 5 studies the optimal tax code for each country. The effects of capital tax harmonization are collected in Section 6. Finally, Section 7 presents some conclusions.

2 The public inputs model

We consider a production function that relates output with three inputs: labor, private capital and public capital stocks. Our choice of the production function assumes that a positive level of public capital is necessary for production, which implies that for the output to be positive, there must be a minimum level of fiscal revenues. The government taxes private consumption goods, capital income and labor income to finance an exogenous sequence of lump-sum transfers, $\{T_t\}_{t=0}^{\infty}$, and a sequence of public investment, $\{I_{gt}\}_{t=0}^{\infty}$, which induces a public consumption of good and services, $\{g_t\}_{t=0}^{\infty}$.

2.1 Households

Consider a model economy where the decisions made by consumers are represented by a stand-in consumer, who's preferences are represented by the following instantaneous utility function:

$$U(C_t, N_t\overline{H} - L_t) = \gamma \log C_t + (1-\gamma)\log(N_t\overline{H} - L_t), \tag{1}$$

Private consumption is denoted by C_t. Leisure is $N_t\overline{H} - L_t$, and is calculated as the number of effective hours in the week times the number of weeks in a year $\overline{H}$, times population in the age of taking labor-leisure decisions, N_t, minus the aggregated number of hours worked in a year L_t. The parameter γ $(0 < \gamma < 1)$ is the proportion of private consumption on total private income. The budget constraint faced by the stand-in consumer is:

$$(1+\tau_t^c)C_t + K_t - K_{t-1} = (1-\tau_t^l)W_t^e L_t + (1-\tau_t^k)(R_t^e - \delta)K_{t-1} + T_t, \tag{2}$$

where T_t is the transfer received by consumers from the government, K_t is the private capital stock, W_t^e is the compensation to employees, R_t^e is the rental rate, δ is the capital depreciation rate which is modelled as tax deductible, and $\tau_t^c, \tau_t^l, \tau_t^k$, are the private consumption tax, the labor income tax and the capital income tax respectively[2]. The budget constraints says that consumption and investment cannot exceed the sum of labor and capital rental income net of taxes and lump sum transfers.

The problem faced by the stand-in consumer is to maximize the value of her lifetime utility given by:

$$Max_{\{C_t,L_t\}_t^\infty} \sum_{t=0}^{\infty} \beta^t \left(\gamma \log C_t + (1-\gamma)\log(N_t\overline{H} - L_t)\right)$$

subject to

$$(1+\tau_t^c)C_t + K_t - K_{t-1} = (1-\tau_t^l)W_t^e L_t + (1-\tau_t^k)(R_t^e - \delta)K_{t-1} + T_t$$

given $\tau_t^c, \tau_t^l, \tau_t^k$ and K_0 and where $\beta \in (0,1)$, is the consumer's discount factor.

2.2 Firms

The problem of the firm is to find optimal values for the utilization of labor and capital given the presence of public inputs. The stand-in firm is represented

[2] Tax rates are constants, and can be interpreted as average marginal tax rates. Jonsson and Klein (1996) use a isoelastic specification of the tax schedule rather than a linear one in order to capture the progressivity of income taxation.

by a nested C.E.S. with a standard Cobb-Douglas production function[3]. The production of final output, Y, requires labor services, L, and two types of capital: private capital, K, and public capital (public infrastructures), G. Goods and factors markets are assumed to be perfectly competitive. The firm rents capital and hire labor in order to maximize period profits, taking public inputs and factor prices as given. The technology exhibits constant return to private factors and thus, the profits are zero in equilibrium. However, the firms earn an economic profit equal to the difference between the value of output and the payments made to the private inputs. We assume that these profits are distributed between the private inputs in an amount proportional to the private input share of output.[4] The technology is given by:

$$Y_t = A_t \left\{ \sigma G_{t-1}^{\rho} + (1-\sigma) \left(K_{t-1}^{\alpha} L_t^{1-\alpha} \right)^{\rho} \right\}^{1/\rho} \tag{3}$$

where A_t is a measure of total-factor productivity, α is the private capital share of output, σ measures the weight on public capital relative to private factors and $1/(1-\rho)$ is a measure of the elasticity of substitution between public inputs and private inputs.[5]

2.3 Government

Finally, we consider the two-side role of the government: as a tax-levying and as supplier of public inputs. The government uses tax revenues to finance spending in public investment (infrastructures) which rises total factor productivity and lump-sum transfers paid out to the consumers. We assume that the government balances its budget period-by-period by returning revenues from distortionary taxes to the agents via lump-sum transfers, T_t.

The government obtain resources from the economy by taxing consumption and income from labor and capital, whose effective average taxes are respectively, τ_t^c, τ_t^l, τ_t^k. The government budget in each period is given by,

$$\tau_t^c C_t + \tau_t^l W_t^e L_t + \tau_t^k (R_t^e - \delta) K_{t-1} = T_t + I_{gt} + g_t. \tag{4}$$

[3] Cassou and Lansing (1998) introduce public capital stock using a Cobb-Douglas production function. In the calibration they consider a range of values for the public capital share of output between 0 and 0.2. Aschauer (1989) and Munnell (1990) estimate values of 0.39 and 0.34, respectively. On the other hand, Aaron (1990) and Tatom (1991) estimate values that are not statistically different from zero.

[4] Guo and Lansing (1997) using a similar technology, assume that each household owns a single firm and that all households receive equal ammounts of total profits.

[5] Fernández de Córdoba and Torregrosa (2005) conducted a similar execise but without the inclusiong of public inputs in the production function.

Public investments, I_{gt}, induce public consumption of goods and services, g_t, which do not contribute to either production or household utility, and these two sources of expenditure plus the transfers to consumers, are the counterpart of fiscal income. We assume that the government views g_t as exogenous. The government keeps a fiscal balance in each period. This assumption is done to highlight the distortionary effects of taxes, mainly on capital accumulation[6]. Public investments accrue into the public structures stock. We will assume that the rate of depreciation of public stocks is identical to private capital, and therefore we write:

$$G_t = (1-\delta)G_{t-1} + I_{gt}$$

which is analogous to the private capital accumulation process. Public investments, such as railroads, airports, roads, law enforcements, etc., induce a yearly flow of nonproductive expenditures, and that we will consider proportional to the public capital stock. Therefore $g_t = \phi G_t$, where $\phi \geq 0$.

2.4 Equilibrium

Our model has three productive factors. However, the third factor, the public capital, has no market price. This implies that the rent generated by the public input must be assigned to the private factors. From the firm profit maximization problem, the first order conditions are:

$$
\begin{aligned}
R_t &= \alpha(1-\sigma)A_t X_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho-1}K_{t-1}^{\alpha-1}L_t^{1-\alpha}, && (5)\\
W_t &= (1-\alpha)(1-\sigma)A_t X_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho-1}K_{t-1}^{\alpha}L_t^{-\alpha}, && (6)\\
\frac{\partial Y_t}{\partial G_{t-1}} &= \sigma A_t X_t^{1/\rho-1}G_{t-1}^{\rho-1}. && (7)
\end{aligned}
$$

Where $X_t = \sigma G_{t-1}^{\rho} + (1-\sigma)\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho}$. Notice that equation (7) is not properly a condition of the model since there is no agent to claim the income generated by the public input. From the above equations we can obtain the following relations that will be useful for our calibration:

$$
\begin{aligned}
R_t K_t &= \alpha(1-\sigma)A_t X_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho},\\
W_t L_t &= (1-\alpha)(1-\sigma)A_t X_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho},\\
\frac{\partial Y_t}{\partial G_{t-1}}G_{t-1} &= \sigma A_t X_t^{1/\rho-1}G_{t-1}^{\rho}.
\end{aligned}
$$

[6]This assumption have been used by Barro (1990), Glomm and Ravikumar (1994), Cassou and Lansing (1998), among others. They argue that this setup may represent a closer approximation to actual constraints than one which allows the government to borrow or lend large amounts.

From private factor income ratios we obtain that $R_tK_t/W_tL_t = \alpha/(1-\alpha)$. The ratio of total private income to total public expenditures provide us with an useful expression:

$$
\begin{aligned}
\frac{R_tK_{t-1}+W_tL_t}{\frac{\partial Y_t}{\partial G_t}G_{t-1}} &= \frac{1-\sigma}{\sigma}\left[\frac{1}{G_{t-1}}K_{t-1}^{\alpha}L_t^{1-\alpha}\right]^{\rho} = \widetilde{Y}_t^{\rho}, \\
\frac{R_tK_{t-1}}{\frac{\partial Y_t}{\partial G_{t-1}}G_{t-1}} &= \alpha\frac{1-\sigma}{\sigma}\left[\frac{1}{G_{t-1}}K_{t-1}^{\alpha}L_t^{1-\alpha}\right]^{\rho} = \alpha\widetilde{Y}_t^{\rho}, \\
\frac{W_tL_t}{\frac{\partial Y_t}{\partial G_{t-1}}G_{t-1}} &= (1-\alpha)\frac{1-\sigma}{\sigma}\left[\frac{1}{G_{t-1}}K_{t-1}^{\alpha}L_t^{1-\alpha}\right]^{\rho} = (1-\alpha)\widetilde{Y}_t^{\rho}.
\end{aligned}
$$

The l.h.s. ratio can be obtained from national accounts, whereas the r.h.s. is a transformation of the usual estimation of the output from an assumed aggregated Cobb-Douglas production function. The firm will produce extraordinary profits of the magnitude $\frac{\partial Y_t}{\partial G_{t-1}}G_{t-1} = \sigma A_t X_t^{1/\rho-1}G_{t-1}^{\rho}$, since this amount is not inputted to the owner of the factor. The government usually does not charge a price that covers the full cost of the services provided with the contribution of public inputs. Therefore a rent is generated. We assume that this rent is dissipated and absorbed by the other factors as:

$$
\begin{aligned}
R_t^eK_{t-1} &= \alpha(1-\sigma)A_tX_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho} + s\sigma A_tX_t^{1/\rho-1}G_{t-1}^{\rho}, \\
W_t^eL_t &= (1-\alpha)(1-\sigma)A_tX_t^{1/\rho-1}\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho} + (1-s)\sigma A_tX_t^{1/\rho-1}G_{t-1}^{\rho}.
\end{aligned}
$$

