

Vasilev, Aleksandar

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# The welfare effect of flat income tax reform: the case of Bulgaria

Aleksandar Vasilev\*

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## Abstract

This paper is a first attempt to provide a quantitative evaluation of the welfare gains resulting from the introduction of flat income taxation in Bulgaria in 2008. Using a calibrated micro-founded endogenous growth model with physical and human capital accumulation to Bulgarian data, a computational experiment is performed to quantify the dynamic welfare effect of progressive income taxation vis-a-vis flat income taxation. The model demonstrates that significant welfare gains, measured in terms of per-period consumption, can be realized with the introduction of flat income taxation. In addition, these welfare gains increase proportionally with the length of the time horizon considered. Finally, sensitivity analysis was performed to demonstrate that the results obtained are robust.

*JEL classification:* H22, I21, D51, D91, O41

*Keywords:* Taxation; Endogenous growth; Human capital; Welfare gains

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\*Aleksandar Vasilev is a CERGE-EI Affiliate Fellow and an Asst. Professor at the Department of Economics, American University in Bulgaria, 1 Georgi Izmirliiev Sq., Blagoevgrad 2700, Bulgaria. Tel: 00 359 73 888 482. The author thanks Omer Moav, Moshe Hazan, Didar Erdinc, Nevena Nenova, Georgi Ganey, Georgi Angelov, Lachezar Bogdanov, Rumen Avramov, participants at the 2014 Warwick Summer Workshop in Economic Growth, Bulgarian Macroeconomic Association seminar, AUBG 8th Research Conference, and two anonymous referees for their excellent comments. All errors and omissions are mine alone. E-mail for correspondence: avasilev@aubg.edu.

# 1 Introduction and Motivation

This paper explores a major tax policy reform in Bulgarian taxation system, and more specifically the switch from a progressive tax schedule to a flat tax regime on Jan. 1, 2008. Throughout the paper, "flat tax" and "proportional tax" would be used interchangeably. Using an endogenous growth model, this study is a first formal attempt to quantitatively evaluate the effect of the introduction of flat income taxation in Bulgaria in 2008.<sup>1</sup> The focus is on the growth effects of flat income tax rate as a result of increased capital accumulation on the supply side, and the corresponding welfare improvement as a result of that.<sup>2</sup> Thus, the model in this paper will abstract away from corporate profit and dividend taxation.<sup>3</sup>

The aim of the paper is two-fold: first, the Baltic countries (Lithuania, Latvia, and Estonia) already adopted proportional taxation in the early 2000s, and realized significant welfare gains from adopting such pro-market policies, as demonstrated in Funke and Strulik (2006) and Azacis and Gillman (2010). Therefore, those three countries could then provide a useful benchmark when analyzing Bulgaria's 2008 income tax reform: after all, Bulgaria is the size of Lithuania, Latvia, and Estonia combined. In addition, all four countries listed are recent EU members, and share similar history of transition from central planning to market economies. In the early 1990s, those countries had to stop running budget deficits, adopt prudent fiscal stance, discontinue subsidizing loss-making state-owned enterprises, and thus harden the (previously) "soft" budget constraints. At the same time, those countries needed to continue providing vital public services, such as law and order, education, healthcare, and general public goods.

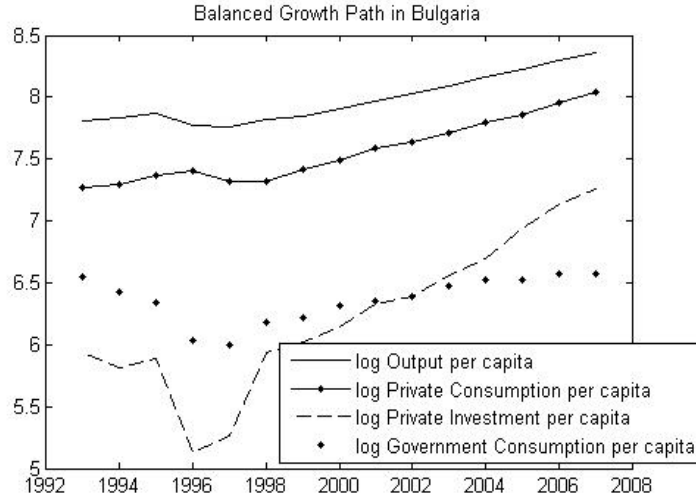
Second, the very question of the nature of the taxation system is a controversial one, and an issue that lies at the very heart of fiscal policy. Furthermore, direct income taxation is an important part of government revenue, and is central for public finance management all over the world. When it comes to tax reforms in transition countries, the World Bank (2000) has advised them to re-design and reform their tax system design by well-grounding them in theory and historical evidence, where both of those recommendations naturally pointed in the direction of simple tax systems with a single bracket and a low statutory rate, to be levied on a broad base. In turn, the reduction of the tax burden would encourage investment and promote long-term growth. Therefore, the Bulgarian tax reform in 2008 may be relevant for other transition and developing countries considering the adoption of flat income taxation.

