Optimal fiscal policy in a model with efficiency wages: the case of Bulgaria

Aleksandar Vasilev*

September 25, 2022

Abstract

Design/Methodology Approach: A dynamic general-equilibrium model with government sector is calibrated to Bulgarian data (1999-2018). Two regimes are compared and contrasted - the exogenous (observed) vs. optimal policy (Ramsey) case.

Purpose: This paper explores the effects of fiscal policy in an economy with efficiency wages, consumption taxes, and a common income tax rate.

Findings: The main findings are: (i) The optimal steady-state income tax rate is zero; (ii) The benevolent Ramsey planner provides three times lower amount of the utility-enhancing public services; (iii) The optimal steady-state consumption tax needed to finance the optimal level of government spending is 18.7 %.

Originality/Value: 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. Bulgarian economy was chosen as a case study due to its major dependence on consumption taxation as a source of tax revenue.

Keywords: Ramsey policies, efficiency wages, unemployment, Bulgaria

JEL Classification Codes: E24, E32, J41

*Senior Lecturer, Lincoln International Business School, UK. E-mail for correspondence: AVasilev@lincoln.ac.uk.

1 Introduction and Motivation

Since the early 1990s, many macroeconomic studies have focused on the effects of observed fiscal policy in general equilibrium setups, and in particular comparing and contrasting it to a benchmark, or "optimal fiscal policy" regime, e.g. Chari, Christiano and Kehoe (1994, 1999), among many others.[1] The setup was then used to inform policymakers about the taxation and spending mix in public finances, and how it needs to be adjusted to improve efficiency in the economy. The main focus of those studies, mostly focused on the US, has been predominantly formulated as follows: "How to raise funds to finance a pre-determined level of government purchases (consumption) and/or government transfers via distortionary capital and labor taxes at the least possible cost?" Given the absence of a federal consumption tax in the US, the literature focused on capital and labor income taxation, and abstracted away from sales, or value-added, taxation (VAT). This differs from European countries where indirect taxes are very important instrument for raising tax revenue. Furthermore, there was also a recent move in Eastern Europe toward a common income tax rate, which was introduced in order to discourage individuals from income evasion by shifting income between labor and capital categories in order to minimize the overall tax burden.

Bulgaria, a small Eastern European economy, and a EU member-state as of 2007, adopted a public finance model that emphasized consumption-based taxation, with a non-differentiated rate, and a common income tax rate. As pointed in Vasilev (2018), VAT revenue is the major source of tax revenue in Bulgaria, responsible for almost half of the total tax revenue raised.[2]

[1] For other studies on Bulgaria, see Can and Korkmaz (2020). For the labor markets structure, as well as on optimal fiscal policy setups on Bulgaria, see Vasilev (2021), Vasilev (2020a, 2020b, 2020c, 2020d), Manolova and Vasilev (2019), Vasilev (2019), Vasilev (2018a, 2018b). For a review of optimal fiscal policy setups in general, the reader is referred to Werning (2007), Schmitt-Grohe and Uribe (2007), as well as to the references therein. Lastly, a very recent study Debortoli et al. (2021) covers the case without commitment, which is outside the scope of the current paper.

[2] The other major source of revenue, making around a third of total tax revenues, are social contributions made by both employers and employees. Compared to consumption-based taxation, which is a tax on demand, income taxation in Bulgaria is of much smaller importance for the budget: for example, over the period 2007- 2014, taxation of both individuals and corporations constitutes around 10 % of overall tax revenue each

In addition, as of 2008 both capital and labor income, as well as corporate profits are taxed at the common rate of 10 %. Therefore, in addition to deciding on the optimal level of public spending, a fiscal authority in the Bulgarian (and also EU-) context is choosing a different set of tax rates - a common income tax rate, and a tax rate on consumption. The computational experiment in this paper could be thus of interest to other Eastern European, and developing countries as well, and to the fiscal policy makers in particular, by suggesting some simple and implementable fiscal rules to be adopted and followed.

Furthermore, Bulgaria, as many other Eastern European countries as well, exhibits a significant rate of involuntary unemployment, which was due to the process of structural transformation. In other words, being out of job is not an optimal choice, but rather represents an inefficient outcome, as it produces a waste of non-storable labor resources. In particular, one aspect of labor market frictions are informational problems, connected to costly monitoring or imperfect verification of worker's effort by an employer. In the absence of perfect information, some workers may decide to shirk, and will be caught with some probability. To prevent shirking from happening, employers offer an incentive-, or "efficiency wage", which, together with a certain probability of being caught shirking, would discourage opportunistic behavior.[3] More specifically, in this paper we follow Alexopoulos (2003), who incorporates Shapiro and Stiglitz (1984) mechanism into a general-equilibrium setup.[4] As we will demonstrate in this paper, the departure from perfect competition, and the use of efficiency wages in particular, could potentially capture an important propagation mechanism, which not only could help us understand labor markets in Bulgaria, but could be also important aspect of reality that should be taken into consideration when designing different policies.

