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# Optimal fiscal policy with utility-enhancing government spending, consumption taxation and a common income tax rate: the case of Bulgaria

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## Abstract

This paper explores the effects of fiscal policy in an economy based on indirect taxes, and one that is constrained to taxing all (labor and capital) income at the same rate. The focus of the paper is on the relative importance of consumption vs. income taxation, as well as on the provision of utility-enhancing public services. To this end, a Real-Business-Cycle model, calibrated to Bulgarian data (1999-2014), was set up with a richer public finance side. Bulgarian economy was chosen as a case study due to its major dependence on consumption taxation as a source of tax revenue. To illustrate the effects of fiscal policy, two regimes were compared and contrasted to one another - exogenous vs. optimal (Ramsey) policy case. The main findings from the computational experiments performed are: (i) The optimal steady-state (capital and labor income) tax rate is zero, as it is the most distortionary tax to use; (ii) The optimal steady-state consumption tax (the only source of revenue) has to almost double to finance the optimally-set level of government purchases.

**Keywords:** consumption tax, income tax, general equilibrium, fiscal policy, Bulgaria

*JEL Classification Codes:* D58, E26, H26

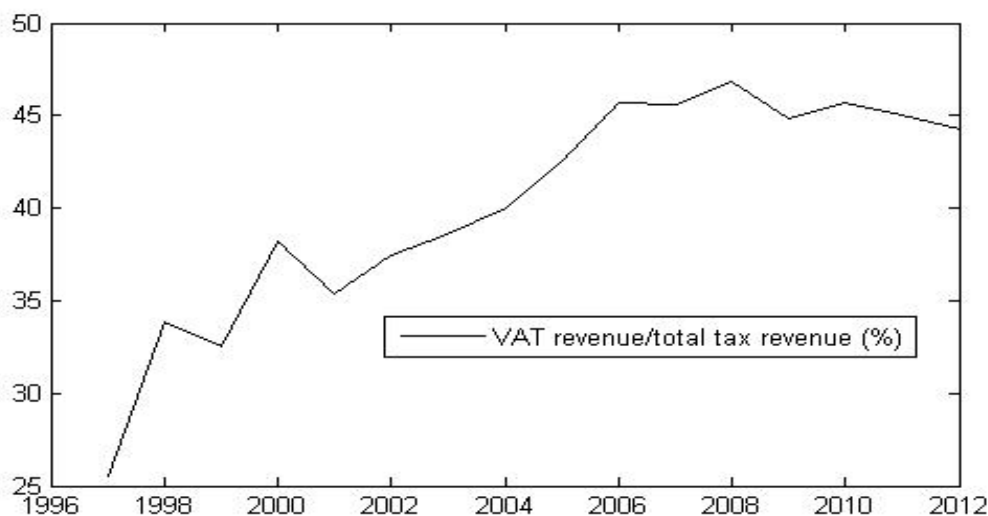
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# 1 Introduction and Motivation

Since the early 1990s, many macroeconomic studies have investigated the effects of both exogenous and optimal fiscal policy in general equilibrium setups.<sup>1</sup> The main focus of the computational experiments performed, however, has been predominantly on the effects of government purchases, public investment and taxes. The literature overemphasized the distinction between capital and labor income taxation, and abstracted away from consumption taxation given the absence of a federal sales tax in the US.<sup>2</sup>

Figure 1: Fiscal importance of VAT revenue in Bulgaria (1997-2012)



Source: WDI (2015)

On the other hand, in Eastern Europe, the move is toward a common income tax rate, and reliance on indirect (consumption/VAT) taxation. Mostly due to the absence of sufficiently qualified tax administration in the early 1990s, Bulgaria, a small Eastern European economy, and a recent EU member-state, adopted a public finance model that was built on consumption-based taxation. As seen from Fig. 1 above, VAT revenue is the major source of

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<sup>1</sup>For, example, Christiano and Eichenbaum (1992), Baxter and King (1993), MacGrattan (1994), Mendoza and Tesar (1998), and Chari, Christiano and Kehoe (1994, 1999), and many others