In the early 1990s, Bulgarian income taxation featured a progressive schedule, which was in line with the social equality objective. However, despite the equity considerations, a progressive tax comes at the expense of additional distortion from marginal tax rates and progressivity itself (not mentioning the high administration cost). On the other hand, proportional taxation is a much simpler tax system, which makes it more transparent, and much easier to administer. The paper will thus focus on the controversial issue which tax policy in Bulgaria is better in terms of stronger supply-side effects, namely on physical capital and skill accumulation, and in terms of welfare effects.

The theoretical setup used in this paper will be based on a simplified version of Lucas's (1988) endogenous growth model with human capital. In addition, the paper contains important sensitivity experiments to demonstrate that the results obtained are robust. As in Barro (1990), government consumption will be modelled as a complementary input in the production function of final output. In other words, government services, accounted for in the wages of government employees, add to the functioning of the economy through the implementations of regulations, construction and maintenance of public infrastructure, contract enforcement, protection of property rights, healthcare provision, etc. In addition, the setup in this paper takes a broader view of capital, and allows for the existence of human capital as well, which will interact with (and complement) the stock of physical capital. The human capital accumulation will be then the channel through which the marginal product of capital will be precluded from entering into a range of diminishing returns. The simultaneous accumulation of both types of capital by the household would then guarantee sustained economic growth, or the so-called balanced growth path (BGP). The observed regularity that aggregate variables tend to grow at a constant (but possibly different across variables) rate over time is a documented stylized fact for many developed economies, and as seen from Fig. 1 below, also holds true for the Bulgarian economy since the early 1990s.

The only notable deviations are in the behavior of government consumption, which registered little growth over the period due to the fact that the public sector was shrinking at the expense of the expanding private sector. That is why investment is growing at a faster rate than both consumption and output over the 1993-2007 period. Another deviation from the theory is the slump in all variables in 1996-97, which was a period of a major banking and financial crisis in Bulgaria. Nevertheless, in light of the relatively short time series consid-

Figure 1: Balanced Growth Path in Bulgaria 1993-2007



ered, the balanced growth assumption is not that bad as an approximation for the behavior of the Bulgarian economy over the period studied in this paper.

National policies, such as taxation policies, are known to affect households' incentives to accumulate capital, and their decisions to provide labor services to businesses. In the standard macroeconomic model, a tax on income decreases the after-tax return to physical and human capital. The high tax rate would then discourage the household from accumulating capital stock and investing in education, and thus the growth rate would decrease. A similar mechanism is at work when instead of average effective tax rate we also consider the degree of progressivity of the tax system. Note that the tax reform results are limited to the set of assumed taxes, and the equal ("balanced") tax rate on both labor and capital. The analysis of the effect of fiscal policies in exogenous and endogenous growth models is relatively recent, e.g., King and Rebelo (1990), Lucas (1990), Stokey and Rebelo (1995), Ortigueira (1998), and the references therein. More recent treatments on the subject include Funke and Strulik (2006) on Estonia, and Azacis and Gillman (2010) on the tax reform in the Baltic countries (Estonia, Latvia, and Lithuania). In their research on the US, King and Rebelo (1990) find that income taxation decreases the return to capital and labor. Rebelo (1991) also uncovers a negative relationship between the tax rate and the growth in a similar setup with both physical and human capital, as the one used in this paper. Ventura (1999) finds a positive effect on capital accumulation and increase in aggregate labor supply in efficiency units (but

not in average hours). In addition, an important conclusion that emerges in the literature is that the welfare cost of taxation turns out to be larger in endogenous growth models, as compared to exogenous growth setups.

The paper is organized as follows: Section 2 lays down the specifics of Bulgaria's 2008 income tax reform. Section 3 then proceeds to presents the models setup. Section 4 describes the data used and the calibration procedure. Section 5 characterizes the model economy's long-run behavior. Section 6 calculates the balanced growth path rate; several robustness checks on model parameters are then performed to determine their quantitative effect on the balanced growth path rate. Section 7 evaluates the welfare cost of progressive income taxation, and provides substantial sensitivity analysis to demonstrate that the results obtained in the paper are robust. Section 8 concludes and provides some directions for future research.

## **2 Bulgaria's 2008 income tax reform**

Until Dec. 31, 2007, Bulgaria applied progressive income taxation on individual income. The old regime featured progressive scale of taxation, a zero-bracket amount, and a significant number of tax incentives and tax deductions. The tax brackets are stipulated in Table 1 below. For additional clarity, tax owed for both annual and monthly income levels was reported.

In 2008, a flat tax rate of 10% on personal income was introduced. This represented a considerable cut in the marginal tax rate on personal income, as compared to the earlier regime. At the same time, workers who were previously paying no taxes due to the size of the deductions, suddenly faced a positive tax rate. To compensate those low-income households, who were the main losers from this tax policy change, the minimum wage (the minimum wage being non-taxable) was increased: The minimum wage went up from BGN 180 to BGN 220 in 2008, then to BGN 240 in 2009, BGN 270 in 2012, BGN 310 in 2013, BGN 340 in 2014, respectively, and reaching BGN 360 in 2015. That is, a minimum-wage worker in 2008 was going to pay at least 20% (22% for the minimum-wage worker in 2009) marginal tax rate had the progressive system not been abolished. The end effect of Bulgaria's 2008 flat tax reform represented a considerable cut in the marginal tax rate on personal income,

Table 1: Progressive Income Taxation in Bulgaria until 2007

Annual taxable income (in BGN)	Tax owed
0-2400	Zero-bracket amount
2400-3000	20% on the amount earned above BGN 2400
3000-7200	BGN 120 + 22% on the excess over BGN 3000
> 7200	BGN 1044 + 24% on the excess over BGN 7200
Monthly taxable income (in BGN)	Tax owed
0-200	Zero-bracket amount
200-250	20% on the amount earned above BGN 200
250-600	BGN 10 + 22% on the excess over BGN 250
> 600	BGN 87 + 24% on the excess over BGN 600

*Source: Petkova (2012), author's calculations*

as compared to the earlier regime. In addition to the progressive scale removal, both the existing tax incentives and most of the tax deductions were repealed.