We then proceed to characterize optimal (Ramsey) fiscal policy in the context of the problem described above,[5] and then to evaluate it relative to the exogenous (observed) fiscal policy

[3]Another possible approach, as demonstrated in Vasilev (2020a), and Vasilev (2021a), is to model the labor market dynamics via a two-sided search and matching setup.

[4]However, the very introduction of efficiency wages creates a pool of involuntary unemployed, as there will be labor rationing in equilibrium. Similar results are documented in Vasilev (2020b), who utilises the notion of "fair" wages to model the Bulgarian economy.

[5]The new labor market structure is one of the novelty elements, which adds contribution to the results. In addition, we perform explicit aggregation from micro-foundations to obtain aggregate labor market dynamics.

regime. The novelty is that the public finance problem with efficiency wages is substantially different from the standard one with perfectly-competitive labor markets, as described in Chari, Christiano and Kehoe (1994, 1999). Still, similar to earlier literature, e.g. Judd (1985), Chamley (1986), and Zhu (1992), allowing for distortionary taxation in a dynamic general-equilibrium framework creates interesting trade-offs: On the one hand, valuable government services directly increase household's utility. On the other, the proportional income taxes will negatively affect the incentives to supply labor and to accumulate physical capital. The presence of informational frictions creates interesting interactions, as shirking now will respond to the after-tax efficiency wage. In turn, higher taxes reduce not only income, but also consumption, which is actually hit twice due to a second round of taxation, this time at the point of consumption. Both types of taxes lower welfare, both directly, and indirectly, by generating less tax revenue which could be spent on valuable public services. The optimal fiscal policy problem discussed in this paper is to choose consumption and a common income tax rate to finance both utility-enhancing and redistributive government expenditure, while at the same time minimizing both the allocative distortions created in the economy, as a result of the presence of proportional taxation.

This paper thus explores the effects of fiscal policy in an economy with efficiency wages, with indirect (consumption) taxes, and all (labor and capital) income being taxed at the same rate. To this end, a dynamic general-equilibrium model with a government sector is calibrated to Bulgarian data (1999-2018). Two regimes are compared and contrasted - the exogenous (observed) vs. optimal policy (Ramsey) case. 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. Bulgarian economy was chosen as a case study due to its major dependence on consumption taxation as a source of tax revenue. The main findings from the computational experiments performed in the paper are: (i) The optimal steady-state income tax rate is zero; (ii) The benevolent Ramsey planner provides the optimal amount of the utility-enhancing public services, which are now three times lower; (iii) The optimal steady-state consumption tax needed to finance the optimal level of government spending is 18.7%, slightly lower than the rate in the exogenous policy case. The results are novel, as such an exercise has never been done before. In particular, the Judd-Chamley (1980) result for zero capital tax has been now extended to both types of income, due to the use of a common income tax rate. In addition, government spending is three times lower. Lastly, the quantitative effect is similar to that in Vasilev (2021a), which comes to show that capturing the non-clearing nature of the labor market in Bulgaria is important, and different modelling approaches are isomorphic to each other. In other words, the particular way of capturing the non-Walrasan nature of the labor markets in Bulgaria is of secondary importance; what is much more important, is to allow for the presence of frictions in the labor markets as a model ingredient in the first place.

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 setup

The structure of the model economy follows Vasilev (2017): There is a unit mass of households, as well as a representative firm. The households own the physical capital and labor, who are supplied to the firm. The firm produces output using labor and capital, but cannot observe the effort exerted by workers. The firm sets a reservation wage to induce an optimal level of effort. The government uses tax revenues from taxing consumption, as well as labor and capital income to finance utility-enhancing government consumption and the lump-sum government transfers.

2.1 Households

There is a unit mass of households in this economy, who own all the capital, and decide how many hours to work. Each household derives utility out of consumption and leisure

$$\sum_{t=0}^{\infty} \beta^t \Big\{ \ln c_t + \eta \ln(1 - e_t h) + \gamma \ln g_t^c \Big\}, \tag{1}$$

where $0 < \beta < 1$ is the discount factor, $\eta > 0$ is the weight attached to leisure, and γ is the weight attached to public services. Variable c_t denotes private consumption in period t, g_t^c denotes government services, h_t denotes hours worked in period t, and e_t is the amount of effort exerted. The time available to each worker is normalized to unity, and worker's effort will be imperfectly observable by firms.

Each household invests in physical capital to collect capital income $r_t k_t$. The law of motion for capital accumulation is

$$k_{t+1} = i_t + (1 - \delta)k_t, \tag{2}$$

where $0 < \delta < 1$ is the depreciation rate. Aggregate after-tax capital income, together with government transfers, g_t^t, is first pooled together (within the "family" of households), and then distributed equally among all households. In this way, households can partially insure one another against unfavorable outcomes in the labor market, *e.g.* not being selected for work. The common consumption can be represented as

$$c_t^h = (1 - \tau^y)r_t k_t + (1 - \delta)k_t - k_{t+1} + g_t^t, \tag{3}$$

where $0 < \tau^y < 1$ is the proportional income tax rate. The other type of income is the labor income, and households would differ in each period depending on their employment status.