The effective return to capital R_t^e, includes a share s of the payment to the public input, and the effective return to labor W_t^e, absorbs the balancing $(1-s)$. If $s=\alpha$, then,

$$
\begin{aligned}
R_t^eK_{t-1} &= \alpha A_tX_t^{1/\rho-1}\left[\sigma G_{t-1}^{\rho} + (1-\sigma)\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho}\right] = \alpha Y_t, \qquad (8) \\
W_t^eL_t &= (1-\alpha)A_tX_t^{1/\rho-1}\left[\sigma G_{t-1}^{\rho} + (1-\sigma)\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho}\right] = (1-\alpha)Y_t.
\end{aligned}
$$

Therefore, the economy satisfies the following feasibility constraint:

$$C_t + I_t + I_{gt} + g_t = R_t^eK_{t-1} + W_t^eL_t \qquad (9)$$

The relation of private factors income to the public input income is:

$$\frac{R_t^eK_{t-1}}{\frac{\partial Y_t}{\partial G_{t-1}}G_{t-1}} = \frac{\alpha\left[\sigma G_{t-1}^{\rho} + (1-\sigma)\left(K_{t-1}^{\alpha}L_t^{1-\alpha}\right)^{\rho}\right]}{\sigma G_{t-1}^{\rho}} = \alpha\left(1+\frac{1-\sigma}{\sigma}\left(\frac{K_{t-1}^{\alpha}L_t^{1-\alpha}}{G_{t-1}}\right)^{\rho}\right)$$

$$\frac{W_t^e L_t}{\frac{\partial Y_t}{\partial G_{t-1}} G_{t-1}} = \frac{(1-\alpha)\left[\sigma G_{t-1}^{\rho} + (1-\sigma)\left(K_{t-1}^{\alpha} L_t^{1-\alpha}\right)^{\rho}\right]}{\sigma G_{t-1}^{\rho}} = (1-\alpha)\left(1 + \frac{1-\sigma}{\sigma}\left(\frac{K_{t-1}^{\alpha} L_t^{1-\alpha}}{G_{t-1}}\right)^{\rho}\right)$$

2.5 Solution of the model

To compute the solution of the model, we assign the Lagrange multiplier λ_t, to the budget constraint at date's t. First order conditions for the consumer are:

$$\gamma \frac{1}{C_t} - \lambda_t(1+\tau_t^c) = 0, \qquad (10)$$

$$-(1-\gamma)\frac{1}{N_t\overline{H} - L_t} + \lambda_t(1-\tau_t^l)W_t^e = 0, \qquad (11)$$

$$\beta^t\left[\lambda_{t+1}\left(1 + (1-\tau_{t+1}^k)(R_{t+1}^e - \delta)\right)\right] - \lambda_t\beta^{t-1} = 0. \qquad (12)$$

Together with the first order conditions of the firm (5) , and (6), the budget constraint of the government (4), and the feasibility constraint of the economy,(9), characterize a competitive equilibrium for the economy.

Definition. A competitive equilibrium for this economy is a sequence of consumption, leisure, and private investment $\{C_t, N_t\overline{H} - L_t, I_t\}_{t=0}^{\infty}$ for the consumers, a sequence of capital and labor utilization for the firm $\{K_t, L_t\}_{t=0}^{\infty}$, and a sequence of government transfers $\{T_t\}_{t=0}^{\infty}$, such that, given a sequence of prices, $\{W_t^e, R_t^e\}_{t=0}^{\infty}$, taxes, $\{\tau_t^c, \tau_t^k, \tau_t^l\}_{t=0}^{\infty}$ and a sequence of public investments $\{I_{gt}\}_{t=0}^{\infty}$:

i) The optimization problem of the consumer is satisfied.

ii) Given prices for capital and labor, and given a sequence for public inputs, the first order conditions of the firm, with respect to capital and labor are satisfied.

iii) Given a sequence of taxes, and government investment, the sequence of transfers and current spending are such that the government constraint is satisfied. And finally,

iv) The feasibility constraint of the economy is satisfied.

Notice that according to the definition of equilibrium for our model economy, the government enters completely parameterized, and fiscal policy is made consistent to the model and the data. In other words, in our model the private sector reacts optimally to policy changes, and this policy changes are given exogenously.

3 Data and Calibration

Before simulating the model, values must be assigned to the parameters. The parameters of the model are:

$$(\alpha, \beta, \gamma, \delta, \sigma, \rho, \tau_c, \tau_l, \tau_k)$$

In calibrating the model presented in the previous section we need three different sets of information: Taxes rates (τ_c, τ_l, τ_k), technological parameters, $(\alpha, \delta, \sigma, \rho)$ and preference parameters, $(\beta, \gamma,)$. Following Kydland and Prescott (1982) we set in advance as many parameters as possible based upon *a priory* information.

3.1 Tax rates

Computational macroeconomic models of fiscal policy depend crucially on realistic measures of tax rates. Agents decisions depend on marginal tax and therefore, effective marginal taxes should be used in the calibration. However, the estimation of marginal tax rates is a difficult task and, as pointed out by Mendoza, Razin and Tesar (1994), at an international level is often an impractical task given limitations imposed by data availability and difficulties in dealing with the complexity of tax systems. Mendoza *et al.* (1994) proposed a method to estimate effective average taxes and show that their estimated average tax rates are within the range of marginal tax rates estimated in previous works and display very similar trends. On the other hand, Mendoza *et al.* (1994) argue that their definition of effective average tax rates can be interpreted as an estimation of specific tax rates that a representative agent, in a general equilibrium context, takes into account. Sørensen (2004) also use empirical estimates of average effective tax rates in calibrating a static GE model.

In this paper we use effective average tax rates, that we borrow from Boscá *et al.* (2005), who use the methodology proposed by Mendoza *et al.* (1994) to estimate effective average tax rates[7]. Table 1 shows the estimated average tax rates of Boscá *et al.* (2005) for the year 2001 for the selected countries, including consumption tax rates, labor tax rates and capital tax rates. However, the use of

[7] Calonge and Conesa (2003) estimated marginal tax rates, following Gouveia and Strauss (1994). They obtain that the aggregate marginal tax rate is 1.8 times bigger than the aggregate average tax rate. However, inspection of figures from estimated average tax rates reveals this proportion to be very large.

average effective tax rates imply the use of conservative values (smaller implied behavioral responses).

Table 1: Effective average tax rates 2001 (Source: Boscá *et al.* (2005))

	τ^c	τ^l	τ^k
Austria	0.141	0.474	0.245
Belgium	0.123	0.452	0.288
Denmark	**0.201**	0.439	**0.388**
Finland	0.178	0.473	0.288
France	0.132	0.433	0.350
Germany	0.124	0.381	0.181
Greece	0.148	0.410	0.164
Ireland	0.173	0.316	*0.136*
Italy	*0.107*	0.417	0.262
Netherlands	0.148	0.363	0.232
Portugal	0.150	0.303	0.245
Spain	0.113	0.341	0.219
Sweden	0.133	**0.555**	0.361
UK	0.123	*0.254*	0.343
Average	0.142	0.400	0.264
Std. Dev.	0.026	0.079	0.076

Table 1 shows the existence of important differences across countries in the EU. In the case of the consumption tax, the maximum value corresponds to Denmark (0.201) whereas the lower value corresponds to Italy (0.107). Therefore, in spite of VAT harmonization teatries in the EU, which leads to a consumption tax convergence, there exist important differences among EU countries. However, standard deviation of consumption tax is significantly lower than the standard deviation of both labor and capital taxes. The labor tax rate ranges from a minimum of 0.254 for UK to a maximum of 0.555 of Sweden. Finally, capital tax rates ranges from the very low rate of Ireland (0.136) to the 0.388 of Denmark, with a variability similar to the one of the labor tax.

3.2 Preference parameters

Second, preference parameters are calibrated using data observations for the years 2000-2001, taken from the OECD National Account Database. From the first order conditions we can obtain the following value of β and γ as a function of data observations:

$$\beta = \frac{1}{1 + (1 - \tau^k_{t+1})(R_{t+1} - \delta)} \frac{(1 + \tau^c_{t+1})C_{t+1}}{(1 + \tau^c_t)C_t} \tag{13}$$

$$\gamma = \frac{C_t}{(\frac{1-\tau_t^l}{1+\tau_t^c})W(N_{\bar{t}}\overline{H} - L_t) + C_t} \tag{14}$$

The value of β goes from 0.937 of Ireland to 0.981 of Denmark. Most of the countries have values in the interval 0.96-0.97. The parameter γ ranges from 0.376 of Denmark and the Netherlands to 0.525 of Greece.

3.3 Technological parameters

Finally, we use data from national income and product account for the 14 countries to calibrate technological parameters. Data are taken from the National Accounts OECD database. First, in order to determine the value of the total number of disposable effective time endowment of individuals, $N_t\overline{H}$, that is, non-sleeping hours of the working-age population, we assume that each adult has a time endowment of 96 hours a week ($\overline{H} = 96$). Population aged from 15 to 64 years and average hours worked by year are obtained from the Corporate Data Environment OECD Database.

Next, we compute the values for all the technological parameters in the model. Aggregate labor income share, $(1-\alpha)$ is computed, following Conesa and Kehoe (2003) as unambiguous labor income divided the sum of unambiguous labor income and unambiguous capital income:

$$1 - \alpha = \frac{CE}{GDP - NWI - TS}$$

where CE is the compensation of employees, GDP is the Gross Domestic Product, NWI is non-wage income of the households, defined as the net operating surplus plus the net mixed income of the household sector of the economy, and TS is taxes less subsidies. The results obtained are consistent with the ones reported in European Commission (1995). Aggregate capital income shares α goes from 0.281 for Portugal to 0.387 of Finland. For most of the countries values are in the interval 0.30-0.34.

The depreciation rate, δ, was chosen to match the depreciation-output ratio obtained in the data. The capital stock was generated using a perpetual inventory method under the assumption of a geometric depreciation rate:

$$K_t = (1-\delta)K_{t-1} + I_t$$

Capital series were generated for the period 1970-2001. The initial capital stock was chosen iteratively to match the average capital-output ratio over the period 1970-1979. In constructing the public capital stock we assume that the depreciation rate is equal to the depreciation rate of the private capital stock. Total public capital stock have been derived using series for government consumption of fixed capital, given the computed depreciation rate. Values for the depreciation rate go from 0.040 of Austria to 0.064 of Denmark.

