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Optimal fiscal policy in a model with reciprocity in labor relations: the case of Bulgaria

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Abstract

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

Design/Methodology/Approach: 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.

Finding: (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%.

Originality/value: This is the first study on optimal fiscal policy with reciprocity in

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labor relations.

Keywords: Ramsey policy, general equilibrium, reciprocity, gift exchange, fair wages, unemployment, Bulgaria

JEL Classification Codes: E24, E32, J41

1 Introduction and Motivation

As pointed out in Vasilev (2021), since the early 1980s, many macroeconomic studies have focused on the effects of observed - or exogenous - fiscal policy in general equilibrium setups, and in particular comparing and contrasting it to a benchmark scenario, or a so-called "optimal fiscal policy" regime, e.g. Chari, Christiano and Kehoe (1994, 1999), for a survey.[1] The results of this quantitative-theoretical experiment were then used to inform fiscal policy-makers how to adjust the (direct and indirect) taxation and spending mix in order to minimize distortions, and thus improve the overall allocative efficiency in the economy, and in turn, the overall well-being of the population.

However, the major downside of those studies was that the main focus - mostly aimed at the US - has been too restrictively formulated as a problem of raising funds in a perfectly-competitive labor markets to finance a pre-determined level of government purchases through the use of distortionary taxes on the capital and labor inputs, and at the least possible cost. The optimal policy literature then focused exclusively on the choice between different types of income taxation, and abstracted away from taxes on final demand, such as the sales-, or value-added, taxation (VAT). This is understandable given the absence of a federal consumption tax in the US. However, the situation is quite different in Europe, where indirect taxes are very important instrument for raising tax revenue. Second, the issue of the optimal government size is very topical, especially after the fall of Communism. 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. Lastly, the labor markets in Eastern Europe, and Europe in general are very far from the perfectly-competitive benchmark that could have been adequate for the case of the US.

Take for example Bulgaria, which is a small Eastern European economy, and a EU member-state as of 2007, adopted a public finance model that emphasized consumption-based taxation

[1] For other studies on Bulgaria, see Manolova and Vasilev (2019). For different labor markets structure, as well as on optimal fiscal policy setups on Bulgaria, see Vasilev (2021), Vasilev (2020a, 2020b, 2020c, 2020d), Vasilev (2019), and Vasilev (2018a, 2018b).

and a common income tax rate. As pointed in Vasilev (2018), VAT revenue is the major source of tax revenue in Bulgaria, and this consumption tax is responsible for almost half of the total tax revenue raised.[2] 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 fiscal policy makers in particular.

In addition, Bulgaria, however, 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, an employers needs to offer an incentive-, or "efficiency wage", which is viewed as a "fair wage," and workers respond by exerting a higher level of effort.[3] In contrast to Vasilev (2017), where the efficiency wages are of the no-shirking type a la Shapiro and Stiglitz (1984), here the wage contracts are in the spirit of "gift exchange" as in Vasilev (2018). In other words, the novelty in this paper is that at the core of the labor relations we introduce a consideration that workers may derive "utility/pleasure" from returning a higher than demanded effort level in exchange for a perceived above-market wage rate paid to them by the firm. Firms, being aware of this counter-gift motive on the side of the worker, then set wages in such a way to elicit the maximum amount of effort from a worker and achieve a maximum profit. As we will demonstrate in this paper, the departure from perfect

[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

[3]3Another 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.

competition, and the presence of reciprocity considerations in labor relations 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 and then to evaluate it relative to the exogenous (observed) fiscal policy regime. The novelty is that the public finance problem with efficiency wages is thus different from the standard one described in Chari, Christiano and Kehoe (1994, 1999). Similar to earlier literature, e.g. Judd (1985), Chamley (1986), and Zhu (1992), allowing 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 minimising 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: This paper 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 last result is novel, as such an exercise has never been done before. Still, 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 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 model economy in this paper follows Vasilev (2018a): there is a unit mass of one-member households, a representative firm, and a government sector. Aside from the gift exchange mechanism in the labor market, the economy is relatively standard: households maximize utility subject to their budget constraint, the firm maximizes profit, and the government runs a balanced budget constraint by spending on government consumption and transfers exactly what it raises in revenue from taxing consumption, labor and capital income. Effort exerted by workers is a productive input in the final goods sector, but unobservable, and thus not directly contractible. However, producers understand that while workers do not like exerting effort, they derive utility from returning the gift of a generous wage by supplying a higher effort level even in an environment of costly monitoring. This leads to the firm paying

an efficiency wage.