From the perspective of firms, all individuals are identical, so employment outcome could be viewed as random, *i.e.* the firm will choose a certain share of households for work, and leave the rest unemployed. Since the level of effort is not directly observable by firms, some of the employed workers will work and exert the required effort level, e_t, stipulated in the contract, while others may decide to shirk. If caught, which happens with probability d due to the imperfect technology of detection, the individual is fired and receives a fraction $0 < s < 1$ of the wage.[6]

The labor contract that the firms then needs to offer provide is to be one that induces workers not to cheat in equilibrium. The contract would specify a wage rate, an effort level,

[6] As in Burnside at al. (2000), the household does not observe whether the others shirked, or were fired, only the initial employment status.

and an implementable rule that a worker caught cheating on the job will be fired and paid only a fraction s of the wage, $0 < s < 1$. All workers know this in advance, and take the terms of the contract and the labor demand as given. In general, the supply of labor will exceed labor demand, so in equilibrium there is going to be involuntary unemployment.

In addition, each employed transfers/contributes T_t units of income to the unemployment pool, where the proceeds are used to payout to the unemployed.[7] The level of transfers is such that individuals who are not selected for work by the firm are at least as well off as employed workers who are caught shirking. Labor income is also taxed at the constant proportional income tax rate of τ. The consumption of an employed worker who does not decide to shirk then equals:

$$c_t = c_t^h + (1 - \tau^y) w_t h_t - T_t, \tag{4}$$

where w_t is the hourly wage rate. Note that an employed worker who decided to shirk, but is not caught, obtains the same consumption as the conscientious worker, but a higher utility of leisure due to the zero effort exerted.[8]

In contrast, a worker who is employed, decides to cheat, and is caught, receives

$$c_t^s = c_t^h + (1 - \tau) s w_t h_t - T_t. \tag{5}$$

Alternatively, as proposed in Alexopoulos (2004), this is identical to a case where the firm pays $s w_t h_t$ upfront, and $(1 - s) w_t h_t$ at the end of the period, which is retained in case the worker is caught cheating.

Note that not everyone will be employed, thus the employment rate $n_t < 1$, and $0 < 1 - n_t < 1$ would denote the mass of unemployed. The consumption of unemployed individuals, c_t^u, is then

$$c_t^u = c_t^h + \frac{n_t}{1 - n_t} T_t, \tag{6}$$

[7] As in Alexopoulos (2004), results are not affected if instead of risk pooling at household level, the government runs an unemployment insurance scheme. In addition, in reality, private insurance does not compensate employees against the risk of being fired if caught shirking.

[8] Note that workers have no incentive to tell on each other, as there is no reward from doing so. In addition, there is a time cost from monitoring other workers.

where the transfer received by each unemployed equals $\frac{n_t}{1-n_t}T_t$.[9] Note that if a household is selected for work and rejects the job offer, there will be no unemployment insurance, or it would receive just the common consumption c_t^h. Therefore, no household selected for work would have an incentive to reject, so the participation constraint will be trivially satisfied.

Depending on whether a household is selected for work or not, the corresponding instantaneous utility levels are:

$$u(c^u, e^u = 0, h^u = 0) = \ln c^u + \eta \ln 1 = \ln c^u, \tag{7}$$

if unemployed,

$$u(c, e, h) = \ln c + \eta \ln(1 - eh), \tag{8}$$

if employed and the worker does not shirk,

$$u(c, e, h) = \ln c + \eta \ln(1) = \ln c, \tag{9}$$

if the person shirks, but is not caught, and

$$u(c^s, e^s = 0, h^s = 0) = \ln c^s + \eta \ln(1) = \ln c^s, \tag{10}$$

if the person shirks, and is caught.

Let n_t^s be the proportion of shirkers and given a detection probability d of a shirker being caught, this implies dn_t^s would be the proportion of shirkers being caught, and $(1-d)n_t^s$ are the shirkers not being caught. In turn, $n_t - n_t^s$ are the employed individuals who decide not to shirk.

Finally, note that the leisure (in efficiency units) of shirkers that are caught, and leisure enjoyed by unemployed individuals is the same. Thus, the lump-sum transfer should be chosen so that the consumption levels of the two groups is equalized, or

$$c_t^s = c_t^u \tag{11}$$

$$c_t^h + (1-\tau^y)sw_t h_t - T_t = c_t^h + \frac{n_t}{1-n_t}T_t. \tag{12}$$

[9]It is straightforward to reformulate the model so that a self-financing unemployment insurance program is provided by the government rather than the household. Therefore, this setup is very close to the one using unemployment lotteries in Rogerson (1988).