The weight of public capital relative to private factors have been calculated from the National Accounts OECD database. The parameter σ is calibrated to match the ratio of public capital to GDP. Values range from the 0.027 of Austria to the 0.12 of Ireland.[8]

Finally, the parameter ρ is set equal to zero, that is, we assume that the elasticity of substitution between public and private inputs is unity, i.e., $\rho = 0$. Note that this assumption implies that the production function given by (3) is transformed into a Cobb-Douglas:

$$Y_t = A_t G_{t-1}^{\sigma} K_{t-1}^{\alpha(1-\sigma)} L_t^{(1-\alpha)(1-\sigma)}$$

Table 2 summarizes the calibrated parameters values for the EU countries used in the computations.

Table 2: Calibrated parameters values

	α	β	γ	δ	σ
Austria	0.334	0.973	0.472	0.040	0.027
Belgium	0.321	0.970	0.471	0.048	0.033
Denmark	0.308	0.981	0.376	0.064	0.031
Finland	0.387	0.957	0.485	0.053	0.070
France	0.335	0.965	0.408	0.051	0.086
Germany	0.313	0.967	0.405	0.053	0.034
Greece	0.291	0.941	0.525	0.043	0.041
Ireland	0.353	0.937	0.380	0.063	0.120
Italy	0.328	0.965	0.500	0.043	0.059
Netherlands	0.337	0.960	0.376	0.057	0.074
Portugal	0.281	0.987	0.406	0.049	0.064
Spain	0.340	0.952	0.458	0.050	0.078
Sweden	0.292	0.975	0.472	0.057	0.059
UK	0.295	0.963	0.443	0.047	0.030

4 The maximum of the Laffer curve

The model computed in the above section can be used to answer several questions about the fiscal policy in the EU countries. The first natural question in

[8] Guo and Lansing (1997) use a value of 0.0525 for the U.S. economy.

our context is related to the relationship between fiscal policy in each country and the Laffer curve. How far are the current tax levels for each country from the maximum tax revenue level? Is there any country to the right of the maximum of the Laffer curve? To answer these questions we first calibrate the model to identify the current situation for each country. This exercise allow us to compute the maximum fiscal revenue level and the maximum productive efficiency level, given the current tax code. Consumption tax rate are fixed and therefore, we focus on the role of capital and labor taxes. Thus, we build a bi-dimensional Laffer curve in terms of labor and capital tax rates, as the *locus* of capital and labor tax rates that yield the same fiscal revenues. This bi-dimensional Laffer curve shows the level of fiscal revenues for each combination of capital and labor taxes. From this calculations we can obtain a map of iso-revenue curves, indicating all the combinations of capital and labor tax rates which generates a given fiscal revenue.

Figure 1(a-m) shows the iso-revenue curves for all countries. In thedr gigures, we plot the iso-revenue curve for the current (referred to 2001) level of fiscal revenues for each country, indicating the current tax code in terms of labor and capital income taxes and, the combinations of tax pairs that produce the same level of fiscal revenues. We also show the iso-revenue curves corresponding to the 90%, 80% and 70% of the current fiscal revenues and the maximum level fiscal revenues tax combination. Several interesting results emerge from these figures. First, the maximum fiscal revenue level corresponds with relatively low tax rates values. This means that, given the current tax level, there is not so much space to increase capital and labor tax rates if countries want to increase fiscal revenues. Second, tax levels that maximize fiscal revenues are fairly similar across countries indicating that the maximum of the Laffer curve is not very different from one country to another. Labor tax rates at the maximum are very similar, around 49% for all the countries. A little more variability is found in the case of the capital tax rates, with a average value around 37%.

One important fact we obtain is that for all the countries, the iso-revenue curves takes the form of an ellipse but very vertical, representing capital tax in the vertical axis and the labor tax in the horizontal axis. This implies that fiscal revenues are very sensitive to changes in the labor tax but not to changes in the capital tax. Several reasons can explain this result. First, labor income is more important than capital income because it represents a larger share of national income. Thus, fiscal revenues are more sensitive to changes in the labor tax than to changes in the capital tax. Second, this result implies that distortionary effects of capital taxes are larger than the corresponding to labor taxes. For instance, an increase in the capital tax rate provokes a very small change in fiscal revenues, due to the fact that such an increase affects negatively, in an important proportion, the capital accumulation.

In Table 3, columns 2 and 3 show tax rates that maximize fiscal revenues and in bracket we show the difference with respect to the current tax rates, while columns 4 and 5 compute tax rates corresponding to the maximum productive efficiency. The last column at the right shows the percentage deviations in terms of fiscal revenues of the current situation for each country with respect to the maximum fiscal revenues.

Table 3: Maximal revenue vs efficient tax codes

	Maximal tax revenues		Maximal efficiency		%
	τ^l	τ^k	τ^l	τ^k	
Austria	0.48 (0.00)	0.33 (0.08)	0.00	0.00	0.20
Belgium	0.50 (0.05)	0.34 (0.05)	0.00	0.00	0.70
Denmark	0.45 (0.01)	0.36 (-0.03)	0.00	0.00	0.03
Finland	0.46 (-0.01)	0.34 (0.05)	0.00	0.00	0.04
France	0.49 (0.06)	0.40 (0.05)	0.05	0.00	1.22
Germany	0.48 (0.10)	0.36 (0.18)	0.00	0.00	4.31
Greece	0.49 (0.05)	0.31 (0.16)	0.00	0.00	2.94
Ireland	0.47 (0.15)	0.40 (0.26)	0.08	0.00	11.17
Italy	0.51 (0.09)	0.37 (0.11)	0.04	0.00	3.33
Netherlands	0.47 (0.11)	0.39 (0.16)	0.01	0.00	5.05
Portugal	0.51 (0.15)	0.45 (0.20)	0.01	0.00	13.64
Spain	0.50 (0.16)	0.40 (0.18)	0.06	0.00	9.55
Sweden	0.51 (-0.04)	0.40 (0.04)	0.01	0.00	0.39
UK	0.50 (0.25)	0.37 (0.03)	0.00	0.00	13.60
Average	0.487	0.373	0.021	0.00	-
Std. Dev.	0.019	0.036	0.028	0.00	-

We observe several countries where the current tax code (referred to the year 2001) is very close to the maximal fiscal revenue tax code. Moreover, some of them, are to the right of the maximum of the bi-dimensional Laffer curve. In fact, Austria, Belgium, Denmark, Finland, France and Sweden are countries in which the current tax code is very close the maximum tax revenue level. On the opposite side, the countries that are farther from the Laffer maximum are Portugal, UK, Ireland, and Spain.

We observe three countries where some taxes are above the maximum fiscal revenue tax level; termed "the prohibitive range" by Laffer (1981). These countries are Denmark, Finland and Sweden[9]. In the case of Denmark we ob-

[9] Jonsson and Klein (2003) calibrating three different GE models, also obtained that Sweden

serve that the capital tax is slightly above the maximum revenue capital tax. In fact, Denmark is the country of the EU-15 with the larger capital tax rate. Simply, by reducing the capital tax rate, fiscal revenues in Denmark would increase. The other two special cases are Finland and Sweden, where the labor tax rate is above the maximum fiscal revenues labor tax, particularly in Sweden. Therefore, in these two countries by reducing the labor tax rate would obtain an increase in both, the fiscal revenue and efficiency.

Finally, we also compute the maximum efficiency tax code for each country, that is, the tax code corresponding to the maximum output level, given the consumption tax rate. Without the existence of public capital in the production function, the maximum efficiency tax code would be trivially zero, as it is obtained in Fernández de Córdoba and Torregrosa (2005). Not surprisingly, the maximum productive efficiency shows zero capital tax rates for all countries. However, we find several examples with positive labor taxes, such as France, Ireland, Italy, Netherlands, Portugal, Spain and Sweden. This finding shows that for these countries, fiscal revenues obtained from consumption taxes are not enough to support the observed level of public input provision. The largest values for the optimal labor tax rates correspond to Ireland (8%) and Spain (6%), followed by France (5%) and Italy (4%). For Austria, Belgium, Denmark, Germany, Greece and UK, fiscal revenues obtained from consumption tax are enough to support the observed level of public input provision.

This set of results show that the macroeconomic implications of the tax system in the European countries are very similar, both in terms of fiscal revenues and efficiency. First, we obtain that capital and labor tax rates corresponding to the maximum of the Laffer bi-dimensional curve are similar across countries. Therefore, a natural way to achieve fiscal harmonization in Europe would be the case if all the countries decide to move to the maximal tax revenues level. If the objective of all countries were to maximize tax revenues, then fiscal harmonization would be almost perfect, with respect to both labor and capital tax rates. Second, a similar behavior is obtained in reference to the maximal efficiency level. In this case total harmonization of the capital tax rates is obtained if all countries decide to use a maximal efficiency tax code.

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is well to the right of the maximum of the Laffer curve for most of the tax instruments. A similar result was found by Hansson (1984) using a static model.

5 The optimal tax code

To maximize productive efficiency given a level of fiscal revenues implies to find an ordered pair (τ_k, τ_l) such that the rate of substitution between capital and labor tax that keeps production constant is equalized to the rate of substitution that keeps fiscal revenues constant. Next, we consider the optimal tax level for each country, fixing fiscal revenues at the currently (2001) observed level. The question we want to answer is, if it is possible to increase productive efficiency in the different European countries by substituting one tax by the other without changing public revenues. Results obtained in the previous section help us to answer this question. For most countries this implies a substitution of capital by labor taxes, that is, government budget balance is maintained through adjustment in the tax rate on labor income.

Table 4 shows the optimal tax code for each country together with the percentage change in output, capital and labor that should be verified in order to attain the optimal tax schedule. Additionally, Figure 2(a-m) combines the iso-revenue curves together with the iso-output curves, representing combinations of capital and labor tax rates that produce the same level of output. We plot the iso-revenue curve corresponding to the current level of fiscal revenues together with the iso-output curves, normalized to 100 at the point of the current tax code. For each level of fiscal revenues, there exists only one pair of tax rates that maximizes output, determined by the tangency point closest to the origin between the iso-revenue and the iso-output lines. As we can observe, the iso-output curves are concave and as we showed in the previous section, the maximum efficiency level corresponds to a non-zero tax rates for some countries[10].