Furthermore, as seen from Table 2 below (data from 2012 was only available in preliminary form, and is thus not reported), the relative importance of personal income tax revenue has increased, both in terms of share of total tax revenue collected and relative to the size of the economy. In addition, the relative share of the revenues from taxed personal income as a share in output has been relatively stable. According to Petkova (2012), the absence of any increase in that component might be due to the financial crisis that unravelled in 2008. The theoretical setup utilized in this paper will be consistent with data along this dimension and feature fixed ratio of tax revenues to output along the balanced growth path.

Table 2: Revenue from personal income taxation

Fiscal year	2007	2008	2009	2010	2011
% of tax revenue	9.40%	8.90%	10.20%	10.70%	10.60%
% of GDP	3.00%	2.90%	3.00%	2.90%	2.90%

*Source: Petkova (2012)*

Next, in Table 3 below, a breakdown of personal income tax revenue is provided. The share of labor income from the personal income tax is the largest (81%) component of personal income tax receipts, and has increases substantially over this short period: 10.97% growth in 2008, 8.41% in 2009, 0.30% in 2010, and 4.43% in 2011. The second component, personal income tax revenue from business activities (14%), is decreasing over the period, which reflects the financial crisis, but then rebounds in 2011.<sup>4</sup>

Table 3: Composition of Personal Income Tax Receipts

Fiscal year	2007	2008	2009	2010	2011
Labor income	77.56%	78.96%	82.30%	83.41%	81.15%
Business activities (sole proprietors, etc.)	16.80%	15.47%	12.19%	10.64%	12.57%
Lump-sum tax	2.00%	1.52%	1.02%	0.94%	0.78%
One-off tax	3.65%	4.06%	4.49%	5.02%	5.50%

*Source: Petkova (2012)*

After presenting the public finance effect of flat income tax rate, the paper will utilize a carefully calibrated general-equilibrium model to match Bulgaria's post-communist behavior will demonstrate that progressive taxation creates a bigger burden by decreasing the return to capital and labor, and thus lowering the steady-state growth, significantly more so than the corresponding average effective tax rate under flat income taxation. Thus, substantial growth benefits can be realized from the switch to flat income taxation.

## 3 Model Setup

### 3.1 Description of the model:

There is a representative household, as well as a representative firm. The household owns the physical capital and labor, which it supplies to the firm. The perfectly-competitive firm produces output using labor and capital. The government uses tax revenues from labor and capital income to finance government consumption. As in Azacis and Gillman (2010), the theoretical setup will be constrained to the closed-economy case.<sup>5</sup>



### 3.2 Representative Household

There is an infinitely-lived representative household in the model economy, and no population growth. Total time available to the household is normalized to unity. The household maximizes the following utility function

$$\sum_{t=0}^{\infty} \beta^t \ln(c_t), \quad (1)$$

where  $c_t$  is consumption at time  $t$ , and the household does not value leisure. The parameter  $\beta$  is the discount factor, with  $0 < \beta < 1$ . The instantaneous utility function is increasing and concave in consumption, and satisfies the Inada conditions. Next, the household has an endowment of one unit of time in each period  $t$ , which is supplied inelastically to labor services in all periods, *i.e.*,  $h_t = 1, \forall t$ . The hourly wage rate is  $w_t$ . However, the wage is paid per efficiency unit of labor, *i.e.*, per hour weighted by the skill  $s_t$  embodied in the labor,  $e_t = s_t h_t$ . The skill level will be treated as a stock of human capital, which can be augmented by investing  $i_t^s$  in education. The law of motion for skill accumulation is

$$s_{t+1} = i_t^s + (1 - \delta^s) s_t, \quad (2)$$

where  $0 < \delta^s < 1$  is the depreciation rate on capital.

The representative household saves by investing in physical capital,  $i_t^k$ .<sup>6</sup> As an owner of capital, the household receives interest income  $r_t k_t$  from renting the capital to the firms;  $r_t$  is the return to private capital, and  $k_t$  denotes physical capital stock in the beginning of period  $t$ .

Household's physical capital evolves according to the following law of motion:

$$k_{t+1} = i_t^k + (1 - \delta^k) k_t, \quad (3)$$

where  $0 < \delta^k < 1$  is the depreciation rate on capital.