or

$$T_t \;=\; (1-n_t)(1-\tau^y)sw_th_t. \tag{13}$$

In this setup the aggregate household takes as given the effort level and wage rate $\{e_t, w_t\}_{t=0}^{\infty}$, which are specified in the contracts that the firm offers.[10] Thus, by taking initial condition for capital, k_0 as given, the household chooses $\{c_t^h, k_{t+1}\}_{t=0}^{\infty}$ to maximize (where we have already used the fact that $c_t^u = c_t^s$)

$$E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ (n_t - n_t^s)[\ln c_t + \eta \ln(1-e_th)] + n_t^s[(1-d)\ln c_t + d \ln c_t^s] + (1-n_t)\ln c_t^s + \gamma \ln g_t^c \Big\} \tag{14}$$

s.t

$$\begin{aligned} (1+\tau^c)[(n_t - dn_t^s)c_t + (dn_t^s + 1 - n_t)c_t^s] = \\ (1-\tau^y)r_tk_t + (1-\delta)k_t - k_{t+1} + g_t^t + (n_t - dn_t^s)(1-\tau^y)w_th_t + dn_t^s(1-\tau^y)sw_th_t, \end{aligned} \tag{15}$$

where τ^c is the consumption tax rate. The first-order conditions (FOCs) are as follows:

$$c_t^h \;:\; \frac{(n_t - dn_t^s)}{c_t} + \frac{(dn_t^s + 1 - n_t)}{c_t^s} = \lambda_t(1+\tau^c) \tag{16}$$

$$k_{t+1} \;:\; \lambda_t = \beta E_t \lambda_{t+1}[(1-\tau^y)r_{t+1} + 1 - \delta] \tag{17}$$

$$TVC \;:\; \lim_{t\to\infty} \beta^t \lambda_t k_{t+1} = 0, \tag{18}$$

where the last equation is the transversality condition (TVC); This is a boundary condition that needs to be imposed to rule out explosive solutions. The other optimality conditions are standard: the first equates the marginal utility of consumption to marginal cost of wealth. The second equation describes how physical capital should be allocated across time (the so-called "Euler equation").

2.2 Firm

There is a perfectly competitive representative firm that produces output via the following Cobb-Douglas production function

$$y_t = Ak_t^{\alpha}(n_the_t)^{1-\alpha}. \tag{19}$$

[10] This means that the household takes firm's labor demand as given, which would produce involuntary unemployment.

The firm chooses the employment rate, capital input, wage rate (and thus effort level) to maximize

$$Ak_t^{\alpha}(n_the_t)^{1-\alpha} - w_tn_th - r_tk_t \tag{20}$$

s.t. "no shirking condition" (the ICC):

$$\ln c_t + \eta\ln(1 - he_t) \geq (1-d)\ln c_t + d\ln c_t^s \tag{21}$$

or

$$d\ln c_t + \eta\ln(1 - he_t) \geq d\ln c_t^s \tag{22}$$

In equilibrium, the firm chooses the optimal quantities of capital and employment. In addition the firm offers an efficiency wage rate w_t to induce a certain optimal effort level, i.e. $e_t = e(w_t)$.[11]

$$k_t : r_t = \alpha\frac{y_t}{k_t}, \tag{23}$$

$$n_t : w_th = (1-\alpha)\frac{y_t}{n_t}. \tag{24}$$

$$w_t : n_th = (1-\alpha)\frac{y_t}{e_t}e'(w_t) \tag{25}$$

Dividing the FOC for employment and wages, we obtain the standard Solow (1979) condition

$$\frac{w_te'(w_t)}{e_t} = 1 \tag{26}$$

or

$$\frac{w_t}{e(w_t)} = (1-\alpha)\frac{y_t}{n_th}. \tag{27}$$

In other words, this is an equation that characterizes firm's labor demand. Note that the firm minimizes cost per efficiency unit here.[12] Firms want to hire labor as cheaply as possible, and $w/e(w)$ is the cost per unit of effective labor.

[11] As in Solow (1979), we assume that the wage rate is a function of effort.

[12] If the firm pays higher efficiency wages to induce more effort, that decreases labor demand (because of the wage premium incorporated in the efficiency wage) and produces involuntary unemployment. Also note that the firm adjusts the extensive margin (employment rates), while hours per person are not changing.

Next, for a given wage rate, the "no-shirking" condition indicated a maximum effort level the firm can obtain from each worker. Rearranging further the constraint, we obtain

$$e_t \leq e(w_t) = \frac{1}{h} - \frac{1}{h}(c_t^s/c_t)^{d/\eta}. \tag{28}$$

The firm takes T_t as given,[13] so the right-hand side is only a function of w_t, since

$$\frac{c_t}{c_t^s} = \frac{c_t^h + (1-\tau^y)w_t h_t - T_t}{c_t^h + (1-\tau^y)s w_t h_t - T_t} \tag{29}$$

and

$$w_t = \frac{c_t - c_t^s}{(1-s)h} \tag{30}$$

It is easy to show that there is only one value (a function of model parameters) for $\frac{c_t^s}{c_t} = \chi > 1$ that solves this equation and produces a positive level of effort in equilibrium.[14]

2.3 Government

The government will be assumed to be running a balanced budget in every period. The government collects revenue from levying taxes on consumption, capital and labor income, and then spends on government consumption and transfers, which are returned lump-sum to the households:

$$\tau^c[(n_t - dn_t^s)c_t + (dn_t^s + 1 - n_t)c_t^s] + \tau^y[r_t k_t + w_t n_t h + \pi_t] = g_t^c + g_t^t, \tag{31}$$

where g_t^c are government purchases. Government spending share will be set equal to its long-run average, so the level will be varying with output. Government transfers will be residually determined and will always adjust to make sure the budget is balanced.