For most countries, optimal tax rates imply a reduction in capital tax rates and an increases in labor tax rates, thus, increasing capital stock and reducing labor. This effect is found in all the countries except Finland and Sweden, that is, the two countries in which the labor tax rate is above the maximum revenue labor tax.

Table 4: Optimal tax code

[10] Laffer (1981), assumes that the iso-output curves between capital and labor taxes are convex, reflecting the implicit assumption of a diminishing marginal rate of substitution between factor tax rates. However, calibration of our model suggests the existence of a increasing marginal rate of substitution between factor tax rates.

	τ^l	τ^k	Change in GDP (%)	Change in K (%)	Change in L (%)
Austria	0.47	0.25	0.00	0.00	0.00
Belgium	0.47	0.20	0.66	6.27	-1.85
Denmark	0.45	0.31	1.07	5.07	-0.61
Finland	0.46	0.30	0.68	-0.09	1.26
France	0.46	0.26	0.61	5.69	-3.20
Germany	0.42	0.00	0.85	8.72	-3.57
Greece	0.43	0.09	0.11	6.40	-1.87
Ireland	0.35	0.00	0.64	8.62	-3.36
Italy	0.46	0.10	1.52	10.68	-2.52
Netherlands	0.40	0.07	0.86	10.12	-3.44
Portugal	0.32	0.00	1.92	9.02	-0.74
Spain	0.40	0.00	1.68	17.07	-3.81
Sweden	0.49	0.28	11.19	16.50	10.22
UK	0.31	0.00	4.32	28.46	-4.26
Average	0.420	0.133	-	-	-
Std. Dev.	0.058	0.127	-	-	-

The tax code is optimal for Austria, i.e., given the current level of fiscal revenues, and given the consumption tax rate in Austria, the combination of capital and labor tax rates in this country corresponds to the maximum output level. Greece is another country where the current tax code is very close to the optimal. In fact, changing the current tax rates would increase output by only 0.11%. However, the reduction in the capital tax rate and the increase in the labor tax rate would generate an increase of 6.4% in the stock of capital and a reduction of 1.87% in labor. On the other hand, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, and Netherlands are countries where the optimal tax code does not cause a significant change in GDP but implies important variations in the utilization of capital and labor. For Germany, Ireland, The Netherlands, Portugal, Spain and the UK, capital tax goes to zero. Razin and Yuen (1999) show that under both, tax competition and tax coordination, the optimal long run tax rate on capital incomes will be zero, resulting in the so-called "race to the bottom" in capital income taxation.

The most inefficient case is that of Sweden, located at the right of the maximum of the Laffer curve. By reducing both, capital and labor taxes, productive efficiency increases whereas tax revenues remain constant. In fact, changing the combination of taxes, output would increases a 11.2%. Moreover, the utilization of capital and labor factors would increase.

Results obtained from the above exercise give us some ideas about the question if optimal tax code for each country, given the current level of fiscal revenues, favors or not fiscal harmonization. The answer is positive in the case of labor tax rates whereas is negative in the case of capital tax rates. Optimal labor tax rates display a standard deviation of 0.058, whereas in the current situation standard deviation is 0.079. Therefore, variability of labor tax rates across countries would be reduced if these countries change the current level of labor tax rates to the optimal ones. However, we observe how capital tax rates variability increases in the optimal tax code. The reason is that for some countries, the optimal capital tax rate is zero, whereas for other countries the optimal rate is different from zero. These results imply that optimal capital tax rates are very sensitive to small differences in preference and technological parameters across European countries whereas a much more homogeneous effect is found with respect to the labor tax rates.

6 Capital tax harmonization

Finally, we conduct a simulation on the effects on fiscal revenues and output of capital tax harmonization in the EU countries. We consider two capital harmonization possibilities: First, harmonization is assumed to take place at the unweighted average capital tax rate, similar to the analysis in Sørensen (2004), and second, harmonization is assumed to take place at the minimum capital tax rate, corresponding to Ireland. The average capital tax rate is 0.264, whereas the Ireland capital tax is 0.14.

Table 5 shows the results of the simulation. First, considering the case of capital tax harmonization based on the average capital tax, we observe that the fiscal revenues do not change significantly for most of the countries, except for the case of Ireland. This result is provoked by the fact that Ireland has a very low capital tax rate compared to other countries. On the other hand, Belgium, Denmark, Finland, France and the UK are countries where fiscal revenues are reduced, whereas fiscal revenues increase in any other country. The most favored country is Sweden, where fiscal revenues remain almost constant, whereas output increases a 2.8%. In terms of output, this harmonization process would affect negatively to Germany, Greece and Ireland, and in a lesser extend to Spain and the Netherlands. On the other hand, output would increases by around 3% in Denmark, France, Sweden and the UK. In general, we obtain that the response of fiscal revenues tyo changes in capital taxes is much more smaller than the response of output.

Next, we consider the case where capital tax harmonization takes place at the minimum capital tax rate, corresponding to Ireland (0.14). This implies a reduction in capital tax rates in all EU-15 countries and no effect on Ireland. In this case, all countries experience a loss of fiscal revenues (except, of course, Ireland), given the significant reduction in the capital tax rate. The most important reductions in fiscal revenues correspond to the UK (around -5%), France (-2.5%) and Spain (-2.2%). However, gains in efficiency are very important, and output increases significantly in all countries. UK is the country were fiscal revenues would decrease in a larger proportion, close to -5 percent but output would increases 7%. In the case of Spain we observe that fiscal revenues are very sensitive to the change in capital tax, but changes in output are small. In fact, the reduction in fiscal revenues are similar in Spain and France, but whereas in the first output increases only by 2.75%, in the case of France output increases 7.7%. The larger effects on output, other than in UK and France, correspond to Finland, where output increases by more than 7%, whereas fiscal revenues decreases by 1 percent, and Denmark where, with a very short reduction in fiscal revenues (-0.43%), output increases in 6.5%.

Table 5: Capital tax harmonization

	Average capital tax		Ireland capital tax	
	Revenues (%)	GDP (%)	Revenues (%)	GDP (%)
Austria	0.03	-0.37	-0.56	4.07
Belgium	-0.17	1.12	-1.05	5.15
Denmark	-0.14	3.77	-0.43	6.50
Finland	-0.10	1.55	-0.99	7.13
France	-0.90	3.63	-2.47	7.69
Germany	0.95	-2.58	-0.51	1.18
Greece	1.04	-3.62	-0.25	0.67
Ireland	3.42	-3.90	0.00	0.00
Italy	0.00	0.00	-1.76	4.19
Netherlands	0.49	-1.07	-1.59	2.92
Portugal	0.12	-0.17	-1.32	1.65
Spain	1.01	-1.52	-2.17	2.75
Sweden	0.01	2.84	-0.16	5.63
UK	-1.90	3.05	-4.93	7.00

7 Conclusions

Fiscal harmonization for the European Union member states is a goal that encounters major difficulties for its implementation. Each country faces a particular trade off between fiscal revenues generated by taxation and the efficiency loss induced by the tax code. Countries for which a particular harmonized tax code requires more taxation, will have to face an increased efficiency loss, and those required to decrease their taxes, will have to face a loss in fiscal revenue. This fiscal harmonization process is particularly important with respect to capital taxes, given the perfect capital mobility across European countries.

This papers provides a quantitative measure of these trade-offs for a number of taxes and for all those countries of the European Union using a DGE model with public input provision. We calibrate the model and use it to answer a set of important questions regarding fiscal policy and fiscal harmonization in the EU-15 context. Calibration of the model for the EU-15, except Luxembourg, yields the following results:

i) First, we calculate bi-dimensional Laffer curves for each country, to compute the maximal revenue tax code for each country. The maximum tax revenue level is not far from the current taxes level for most countries.

ii) The case of Sweden, Denmark and Finland are anomalous, as efficiency can be gained by lowering tax rates without changing fiscal revenues. This is due to the fact that these three countries are to the right of the maximum of the Laffer curve for some tax.

iii) In general, countries would obtain efficiency gains without changing fiscal revenues by reducing capital taxes and increasing labor taxes. We obtain a group of countries for which the maximal efficiency capital tax rate is zero.

iv) Finally, we conduct a simulation exercise showing that capital tax harmonization to the average capital tax rate can be done with quite small changes in both fiscal revenues and output for the majority of countries. However, when capital harmonization is supposed to be at the minimum current capital tax, changes in fiscal revenues and output would be significant.

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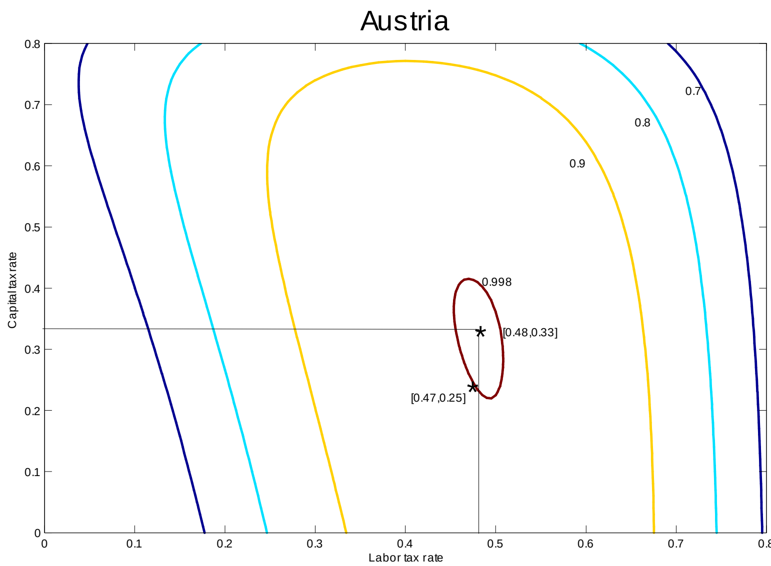

Figure 1.a: Iso-revenue curves (Austria).