2.1 Households

There is a continuum of identical one-member households distributed on the $[0, 1]$ interval and indexed by i. Each household i derives utility out of consumption and leisure. As in Danthine and Kurmann (2010), household i's expected discounted total utility is given by

$$\sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t^i + \ln(1 - h_t^i) - h_t^i \left[\frac{(e_t^i)^2}{2} - \mathfrak{R}(e_t^i, .) \right] + \gamma \ln g_t^c \right\}, \tag{1}$$

where $0 < \beta < 1$ denotes the discount factor, c_t^i is consumption of household i in period t, h_t^i is the fraction of time available to household i that is spent working, and e_t^i is the level of effort exerted. g_t^c denotes the consumption of public goods, and $\gamma > 0$ reflects the relative preference for government services.

The total time endowment available to each household i is normalized to unity, thus leisure, $l_t = 1 - h_t$ is implicitly expressed as time off work. Lastly, the $\mathfrak{R}(e_t^i, .)$ utility term is included to capture that workers may derive utility out of "reciprocal behavior towards their employer." As long as $\mathfrak{R}_e(e_t^i, .) > 0$, household i would be willing to reward a wage that is perceived to be above the competitive one (even in the absence of any direct material gain resulting from such an action) with a positive level of effort.

As in Hansen (1985) and Rogerson (1988) household i's labor supply is assumed to be indivisible, i.e. $h_t^i \in \{0, \bar{h}\}, \forall t$. In equilibrium, only a fraction n_t would be selected to work a full shift in each period t.[4] In order to Pareto-improve the consumption bundle received by both workers and non-workers, a lottery market can be included to provide insurance against unemployment (i.e., not being selected for work) in certain period. Such an arrangement would achieve full insurance (efficient risk sharing), so everyone would receive the same consumption independent of the employment status. If we assume that all households pool their resources together and maximize aggregate welfare, the resulting discounted utility function

[4]Hence, from the perspective of workers, n_t is not a choice variable.

becomes

$$\sum_{t=0}^{\infty} \beta^t \Bigg\{ \ln c_t + n_t^i \Bigg[\ln(1-\bar{h}) - \frac{(e_t^i)^2}{2} + \mathfrak{R}(e_t^i, .) \Bigg] + \gamma \ln g_t^c \Bigg\}. \tag{2}$$

Each household starts with $k_0^i = k_0$ initial capital, which is equal to the aggregate capital in period 0. Aggregate capital stock then evolves as follows:

$$k_{t+1} = i_t + (1-\delta)k_t \tag{3}$$

where $0 < \delta < 1$ denotes the depreciation rate on capital. The before-tax rental rate on capital is r_t, and in addition the households have legal claim on all the firm's profit π_t.

In addition to capital income, households receive labor income as well. The hourly wage rate in the economy is w_t, so the total before-tax labor income generated in each period is $w_t n_t \bar{h}$. The aggregate household's budget constraint is then

$$(1+\tau^c)c_t + k_{t+1} - (1-\delta)k_t = (1-\tau^y)[w_t n_t \bar{h} + r_t k_t + \pi_t] + g_t^t, \tag{4}$$

where τ^c is the tax on consumption, τ^y is the common income tax rate, and g_t^t are aggregate government transfers. The problem now is to maximize aggregate utility (2) subject to the aggregate budget constraint (4). The first-order optimality conditions are as follows:

$$c_t \;:\; \frac{1}{c_t} = \Lambda_t \tag{5}$$

$$e_t \;:\; e_t = \mathfrak{R}_e(e_t, .) \tag{6}$$

$$k_{t+1} \;:\; \Lambda_t = E_t \Lambda_{t+1}[1 + (1-\tau)r_{t+1} - \delta] \tag{7}$$

$$TVC \;:\; \lim_{t\to\infty} \Lambda_t k_{t+1} = 0, \tag{8}$$

where Λ_t is the Lagrangian multiplier attached to the household's budget constraint. The first optimality condition equates the marginal utility of consumption to the marginal utility of wealth. The second condition specifies the optimum amount of effort. The third condition is the so called Euler equation, which describes the optimal allocation of capital in any two adjacent periods. The last condition, the Transversality condition (TVC), is a boundary condition that needs to be imposed to eliminate explosive solutions.

2.2 Reciprocity

As in Vasilev (2018a), the reciprocity $\mathfrak{R}(e_t, .)$ term in the household's utility function as a product of the mutual "gifts" of an employed household and the representative firm:

$$\mathfrak{R}(e_t, .) = d(e_t)g(w_t), \tag{9}$$

where $d(e_t)$ denote the gift of the employed household towards the firm, expressed in terms of effort exerted, and $g(w_t, .)$ is the counter-gift of the firm to the worker in terms of the wage rate paid. Both terms are assumed to be concave in their respective arguments, i.e. $d_e(e_t) > 0, d_{ee}(e_t) < 0$ and $g_w(w_t) > 0, g_{ww}(w_t) < 0$. Hence, when a worker receives a wage offer that is perceived as generous (e.g. a wage above the competitive rate), i.e. $g(w_t) > 0$, the household's utility increases if there is a reciprocal gift expressed in terms of higher effort, $d(e_t) > 0$. In addition, from the perspective of an individual worker, the wage rate is taken as given, that is why $d_w(e_t) = 0$. In addition, employed households do not take into consideration the effect of their (individual) effort on the firm's output, and hence on the gift made by the firm to the worker, i.e., $g_e(w_t) = 0$ from the perspective of an employed household.

Note that in defining the two gifts, both are expressed as deviations from some expected norm ("reference level"). To simplify the analysis, we will normalize the minimum acceptable effort level to be $e_{min} = 0$. The worker's gift then can be expressed as:

$$d(e_t) = e_t^{\alpha}, \tag{10}$$

with $0 < \alpha < 1$.[5]

Next, modelling the firm's gift follows an agnostic approach. In other words, we will follow Vasilev (2018) and utilize an encompassing specification that would allow us to discriminate between different theories when subjected to empirical tests.[6] We define the firm's gift as

[5]This parameter is set intentionally the same as the labor share in the firm's production function, as we will se later on.

[6]Note that the specification of the firm's gift is of critical importance, as it would affect the optimal wage offer made by the firm.

follows:

$$\begin{aligned} g(w_t) &= \ln(1-\tau^y)w_t - \varphi_1 \ln(1-\tau^y)\frac{y_t}{n_t} \\ &\quad -\varphi_2 \ln(1-\tau^y)\bar{w}_t\bar{n}_t - \varphi_3 \ln(1-\tau^y)w_{t-1}, \end{aligned} \tag{11}$$

where the first term on the right-hand-side, $\ln(1-\tau)w_t$, is the utility benefit resulting from a higher consumption, which the worker attributes to the firm's wage offered. The remaining terms in $g(w_t)$ are a weighted average of utility levels under different compensations (which are connected to different reference points).[7] More specifically, $\ln(1-\tau^y)\frac{y_t}{n_t}$ term has to do with rent-sharing considerations between the firm and the worker, as it represents the surplus to be shared (worker's product). In this case it represents a case where the firm distributes all the revenue to its workers. The term $\ln(1-\tau^y)w_t\bar{n}_t$ represents an outside option, the alternative income that the worker can earn if s/he leaves the firm. Note that the individual wage equals the average wage rate in our model. Lastly, the term $\ln(1-\tau^y)w_{t-1}$ is the past average/individual wage in the economy.