<sup>2</sup>A non-exhaustive list includes Jones et al. (1997), Coleman (2000), Correia (2010), Turnovsky (2000), Lacro and Rossi (2015), Schmitt-Grohe and Uribe (2006), and Schmitt-Grohe and Uribe (2007).

tax revenue in Bulgaria (and most of Central and Eastern Europe, for that matter).<sup>3</sup> Post-1997, the share of VAT revenue in total government revenue increased until it levelled off at approximately 45% of total tax revenue after Bulgaria's EU accession in 2007. Compared to consumption-based taxation, income taxation in Bulgaria is of much smaller importance for the budget: for example, over the period 2007-2014, taxation of individuals constitutes 9-11 % of overall tax revenue. In order to attract foreign investors, and to decrease the incentive to declare income as the one that is levied at a lower rate, as of 2008 both capital and labor income, as well as corporate profits are taxed at the same flat rate of 10%. Such an important institutional constraint poses a slightly different public finance problem, as compared to the ones discussed in the literature. Instead of choosing three tax rates, the fiscal authority is setting a common income tax rate, and a tax rate on consumption.

Several earlier Ramsey setups abstracted away from consumption taxation due to an indeterminacy problem: In the household's marginal rate of substitution, there is a term containing two taxes  $(1 - \tau^l)/(1 + \tau^c)$ , but only the ratio can be determined. Turnovsky (2000) on the other hand, emphasized the fact that to offset any distortionary effect, the ratio should be unity, hence  $\tau^c = -\tau^l$ . This result is broken in our paper, as Bulgaria operates under an additional constraint, namely a common income tax rate, i.e.,  $\tau^y = \tau^k = \tau^l$ . The decision for a non-differentiated rate on capital and labor tax rate was taken to discourage investors from shifting income to the category with the lower rate. This constrained specification of the form of income taxation is thus an important variation of the problem in the public finance literature, as this representation is the more relevant one for many policy-makers both in the EU, as well as in Eastern Europe, where the economies are based around low income taxes and higher indirect taxes. In addition, we will utilize a setup where both tax rates and spending is chosen optimally, which distinguishes this study from other papers in the literature, e.g. Coleman (2000), Turnovsky (2000), and Correia (2010), among many others. Last, but not least, the focus is on the steady-state, in contrast to Correia (2010), who focuses on optimized impulse responses, and Schmidt-Grohe and Uribe (2006,

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<sup>3</sup>VAT as a share in total tax revenue increased in importance after its introduction and implementation in 1994 from 25% of total tax revenue to 35% in the years following the currency board implementation (in 1997), where the increase was due to the macroeconomic stability that was achieved by fixing the Bulgarian lev (BGN) to the German mark at parity.

2007) who also study the adjustment of fiscal policy instruments along the transition path; instead, here we are more interested in the average rates of income and consumption taxes, given that consumption taxation is responsible for almost a half of total government revenue.

The paper then proceeds to characterize optimal fiscal policy in the context above and then to evaluate it relative to the exogenous (observed) one. Similar to earlier literature, e.g. Judd (1985), Chamley (1986), and Zhu (1992), allowing for fiscal interventions in an RBC framework creates interesting trade-offs: On the one hand, spending on productive government services directly increases household's utility. On the other, the proportional taxes on labor and capital are known to distort incentives to supply labor in the private and public sectors, and to accumulate physical capital. Therefore, higher taxes reduce consumption, which in turn lowers welfare - both directly, and indirectly by generating less consumption revenue which could be spent on utility-enhancing public services. However, in contrast to income taxes, consumption taxation is less-distortionary, as it is a tax on demand.

The public finance problem discussed in this paper is now to choose consumption and (labor and capital) income tax rate to finance both productive and redistributive government expenditure, while at the same time minimizing the allocative distortions created in the economy, as a result of the presence of proportional taxation. The main findings from the computational experiments performed are: (i) The optimal steady-state (capital and labor income) tax rate is zero, as it is the most distortionary tax to use; (ii) The optimal steady-state consumption tax has to almost double to finance the now much higher government spending.