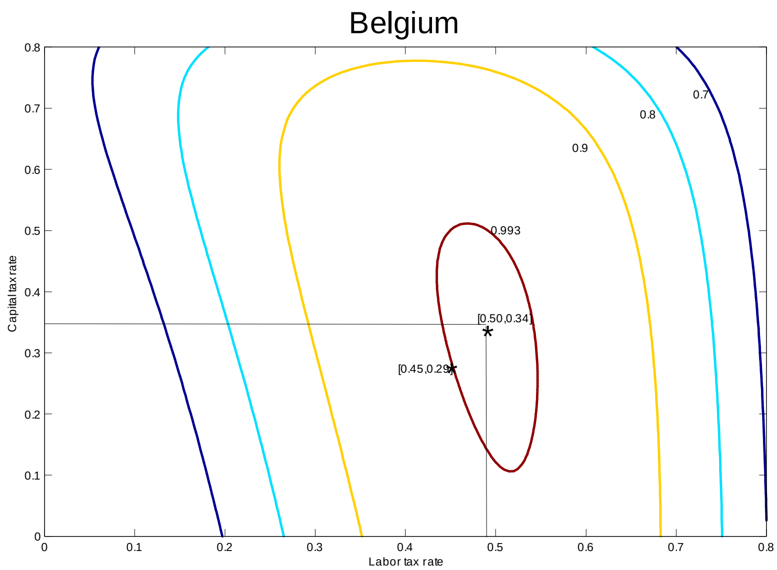

Figure 1.b: Iso-revenue curves (Belgium).

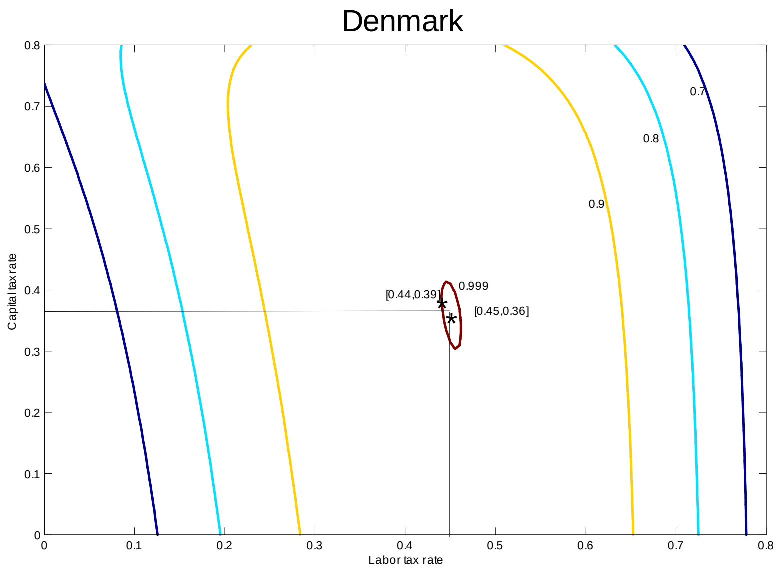

Figure 1.c: Iso-revenue curves (Denmark).

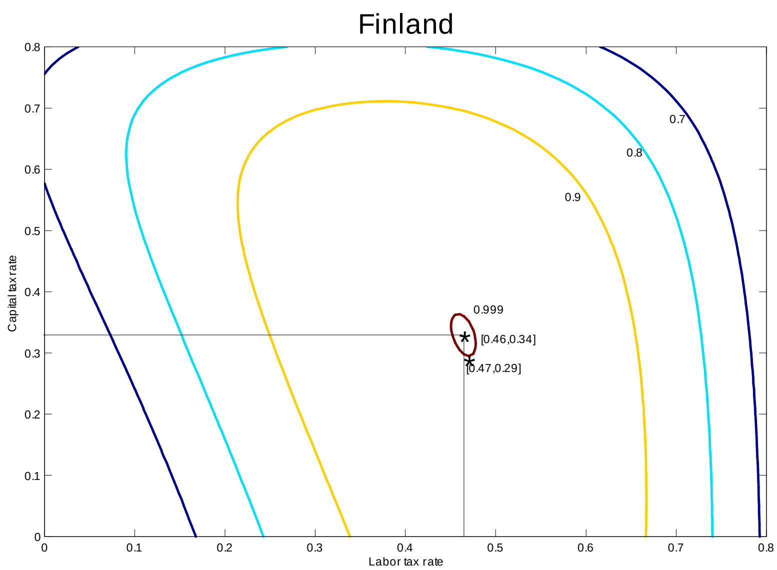

Figure 1.d: Iso-revenue curves (Finland).

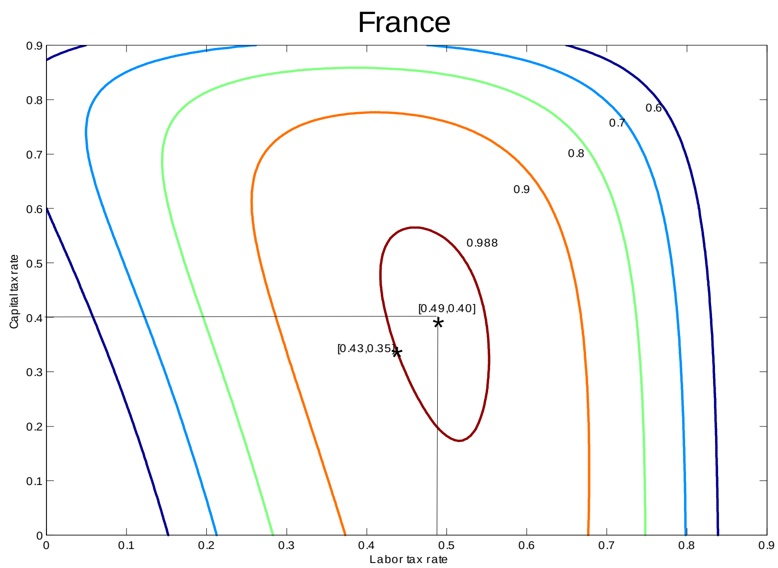

Figure 1.e: Iso-revenue curves (France).

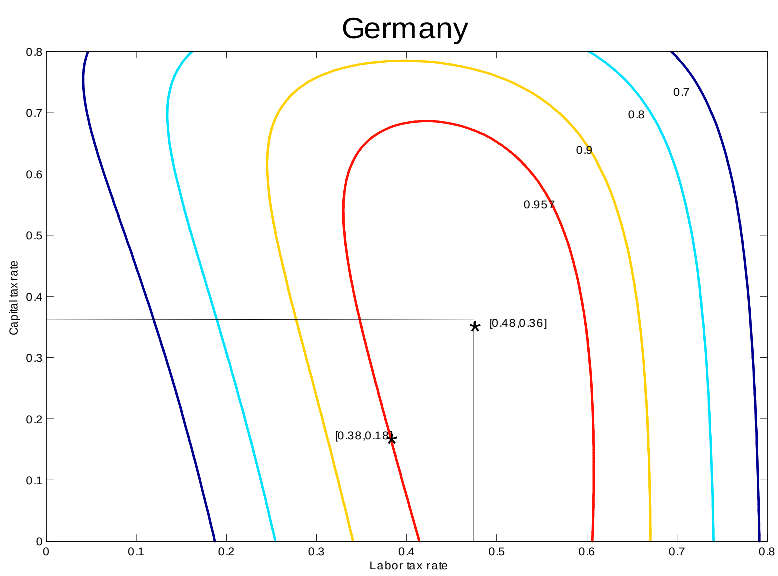

Figure 1.f: Iso-revenue curves (Germany).

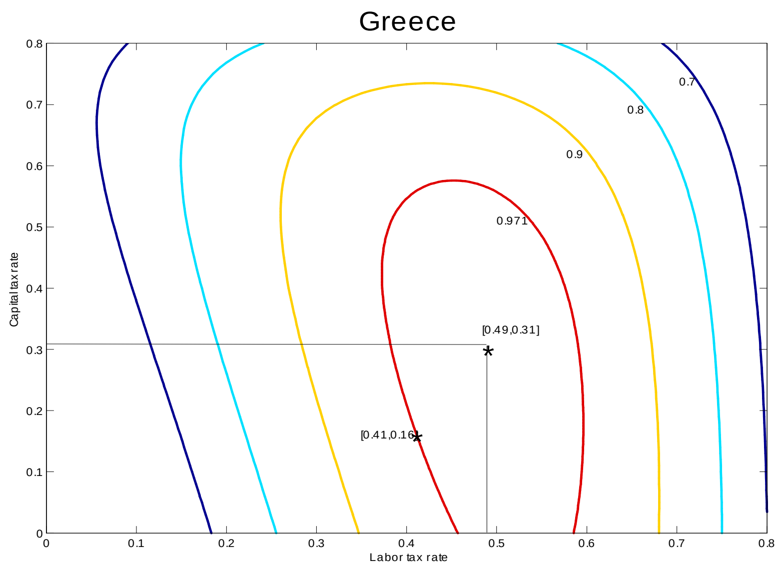

Figure 1.g: Iso-revenue curves (Greece).

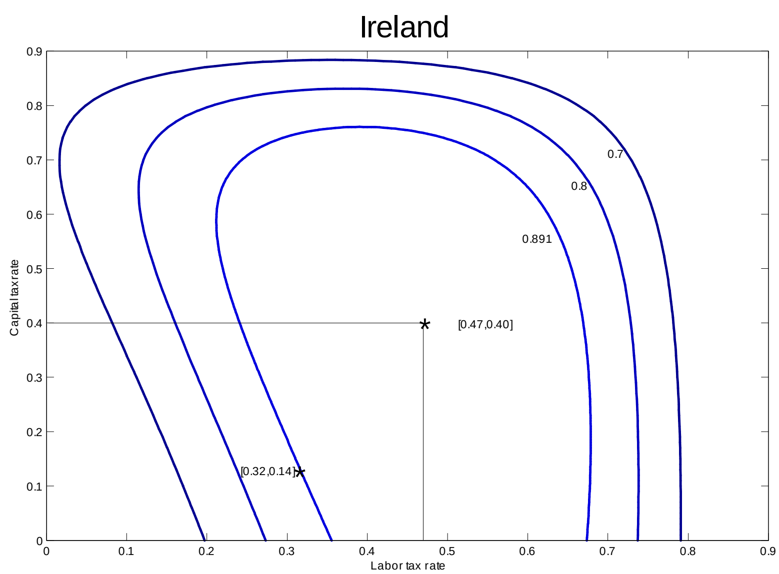

Figure 1.h: Iso-revenue curves (Ireland).