2.4 Decentralized Dynamic Equilibrium (DDE) with Efficiency Wages

Given total factor productivity level $\{A\}$, tax rates $\{\tau^c, \tau^y\}$, initial capital endowments stock k_0, hours worked per household h, the decentralized dynamic equilibrium with efficiency

[13]The firm cannot influence T_t, as it is determined by the average compensation of a household.

[14]In general, the optimal level of employment, will not coincide with the proportion of workers wishing to accept the contract $(w_t, e(w_t))$, so due to the labor rationing there will be involuntary unemployment in equilibrium.

wages is a list of sequences $\{c_t, c_t^s, i_t, k_t, n_t, e_t\}_{t=0}^{\infty}$ for each household i, input levels $\{k_t, n_t\}$ chosen by the firm in each time period t, 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) each household i maximizes its utility function subject to its budget constraint; (ii) the representative firm maximizes profit by setting an efficiency wage to satisfy the workers' incentive compatibility constraint and to induce an optimal effort level; (iii) government budget is balanced in each period; (iv) all markets clear.

3 Data and model calibration

When modelling business cycle fluctuations in Bulgaria, we will focus on the period after the introduction of the currency board (1999-2018). Data on output, consumption and investment was collected from National Statistical Institute (2019), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2019). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics, *e.g.* Kydland and Prescott (1982). First, the average income tax rate was set to its (average effective) rate $\tau^y = 0.100$. Similarly, the consumption tax rate was set to the statutory rate, $\tau^c = 0.2$. The depreciation rate of physical capital in Bulgaria, $\delta = 0.05$, was taken from Vasilev (2015a). The rate was estimated as the average depreciation rate over the period 1999-2014. The discount factor, $\beta = 0.942$, is set to match the steady-state capital-to-output ratio in Bulgaria, $k/y = 3.491$, in the steady-state Euler equation. The labor share parameter, $\alpha = 0.429$, was 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 during Communism.

As in Vasilev (2018), we set $\gamma = 0.25$. Next, we set χ to match the average c_t/c_t^u in data. The rate $s = 0.82$ was set to match that in steady state employment rate in Bulgaria was $n = 0.533$, as in Vasilev (2016). The relative weight attached to the utility out of leisure in the household's utility function, η, and the shirking detection probability d, can only be determined as a ratio, which would be calibrated to match χ. Following Vasilev (2015b), the hours worked per person h is set to one-third. Table 1 on the next page summarizes the values of all model parameters used in the paper.

Table 1: Model Parameters

Parameter	Value	Description	Method
β	0.942	Discount factor	Calibrated
α	0.429	Capital Share	Data average
γ	0.250	Relative weight attached to public goods	Set
d/η	0.062	Shirking detection probability to leisure weight ratio	Calibrated
s	0.72	Proportion of income retained if caught shirking	Calibrated
δ	0.050	Depreciation rate on physical capital	Data average
χ	1.285	consumption ratio employed-to-unemployed	Calibrated
h	0.333	Share of time spent working	Calibrated
n	0.533	Employment rate	Data average
τ^y	0.100	Average tax rate on income	Data average
τ^c	0.200	Consumption tax rate	Data average

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 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 unity), which greatly simplified the computations, and allows the steady-state to be solved by hand. Next, the model matches consumption-to-output ratio by construction; The investment and government purchases ratios are also closely approximated. The shares of income are also identical to those in data, which follows directly from the constant-returns to scale featured by the aggregate production function.[15] The after-tax return, where $\tilde{r} = (1-\tau^y)r - \delta$ is also relatively well-captured by the model.

[15]The unemployment in the model is a bit higher, as it also includes the "out of the labor force" group in national accounts.

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
g^c/y	Government cons-to-output ratio	0.159	0.151
k/y	Capital-to-output ratio	3.491	3.491
wnh/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
n	Employment rate	0.533	0.533
u	Unemployment rate	0.467	0.467
e	Effort level	N/A	1.979
A	Scale parameter of the production function	N/A	1.062
$\tilde{r}$	After-tax net return on capital	0.056	0.061

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

In this section, we solve for the optimal fiscal policy scenario under full commitment. More specifically, the government will be modelled as a benevolent planner, who has the same preferences as the people in the economy, *i.e.*, it will choose to maximize the household's utility function, while at the same time taking into account the optimality conditions by both the household and the firm, or the equations describing the Decentralized Dynamic Equilibrium (DDE) with Efficiency Wages.[16] The fiscal instruments at government's disposal are consumption and income tax rate, and the level of public consumption spending.[17] In addition, it will be assumed that the government can also fully and credibly commit to the

[16]Note that when the household and the firm are making optimal choices, they are taking all fiscal policy variables as given. Also note that the benevolent government treats everyone the same.