Finally, the household owns all firms in the economy, and receives all profit ( $\pi_t$ ) in the form of dividends. The household's budget constraint is

$$c_t + i_t^k + i_t^s \leq (1 - \tau_t)[r_t k_t + w_t s_t h_t] + \pi_t, \quad (4)$$

where as in Guo and Lansing (1998),

$$\tau_t = \eta \left( \frac{y_t}{y} \right)^\phi \quad (5)$$

denotes the tax rate on total (capital and labor) income, *i.e.*,  $y_t = r_t k_t + w_t s_t h_t$ , and  $y$  is the steady-state level of household's income. In addition,  $0 < \eta < 1$  and  $0 \leq \phi < 1$ , where  $\phi$  measures the progressivity of the tax system, and  $\eta$  is the average effective tax rate in steady state.<sup>7</sup>

The representative household acts competitively by taking prices  $\{w_t, r_t\}_{t=0}^\infty$ , the tax schedule  $\{\tau_t\}_{t=0}^\infty$  as given, and chooses allocations  $\{c_t, i_t^k, i_t^s, k_{t+1}, s_{t+1}, h_t\}_{t=0}^\infty$  to maximize Eq. (1) s.t. Eqs. (2)-(5), and initial conditions for physical and human capital stocks  $\{k_0, s_0\}$ .<sup>8</sup>

The optimality conditions from the household's problem, together with the transversality conditions (TVC) for physical and human capital are as follows:<sup>9</sup>

$$c_t : c_t^{-1} = \lambda_t \quad (6)$$

$$k_{t+1} : \lambda_t = \beta \lambda_{t+1} \left[ 1 - \delta + \left( 1 - (1 + \phi) \tau_{t+1} \right) r_{t+1} \right] \quad (7)$$

$$s_{t+1} : \lambda_t = \beta \lambda_{t+1} \left[ 1 - \delta^s + \left( 1 - (1 + \phi) \tau_{t+1} \right) w_{t+1} h_{t+1} \right] \quad (8)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t c_t^{-1} k_{t+1} = 0 \quad (9)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t c_t^{-1} s_{t+1} = 0, \quad (10)$$

where  $\lambda_t$  is the Lagrangian multiplier on the household's budget constraint. The household equates marginal utility from consumption with the marginal cost imposed on its budget. Next, the Euler equation describes the optimal physical capital accumulation rule, and implicitly characterizes the optimal consumption allocations chosen in any two contiguous periods. Skill level<sup>10</sup> is then chosen so that at the margin the investment cost in education is equal to the benefit of doing so, measured in terms of extra labor income in the next period. As seen from the first-order conditions, the presence of progressive taxation ( $\phi > 0$ ) additionally decreases the after-tax return to physical and human capital through the  $(1 + \phi)$  inflating factor that appears in Eqs. (7)-(8).<sup>11</sup> The last two expression, Eqs. (9)-(10), are the so-called "transversality conditions", imposed to ensure that the value of the physical

and human capital stocks that remain at the end of the optimization horizon, is zero. Those two boundary conditions guarantee that the model equilibrium is well-defined by ruling out explosive solution paths.

### 3.3 Stand-in Firm

There is also a representative private firm in the model economy. It produces a homogeneous final product using a production function that requires physical capital  $k_t$  and efficiency units of labor  $e_t = s_t h_t$ . Note that the firm cannot choose skill level and labor hours separately respectively. The production function is as follow

$$y_t = Ak_t^\theta e_t^{1-\theta} (g_t^c)^\epsilon, \quad (11)$$

where  $A$  measures the level of total factor productivity,  $0 < \theta < 1$  denotes the productivity of physical capital ( $1 - \theta$  denotes the productivity of efficiency labor). Following Barro (1990),  $0 < \epsilon < 1$  is the degree of complementarity from the presence of government consumption as an extra input in the production function of the final good.

The representative firm acts competitively by taking prices  $\{w_t, r_t\}_{t=0}^\infty$ , income tax rate  $\tau$ , policy variable  $\{g_t^c\}_{t=0}^\infty$  as given, and chooses  $k_t, e_t, \forall t$  to maximize firm's static profit:

$$\pi_t = Ak_t^\theta e_t^{1-\theta} (g_t^c)^\epsilon - r_t k_t - w_t e_t. \quad (12)$$

In equilibrium profit is zero. In addition, efficiency labor and capital receive their marginal products, *i.e.*

$$r_t = \theta \frac{y_t}{k_t}, \quad (13)$$

$$w_t = (1 - \theta) \frac{y_t}{e_t}. \quad (14)$$

### 3.4 Government

The government collects tax revenue from efficiency labor and capital income to finance (productive) government consumption, which is used as an input in the firm's production function.<sup>12</sup> The government budget constraint is then

$$\tau_t [r_t k_t + w_t e_t] = g_t^c. \quad (15)$$

Government takes prices  $\{w_t, r_t\}_{t=0}^{\infty}$  and allocations  $\{k_t, e_t\}_{t=0}^{\infty}$  as given. Government consumption  $\{g_t^c\}_{t=0}^{\infty}$  will be residually determined: it will adjust to ensure the government budget constraint is balanced in every time period.