The rest of the paper is organized as follows: Section 2 describes the model framework and describes the decentralized equilibrium system, Section 4 discusses the calibration procedure, and Section 4 presents the steady-state model solution. Sections 5 proceeds with the optimal taxation (Ramsey) policy problem, and evaluates the long-run effects on the economy. Section 6 concludes the chapter.

## 2 Model Description

There is a representative households which derives utility out of consumption, leisure and public services. The time available to households can be spent in productive use or as leisure. The government taxes consumption spending and levies a common tax on all income, in order to provide utility-enhancing public services and government transfers. On the production side, there is a representative firm, which hires labor and capital to produce a homogenous final good, which could be used for consumption, investment, or government purchases.

### 2.1 Households

There is a representative household, which maximizes its utility function:

$$\sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \gamma \ln(1 - h_t) + \phi \ln g_t^c \right\}, \quad (2.1)$$

where  $c_t$  denotes household's private consumption in period  $t$ ,  $h_{it}$  are non-leisure hours in period  $t$ ,  $g_t^c$  is the per-household consumption of public services,  $0 < \beta < 1$  is the discount factor,  $\gamma > 0$  is the relative weight that the household attaches to leisure, and  $\phi > 0$  is the relative weight that the household attaches to the consumption of public services.<sup>4</sup>

The household starts with an initial stock of physical capital  $k_0$ , and has to decide how much to add to it in the form of new investment. Every period physical capital depreciates at a rate  $\delta$ ,  $0 < \delta < 1$ . The law of motion for physical capital is then

$$k_{t+1} = i_t + (1 - \delta)k_t, \quad (2.2)$$

and the real interest rate is  $r_t$ , hence the before-tax capital income of the household in period  $t$  equals  $r_t k_t$ . In addition to capital income, the household can generate labor income. Hours supplied to the representative firm are rewarded at the hourly wage rate of  $w_t$ , so pre-tax labor income equals  $w_t h_t$ .

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<sup>4</sup>This way of modelling government services follows Baxter and King (1993), among many others. The log-separable class of utility functions was chosen to greatly simplify the algebra that is to follow, without affecting the main results of the paper in any major way.

Next, the household's problem can be now simplified to

$$\sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \gamma \ln(1 - h_t) + \phi \ln g_t^c \right\} \quad (2.3)$$

s.t.

$$(1 + \tau_t^c)c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau_t^y)[w_t h_t + r_t k_t] + g_t^t + \pi_t, \quad (2.4)$$

where  $\tau_t^c$  is the tax on consumption,  $\tau_t^y$  is the proportional income tax rate ( $0 < \tau^y < 1$ ), levied on both labor and capital income,  $\pi_t$  are the claims to firm's profit, and  $g_t^t$  denotes government transfers. The problem generates the following optimality conditions:

$$c_t : \frac{1}{c_t} = \lambda_t(1 + \tau_t^c) \quad (2.5)$$

$$k_{t+1} : \lambda_t = \beta \lambda_{t+1} [1 + (1 - \tau_{t+1}^y)r_{t+1} - \delta] \quad (2.6)$$

$$h_t : \frac{\gamma}{1 - h_t} = \lambda_t(1 - \tau_t^y)w_t \quad (2.7)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t \lambda_t k_{t+1} = 0, \quad (2.8)$$

where  $\lambda_t$  is the Lagrangean multiplier attached to household's budget constraint in period  $t$ .

The interpretation of the first-order conditions above is standard: the first one states that for each household, the marginal utility of consumption equals the marginal utility of wealth, corrected for the consumption tax rate. The second equation is the so-called "Euler condition," which describes how the household chooses to allocate physical capital over time. Next, at the margin, each hour spent working for the firm should balance the benefit from doing so in terms of additional income generates, and the cost measured in terms of lower utility of leisure. The last condition is called the "transversality condition" (TVC): it states that at the end of the horizon, the value of physical capital should be zero.