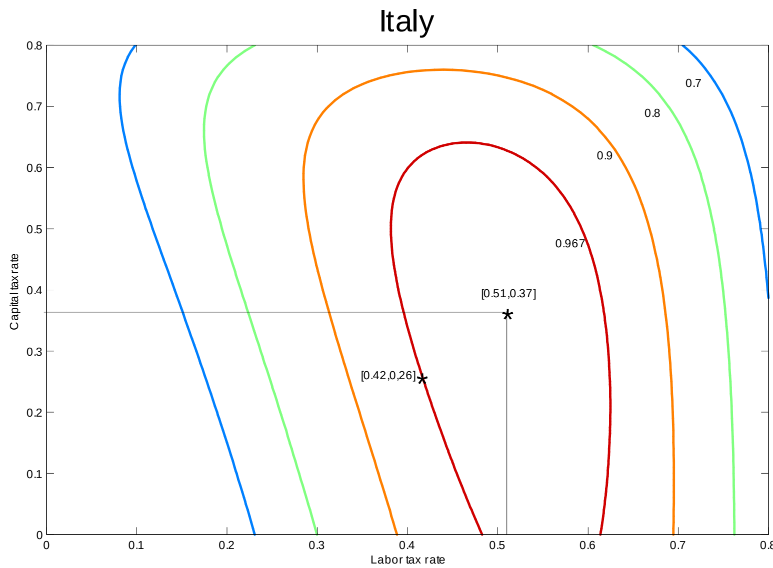

Figure 1.i: Iso-revenue curves (Italy).

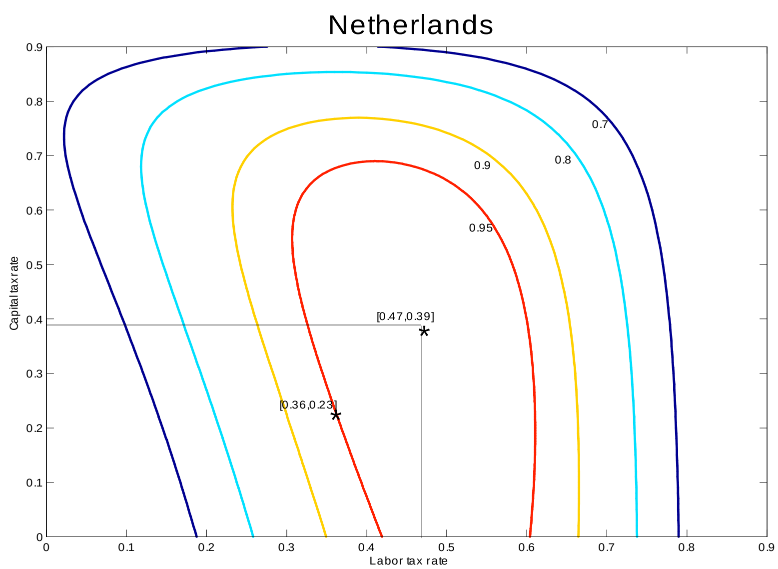

Figure 1.j: Iso-revenue curves (Netherlands).

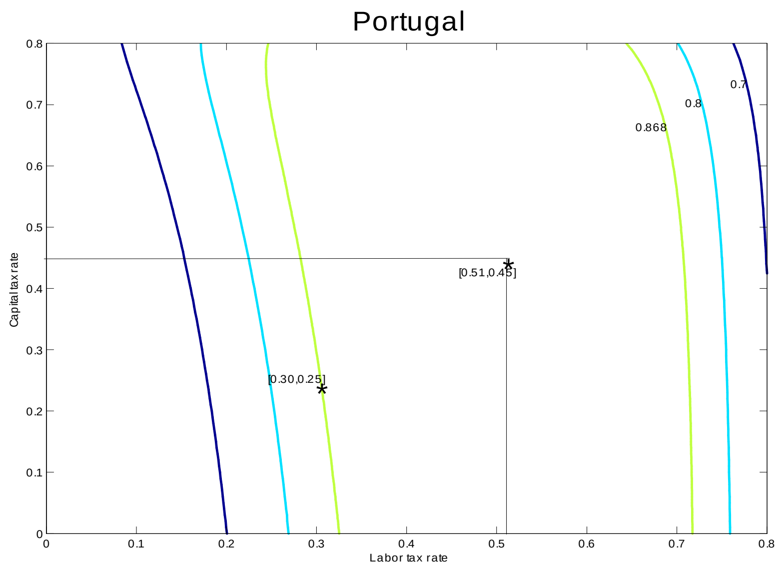

Figure 1.k: Iso-revenue curves (Portugal).

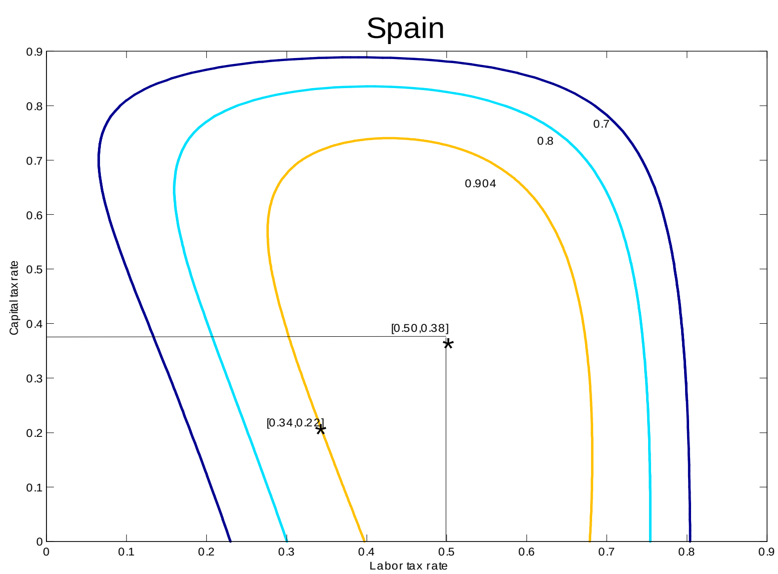

Figure 1.l: Iso-revenue curves (Spain).

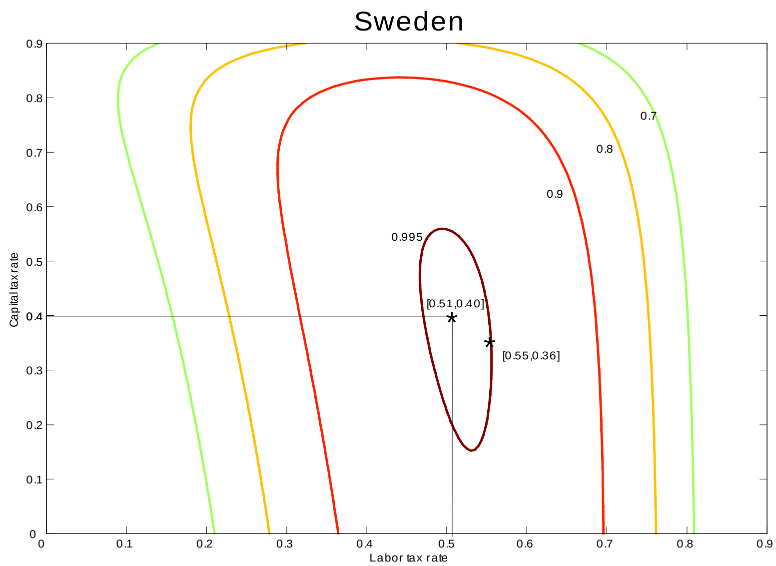

Figure 1.m: Iso-revenue curves (Sweden).

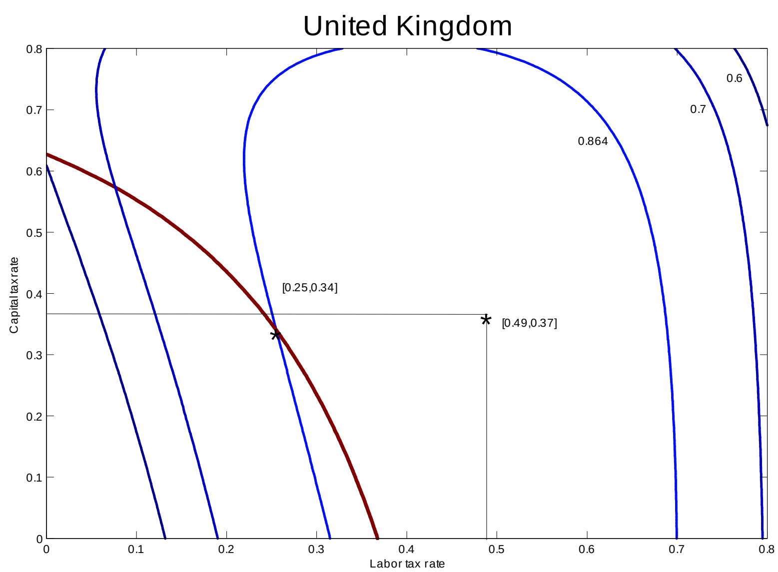

Figure 1.n: Iso-revenue curves (UK).