We can rewrite the firm's gift as follows

$$g(w_t) = \ln w_t - \varphi_1 \ln \frac{y_t}{n_t} - \varphi_2 \ln w_t n_t - \varphi_3 \ln w_{t-1}. \tag{12}$$

Plugging this expression into the optimal effort condition

$$e_t = \mathfrak{R}_e(e_t, .) = d_e(e_t)g(w_t), \tag{13}$$

where the last equality follows from the assumption that $g(w_t)$ did not vary with e_t. Given our functional forms that results in $e_t = \alpha e_t^{\alpha-1} g(w_t)$, or $e_t^{2-\alpha} = \alpha g(w_t)$. Rearranging terms, we can express the wage rate as

$$e_t^{2-\alpha} = \alpha \left[\ln w_t - \varphi_1 \ln \frac{y_t}{n_t} - \varphi_2 \ln w_t n_t - \varphi_3 \ln w_{t-1}. \right].$$

or

$$\ln w_t = \frac{e_t^{2-\alpha}}{\alpha} + \varphi_1 \ln \frac{y_t}{n_t} + \varphi_2 \ln w_t n_t + \varphi_3 \ln w_{t-1}.$$

[7] In other words, $\varphi_1 + \varphi_2 + \varphi_3 = 1$.

From this equation it follows that the wage rate set by the firm positively depends on the firm's revenue per worker ($\varphi_1 > 0$), as it increases the total surplus/rent of the labor relationship. This is also referred to as a rent-sharing motive. When $\varphi_2 > 0$, the wage function is increasing in the average wage in the economy and the level of employment, which are proxies of the external labor conditions. If $\varphi_3 > 0$, the firm's optimal wage rate would also depend on the past wage, or the so-called "wage entitlement effect" as referred to in Danthine and Kurmann (2010).

After some algebra, the expression can be simplified to

$$\ln w_t = \frac{1}{\varphi_1 + \varphi_3} \frac{e_t^{2-\alpha}}{\alpha} + \frac{\varphi_1}{\varphi_1 + \varphi_3} \ln y_t + \frac{\varphi_2 - \varphi_1}{\varphi_1 + \varphi_3} \ln n_t + \frac{\varphi_3}{\varphi_1 + \varphi_3} \ln w_{t-1} \tag{14}$$

2.3 Firm

There is a stand-in firm, which produces a homogeneous final good that can be used for consumption, investment, or government purchases. The Cobb-Douglas production function uses physical capital and efficiency labor as inputs an is as follows:

$$y_t = A_t k_t^{1-\alpha} (e_t n_t \bar{h})^{\alpha}, \tag{15}$$

where A captures the level of technology, $0 < \alpha < 1$ is the labor share, and $1 - \alpha$ is the capital share.

The firm maximizes profit subject to the household's participation condition and effort condition being satisfied, which turns the firm's problem becomes dynamic. More specifically, this is because the wage set today influences effort next period through the existence of past wage, w_{t-1} as an argument in the effort condition.[8] The firm discounts profit by the stochastic discount factor (expressed in utility terms) $\Lambda_t = \frac{1}{c_t}$, hence the firm's dynamic problem is as follows:

$$\max_{k_t, w_t, n_t} \sum_{t=0}^{\infty} \beta^t \Lambda_t [A k_t^{1-\alpha} (e_t n_t \bar{h})^{\alpha} - w_t n_t \bar{h} - r_t k_t] \tag{16}$$

[8] In other words, wages become a state variable.