## 2.2 Firm

There is a representative firm in the economy, which produces a homogeneous product. The price of output is normalized to unity. The production technology is Cobb-Douglas and uses both physical capital,  $k_t$ , and labor hours,  $h_t$ , to maximize static profit

$$\Pi_t = A k_t^\alpha h_t^{1-\alpha} - r_t k_t - w_t h_t, \quad (2.9)$$

where  $A$  denotes the level of technology. Since the firm rents the capital from households, the problem of the firm is a sequence of static profit maximizing problems. In equilibrium, there are no profits, and each input is priced according to its marginal product, *i.e.*:

$$k_t : \alpha \frac{y_t}{k_t} = r_t, \quad (2.10)$$

$$h_t : (1 - \alpha) \frac{y_t}{h_t} = w_t. \quad (2.11)$$

## 2.3 Government

In the model setup, the government is levying taxes on labor and capital income, as well as consumption in order to finance spending on utility-enhancing government purchases. The government budget constraint is as follows:

$$g_t^c + g_t^t = \tau_t^c c_t + \tau_t^y [w_t h_t + r_t k_t] \quad (2.12)$$

Tax rates and government consumption-to-output ratio would be chosen to match the average share in data, and government transfers would be determined residually in each period so that the government budget is always balanced.

## 2.4 Dynamic Competitive Equilibrium (DCE)

For a given level of technology  $A$ , average tax rates  $\{\tau^c, \tau^y\}$ , initial capital stock  $k_0$ , the decentralized dynamic competitive equilibrium is a list of sequences  $\{c_t, i_t, k_t, h_t\}_{t=0}^{\infty}$  for the household, a sequence of government purchases and transfers  $\{g_t^c, g_t^t\}_{t=0}^{\infty}$ , and input prices  $\{w_t, r_t\}_{t=0}^{\infty}$  such that (i) the household maximizes its utility function subject to its budget constraint; (ii) the representative firm maximizes profit; (iii) government budget is balanced in each period; (iv) all markets clear.

# 3 Data and Model Calibration

To compute optimal fiscal policy in Bulgaria, we will focus on the period after the introduction of the currency board (1999-2014). Annual data on output, consumption and investment was collected from National Statistical Institute (2015), while the real interest rate is taken



from Bulgarian National Bank Statistical Database (2015). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: first, as in Vasilev (2013), the discount factor,  $\beta = 0.937$ , is set to match the steady-state capital-to-output ratio in Bulgaria,  $k/y = 3.491$ , in the steady-state consumption-Euler equation (2.6). The labor share parameter,  $1 - \alpha = 0.571$ , is obtained as the average value of labor income in aggregate output over the period 1999-2014. This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital, which was part of the ideology of the totalitarian regime, which was in place until 1989.

The relative weight attached to the utility out of leisure in the household's utility function,  $\gamma$ , is calibrated to match that in steady-state consumers would supply one-third of their time endowment to working. This is in line with the estimates for Bulgaria as well over the period studied. The weight attached to public goods is set to  $\phi = 0.25$  to reflect the fact that households value public consumption four times less than private consumption. The value of  $\phi$  is also in line with Vasilev (2016a), who found the same proportion of spending efficiency on the two categories of consumption, i.e spending on public consumption is four time less efficient than spending on final consumption.<sup>5</sup> The depreciation rate of physical capital in Bulgaria,  $\delta = 0.05$ , was taken from Vasilev (2015). It was estimated as the average depreciation rate over the period 1999-2014. Finally, the average income tax rate was set to  $\tau^y = 0.1$ . This is the average effective tax rate on income between 1999-2007, when Bulgaria used progressive income taxation, and equal to the proportional income tax rate introduced as of 2008. Finally, the tax rate on consumption is set to its value over the period,  $\tau^c = 0.2$ . Table 1 below summarizes the values of all model parameters used in the paper.

## 4 Steady-State

Once the values of model parameters were obtained, the steady-state equilibrium system solved, the "big ratios" can be compared to their averages in Bulgarian data. The results

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<sup>5</sup>Thus we take the quantities to reflect people's revealed preferences for each consumption. Furthermore, parameter  $\phi$  becomes relevant only in the optimal policy framework. Robustness checks were performed, and it turned out the value of  $\phi$  does not change the qualitative results.