### 3.5 Decentralized Equilibrium and Balanced Growth Path

Given the initial conditions for the state variables  $k_0, s_0$ , a Decentralized Competitive Equilibrium (DCE) is defined to be a sequence of prices  $\{r_t, w_t\}_{t=0}^{\infty}$ , allocations  $\{c_t, i_t^k, i_t^s, k_{t+1}, s_{t+1}, h_t, g_t^c\}_{t=0}^{\infty}$ , income tax rate  $\{\tau_t\}_{t=0}^{\infty}$  such that (i) the representative household maximizes utility; (ii) the stand-in firm maximizes profit every period; (iii) government budget is balanced in each time period; (iv) all markets clear.

Given the initial conditions for the state variables  $k_0, s_0$ , a balanced growth path (BGP) is a set of sequences of prices  $\{r_t, w_t\}_{t=0}^{\infty}$ , allocations  $\{c_t, i_t^k, i_t^s, k_{t+1}, s_{t+1}, h_t, g_t^c\}_{t=0}^{\infty}$ , and income tax rate  $\{\tau_t\}_{t=0}^{\infty}$  satisfying the Decentralized Competitive Equilibrium definition such that the paths  $\{c_t, i_t^k, i_t^s, k_{t+1}, s_{t+1}, g_t^c\}_{t=0}^{\infty}$  grow at the same rate  $\gamma$ ,  $\{h_t\}_{t=0}^{\infty}$  and prices  $\{r_t, w_t\}_{t=0}^{\infty}$  remain constant, and the output-physical capital and output-human capital ratio is constant.

## 4 Data and model calibration

The model is calibrated to Bulgarian data at annual frequency. The period under investigation is 1993-2012, and the 1993-2007 sub-period is the time when taxation was progressive. Starting from 2008, a flat income tax rate of 10 % for both labor and capital income was introduced. Both the data set and steady-state DCE relationships of the models will be used to set the parameter values, in order to replicate relevant long-run moments of the reference economy for the question investigated in this paper. Data on the household consumption and private fixed investment shares in output were obtained from the World Bank World Development Indicators (WDI) Database (2014). Private expenditure on human capital as a share of output, as well as government transfers as a share of output were then computed using data from the National Statistical Institute (NSI). Finally, the long-term interest rate (LTIR) was obtained from Bulgarian National Bank (BNB) Statistics.

Following a standard approach in quantitative macroeconomics, the discount factor was ob-

tained as  $\beta = \frac{1}{1+\text{mean}(LTIR)} = 0.968$ , which is a standard value in the literature. Next, following Ganev (2005), capital income share is set to its average value  $\theta = 0.429$ , and the labor income share is  $1 - \theta = 0.561$ . As in Aschauer (1989),  $\epsilon = 0.176$  was set equal to the average share of government consumption in output over the 1993-2007 period. Without any loss of generality, the level of total factor productivity can be normalized to unity,  $A = 1$ . This parameter has only a level effect in the model, and no effect on the balanced growth path.

Next, using Ganev's (2005) estimate that  $k/y = 3.491$ , and WDI's data on mean  $i^k/y = 0.165$ , we can obtain the depreciation rate on physical capital,  $\delta^k = 0.047$ , from the  $\frac{i^k}{y} = \frac{\delta^k k}{y}$  identity. Similar values have been reported for the other EU member states in Goertzig (2007). Using NSI data on the total expenditure on education as a proxy for investment in skills, we obtain that the share of human capital in output is  $i^s/y = 0.048$ . Given that  $i^s = \delta^s s$ , we can express  $s/y$  in terms of  $s$  and obtain steady-state human capital stock from the BGP using physical capital. That procedure produces  $s/y = 7.61$  and  $\delta^s = 0.006$ . This value is close to the one used in Mulligan and Sala-i-Martin (1993),  $\delta^s = 0.01$ . Thus, the depreciation rate on human capital is much smaller than the corresponding rate on physical capital.

Following Conesa, Kehoe and Ruhl (2007),  $\eta = 0.14$  for the progressive tax, and  $\eta = 0.11$  for the flat tax. More precisely, the average effective tax rate is approximated by the average amount of tax actually paid, divided by total income. Next, the (gross) degree of progressivity,  $1 + \phi$ , was computed as the ratio of the marginal to the average tax rate. For the three tax brackets, we obtained  $\phi = 0.43, 0.57, 0.70$  respectively. (In the flat tax regime,  $\phi = 0$  for all income levels.) Due to data limitation on the distribution of income levels, we will make the conservative assumption that the lower bound  $\phi = 0.43$  is a reasonable value for the progressivity parameter. In other words, instead of reporting their full income, workers in the higher brackets reported earnings in the lowest bracket and pocketed the rest. In Section 8, we perform robustness checks, where we allow  $\phi$  to vary. Table 4 below summarizes the values of all model parameters used:

Table 4: Model Parameters

Param.	Value	Definition	Source
$\beta$	0.968	Discount factor	Calibrated
$\theta$	0.429	Capital income share	Data Average
$\epsilon$	0.176	Degree of complementarity	Data Average
$\delta^k$	0.047	Depreciation rate of physical capital	Calibrated
$\delta^s$	0.006	Depreciation rate of human capital	Calibrated
$\eta$	{0.11; 0.14}	Average effective income tax rate (flat/progressive)	Data average
$\phi$	{0; 0.43}	Average tax progressivity (flat/progressive)	Data average
$A$	1.000	Steady-state level of total factor productivity	Calibrated

## 5 Steady-State

Once model parameters were obtained, the steady-state ratios for the model calibrated to Bulgarian data were obtained. The results are reported in Table 5 below.