The resulting first-order conditions are

$$k_t \quad : \quad (1-\alpha)\frac{y_t}{k_t} = r_t. \tag{17}$$

$$n_t \quad : \quad \alpha\frac{y_t}{n_t} + \alpha\frac{y_t}{e_t}\frac{n_t}{n_t}\frac{\partial e_t}{\partial n_t} = w_t\bar{h} \tag{18}$$

$$w_t \quad : \quad \alpha\frac{\partial y_t}{\partial e_t}\frac{\partial e_t}{\partial w_t} + E_t\left[\beta\frac{\Lambda_{t+1}}{\Lambda_t}\frac{\partial y_t}{\partial e_t}\frac{\partial e_t}{\partial w_t}\right] = n_t\bar{h} \tag{19}$$

The first condition describes optimal renting of capital: in equilibrium it receives its marginal product. The second condition characterizes labor demand by the firm: in this setup there is an elasticity term, $\frac{\partial e_t}{\partial n_t}\frac{n_t}{e_t} \geq 0$, which appears to capture the effect of a new margin of adjustment. More specifically, a higher level of employment, though costly in terms of labor productivity, may actually increase the value of the firm's gift (wage paid) and in turn worker's counter-gift (worker's effort).[9] In other words, given the dynamic implications of the wage on the effort exerted, the firm is hiring more people as compared to the perfectly competitive, perfect effort observability case.

The last equation describes how efficiency wages are set, i.e. how the firm chooses a wage rate to inspire the worker to supply optimum effort. Combining the optimality conditions for employment and wages produces:

$$1 = \epsilon(e_t, w_t) - \epsilon(e_t, n_t) + \beta E_t\left[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{y_{t+1}}{y_t}\epsilon(e_{t+1}, w_t)\right], \tag{20}$$

where $\epsilon(e_t, w_t) = \frac{\partial e_t}{\partial w_t}\frac{w_t}{e_t}$ denotes the elasticity of effort level with respect to the wage rate and $\epsilon(e_{t+1}, w_t) = \frac{\partial e_t}{\partial w_t}\frac{w_t}{e_{t+1}}$ denotes the elasticity of next-period effort level with respect to the current wage rate. Danthine and Kurmann (2010) refer to this equation as the *Modified Solow Condition* (MSC).[10] In this case, as Danthine and Kurmann (2010) show, with $\epsilon(e_t, w_t) > 0$, the standard Solow (1979) condition does not apply, since an increase in the wage rate at the margin produces an extra increase in worker's productivity (which in turn would decrease the firm's gift and worker's effort/counter-gift). Similarly, with $\epsilon(e_{t+1}, w_t) < 0$ under our

[9] Using an analogy from finance, from the firm's point of view, the worker is a multi-period asset.

[10] Note that when $\epsilon(e_t, n_t) = 0$ (i.e., in the absence of reciprocity in labor relations) and $\epsilon(e_{t+1}, w_t) = 0$ (i.e. the past wage rate does not matter), the MSC reduces to Solow's (1979) original condition, which states that at the optimum wage, the costs per efficiency unit of labor are minimizes, or the average cost per efficiency unit of labor equals the average cost per unit of labor.

specification here, the firm has to take into consideration the future effect of the current wage rate - a higher wage paid today makes it more costly to extract higher effort from a worker in the future.

2.4 Government

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

$$\tau^c c_t + \tau^y [r_t k_t + w_t n_t h + \pi_t] = g_t^c + g_t^t, \tag{21}$$

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.

2.5 Decentralized Dynamic Equilibrium with Efficiency Wages

Given the total factor productivity level $\{A\}$, taxes $\{\tau^c, \tau^y\}$, initial capital endowments stock k_0, hours worked per household h, the decentralized dynamic equilibrium with efficiency wages is a list of sequences $\{c_t, i_t, k_t, n_t, e_t\}_{t=0}^{\infty}$ for each household i, input levels $\{k_t, n_t, e_t\}_{t=0}^{\infty}$ 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 (2019). The calibration strategy described in this section follows Vasilev (2015c). First, as in Vasilev (2016c), the average income tax rate was set to its (average effective) rate $\tau = 0.100$. The depreciation rate of physical capital in Bulgaria, $\delta = 0.05$, is taken from Vasilev (2015a). 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.[11] As in Vasilev (2018b), we set $\gamma = 0.25$. Next, steady state employment rate in Bulgaria is set to $n = 0.533$, as in Vasilev (2016a). Following Vasilev (2015b), $h = 1/3$. The values for $\varphi_1, \varphi_2, \varphi_3$ were taken as the point estimates from running a simple multivariate regression on the specification in Eq. (14). Table 1 below summarizes the values of all model parameters used in the paper.