Table 1: Model Parameters

Parameter	Value	Description	Method
$\beta$	0.937	Discount factor	Calibrated
$\alpha$	0.429	Capital Share	Data average
$1 - \alpha$	0.571	Labor Share	Calibrated
$\gamma$	1.121	Relative weight attached to leisure	Calibrated
$\phi$	0.250	Relative weight attached to public services	Data average
$\delta$	0.050	Depreciation rate on physical capital	Data average
$\tau^y$	0.100	Average tax rate on income	Data average
$\tau^c$	0.200	VAT/consumption tax rate	Data average

are reported in Table 2 on the next page. The steady-state level of output was normalized to unity (hence the level of technology  $A$  differs from one, which is usually the normalization done in other studies), which greatly simplified the computations. Next, the model matches consumption-to-output and government purchases ratios by construction; The investment ratios are also closely approximated, despite the closed-economy assumption and the absence of foreign trade sector. The shares of income are also identical to those in data, which is an artifact of the assumptions imposed on functional form of the aggregate production function. The after-tax return, where  $\bar{r} = (1 - \tau^y)r - \delta$  is also relatively well-captured by the model. Lastly, given the absence of debt, and the fact that transfers were chosen residually to balance the government budget constraint, the result along this dimension is understandably not so close to the average ratio in data.

## 5 The Ramsey problem (Optimal fiscal policy under full commitment)

In this section, following Chari, Christiano and Kehoe (1994, 1999), we solve for the optimal fiscal policy scenario under full commitment. More specifically, the government will be modelled as a benevolent planner, who maximizes the household's utility function, while at the same time taking into account the optimality conditions by both the household and the

Table 2: Data Averages and Long-run Solution

Variable	Description	Data	Model
$y$	Steady-state output	N/A	1.000
$c/y$	Consumption-to-output ratio	0.674	0.674
$i/y$	Investment-to-output ratio	0.201	0.175
$k/y$	Capital-to-output ratio	3.491	3.491
$g^c/y$	Government cons-to-output ratio	0.151	0.151
$g^t/y$	Government transfers-to-output ratio	0.220	0.074
$wh/y$	Labor income-to-output ratio	0.571	0.571
$rk/y$	Capital income-to-output ratio	0.429	0.429
$h$	Share of time spent working	0.333	0.333
$A$	Scale parameter of the production function	N/A	1.095
$\bar{r}$	After-tax net return on capital	0.056	0.067

firm.<sup>6</sup> The fiscal instruments at government's disposal are consumption and income tax rate, and level of public consumption spending. Note that the government transfers will be held fixed at the level computed from the equilibrium under the exogenous policy case. In this section we allow only for distortionary, or proportional, taxes - otherwise using lump-sum taxation the government can achieve the first-best (Pareto) allocation. In addition, it will be assumed that the government can also fully and credibly commit to the future sequence of taxes and spending until the end of the optimization period. Thus, only a second-best outcome can be achieved. Still, the focus on second-best outcome only adds to the realism of the model.

Under the Ramsey framework, the choice variables for the government are  $\{c_t, h_t, k_{t+1}, w_t, r_t\}_{t=0}^{\infty}$  plus the two tax rates  $\{\tau_t^c, \tau_t^y\}_{t=0}^{\infty}$ . The initial conditions for the state variable  $\{K_0, \}$  as well as the sequence of government transfers  $\{g_t^t\}_{t=0}^{\infty}$  and the fixed level of total factor productivity  $A$  are taken as given. The optimal policy problem is then recast as a setup where the

<sup>6</sup>Note that when the household and the firm are making optimal choices, they are taking all fiscal policy variables as given.

government chooses after-tax input prices  $\tilde{r}_t$  and  $\tilde{w}_t$  directly, where

$$\tilde{r}_t \equiv (1 - \tau_t^y)r_t \quad (5.1)$$

$$\tilde{w}_t \equiv (1 - \tau_t^y)w_t. \quad (5.2)$$

Thus, government budget constraint is now represented by

$$\tau_t^c c_t + Ak_t^\alpha h_t^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t h_t = g_t^c + g_t^t \quad (5.3)$$