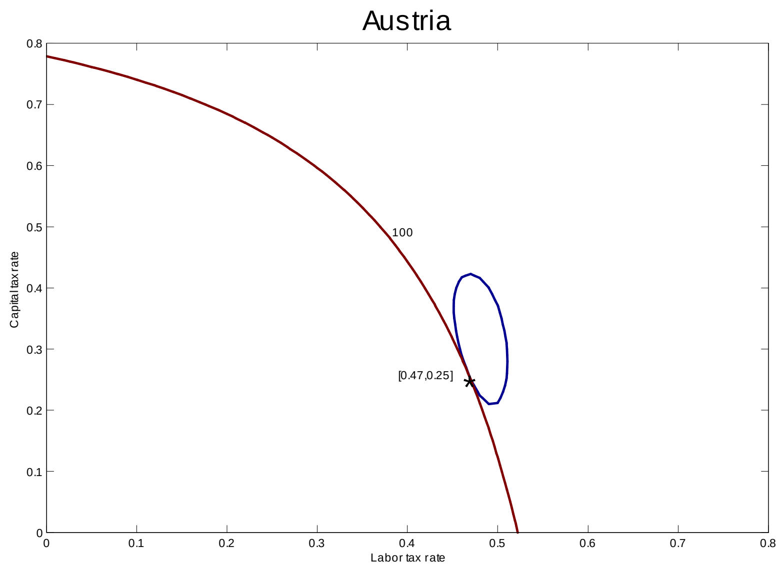

Figure 2.a: Optimal tax code (Austria).

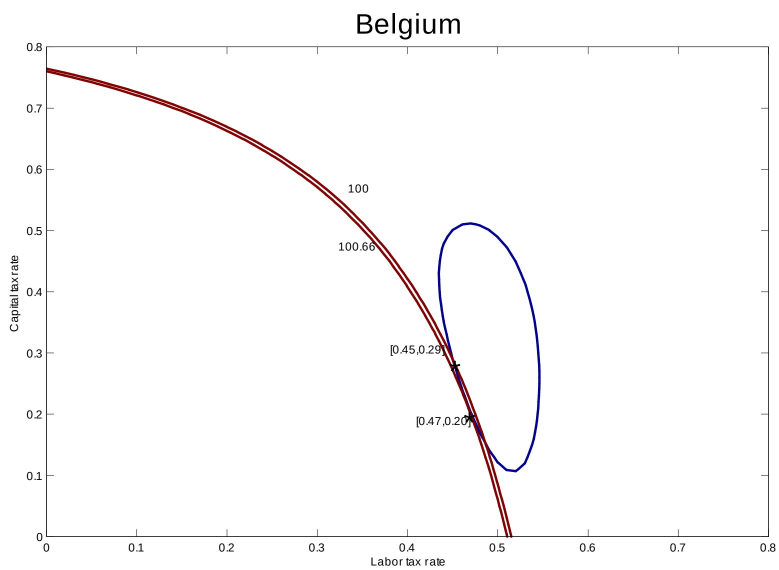

Figure 2.b: Optimal tax code (Belgium).

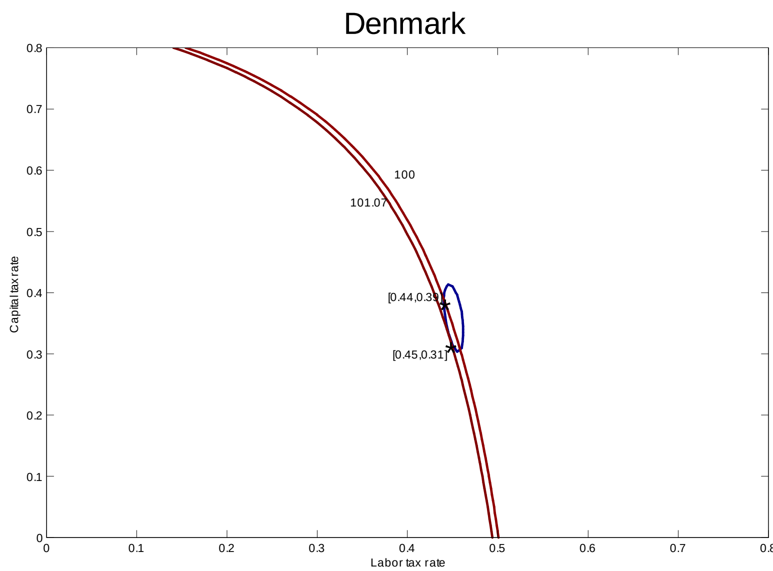

Figure 2.c: Optimal tax code (Denmark).

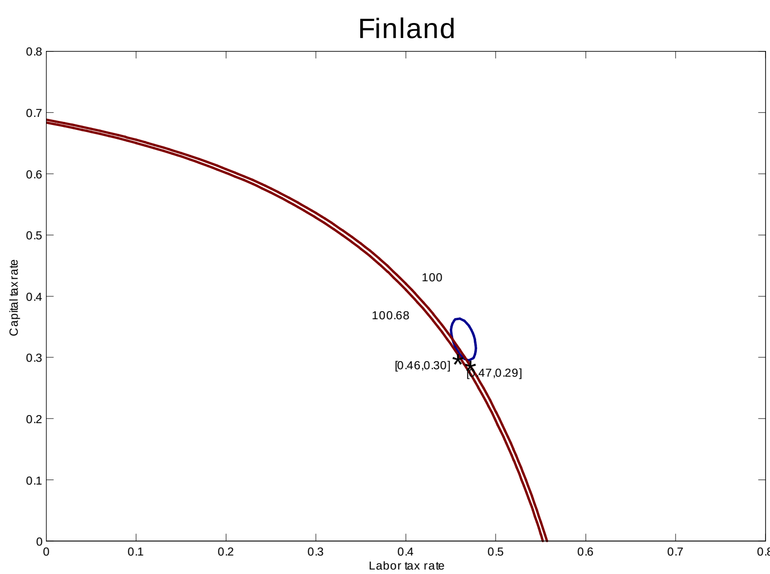

Figure 2.d: Optimal tax code (Finland).

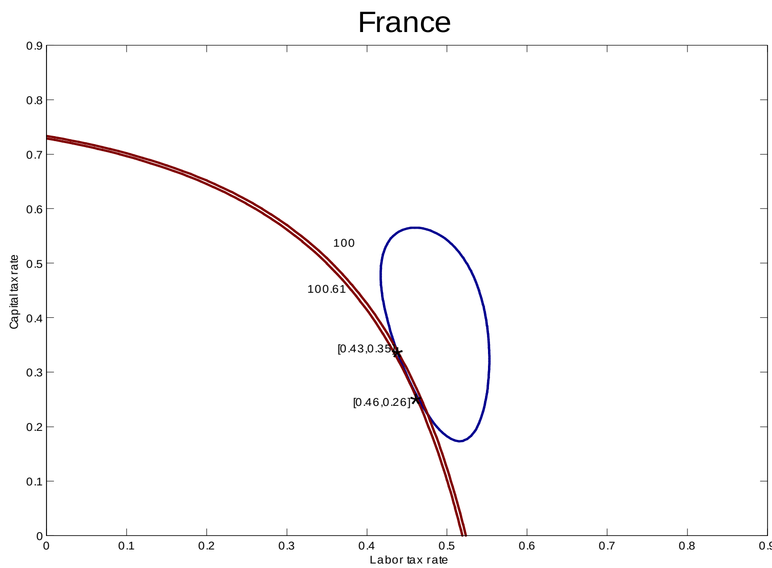

Figure 2.e: Optimal tax code (France).

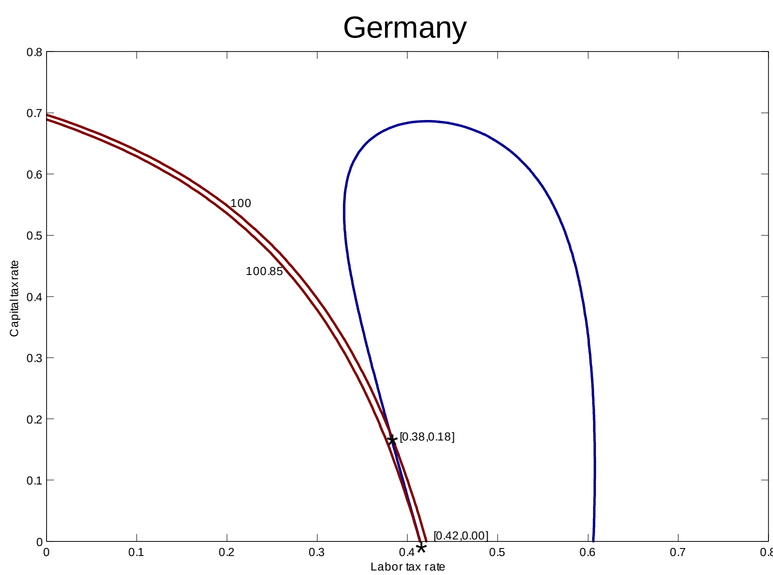

Figure 2.f: Optimal tax code (Germany).

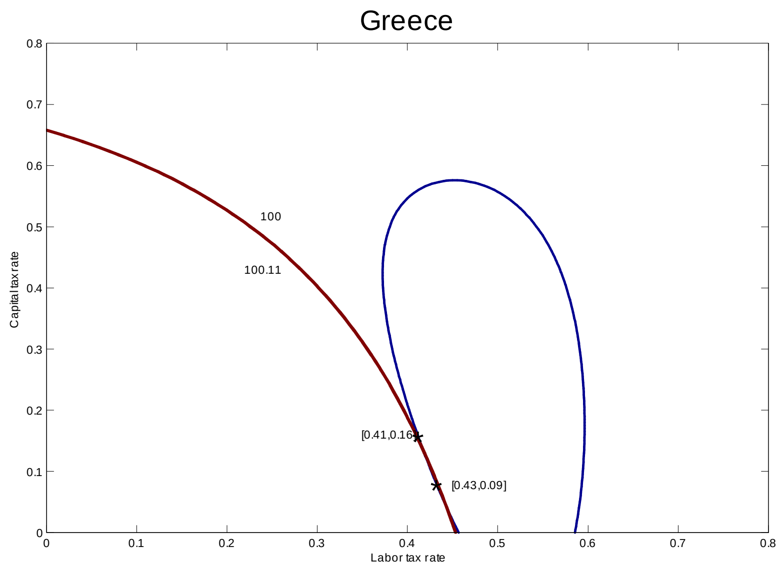

Figure 2.g: Optimal tax code (Greece).