Table 5: Data Averages and Long-run solution

	Description	BG Data	Model (prog.)	Model (flat)
$c/y$	Consumption-to-output ratio	0.672	0.647	0.677
$i^k/y$	Fixed investment-to-output ratio	0.165	0.165	0.165
$i^s/y$	Human capital investment-to-output ratio	0.048	0.048	0.048
$g^c/y$	Gov't cons-to-output ratio	0.176	0.140	0.110
$k/y$	Physical capital-to-output ratio	3.491	3.491	3.491
$s/y$	Human capital-to-output ratio	N/A	7.610	7.610
$wh/y$	Labor share in output	0.571	0.571	0.571
$rk/y$	Capital share in output	0.429	0.429	0.429
$\tilde{r}$	After-tax net return to physical capital	0.040	0.051	0.062

By construction, the model featuring a balanced growth path will be set to match the investment shares, and capital to output ratios. In addition, government consumption ratio is also quite well-captured from the simple government budget constraint: Since  $r_t k_t + w_t s_t h_t =$

$y_t$ , it follows from the balanced government budget that  $g^c/y = \tau$ , which is consistent with data. Thus, under the flat tax regime, government spending share is lower, hence consumption share is slightly higher as compared to the progressive taxation case. Lastly, the parsimonious model does a relatively good job at matching the after tax net return to capital, which is given by  $\tilde{r} = [1 - (1 + \phi)\tau]r - \delta^k$ .

## 6 Solving for the balanced growth path

After carefully calibrating the model parameters and the steady-state, the long-run growth rate can be obtained as follows:

$$\frac{c_t}{c_{t-1}} = \beta \left[ 1 - \delta^k + \left( 1 - (1 + \phi)\tau_t \right) \theta \frac{y_t}{k_t} \right] \quad (16)$$

The balanced growth path rate is positively related to the discount factor ( $\beta$ ), capital share parameter ( $\theta$ ), and negatively related to the depreciation rate ( $\delta^k$ ), capital-to-output ratio ( $k/y$ ), degree of tax progressivity ( $\phi$ ) and the average effective income tax rate ( $\tau$ ). In addition, both growth rates,  $\gamma^{PROG} = 1.81\%$ , and  $\gamma^{FLAT} = 2.89\%$ , are consistent with a finite utility.<sup>13</sup> Using the WDI (2014) data, the growth rate over 1993-2007, which is a period of progressive taxation, is 1.58%. This dimension of data is relatively well-captured by the model.<sup>14</sup> Table 6 below summarizes the observed and predicted average growth rates, both before and after the adoption of the flat income tax rate.

Table 6: Long-run growth (1993-2007)

Description	BG Data	Model (prog.)
$\gamma_y$ Avg. growth in output per capita	0.0158	0.0181
$\gamma_c$ Avg. growth in consumption per capita	0.0184	0.0181
$\gamma_i$ Avg. growth in investment per capita	0.0716	0.0181

The difference between the empirical and theoretical growth rate in output and investment during the 1993-2007 period can be rationalized with some tiny changes in two of the model parameters: If, instead of the benchmark value of the discount factor ( $\beta = 0.968$ ),  $\beta = 0.96$  is used, the model will generate growth of 1.5%. This value (see Table 7 on the next page)

is now very close to both the average output and consumption growth rates. On the other hand, when the depreciation rate of physical capital is rounded off to  $\delta^k = 0.05$  (as in Ganev 2005, instead of the  $\delta^k = 0.047$  value used in the benchmark calibration), growth will be brought further down to 1.47%, and away from the target. Therefore, the discrepancy seems to be due to the noise in the calibrated parameters (since we use the average value of data series and disregard the standard error) due to the short and volatile time period.

Table 7: Long-run growth (1993-2007): robustness checks

Description	BG Data	Model	Model	Model
		(benchmark)		
		$\beta = 0.968$	$\beta = 0.965$	$\beta = 0.968$
		$\delta^k = 0.047$	$\delta^k = 0.047$	$\delta^k = 0.05$
$\gamma_y$ Avg. growth in output per capita	0.0158	0.0181	0.0150	0.0147
$\gamma_c$ Avg. growth in cons. per capita	0.0184	0.0181	0.0150	0.0147
$\gamma_i$ Avg. growth in inv. per capita	0.0716	0.0181	0.0150	0.0147

In addition, during the 1993-2007 period, the average private consumption growth rate is 1.84%, which is very close to the estimated balanced growth path. Lastly, investment (private gross fixed capital formation) is growing on average by 7.16% during the period, and the model significantly underestimates it. This can be attributed to the responsiveness of investment and the volatile time period studied. In addition, over the period 1993-2007, the share of government spending in output has been steadily decreasing as well.

Yet another reason for the different rate of growth of investment might be due to the presence of investment-specific technological progress (as in Greenwood, Hercowitz and Huffman 1992), which would affect the investment function and produce unbalanced growth.<sup>15</sup> It is quite plausible that starting in the early 1990s, firms began investing in new capital (with modern technology embodied in the new machines), which was an crucial requirement for competitiveness in the market environment. Still, the results obtained in Table 7 above is great news for the parsimonious endogenous growth model with human capital in this paper, as the setup with the progressive tax schedule turns out to produce a very good approximation to the actual behavior of the Bulgarian economy during that period. In turn,



introducing flat income taxation into the representative household model is straightforward, and thus requires no additional modelling justification.