[17]Note that the government transfers will be held fixed at the level computed from the equilibrium under the exogenous policy case.

future sequence of taxes and spending until the end of the optimization period, so the policy is time-consistent. Under the Ramsey framework, the choice variables for the government are $\{c_t, n_t, g_t^c, k_{t+1}, w_t, r_t\}_{t=0}^{\infty}$ 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 realized 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 government chooses after-tax input prices $\tilde{w}_t$ and $\tilde{r}_t$ directly, where

$$\tilde{w}_t = (1-\tau_t^y)w_t \tag{32}$$

$$\tilde{r}_t = (1-\tau_t^y)r_t. \tag{33}$$

Thus, government budget constraint is now represented by

$$\tau_t c_t + Ak_t^{\alpha}(n_t he)^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t h_t = g_t^c + g_t^t \tag{34}$$

Note that we have imposed an efficiency wage, which extracts an optimal level $e > 0$, which in turn eliminates shirkers, i.e. $n^s = 0$, and is equivalent to having $d = 1$ in the model. The Ramsey problem then simplifies to and becomes

$$\max_{\{c_t, n_t, g_t^c, k_{t+1}, \tilde{r}_t, \tau_t^c\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + n_t \eta \ln(1-eh) + \gamma \ln g_t^c \right\}, \tag{35}$$

s.t.

$$\frac{1}{c_t} = \beta \frac{1}{c_{t+1}}[1 + \tilde{r}_{t+1} - \delta] \tag{36}$$

$$Ak_t^{\alpha}(n_t he)^{1-\alpha} = c_t + k_{t+1} - (1-\delta)k_t + g_t^c \tag{37}$$

$$\tau_t c_t + Ak_t^{\alpha}(n_t he)^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t n_t h = g_t^c + g_t^t \tag{38}$$

In order to solve the problem we set up the corresponding Lagrangian (use μ-s for Lagrangian multipliers).

$$\begin{aligned} \mathcal{L} = \max_{\{c_t, n_t, g_t^c, k_{t+1}, \tilde{r}_t, \tau_t^c\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + n_t \eta \ln(1-eh) + \gamma \ln g_t^c \right\}, \\ + \beta^t \mu_t^1 \Big[- c_{t+1} + \beta c_t(1 + \tilde{r}_{t+1} - \delta) \Big] \\ + \beta^t \mu_t^2 [Ak_t^{\alpha}(n_t he)^{1-\alpha} - c_t - k_{t+1} + (1-\delta)k_t - g_t^c] \\ + \beta^t \mu_t^3 [\tau_t c_t + Ak_t^{\alpha}(n_t he)^{1-\alpha} - \tilde{r}_t k_t - \tilde{w}_t n_t h - g_t^c - g_t^t] \end{aligned} \tag{39}$$

The first-order conditions are as follows:

$$c_{t+1} \quad : \quad \frac{\beta}{c_{t+1}} - \mu_t^1 + \beta^2\mu_{t+1}^1(1+\tilde{r}_{t+2}-\delta) - \beta\mu_{t+1}^2 + \beta\mu_{t+1}^3\tau_{t+1}^c = 0 \tag{40}$$

$$k_{t+1} \quad : \quad -\mu_t^2 + \beta\mu_{t+1}^2[\alpha A k_t^{\alpha-1}(n_t he)^{1-\alpha} + 1 - \delta] + \beta\mu_{t+1}^3[\alpha A k_t^{\alpha-1}(n_t he)^{1-\alpha} - \tilde{r}] \tag{41}$$

$$n_t \quad : \quad \eta\ln(1-eh) + \mu_t^2(1-\alpha)(y_t/n_t) + \mu_t^3[(1-\alpha)(y_t/n_t) - \tilde{w}_t h] = 0 \tag{42}$$

$$g_t^c \quad : \quad \frac{\gamma}{g_t^c} = \mu_t^2 + \mu_t^3 \tag{43}$$

$$\tilde{r}_t \quad : \quad \beta c_t\mu_t^1 = \beta\mu_{t+1}^3 k_t \tag{44}$$

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

$$y_t = Ak_t^{\alpha}(n_t he)^{1-\alpha} \tag{45}$$

$$y_t = c_t + k_{t+1} - (1-\delta)k_t + g_t^c \tag{46}$$

$$i_t = k_{t+1} - (1-\delta)k_t \tag{47}$$

$$r_t = \alpha\frac{y_t}{k_t}, \tag{48}$$

$$w_t h = (1-\alpha)\frac{y_t}{n_t}. \tag{49}$$

As in Vasilev (2018d), we will shut down all stochasticity (uncertainty) and focus on the steady-state allocations and prices. We solve the problem numerically and report the results in Table 3 below against the values from the exogenous (observed) policy case. As expected, total discounted welfare is higher under the Ramsey regime: parameter ξ, documents a substantial welfare gain in terms of higher steady-state consumption (82%), which can be achieved when the economy moves to the optimal fiscal policy case. Next, private consumption, private capital- and investment are higher under the optimal policy regime, and thus the interest rate is lower. The model generates a zero long-run income tax, which consistent with the findings in earlier studies, *e.g.* Judd (1985), Chamley (1986), and Zhu (1992). This leads to higher capital input and employment in steady-state, which in turn translates into higher output and investment. Under Ramsey, public consumption is three times lower; to finance the decreased government spending on public goods, consumption tax rate can be lowered to 18.7 %.[18] Therefore, the optimal policy suggests abolishing all direct taxation,