The Ramsey problem then becomes

$$\max_{\{c_t, h_t, k_{t+1}, g_t^c, \tilde{w}_t, \tilde{r}_t, \tau_t^c\}} \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \gamma \ln(1 - h_t) + \phi \ln g_t^c \right\} \quad (5.4)$$

s.t.

$$\frac{1}{(1 + \tau_t^c)c_t} = \beta \frac{1}{(1 + \tau_{t+1}^c)c_{t+1}} [1 - \delta + \tilde{r}_{t+1}] \quad (5.5)$$

$$\frac{\gamma}{1 - h_t} = \frac{\tilde{w}_t}{(1 + \tau_t^c)c_t} \quad (5.6)$$

$$Ak_t^\alpha h_t^{1-\alpha} = c_t + k_{t+1} - (1 - \delta)k_t + g_t^c \quad (5.7)$$

$$\tau_t^c c_t + Ak_t^\alpha h_t^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t h_t = g_t^c + g_t^t \quad (5.8)$$

Set up the Lagrangean

$$\begin{aligned} \mathcal{L} = & \max_{\{c_t, h_t, k_{t+1}, g_t^c, \tilde{w}_t, \tilde{r}_t, \tau_t^c\}} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \gamma \ln(1 - h_t) + \phi \ln g_t^c \right. \\ & + \lambda_t^1 [-(1 + \tau_{t+1}^c)c_{t+1} + (1 + \tau_t^c)c_t(1 - \delta + \tilde{r}_{t+1})] \\ & + \lambda_t^2 [\gamma c_t(1 + \tau_t^c) - (1 - h_t)\tilde{w}_t] \\ & + \lambda_t^3 [Ak_t^\alpha h_t^{1-\alpha} - c_t - k_{t+1} + (1 - \delta)k_t - g_t^c] \\ & \left. + \lambda_t^4 [\tau_t^c c_t + Ak_t^\alpha h_t^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t h_t - g_t^c - g_t^t] \right\} \quad (5.9) \end{aligned}$$

The first-order optimality conditions are as follows:

$$c_t : -\frac{\lambda_{t-1}^1(1 + \tau_t^c)}{\beta} + \frac{1}{c_t} + \lambda_t^1(1 + \tau_t^c)(1 - \delta + \tilde{r}_{t+1}) + \lambda_t^2\gamma(1 + \tau_t^c) - \lambda_t^3 + \lambda_t^4\tau_t^c = 0 \quad (5.10)$$

$$h_t : -\frac{\gamma}{1 - h_t} + \lambda_t^2\tilde{w}_t + \lambda_t^3w_t + \lambda_t^4[w_t - \tilde{w}_t] = 0 \quad (5.11)$$

$$k_{t+1} : -\frac{\lambda_{t-1}^3}{\beta} + \lambda_t^3[r_t + 1 - \delta] + \lambda_t^4[r_t - \tilde{r}_t] = 0 \quad (5.12)$$

$$g_t^c : \frac{\phi}{g_t^c} = \lambda_t^3 + \lambda_t^4 \quad (5.13)$$

$$\tau_t^c : -\frac{\lambda_{t-1}^1}{\beta}c_t + \lambda_t^1c_t[1 - \delta + \tilde{r}_{t+1}] + \lambda_t^2\gamma = -\lambda_t^4 \quad (5.14)$$

$$\tilde{r}_t : \frac{\lambda_{t-1}^1(1 + \tau_{t-1}^c)c_{t-1}}{\beta} = \lambda_t^4k_t \quad (5.15)$$

$$\tilde{w}_t : \lambda_t^2(1 - h_t) = -\lambda_t^4h_t \quad (5.16)$$

We can also add the equations for the auxiliary variables, namely

$$y_t = Ak_t^\alpha h_t^{1-\alpha} \quad (5.17)$$

$$y_t = c_t + k_{t+1} - (1 - \delta)k_t + g_t^c \quad (5.18)$$

$$i_t = k_{t+1} - (1 - \delta)k_t \quad (5.19)$$

$$r_t = \alpha \frac{y_t}{k_t} \quad (5.20)$$

$$w_t = (1 - \alpha) \frac{y_t}{h_t} \quad (5.21)$$

The steady-state Ramsey equilibrium is summarized in Table 3 below, where the same values for the parameters from the exogenous policy section (see Table 1) were used.