Table 1: Model Parameters

Par.	Value	Description	Method
β	0.942	Discount factor	Calibrated to match k/y in data
α	0.571	Labor Share	Data (avg. ratio wage bill/output)
γ	0.250	Relative weight attached to public goods	Set to match c/g in data
δ	0.050	Depreciation rate on physical capital	Data average
$\bar{h}$	0.333	Share of time spent working	Data (avg. ratio working/ tot. hrs)
n	0.533	Employment rate	Data (avg. ratio employment/lab. force)
φ_1	0.168	Weight on rent-sharing consideration	Estimated (regression)
φ_2	0.096	Weight on external labor conditions	Estimated (regression)
φ_3	0.736	Weight on wage-entitlement consider.	Estimated (regression)
τ^c	0.100	Consumption tax rate	Data (statutory tax rate)
τ^y	0.100	Income tax rate	Data (avg. effective tax rate)

[11] This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital during Communism.

4 Steady-State

Once the values of model parameters were obtained, and the steady-state equilibrium system has been solved for, 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. The after-tax return, where $\tilde{r} = (1-\tau^y)r-\delta$ is also relatively well-captured by the model.

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	0.389
A	Scale parameter of the production function	N/A	1.062
$\tilde{r}$	After-tax net return on capital	0.056	0.061

Note that the level of output is not particularly important, hence the normalization; what we aim to match are the major ratios, expressed as shares in output. All the ratios in Table

2 are intended to be evaluated similar to the logic of the general method of moments (GMM) econometric procedure. If the model-generated ratios are not far off from the empirical ones in data, then the theoretical model is calibrated well, and approximates the real Bulgarian economy along the important dimensions.

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 DCE.[12] The fiscal instruments at government's disposal are consumption and income tax rate, and the level of public consumption spending.[13] 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, 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

$$\tilde{w}_t = (1-\tau_t^y)w_t \tag{22}$$

$$\tilde{r}_t = (1-\tau_t^y)r_t. \tag{23}$$

Thus, government budget constraint is now represented by

$$\tau_t c_t + Ak_t^{1-\alpha}(n_t he)^{\alpha} - \tilde{r}_t k_t - \tilde{w}_t h_t = g_t^c + g_t^t \tag{24}$$

[12]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.

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

The Ramsey problem then simplifies to and becomes

$$\max_{\{c_t,n_t,g_t^c,k_{t+1},\tilde{r}_t,\tau_t^c\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \Bigg\{ \ln c_t + n_t^i \Bigg[\ln(1-\bar{h}) - \frac{(e_t^i)^2}{2} + \mathfrak{R}(e_t^i,.) \Bigg] + \gamma \ln g_t^c \Bigg\}. \tag{25}$$

s.t.

$$\frac{1}{c_t} = \beta \frac{1}{c_{t+1}} [1 + \tilde{r}_{t+1} - \delta] \tag{26}$$

$$Ak_t^{1-\alpha}(n_t h e)^{\alpha} = c_t + k_{t+1} - (1-\delta)k_t + g_t^c \tag{27}$$

$$\tau_t c_t + Ak_t^{1-\alpha}(n_t h e)^{\alpha} - \tilde{r}_t k_t - \tilde{w}_t n_t h = g_t^c + g_t^t \tag{28}$$