[18]The results are novel, as such an exercise has never been done before. In particular, the Judd-Chamley (1980) result for zero capital tax has been now extended to both types of income, due to the use of a common income tax rate. In addition, government spending is three times lower. Lastly, the quantitative

Table 3: Data Averages and Long-run Solution

Variable	Description	Data	Model (exo policy)	Model (optimal)
y	Steady-state output	N/A	1.000	1.061
c/y	Consumption-to-output ratio	0.674	0.674	0.724
i/y	Investment-to-output ratio	0.201	0.175	0.224
g^c/y	Government cons-to-output ratio	0.159	0.151	0.052
k/y	Capital-to-output ratio	3.491	3.491	4.475
wnh/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	0.333
n	Employment rate	0.533	0.533	0.586
u	Unemployment rate	0.467	0.467	0.414
e	Effort level	N/A	1.979	1.979
τ^y	Income tax rate	0.100	0.100	0.000
τ^c	Consumption tax rate	0.200	0.200	0.187
ξ	Welfare gain (% cons.)	-	0.000	0.820

and adopt a public finance model that relies exclusively on indirect taxation, as well as a much smaller size of the government. These results are new and could be of interest to policy makers, as they bring back into the picture the issue of maximizing efficiency of government spending.

Overall, the paper gives clear policy recommendations as to taxing the major factors of production. The results, however, are to be interpreted with caution, as we solved for the full-commitment case, which might not be feasible. In reality, successive governments refuse

effect is similar to that in Vasilev (2021a), which comes to show that capturing the non-clearing nature of the labor market in Bulgaria is important, and different modelling approaches are isomorphic to each other. In other words, the particular way of capturing the non-Walrasan nature of the labor markets in Bulgaria is of secondary importance; what is much more important, is to allow for the presence of frictions in the labor markets as a model ingredient in the first place.

to continue the policy of the previous government that was voted out of office. Clearly, without full commitment (which was a theoretical benchmark that is not present in reality), we still need positive income taxes. Thus, nothing major needs to change in the Bulgarian economy in the absence of full commitment; The zero capital and labor taxation is too extreme of a result, as in reality taxing an already installed capital is an easy source of ta revenue.

6 Conclusions

This paper explores the effects of fiscal policy in an economy with efficiency wages, consumption taxes, and a common income tax rate in place. To this end, a dynamic general-equilibrium model with government sector is calibrated to Bulgarian data (1999-2018). Two regimes are compared and contrasted - the exogenous (observed) vs. optimal policy (Ramsey) case. 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. Bulgarian economy was chosen as a case study due to its major dependence on consumption taxation as a source of tax revenue. The main findings from the computational experiments performed in the paper are: (i) The optimal steady-state income tax rate is zero; (ii) The benevolent Ramsey planner provides the optimal amount of the utility-enhancing public services, which are now three times lower; (iii) The optimal steady-state consumption tax needed to finance the optimal level of government spending is 18.7%, slightly lower than the rate in the exogenous policy case. Therefore, the optimal fiscal policy in this realistic theoretical model setup (especially in the aspect with the single income tax rate on both labor and capital income) suggests abolishing all direct taxation, and adopting a public finance model that relies exclusively on indirect taxation, as well as a much smaller size of the government. These results are new and could be of interest to policy makers not only in Bulgaria, but in similar-size developing countries.

Several limitations of the paper need to be acknowledges. First, some of the results are conditional on the assumption of the representative-agent economy, which abstracts away from distributional effects. To fully capture those, we need a heterogeneous-agent model, which is beyond the scope of this paper. Second, we focus on optimal linear income- and consumption tax rules, while there might be an optimal income- and/or consumption tax schedule that might feature some progressivity. Such non-linear tax rules are beyond the scope of this paper and the investigation of their effect is left for future research. Lastly, we abstracted away from employer and employee social contributions, which are part of the redistributive role of the government. However, to study those, we need a heterogeneous-agent model with overlapping-generations structure to study the effect of pension, health and unemployment insurance. Such a setup is beyond the scope of this paper, and thus all those issues left for future research.

Conflict of interest statement: The Author declares no conflict of interest.

References

Alexopoulos, M. (2003) "Growth and Unemployment in a Shirking Efficiency Wage Model," *The Canadian Journal of Economics* 36 (3): 728-746.