As seen from Table 3 on the previous page, total discounted welfare is higher under the Ramsey regime: As in Lucas (1990), parameter  $\xi$  is introduced to measure the welfare gain in terms of higher steady-state consumption (26%) when the economy moves to the optimal fiscal policy case.<sup>7</sup> Next, private consumption in the optimal policy case is higher (even though the consumption share is lower, which is since output is now much higher), while private capital- and investment shares are higher, and thus the interest rate is lower. The model generates a zero long-run income tax, which consistent with the findings in earlier studies,

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<sup>7</sup>The expression behind  $\xi$  is derived in the Appendix.

Table 3: Data Averages and Long-run Solution

Variable	Description	Data	Model (exo. policy)	Model (optimal)
$y$	Steady-state output	N/A	1.000	1.250
$c/y$	Consumption-to-output ratio	0.674	0.674	0.653
$i/y$	Investment-to-output ratio	0.201	0.175	0.183
$k/y$	Capital-to-output ratio	3.491	3.491	3.656
$g^c/y$	Government cons-to-output ratio	0.151	0.151	0.163
$g^t/y$	Government transfers-to-output ratio	0.220	0.076	0.059
$wh/y$	Labor income-to-output ratio	0.571	0.571	0.571
$rk/y$	Capital income-to-output ratio	0.429	0.429	0.429
$h$	Share of time spent working	0.333	0.333	0.472
$A$	Scale parameter of the production function	N/A	1.095	1.095
$\bar{w}$	After-tax wage rate	-	1.543	1.513
$\bar{r}$	After-tax net return on capital	0.056	0.067	0.067
$\tau^y$	Income tax rate	0.100	0.100	0.000
$\tau^c$	Consumption tax rate	0.200	0.200	0.340
$\xi$	Welfare gain (% cons.)	-	0.000	26.06

e.g. Judd (1985), Chamley (1986), and Zhu (1992). This leads to higher capital input and labor supplied in steady-state, which in turn translates into higher output and investment. Under Ramsey, the steady-state private consumption is lower, but public consumption overcompensates, so overall welfare increases despite the increase in hours. In other words, the government internalizes (at least partially) the externality of the utility-enhancing public services when maximizing household's overall utility.<sup>8</sup> Finally, in order to finance the increased government consumption spending, consumption tax rate has to almost double - from 20% to 34%. In contrast to the income tax, the consumption tax is less distortionary, as it is a tax

<sup>8</sup>However, given that  $\phi$  is significantly lower than unity, government purchases do not change much, especially as a share of output.

on demand, rather than tax on productive inputs.<sup>9</sup> Therefore, the optimal policy suggests abolishing all direct taxation, which is akin to a "race to the bottom" result and adopt a public finance model that relies exclusively on indirect taxation. These results are new and could be of interest to policy makers, as previous research had ignored those important dimensions.

Still, we should acknowledge the limitations of the current research. More specifically, we should take the results from the computational experiment above with a grain of salt. A possible reason why we do not see zero income tax in reality is the perfect information. In the real world, government cannot observe each and every transaction. At the same time, it would like to know the size of the aggregate economy. Thus, fiscal authorities want to have a way to double and triple check, especially in the presence of informal activity ("grey economy"), hence governments levy consumption taxes on final use, while also taxing income at the stage when it is generated. In addition, consumption tax is also a value-added tax (VAT), levied in each stage of production but deductible unless it is the final stage. Thus, having a VAT taxation in place is yet another useful approach (the value-added approach) to estimate the size of the economy. So from the perspective of a fiscal authority, all types of taxes should be used, as they serve important measurement purposes.<sup>10</sup>

## 6 Conclusions

This paper characterizes optimal fiscal policy and evaluates it relative to the exogenous (observed) one. The focus is on the optimal consumption and income tax rates, as well as the optimal provision of public services. To this end, a Real-Business-Cycle model, calibrated to Bulgarian data (1999-2014), is set up with a richer government spending side. To illustrate the effects of fiscal policy, two regimes are compared and contrasted to one another - exogenous vs. optimal (Ramsey) policy case. The main findings from the computational experiments performed in this chapter are: (i) The optimal steady-state (capital and labor

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<sup>9</sup>The relative change in the magnitude also makes sense - if consumption taxation was responsible for all of the total revenue, in the absence of any income taxation, the rate has to double as this indirect taxation becomes the only source for generating tax revenue, while government purchases are also optimally chosen.