Table 8 below documents once more the stark contrast with the predicted long-run growth rates under a no reform scenario, and the one with the flat tax reform. The results from the calibration exercise suggest that, *ceteris paribus*, the adoption of proportional taxation would generate an extra percentage point in average economic growth in Bulgaria after 2008. However, one important caveat of the analysis is that the second period, 2008-2013,

Table 8: Predicted average growth rate (2008-2013) with and without tax reform

Description	Progressive taxation (no reform)	Flat-tax reform
$\gamma_y$ Avg. growth in output per capita	0.0181	0.0289
$\gamma_c$ Avg. growth in consumption per capita	0.0181	0.0289
$\gamma_i$ Avg. growth in investment per capita	0.0181	0.0289

is too short and coincides with the financial crisis and its aftermath. This significant and largely unexpected negative shock has had a major effect on the forecasting ability of the model and its failure to match the average growth rate of both consumption and output growth rate. However, from a modelling perspective, the introduction of flat income tax poses no theoretical issues for the model in this paper. Furthermore, the obtained good fit by the parsimonious model will allow us to evaluate the effect of the implementation of just the change in taxation, while keeping the values of all model parameters constant. In the next section, the model will be used to quantify the welfare gain from switching from progressive to flat income taxation in a computational experiment.

## 7 Welfare analysis

We will now consider a hypothetical scenario in which Bulgaria starts in 2008 but did not adopt flat income tax rate (the counterfactual scenario). To this thought experiment, we will contrast the observed scenario with flat income taxation since 2008. This would allow us to evaluate the effect of the difference in taxation, holding everything else in the model unchanged. Parameter  $\lambda$  will be used to denote the percentage by which balanced-growth-path

consumption under progressive income taxation needs to be increased every period along the transition path, to make the household as well off as under the flat tax regime.<sup>16</sup> Alternatively, we would like to compute by how much the indifference curve needs to be shifted to make the consumer indifferent between the two consumption sequences.<sup>17</sup> Thus, such consumption-based measure is the theoretically-correct approach to be taken when comparing welfare across two regimes.

As in Lucas (1990), welfare will be compared under both progressive and flat income taxation. The initial time horizon used to evaluate the welfare effects of flat-tax rate policy will be 6 periods, which would correspond to the period 2008-2013, and no financial crisis. The resulting compensatory variation is  $\lambda = 0.0356$  (see Table 9 below). This means that the household realizes a by 3.56% consumption gain in every period by switching to the equilibrium featuring flat income taxation. Our predicted gain seems to be in the plausible range obtained in previous studies on the Baltics: Azacis and Gillman (2010) find similar welfare gains 2.2 – 3% for the case of the flat tax reform in the Baltic countries during 2000-07. Funke and Strulik (2006) find much smaller welfare gains using an exogenous growth model to study the effect of the Estonian 2000 income tax act.

Table 9: Welfare effect from flat tax adoption

Optimization horizon (years)	6	20	50
Compensatory variation (%)	3.56	10.11	21.54

Next, we extend the horizon to 20 years to obtain a 10.11% consumption gain per period by switching to the equilibrium featuring flat income taxation. Similarly, if the horizon is further extended to 50 periods, due to a compounding effect, the welfare gain will be even higher. In that case, as seen in Table 9,  $\lambda = 0.2154$ , or a 21.54% increase in consumption is required in every period to make the household under the progressive tax regime as well-off as under the flat income taxation.

Now we perform a series of robustness checks to demonstrate that the model predictions do not change qualitatively when we vary some of parameter values. In Table 10 below we summarize the compensatory variation figures when the tax progressivity parameter from higher income bracket is used. As seen from the table, higher tax progressivity generates a larger welfare gain when proportional taxation is adopted, ranging between 0.6 – 10.34

percentage points depending on the level of progressivity and the time horizon considered.

Table 10: Welfare effect as a function of tax progressivity

Optimization horizon (years)	6	20	50
Compensatory variation (%) with $\phi = 0.43$	3.56	10.11	21.54
Compensatory variation (%) with $\phi = 0.57$	4.24	12.34	26.57
Compensatory variation (%) with $\phi = 0.70$	4.99	14.61	31.80

The final robustness check performed in the model framework was to take the top marginal tax rate (22%) under the progressive regime as a better determinant for investment and use it instead of the effective rate when computing the compensatory variation. Results are reported in Table 11 below:

Table 11: Welfare effect with  $\tau^{PR} = 0.24$  (top marginal tax rate)

Optimization horizon (years)	6	20	50
Compensatory variation - benchmark case (%)	3.56	10.11	21.54
Compensatory variation - top marginal tax rate (%)	9.30	28.28	65.59

As expected, the gain is significantly larger in this case; it is almost triple relatively to the benchmark computation, as the top marginal tax rate used in this exercise creates a much larger distortion in the Euler equations for physical and human capital stocks. This results in a lower after-tax return to both factors of production and slows down the rate at which they are accumulated. Thus, in the absence of reforms and under the extreme assumption that the top marginal tax rate is the most important driving force for investment decisions, average growth shrinks to a mere 0.11%.