Alexopoulos, M. (2004) "Unemployment and the business cycle," *Journal of Monetary Economics* 51: 277-298.

Bulgarian National Bank (2019) *BNB Statistical Database*. Available on-line at www.bnb.bg. Last accessed on July 18, 2019.

Can, H. and Korkmaz, O. (2020) "The relationship between renewable energy consumption and economic growth: The case of Bulgaria", *International Journal of Energy Sector Management* 13(3): 573-589.

Chamley C (1986): "Optimal Taxation of Capital Income in General Equilibrium." *Econometrica* 54:604-622.

Chari V.V, Kehoe P (1994): "Optimal Fiscal Policy in a Real Business Cycle Model."

Journal of Political Economy 102(4):617-652.

Chari V.V., Kehoe P (1999): ”Optimal Fiscal and Monetary Policy.” In: Taylor J, Woodford M (eds): *Handbook of Macroeconomics*, vol.1(Amsterdam: North-Holland).

Debrtoli, D., Nunes, R., and P. Yared (2021) ”Optimal Fiscal Policy without committment: Revisiting Lucas-Stockey,” *Journal of Political Economy* 129(5): 1640-65.

Judd, K. (1985) ”Redistributive Taxation in a Simple Perfect Foresight Model.” *Journal of Public Economics*, 28:59-83.

Manolova, H., and Vasilev, A. (2019) ”Wage Dynamics in Bulgaria: Co-Movement and Causality,” *South-Eastern Europe Journal of Economics* 17(1): 91-127.

National Statistical Institute (2019) *NSI Statistical Database*. Available on-line at www.nsi.bg. Last accessed on July 18, 2019.

Rogerson, R. (1988) ”Indivisible labor, lotteries and equilibrium,” *Journal of Monetary Economics*, vol. 21(1), pp. 3-16.

Schmitt-Grohe, S. and M. Uribe (2007) ”Optimal simple and implementable monetary and fiscal rules,” *Journal of Monetary Economics* 54: 17021725.

Shapiro, C. and Stiglitz, J.E. (1984) ”Equilibrium unemployment as a worker discipline device,” *American Economic Review* 36, pp. 1291-1303.

Solow, R. (1979) ”Another possible source of wage stickiness,” *Journal of Macroeconomics* 1, 595-618.

Vasilev, A.Z. (2009) ”Business cycles in Bulgaria and the Baltic countries: an RBC approach,” *International Journal of Computational Economics and Econometrics*, vol. 1(2), pages 148-170.

Vasilev, A.Z. (2015a) "Welfare Effect of Flat Income Tax Reform: The Case of Bulgaria," *Eastern European Economics*, vol. 53(3), pp. 205-220.

Vasilev, A. (2015b) "Welfare gains from the adoption of proportional taxation in a general-equilibrium model with a grey economy: the case of Bulgaria's 2008 flat tax reform," *Economic Change and Restructuring*, 48(2): 169-185.

Vasilev, A. (2017) "A Real-Business-Cycle Model with Efficiency Wages and Fiscal Policy: The Case of Bulgaria," *Central European Journal of Economic Modelling and Econometrics* 9(4): 359-377.

Vasilev, A. (2018a) "Optimal Fiscal Policy in the Presence of VAT Evasion: The Case of Bulgaria," *Czech Journal of Economics and Finance* 68(4): 399-414.

Vasilev, A. (2018b) "Optimal fiscal policy with utility-enhancing government spending, consumption taxation, and a common income tax rate: the case of Bulgaria," *Review of Economics* 69(1): 1-16.

Vasilev, A. (2019) "Optimal fiscal policy with an environmental tax and abatement spending in a model with pollution and utility-enhancing environmental quality: the case of Bulgaria," *Macroeconomics and Finance in Emerging Market Economies* 12(1): 24-35.

Vasilev, A. (2020a) "Search and matching frictions and business cycle fluctuations in Bulgaria," *International Journal of Business and Economics* 19(3): 319-40.

Vasilev, A. (2020b) "Are "fair" wages quantitatively important for business cycle fluctuations in Bulgaria?," *Review of Economic Perspectives* 1: 91-105.

Vasilev, A.Z. (2020c) "Are labor unions important for business cycle fluctuations? Lessons from Bulgaria," *Eurasian Economic Review* 10(1): 143-161.

Vasilev, A. (2020d) "Optimal fiscal policy with Epstein-Zin preferences and utility-enhancing government services: lessons from Bulgaria (1999-2016)," *Problems of Economic Transition* 62 (1-2): 133-146.

Vasilev A.Z. (2021a) "Optimal fiscal policy in a model with search-and-matching frictions: the case of Bulgaria (1999-2018)," Post-Communist Economies, 33(4): 500-515.

Werning, I. (2007) "Optimal Fiscal Policy with Redistribution," *Quarterly Journal of Economics* 3: 925-967.

Zhu X (1992): "Optimal Fiscal Policy in a Stochastic Growth Model." *Journal of Monetary Economics*, 58:250-289.