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

$$\begin{aligned} \mathcal{L} = \max_{\{c_t,n_t,g_t^c,k_{t+1},\tilde{r}_t,\tau_t^c\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \Bigg\{ \ln c_t + n_t^i \Bigg[\ln(1-\bar{h}) - \frac{(e_t^i)^2}{2} + \mathfrak{R}(e_t^i,.) \Bigg] + \gamma \ln g_t^c \Bigg\}, \\ + \beta^t \mu_t^1 \Bigg[- c_{t+1} + \beta c_t (1 + \tilde{r}_{t+1} - \delta) \Bigg] \\ + \beta^t \mu_t^2 [A k_t^{1-\alpha}(n_t h e)^{\alpha} - c_t - k_{t+1} + (1-\delta)k_t - g_t^c] \\ + \beta^t \mu_t^3 [\tau_t c_t + A k_t^{1-\alpha}(n_t h e)^{\alpha} - \tilde{r}_t k_t - \tilde{w}_t n_t h - g_t^c - g_t^t] \end{aligned} \tag{29}$$

The first-order conditions are as follows:

$$c_{t+1} \;:\; \frac{\beta}{c_{t+1}} - \mu_t^1 + \beta^2 \mu_{t+1}^1 (1 + \tilde{r}_{t+2} - \delta) - \beta \mu_{t+1}^2 + \beta \mu_{t+1}^3 \tau_{t+1}^c = 0 \tag{30}$$

$$k_{t+1} \;:\; \mu_t^2 = \beta \mu_{t+1}^2 [(1-\alpha) A k_t^{-\alpha} (n_t h e)^{\alpha} + 1 - \delta] + \beta \mu_{t+1}^3 [(1-\alpha) A k_t^{-\alpha} (n_t h e)^{\alpha} - \tilde{r}] \tag{31}$$

$$n_t \;:\; -\Bigg[\ln(1-\bar{h}) - \frac{(e_t^i)^2}{2} + \mathfrak{R}(e_t^i,.) \Bigg] = \mu_t^2 (1-\alpha) \frac{y_t}{n_t} + \mu_t^3 [(1-\alpha)\frac{y_t}{n_t} - \tilde{w}_t h] \tag{32}$$

$$g_t^c \;:\; \frac{\gamma}{g_t^c} = \mu_t^2 + \mu_t^3 \tag{33}$$

$$\tilde{r}_t \;:\; \beta c_t \mu_t^1 = \beta \mu_{t+1}^3 k_t \tag{34}$$

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

$$y_t = A k_t^{1-\alpha} (n_t h e)^{\alpha} \tag{35}$$

$$y_t = c_t + k_{t+1} - (1-\delta)k_t + g_t^c \tag{36}$$

$$i_t = k_{t+1} - (1-\delta)k_t \tag{37}$$

$$r_t = (1-\alpha)\frac{y_t}{k_t}, \tag{38}$$

$$w_t h = \alpha \frac{y_t}{n_t}. \tag{39}$$

As in Vasilev (2018d), we will focus on the steady-state allocations and prices. We solve the problem numerically and report the results from the Ramsey (optimal fiscal) policy problem in Table 3 below against the values from data and the exogenous (observed) policy case, which were presented in Table 2, and repeated below for easier comparison.[14]

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	0.389	0.389
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

As expected, total discounted welfare is higher under the Ramsey regime: parameter ξ in the last line of Table 3, 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 fiscal 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

[14] As pointed earlier, the results from the optimal policy are to be interpreted as the "ideal" allocations, given all the constraints in the economy.

in steady-state, which in turn translates into higher output and investment.

Under Ramsey, public consumption is three times lower as compared to the exogenous policy case; in addition, to finance the decreased government spending on public goods, consumption tax rate can be lowered to 18.7 %. Therefore, the optimal policy 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.[15]

6 Conclusions

This paper explores the effects of fiscal policy in an economy with reciprocity in labor relations, fair 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

[15]Interestingly, the quantitative result is similar when the labor market is modelled as a two-side search and marching process, as in Vasilev (2021). This could be an indication that the gift-exchange mechanism is isomorphic to the search-and-marching setup. In other words, the real frictions in the labor market is what matters, and not the particular way those are modelled.

Bulgaria, but in other similar-size developing economies.

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.

Declarations

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