## 8 Conclusions

This paper was a first attempt to provide a quantitative evaluation of welfare gains from the introduction of flat income taxation in Bulgaria in 2008. Using a calibrated micro-founded endogenous growth model with physical and human capital accumulation to Bulgarian data,

a computational experiment was performed to quantify the dynamic welfare effect of progressive income taxation vis-a-vis flat income taxation in a closed-economy context. The model demonstrated that significant welfare gains, measured in terms of per-period consumption, could be realized with the introduction of flat income taxation. In addition, these welfare gains increased proportionally with the length of the time horizon considered. Finally, sensitivity analysis was performed to demonstrate that the results obtained are robust.

The limitations of the study should also be properly acknowledged: First, the model is too simple to capture all aspects of reality. As a task left for future work, the simple model could be easily extended to incorporate different tax rates on capital and labor. As in Stokey and Rebelo (1995), this would allow to analyze the quantitative impact of different tax rates on the long-run rate of growth, conditional on the type of income the household receives. Another limitation was that the representative-agent framework says little about distributional effects of taxation and ignores possible effect on inequality. For distributional aspects of the tax reform, Ventura (1999) studies the issue in a calibrated dynamic stochastic general equilibrium model with heterogeneous agents. However, extensions of the model along those lines are left for future research.

## Notes

<sup>1</sup>Even though a flat corporate tax rate of 10 % (and a 5% dividend/capital gains tax) was introduced in 2007, the flat tax rate of 10 % on household's income was introduced in 2008.

<sup>2</sup>Countries that have adopted flat tax rates are Abkhazia, Anguilla, Belize, Belarus, Bolivia, Bosnia and Herzegovina, East Timor, Estonia, FYROM (Former Yugoslav Republic of Macedonia), Greenland, Grenada, Guernsey, Guyana, Hungary, Jamaica, Jersey, Kyrgyzstan, Kuwait, Kazakhstan, Latvia, Lithuania, Madagascar, Mauritius, Mongolia, Nagorno-Karabakh, Poland, Romania, Russia, Saint Helena, Saudi Arabia, Serbia, Seychelles, South Osetia, Transnistria, Trinidad and Tobago, Turkmenistan, Tuvalu, Ukraine.

<sup>3</sup>Shutting this channel would be achieved by setting up the framework in a way that would produce zero economic profit in equilibrium.

<sup>4</sup>Lump-sum taxes include fines, legal fees, and other administrative charges that might be tied to the level of the minimum wage. One-off taxes include taxes on bequests, etc. Those two groups are not quantitatively important as they are jointly responsible for 5.6-5.8% of personal income tax revenue, or only 0.6% of total tax revenue.

<sup>5</sup>In addition to the tax rate affecting the growth rate, welfare calculations in a closed-economy framework include that effect on the growth rate. Furthermore, the analysis of tax effects in a closed-economy context

should be regarded as a first approximation, as in Funke and Strulik (2006).

<sup>6</sup>For simplicity, we shall assume that in this economy there are no financial assets and the public sector cannot issue debt.

<sup>7</sup>Notice that when  $\phi = 0$ ,  $\tau_t = \eta$ , *i.e.*, the tax rate is constant ("flat tax"), while  $\phi > 0$  produces a tax rate that rises with total income ("progressive tax"). In addition, under progressive taxation the marginal tax rate is higher than the average tax rate.

<sup>8</sup>Even though technically physical and human capital stocks are state variables, and investment in physical and human capital are controls, by choosing how much to invest in the current period, the household indirectly "chooses" next period capital.

<sup>9</sup>Readers interested in a deeper mathematical presentation and a rigorous proof of the respective necessary conditions derived should consult the abstract setup presented in Blot and Chebbi (2000).

<sup>10</sup>Throughout the paper "skill level" and "human capital stock" will be used interchangeably.

<sup>11</sup>This factor shows up due to the fact that the marginal tax rate is higher than the average tax rate under progressive taxation.

<sup>12</sup>We will abstract away from consumption tax revenue, and government transfers. This is not that of a restrictive assumption, as in data the two categories tend to cancel each other.

<sup>13</sup>The assumption of a finite total utility is important for the evaluation of the welfare effect of the two tax regimes.

<sup>14</sup>This particular period was chosen since there was little market reform in the period 1990-1991, and it was already 1992 when the first reforms started to give results. Thus, the initial years can be regarded as significant deviation from equilibrium behavior, or a period of transition to the balanced growth path, and thus can be discarded.

<sup>15</sup>Such an extension is straightforward to implement in the theoretical model. Unfortunately, due to data limitations, it is not possible to separate capital stock and labor services used in the consumption sector from the ones utilized in the investment sector. Nevertheless, the performance of the very simple model in this paper is quite impressive.

<sup>16</sup>This consumption-based welfare measure is not to be mistaken with the Lagrangian multiplier of the household budget constraint in the household's maximization problem.

<sup>17</sup>The value of  $\lambda$  is independent of any monotone (multiplicative and/or additive) transformations applied to the utility function.

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