<sup>10</sup>In addition, in reality there are administrative costs from running a taxation system, and/or evasion activity going on. In an augmented setup, Vasilev (2016) considers optimal taxation under VAT evasion.

income) tax rate is zero, as it is the most distortionary tax to use; (ii) The optimal steady-state consumption tax has to almost double to finance the now higher government spending. Overall, the results in this paper suggest that there are substantial efficiency gains that could be realized by moving to a public finance model based around low income taxes and higher indirect taxes to finance government spending.

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## Appendix: Derivation of the welfare gain measure

In this section we derive the formula behind the steady-state consumption gain measure,  $\xi$ , used in the computational experiment. In other words, by what percent we need to increase household's steady-state consumption under the exogenous (observed) fiscal policy, in order to make it indifferent to the allocations from the optimal fiscal policy regime? That requires

$$\sum_{t=0}^{\infty} \beta^t \{\ln(1 + \xi)c^e + \gamma \ln(1 - h^e) + \phi \ln(g^c)^e\} = \sum_{t=0}^{\infty} \beta^t \{\ln c^o + \gamma \ln(1 - h^o) + \phi \ln(g^c)^o\},$$

where "e" denotes an allocation from the exogenous (or "observed") policy case, while "o" is an allocation obtained under the optimal policy case. Since we focus on the long-run consumption gain, it follows that

$$\{\ln(1 + \xi)c^e + \gamma \ln(1 - h^e) + \phi \ln(g^c)^e\} \sum_{t=0}^{\infty} \beta^t = \{\ln c^o + \gamma \ln(1 - h^o) + \phi \ln(g^c)^o\} \sum_{t=0}^{\infty} \beta^t,$$

or

$$\frac{1}{1-\beta} \{\ln(1+\xi)c^e + \gamma \ln(1-h^e) + \phi \ln(g^e)^e\} = \frac{1}{1-\beta} \{\ln c^o + \gamma \ln(1-h^o) + \phi \ln(g^o)^o\}.$$

Cancel the common multiplier to obtain

$$\ln(1+\xi) + \ln c^e + \gamma \ln(1-h^e) + \phi \ln(g^e)^e = \ln c^o + \gamma \ln(1-h^o) + \phi \ln(g^o)^o.$$

Rearrange terms, and after some algebra one can obtain

$$\ln(1+\xi) = \ln c^o - \ln c^e + \gamma [\ln(1-h^o) - \ln(1-h^e)] + \phi [\ln(g^o)^o - \ln(g^e)^e],$$

$$\ln(1+\xi) = \ln \left[ \frac{c^o}{c^e} \right] + \gamma \ln \left[ \frac{1-h^o}{1-h^e} \right] + \phi \ln \left[ \frac{(g^o)^o}{(g^e)^e} \right],$$

$$\ln(1+\xi) = \ln \left[ \frac{c^o}{c^e} \right] \left[ \frac{1-h^o}{1-h^e} \right]^\gamma \left[ \frac{(g^o)^o}{(g^e)^e} \right]^\phi,$$

$$1+\xi = \left[ \frac{c^o}{c^e} \right] \left[ \frac{1-h^o}{1-h^e} \right]^\gamma \left[ \frac{(g^o)^o}{(g^e)^e} \right]^\phi,$$

$$\xi = \left[ \frac{c^o}{c^e} \right] \left[ \frac{1-h^o}{1-h^e} \right]^\gamma \left[ \frac{(g^o)^o}{(g^e)^e} \right]^\phi - 1,$$