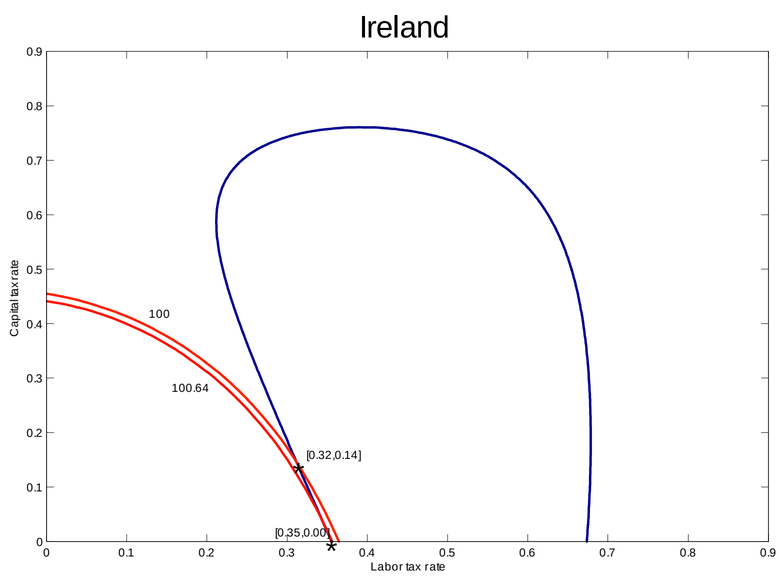

Figure 2.h: Optimal tax code (Ireland).

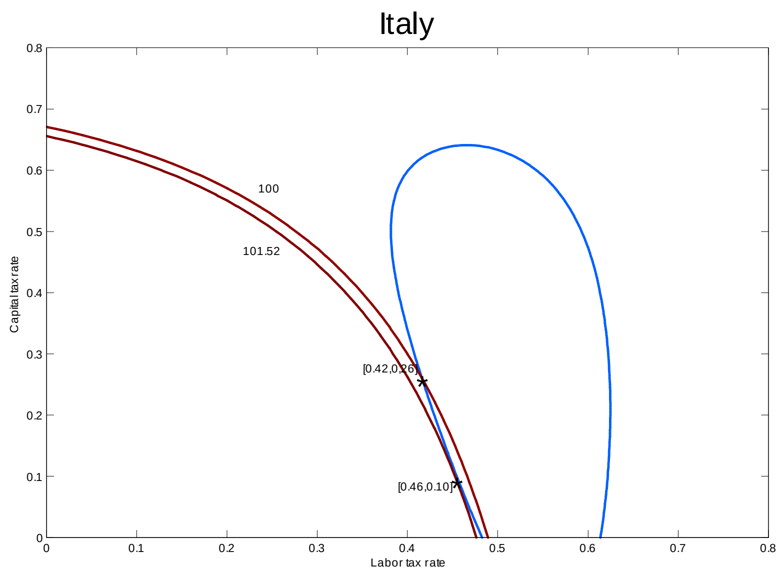

Figure 2.i: Optimal tax code (Italy).

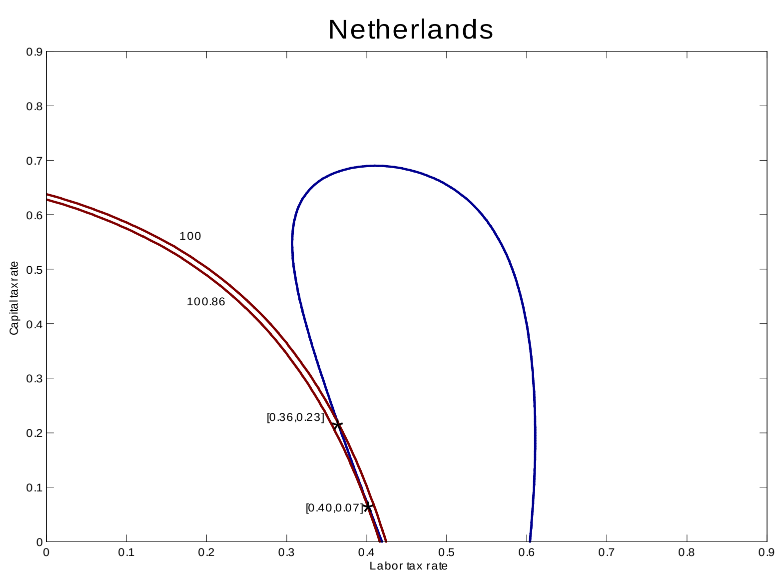

Figure 2.j: Optimal tax code (Netherlands).

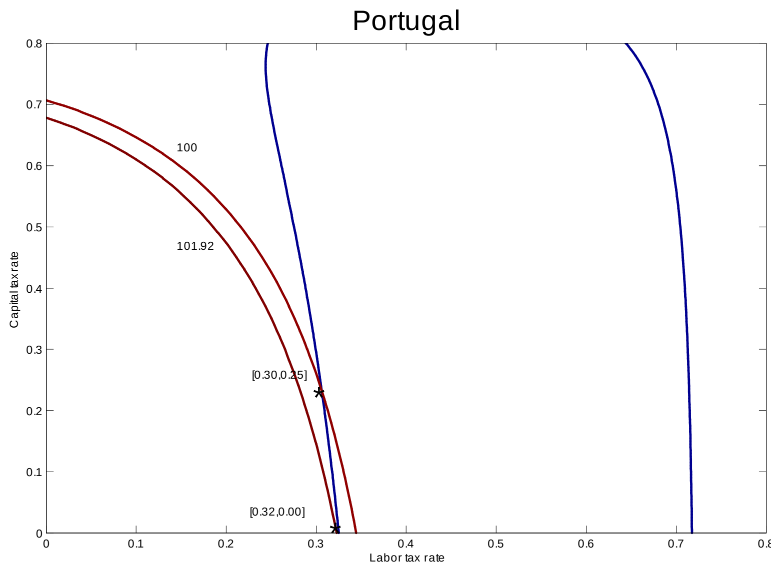

Figure 2.k: Optimal tax code (Portugal).

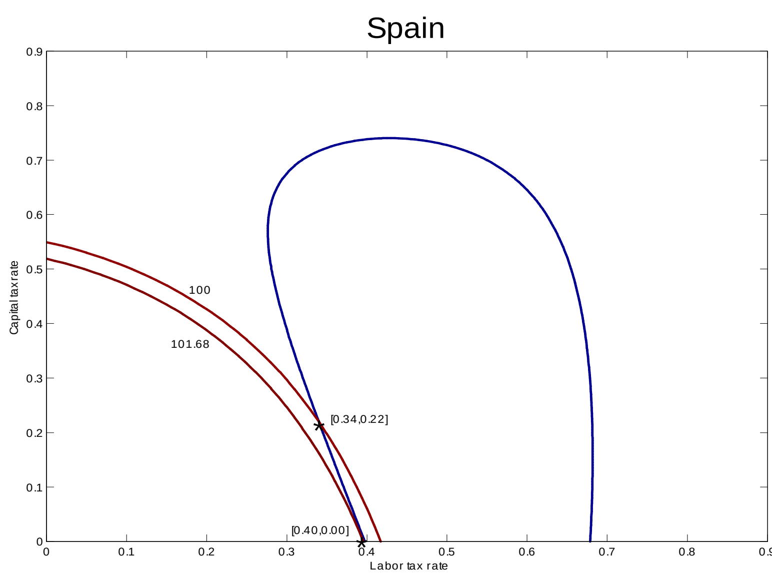

Figure 2.l: Optimal tax code (Spain).

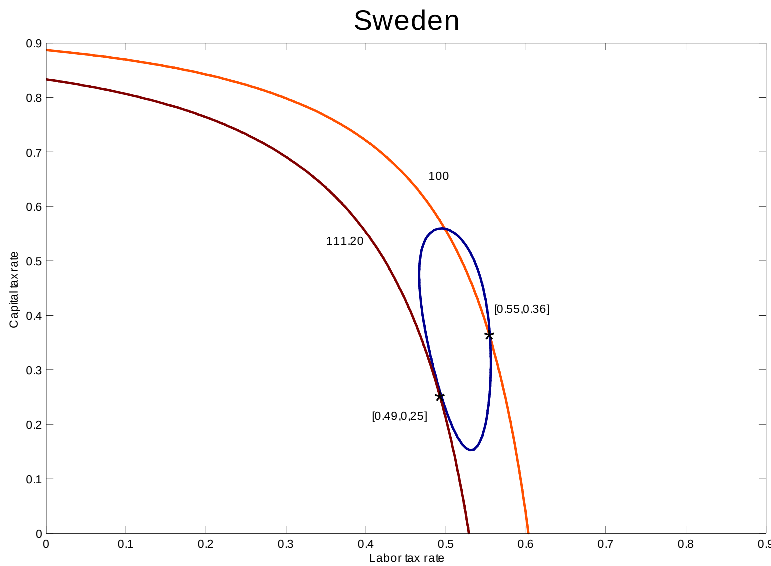

Figure 2.m: Optimal tax code (Sweden).

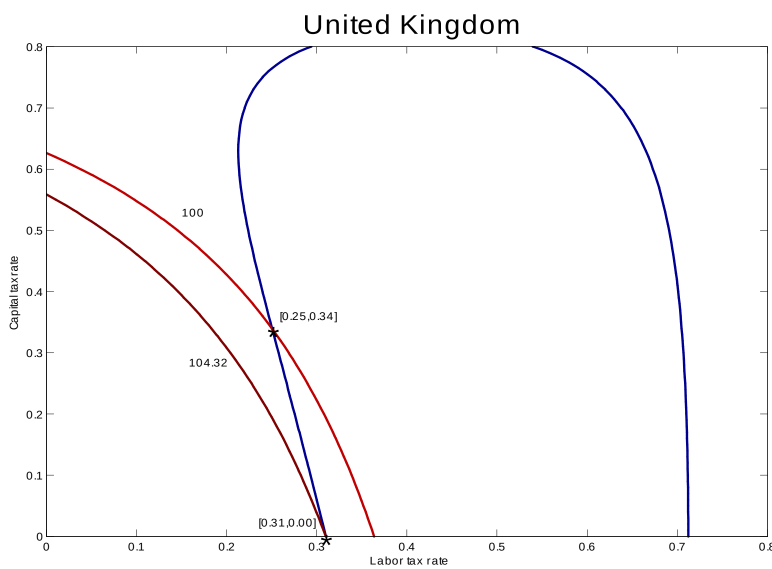

Figure 2.n: Optimal tax code (UK).